Consumer-food security nexus framework for understanding agri-food value chains

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April, 2020

A Thesis Submitted to McGill University in partial fulfillment of the requirement for the degree of Doctor of Philosophy

This thesis is dedicated to God Almighty

Abstract

The value chain approach has been applied to improve the performance of firms over the years and recently in agri-food value chains. It is an approach used to disintegrate the activities in a chain into its parts, examine its current state and identify measures for improvement. In agri-food value chains, the approach has been used mainly to identify the flow of the product, the relationship among actors, constraints and areas where interventions can be targeted to improve profitability of the chain. Recently, the concept of value chain analysis has been broadened to include social, environmental, and economic dimensions. Although the output of value chain activities is targeted towards the consumer, their satisfaction is largely ignored in value chain analysis. There are currently no frameworks developed that adequately captures the link between food value chains, consumer preferences and food security. The disconnect between consumer satisfaction and the way food value chains are assessed creates a gap.

The study is therefore designed to answer the primary question, "how can agri-food value chain assessments be made more consumer-focused and produce results from which inferences can be made for food security?" The question was answered in a 5 -step process. It started with the formulation of a methodological framework for agri-food value chain analysis based on a consumer-food security nexus. The framework is an integrated value chain analysis (VCA) approach that introduces different dimensions into the analysis and determines how they influence consumer preferences. Additionally, this approach is designed to provide important inferences for food security. The framework effectively captures consumers' preferences and translate those preferences into measurable value chain actions. Consumer preferences are categorized and linked to food security indicators. Following these indicators, criteria and dimensions are identified as output parameters to evaluate the performance of the chain in meeting consumer requirements and food security indicators. The framework analyses the following broad dimensions (made up of indicators) for different stages along the chain: social, environmental, economic, operational, quality, perception and attitude, agility, governance, and management dimensions. The tool calculates performance values for each broad food security indicator (FSI) using the value chain dimension scores. Measures required to align value chain activities to meet consumer preferences and food security indicators are then recommended after performance evaluation.

After the design of the conceptual framework, the next step was to apply it practically to evaluate the performance of a selected value chain (common bean value chain in Zambia) to ascertain its validity. In doing this, the first step was to assess consumer preferences and the factors influencing demand, preparation, and consumption of common beans (*Phaseolus vulgaris*). The results serve as a basis for the assessment of the performance of the common bean value chain. The findings show that bean purchase frequency and quantity were influenced by price, income and availability. Conjoint based choice analysis revealed that urban consumers placed more importance on tasty and low-priced beans while rural consumers placed more importance on beans with lesser cooking time and larger sized beans. Hedonic price analysis revealed that consumers were found to be willing to pay premiums for larger size beans (0.3% of the average price), bright-colored beans (18%), and packaging (10%). Discounts were paid for beans with a higher level of damage (11%) and beans which causes flatulence (10%). Cluster analysis showed that 44% of the consumers fell within the cluster characterized by taste, price and level of bean damage. Bean preparation was found to require lengthy preparation time and high consumption of energy. Regarding beans consumption, 45% of the consumers were willing to substitute beans with other food products. Overall, the findings show that affordability (price), accessibility (desired varieties) and acceptability were important factors to consumers. With regards to acceptability, factors such as convenience (cooking time), appearance (colourful and larger size), taste, quality beans (not broken or infested) and low flatulence were considered important. Consumers expressed concerns with bean attributes such as price, long preparation time and resource (water and fuel use) and indicated the need for their improvement among other factors.

Based on the knowledge of consumers' preferences and needs, the next step was to evaluate the performance of the value chain in meeting consumer preferences and food security indicators. The consumer-based framework was applied in the evaluation of the performance of the chain. Consumers' preferences and needs were not found to be adequately met because performance assessment revealed low scores of food security indicators. The common beans value chain scored below average for all indicators, 36% for availability, 48% for accessibility, 46% for affordability, 41% for acceptability and 39% for utilization. The low-performance scores can be attributed to inefficient performance and management of activities along the value chain, low stakeholder involvement, lack of financial and technical capacity etc. These factors are reflected in the low-performance scores for the value chain dimensions used in measuring the efficiency of activities

and their effect on food security indicators. The value chain obtained lower scores for agility (37%) and management (39%) dimension and a higher score for the economic dimension (54%).

Changes in value chain activities must not only provide value to consumers but benefit value chain actors. The next step was then to determine if there would be economic benefits from adjusting value chain activities to meeting consumer preferences. The results of the study showed that consumers were willing to pay additional amounts ranging from 13% to 25% of the average price to have their desired bean attribute levels. This was an indication that investment in the meeting consumer preferences will be worth it. Based on a value selection index developed in the study, scenarios were created to estimate the economic benefits for meeting consumer preferences for different attributes. The estimates showed that the improvement of different combinations of attribute levels is likely to result in between 11 % to 79% increase in profits. However, current storage practices were found to have negative quantity and quality effects. Specifically, storage methods and conditions resulted in significant changes in colour (darkening of beans), shine (less shiny), cooking time (increased cooking time), and quantity (losses due to infestation). Due to this, profit margins decreased from 27% to 65%. This has implications for consumer satisfaction, food security and profitability.

This led to recommendations of measures necessary to align value chain activities to consumer preferences. This is required to ensure increased consumer satisfaction and profitability. The study recommends the design and implementation of interventions to strengthen the capacity of value chain actors to scale up production and marketing and also produce quality, affordable and value-added bean products. The involvement of public and private enterprises to support training, research and market development are recommended.

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Résumé

L'approche de la chaîne de valeur a été appliquée pour améliorer la performance des entreprises au cours des années et récemment dans les chaînes de valeur agroalimentaires. C'est une approche utilisé pour désintégrer les activités d'une chaîne en ses parties, d'examiner son état actuel et d'identifier les mesures d'amélioration. Dans les chaînes de valeur agroalimentaires, elle a été utilisée principalement pour identifier le flux du produit, la relation entre les acteurs, les contraintes et les domaines où les interventions peuvent être ciblées pour améliorer la viabilité économique de la chaîne. Récemment, le concept d'analyse de la chaîne de valeur a été élargi pour inclure les dimensions sociales, environnementales et économiques. Bien que la production des activités de la chaîne de valeur soit ciblée vers le consommateur, sa satisfaction est largement ignorée dans l'analyse de la chaîne de valeur. Il n'y a pas de cadres qui ont été élaboré pour saisir de manière adéquate le lien entre les chaînes de valeur alimentaires, les préférences des consommateurs et la sécurité alimentaire. La déconnexion entre la satisfaction des consommateurs et la manière dont les chaînes de valeur alimentaires sont évaluées crée un écart.

L'étude est donc conçue pour répondre à la question principale: « comment les évaluations de la chaîne de valeur agroalimentaire peuvent-elles être davantage axées sur le consommateur et produire des résultats à partir desquels des inférences peuvent être faites pour la sécurité alimentaire? ». La question a été répondue en 5 étapes. Elle a commencé par la formulation d'un cadre méthodologique pour l'analyse de la chaîne de valeur agroalimentaire basée sur un lien entre la sécurité des consommateurs et la sécurité alimentaire. Une approche d'analyse de la chaîne de valeur intégrée qui introduit différentes dimensions dans l'analyse et détermine comment elles influencent les préférences des consommateurs. De plus, cette approche est conçue pour fournir des déductions importantes pour la sécurité alimentaire. Le cadre capture efficacement les préférences des consommateurs et traduit ces préférences en caractéristiques de chaîne de valeur mesurables. Les préférences des consommateurs sont classées par catégorie et liées aux indicateurs de sécurité alimentaire. À la suite de ces indicateurs, des critères et des dimensions sont identifiés comme des paramètres de sortie pour évaluer la performance de la chaîne à répondre aux exigences des consommateurs et aux indicateurs de sécurité alimentaire. Le cadre analyse les grandes dimensions suivantes (constituées d'indicateurs) pour différentes étapes le long de la chaîne: sociales, environnementale, économique, opérationnelle, qualité, perception et attitude, agilité,

gouvernance et dimensions de gestion. L'outil calcule les valeurs de performance pour chaque indicateur vaste de sécurité alimentaire en utilisant les pointages de dimension de la chaîne de valeur. Des mesures sont nécessaires pour aligner les activités de la chaîne de valeur pour rencontrer les préférences des consommateurs et les indicateurs de sécurité alimentaire après l'évaluation des performances.

Après la conception du cadre conceptuel, l'étape suivante a consisté à l'appliquer pratiquement pour évaluer les performances d'une chaîne de valeur sélectionnée (chaîne de valeur du haricot commun) afin de vérifier sa validité. En faisant cela, la première étape a été d'évaluer les préférences des consommateurs et les facteurs influençant la demande, la préparation et la consommation de haricots communs. Les résultats servent de base à l'évaluation de la performance de la chaîne de valeur commune du haricot. Les résultats montrent que la fréquence et la quantité d'achat des haricots ont été influencées par le prix, le revenu et la disponibilité. Une analyse de choix conjointe a révélé que les consommateurs urbains accordaient plus d'importance aux haricots savoureux et à bas prix, tandis que les consommateurs ruraux accordaient plus d'importance aux haricots avec moins de temps de cuisson et aux haricots de plus grande taille. L'analyse des prix hédoniques a révélé que les consommateurs ont été trouvés prêts à payer des primes pour les haricots de plus grande taille (0,3% du prix moyen), les haricots de couleur vive (18%) et les emballages (10%). Des remises ont été versées pour les haricots présentant un niveau de dommage plus élevé (11%) et les haricots qui provoquent des flatulences (10%).

L'analyse par grappes a montré que 44,7% des consommateurs tombaient dans le groupe caractérisé par le goût, le prix et le niveau de dégâts des haricots. La préparation des haricots a été trouvé à requérir un temps de préparation long et une consommation d'énergie élevée. Concernant la consommation de haricots, 45% des consommateurs étaient disposés à remplacer les haricots par d'autres produits alimentaires. Dans l'ensemble, les résultats montrent que l'abordabilité (prix), l'accessibilité (variétés souhaitées), et l'acceptabilité étaient des facteurs importants pour les consommateurs. En ce qui concerne l'acceptabilité, des facteurs tels que la commodité (temps de cuisson), l'apparence (coloré et de plus grande taille), le goût, des haricots de qualité (non cassés ou infestés) et une faible flatulence ont été considéré importants. Les consommateurs ont exprimé des préoccupations concernant les attributs des haricots tels que le prix, le long temps de préparation et les ressources (utilisation de l'eau et du carburant) et ont indiqué la nécessité de les améliorer, entre autres facteurs.

Basé sur la connaissance des préférences et des besoins des consommateurs, la prochaine étape consistait à évaluer les performances de la chaîne de valeur pour répondre aux préférences des consommateurs et aux indicateurs de sécurité alimentaire. Le cadre basé sur le consommateur a été appliqué dans l'évaluation de la performance de la chaîne. Les préférences et les besoins des consommateurs n'ont pas été trouvés adéquatement rencontrés car l'évaluation des performances a révélé de pointages faibles d'indicateurs de sécurité alimentaire. La chaîne de valeur des haricots communs a marqué en dessous de la moyenne pour tous les indicateurs, 36% pour la disponibilité, 48% pour l'accessibilité, 46% pour l'abordabilité, 41% pour l'acceptabilité et 39% pour l'utilisation. Les pointages de performance faibles peuvent être attribués à la performance et à la gestion inefficaces des activités au long de la chaîne de valeur, à la faible implication des parties prenantes, au manque de capacités financières et techniques, etc. Ces facteurs se reflètent dans les pointages de performance faibles pour les dimensions de la chaîne de valeur utilisées pour mesurer l'efficacité des activités et leur effet sur les indicateurs de sécurité alimentaire. La chaîne de valeur a obtenu des pointages plus faibles pour la dimension d'agilité (37%) et pour la dimension de gestion (39%) et un pointage plus élevé pour la dimension économique (54%).

Les changements dans les activités de la chaîne de valeur doivent non seulement fournir de la valeur aux consommateurs mais bénéficient les acteurs de la chaîne de valeur. L'étape suivante consistait alors à déterminer s'il y aurait des avantages économiques d'ajuster les activités de la chaîne de valeur pour répondre aux préférences des consommateurs. Les résultats de l'étude ont montré que les consommateurs étaient prêts à payer des montants supplémentaires allant de 13% à 25% du prix moyen pour avoir les niveaux d'attributs de haricots souhaités. Ceci était une indication que l'investissement dans la satisfaction des préférences des consommateurs en vaudrait la peine. Sur la base d'un indice de sélection de valeur développé dans l'étude, des scénarios ont été créés pour estimer les avantages économiques pour répondre aux préférences des consommateurs pour différents attributs. Les estimations ont montré que l'amélioration de différentes combinaisons de niveaux d'attribut entraînerait probablement une augmentation de 11% à 79% des bénéfices. Cependant, les pratiques de stockage actuelles ont été trouvées d'avoir des effets négatifs sur la quantité et la qualité. Précisément, les méthodes et conditions de stockage

ont entraîné des changements significatifs de couleur (assombrissement des haricots), de brillance (moins brillant), de temps de cuisson (temps de cuisson accru) et de quantité (pertes dues à l'infestation). Dû à ceci, les marges bénéficiaires ont diminué de 27% à 65%. Ceci a des implications sur la satisfaction des consommateurs, la sécurité alimentaire et la rentabilité.

Cela a conduit à des recommandations de mesures nécessaires pour aligner les activités de la chaîne de valeur sur les préférences des consommateurs nécessaires pour assurer une satisfaction et une rentabilité accrues des consommateurs. L'étude recommande la conception et la mise en œuvre d'interventions pour renforcer la capacité des acteurs de la chaîne de valeur à accroître la production et la commercialisation et également à produire des produits de haricots de qualité, abordables et à valeur ajoutée. L'implication des entreprises publiques et privées pour soutenir la formation, la recherche et le développement des marchés sont recommandées.

Acknowledgments

I gratefully acknowledge the Most High God for His guidance and strength throughout the entire period. I am very thankful for His presence, provision, protection, love, and favor, which has kept and successfully seen me through this research work and school.

I am also profoundly grateful to my family for their unconditional support, love, prayers, encouragement, and provision throughout my studies. May the Almighty God bless and reward them in multiple folds for all the help that I received.

I want to express my sincere gratitude to my supervisor, Prof. Michael O. Ngadi, for his constructive comments and instructions. His guidance, patience, attention, show of care and concern are much appreciated. Additional thanks go to Dr. Ebenezer Kwofie for his support, advice, assistance, and insightful comments, as well as Dr. Ogan Mba for his willingness and commitment to teach and provide valuable feedback from the start to completion of my lab work.

My immense gratitude goes to Prof. Benjamin Simpson and the Arhin Family, who have gone above and beyond to assist me in any way possible through my study. Their assistance, counsel, and encouragement have been tremendously helpful.

I am also very grateful beyond words to my lovely friends, Bernard Ato Hagan, Gabriella Djangmah, Isaac Nyamekye, Maudline Okyere, Elizabeth Duah, Naa Torshie Owusu-Boaitey, Yvonne Goy, Priscilla Boadi, Josephine Ampofo, Jacob Liberty and all members of Prof Ngadi's lab for their encouragement, proofreading the thesis and assisting in finding solutions to the challenges related to the study.

CONTRIBUTION OF AUTHORS

Emmanuella Ellis is the principal author of the study. She planned, designed and carried out surveys and experiments, data analysis, reporting of findings, manuscript preparation and revision for publication. She was supervised by Prof. Michael O. Ngadi who guided and provided constructive comments through the entire process. He also reviewed and edited manuscripts prepared for publication. Dr. Ebenezer Kwofie assisted in the editing and revision of manuscripts and thesis chapters. He also contributed to the development of ideas and data analysis for some of the manuscripts. Dr. Ogan Mba assisted in laboratory work to ensure that technical and scientific standards were met.

Parts of the thesis submitted for publication include;

- **Ellis, E.,** Kwofie, M. E. & Ngadi, M. (2019). Value beyond price: End-user value chain analysis. *Journal on Food System Dynamics, 10(4),* 347-360.
- **Ellis, E.,** Kwofie, M. E. & Ngadi, M. Economic and nutritional implications of losses along the common bean value chain. *Journal of Stored Product Research*, (in press).
- **Ellis, E.,** Kwofie, M. E. & Ngadi, M. A consumer-food security nexus framework for understanding agri-food value chains. *Global Food Security*. Prepared for publication.
- **Ellis, E.,** Kwofie, M. E. & Ngadi, M. Consumer preferences for common beans attributes using Conjoint Choice Experiments and Cluster analysis. *American Journal of Agricultural Economics*. Prepared for publication.
- **Ellis, E.,** Kwofie, M. E. & Ngadi, M. Application of selection index method to determine strategies for economic gains by value chain actors. *Journal of Agricultural Economics*. Prepared for publication.

Table of Contents

Abstract ii
Résumé v
Acknowledgments ix
Contribution of authors x
Table of Contents xi
List of Tables xviii
List of Figures xxii
Nomenclature xxvi
CHAPTER 1 Introduction 1
1.1 Background 1
1.2 The rationale of the study 2
1.3 Research questions 4
1.4 Objectives 5
1.5 Justification of the study 5
CHAPTER 2 Literature Review 9
2.1 Introduction 9
2.2 Variations in the description and definition of value chain elements 10
2.2.1 Variations in the description of value 10
2.2.2 Variations in value chain analysis definitions 12
2.3 Application of the VCA concept in Agri-food sector 13
2.3.1 Value chain approaches employed in agri-food literature 14
2.4 Research gaps and opportunities in value chain analysis 21
2.4.1 Research gaps in agri-food value chain analysis 21
2.4.2 Opportunities for further improvement 25
2.4.2.1 Importance of consumer focus in agri-food value chain assessment 26
2.4.2.2 Importance of food security focus in agri-food value chain assessment 27
2.4.2.3 Proposed approach: VCA towards consumer satisfaction and food security 28
Connecting Text 32

CHAPTER 3 A methodological framework for agri-food value chain analysis based on a consumer-food security nexus 33
3.1 Introduction 34
3.2 Value chain concept 34
3.2.1 Consumer-based assessment of agri-food value chains 36
3.3 Design and application of the consumer-based VCA model 37
3.3.1 Conceptual model of a consumer-food security nexus for agri-food value chain analysis……. 38
3.3.2 Application of the consumer-based model 40
3.3.2.1 Analysis of the consumption chain 40
3.3.2.2 Connecting consumer preferences with food security indicators 40
3.3.2.3 Consumer-based performance assessment index for agri-food value chains 42
3.3.2.3.1 Translate consumer requirements (linked to food security indicators) into product features 42
3.3.2.3.2 Translate consumer requirements (linked to food security indicators) into supply chain features 42
3.3.2.3.3 Determination of indicators, criteria and dimension 43
3.3.2.3.4 Selection of food supply chain assessment indicators 45
3.3.2.3.5 Methodology 48
3.3.2.3.6 Test of correlation 52
3.3.3 Alignment of value chain activities to consumer requirements and food security indicators 52
3.4 Conclusion 65
Connecting Text 66
CHAPTER 4 Assessment of consumer preferences along the common bean consumption chain……………. 67
4.1 Introduction 69
4.2 The household value chain analysis 71

4.2.1 Household food value chain (HFVC) 73

4.2.2 Household Food Value Chain Analysis 75

4.3 Materials and Methods 77

4.3.1 Study area 77

4.3.2 Data collection 78

4.3.3 Sample selection 79

4.3.4 Methods 80

4.3.4.1 Descriptive analysis 80

4.3.4.2 Assessment of expenditure share on common beans 81

4.3.4.3 Knowledge, attitude and perception (KAP) assessment 81

4.3.4.4 Conjoint analysis 82

4.3.4.5 Cluster analysis 84

4.3.4.6 Hedonic price analysis 85

4.3.4.7 Resource Utilization 89

4.4 Results 91

4.4.1 Consumers of the product and their characteristics 91

4.4.1.1 Product and Household characteristics 91

4.4.1.2 Consumer and household characteristics 92

4.4.2 Activities along the Household Food Value Chain 94

4.4.2.1 Input Acquisition 94

4.4.2.2 Purchasing factors 96

4.4.2.2.1 Availability and price 96

4.4.2.2.2 Income and expenditure shares on food and beans 97

4.4.2.2.3 Factors influencing expenditure share on beans 99

4.4.2.2.4 Bean Quality 100

4.4.2.2.5 Quality attributes considered during purchase 102

4.4.2.2.6 Importance of bean attributes and attribute levels during purchase: Choice based conjoint analysis 104
4.4.2.2.7 Cluster analysis 107
4.4.2.2.8 Value attributed to quality attributes (premiums and discounts): Hedonic price analysis 111
4.4.2.3 Preparation 117
4.4.2.3.1 Processing Equipment 117
4.4.2.3.2 Bean preparation methods 118
4.4.2.3.3 Energy supply and use 119
4.4.2.3.4 Determinants of bean processing energy consumption 120
4.4.2.3.5 Water supply and use 123
4.4.2.3.6 Time allocation and use 125
4.4.2.4 Storage/Delivery 128
4.4.2.5 Consumption 128
4.4.2.5.1 Knowledge, Attitude and Practice Assessment of consuming households . 130
4.4.2.5.2 Level of satisfaction with bean preparation and consumption 132
4.4.2.5.3 Post Consumption evaluation: Satisfaction of household members with respect to bean consumption 133
4.4.2.6 Disposal 134
4.4.3 Map of the Household food value chain 134
4.4.3.1 Correlation among activities along the chain 135
4.4.4 Value Assessment: Overall satisfaction with product 136
4.4.5 Constraints and concerns with product use along the HVC 137
4.5 Discussion and conclusion 137
Connecting Text 141

CHAPTER 5 Performance of the common bean value chain in meeting consumer preferences and food security indicators 142
5.1 Introduction 144
5.2 Study Area 145
5.3 Methodology 146
5.3.1 Data collection 146
5.3.2 Sample selection 148
5.3.3 Data analysis 149
5.3.3.1 Assessment of chain structure 150
5.3.3.2 Assessment of chain dynamics 150
5.3.3.3 Total Performance Assessment 156
5.4 Results 157
5.4.1 Structure of the value chain 157
5.4.1.1 Value chain activities 158
5.4.2 Value chain dynamics 163
5.4.2.1 Economic assessment 163
5.4.2.2 Governance assessment 167
5.4.2.3 Assessment of Operations 172
5.4.2.4 Management assessment 173
5.4.2.4.1 Knowledge assessment 173
5.4.2.4.2 Postharvest loss Assessment 180
5.4.2.5 Agility Evaluation 187
5.4.2.6 Perception and Attitude Assessment 190
5.4.2.7 Social Assessment 191
5.4.2.8 Environmental Assessment 193
5.4.2.9 Quality Assessment 194

5.4.3 Value Chain performance Assessment ... 200
5.4.3.1 Availability ... 202
5.4.3.2 Accessibility ... 205
5.4.3.3 Affordability ... 207
5.4.3.4 Acceptability ... 208
5.4.3.5 Utilization and consumption ... 210
5.4.3.6 Food security achievement ... 212
5.4.3.7 Comparison of value chain-based performance assessment and consumer-based performance assessment ... 215
5.4.3.8 Implications for consumer preference ... 216
5.4.3.9 Cluster analysis: Clustering value chain actors with respect to scores ... 217
5.4.3.10 Implications for the common bean value chain ... 219
5.5 Conclusion ... 223
Connecting text ... 226
CHAPTER 6 Assessment of the economic viability of meeting consumer preferences and food security indicators ... 227
6.1 Introduction ... 228
6.2 Methodology and data collection ... 229
6.2.1 Consumer survey ... 229
6.2.1.1 Value Selection (Economic) Index ... 230
6.2.1.2 Simulation (Prediction of attribute and monetary responses based on different selection criteria) ... 231
6.2.2 Lab experiments ... 231
Statistical Analysis ... 234
6.3 Results ... 234
6.3.1 Determination of price effects (consumer willingness to pay for additional units of attribute levels) ... 234

6.3.2 Value Selection Index 240
6.3.3 Value selection index simulations 241
6.3.3.1 Statistical Results 246
6.3.4 Determination of Quantity and Quality Effects (Influence of storage factors on product attributes) 247
6.3.4.1 Seed size 247
6.3.4.2 Grain damage 248
6.3.4.3 Color 249
6.3.4.4 Moisture 251
6.3.4.5 Protein content 253
6.3.4.6 Lipids 255
6.3.4.7 Moisture uptake 256
6.3.4.8 Cooking time 258
6.3.4.9 Protein digestibility 262
6.3.5 Influence of storage factors on economic gains: Implication for value chain actors…… 263
6.4 Conclusion 266
Connecting text 268
CHAPTER 7 Recommendation for improvement of value chain performance 269
Connecting text 272
CHAPTER 8 General summary and conclusion 273
8.1 General summary 273
8.2 Contribution to knowledge 277
8.3 General recommendation 278
Appendix 279
REFERENCES 284

List of Tables

Table 2. 1: Definitions of value chain by different authors 11
Table 2. 2 Variations in VCA techniques 14
Table 3. 1: Indicators and their measurements 53
Table 4. 1: Selected bean attributes and their corresponding levels 83
Table 4. 2: Measurements recorded for resource supply and use 90
Table 4. 3: Characteristics of consumers in Zambia and Malawi 92
Table 4. 4: Consumption and purchase frequency 97
Table 4. 5: Factors influencing expenditure share on beans (OLS results) 99
Table 4. 6: Quality attributes considered during purchase 102
Table 4. 7: Part-worth utilities and relative importance of attributes and levels. 105
Table 4. 8: Average relative importance of bean attributes among clusters 108
Table 4. 9: Box-Cox test of functional form for the hedonic model 111
Table 4. 10: Descriptive statistics of variables 112
Table 4. 11: Hedonic price model results 113
Table 4. 12: Estimated percentage price change per kilogram a unit change in the independent variables 116
Table 4. 13: Wood species for bean processing 120
Table 4. 14: Association among IKAPP scores on nutrient dense foods and their consumption 132
Table 4. 15: Improvement of factors influencing purchase and consumption of beans 136
Table 5. 1: Financial performance indicators 151
Table 5. 2: Demographic characteristics of value chain actors (producers and traders) 157
Table 5. 3: Financial performance for producers and traders 165
Table 5. 4: Response rate by producers for each factor under the 5 forces 168
Table 5. 5: Response rate by traders for each factor under the 5 forces 169
Table 5. 6: Challenges ranked by farmers 173
Table 5. 7: Summary Statistics of variables included in knowledge management assessment .. 174
Table 5. 8: Factors influencing the types of knowledge obtained by producers 178
Table 5. 9: Postharvest economic loss estimations (2017 season) 181
Table 5. 10: Nutrient profile of beans 183
Table 5. 11: Nutrient losses along the chain 185

Table 5. 12: Farmers awareness of factors affecting losses 186
Table 5. 13: Changing factors along the common bean value chain 187
Table 5. 14: Changing factors along the common bean value chain 188
Table 5. 15: Summary of assets 190
Table 5. 16: Colour characteristics of kabulangeti and *Sugar* bean 197
Table 5. 17: Effect of value chain processes on bean attributes 199
Table 5. 18: Summary units of measurement and scaling 200
Table 5. 19: Performance scores of food security indicators 202
Table 5. 20: Spearman's correlation between variables used in assessing the performance of the value chain in contributing to achieving food security indicators 203
Table 5. 21: Spearman's correlation between variables used in assessing the performance of the value chain in contributing to achieving food security indicators 206
Table 5. 22: Spearman's correlation between variables used in assessing the performance of the value chain in contributing to achieving food security indicators 208
Table 5. 23: Spearman's correlation between variables used in assessing the performance of the value chain in contributing to achieving food security indicators 210
Table 5. 24: Spearman's correlation between variables used in assessing the performance of the value chain in contributing to achieving food security indicators 212
Table 5. 25: Distribution of value chain actors within performance groups 213
Table 5. 26: Correlation coefficients between food security indicators and food security score 214
Table 5. 27: Comparison of performance scores based on value chain evaluation and consumer assessment 215
Table 5. 28:Difference between clusters 218
Table 5. 29: Performance score across dimensions 219
Table 5. 30: Correlations between performance scores for dimensions 220
Table 6. 1: Attributes considered in the sturdy and their levels 229
Table 6. 2: Mean attribute levels of beans 236
Table 6. 3: Ranking of attributes 237
Table 6. 4: Derived economic values for product attributes (in Zambian Kwacha) 238
Table 6. 5: Value selection index 241
Table 6. 6: Scenario based value selection index based on rural consumer preferences 243

Table 6. 7: Scenario based value selection index based on urban consumer preferences 244
Table 6. 8: Scenario based value selection index based on preferences of both consumer groups combined 245
Table 6. 9: Differences in value selection index improvements 246
Table 6. 10: Moisture content of Kabulangeti beans under different storage conditions with different packaging materials 251
Table 6. 11: Moisture content of sugar beans under different storage conditions with different packaging materials 252
Table 6. 12: Protein content of kabulangeti beans under different storage conditions with different packaging materials 253
Table 6. 13: Protein content of sugar beans under different storage conditions with different packaging materials 254
Table 6. 14: Lipid content of kabulangeti beans under different storage conditions with different packaging materials 255
Table 6. 15: Lipid content of sugar beans under different storage conditions with different packaging materials 255
Table 6. 16: Swelling of kabulangeti beans over 5 storage months.. 257
Table 6. 17: Swelling of sugar beans over 5 storage months.. 257
Table 6. 18: Protein digestibility of kabulangeti beans over 5 storage months 262
Table 6. 19: Protein digestibility of sugar beans over 5 storage months 263
Table 6. 20: Effect of storage conditions on bean attributes for kabulangeti beans 263
Table 6. 21: Effect of storage conditions on bean attributes for sugar beans 265
Table 7. 1: Measures required to align value chain activities in meeting consumer preferences270
Table A 1: Summary statistics for the perfromance index……………………………………..279
Table A 2: Sperman's correlation between dimensions used in assessing the performance of the chain in relation to availability……………………………………………………………281
Table A 3: Sperman's correlation between dimensions used in assessing the performance of the chain in relation to accesibility……………………………………………………………281
Table A 4: Sperman's correlation between dimensions used in assessing the performance of the chain in relation to affordability…………………………………………………………..282

Table A 5: Sperman's correlation between dimensions used in assessing the performance of the chain in relation to acceptability……………………………………………………………282
Table A 6: Sperman's correlation between dimensions used in assessing the performance of the chain in relation to utilization and consumption………………………………………………282

List of Figures

Figure 1. 1 Flow representation of research questions and objectives 8
Figure 2. 1 A consumer-centered approach to value chain analysis... 28
Figure 2. 2 Multidimensional consumer-centered agri-food VCA framework 29
Figure 3. 1 Consumer-based value chain.. 39
Figure 3. 2 Flow of Consumer-based Value Chain Analysis.. 39
Figure 3. 3 The influence of value chain activities and their operational environment on consumer activities (requirements) and FSIs. 43
Figure 3. 4 Dimensions used in the assessment of food security indicators............................... 48
Figure 3. 5 Pictorial view of the framework 49
Figure 3. 6 Standard states that the dimensions in meeting FSIs.. 51
Figure 4. 1 Household value chain as a component of the product value chain.......................... 71
Figure 4. 2 Household food value chain 73
Figure 4. 3 Framework for analysis 77
Figure 4. 4: A choice experiment sample card 84
Figure 4. 5: Bean varieties consumed within a household (Rural consumers)............................ 95
Figure 4. 6: Bean varieties consumed within a household (Urban consumers)........................... 96
Figure 4. 7: Most consumed bean varieties 96
Figure 4. 8: Bean quality description by rural consumers 101
Figure 4. 9: Bean quality description by urban households.. 102
Figure 4. 10: Preference levels for bean attributes (Rural consumers)...................................... 103
Figure 4. 11: Preference levels for bean attributes (Urban consumers)..................................... 104
Figure 4. 12: Dendrogram of clusters by cases (Rural consumers) 110
Figure 4. 13: Dendrogram of clusters by cases (Urban consumers) 110
Figure 4. 14: Resource Acquisition flow diagram 118
Figure 4. 15: Effect of cooking system on bean processing fuel and energy consumption (*Kabulangeti*) 121
Figure 4. 16: Effect of bean type on bean processing energy consumption 122
Figure 4. 17: Effect of soaking on fuel consumption for (a) *Kabulangeti* beans (b) *Mixed* beans 123

Figure 4. 18: Effect of processing systems and conditions on water consumption during bean cooking (a) cooking system (b) soaking ... 124
Figure 4. 19: Effect of processing method on bean processing time ... 125
Figure 4. 20: Time distribution during bean processing (a) *Kabulangeti* on a TSF system (b) *Kabulangeti* on a charcoal system (c) *Mixed* beans on TSF system (d) *Mixed* beans on charcoal system ... 126
Figure 4. 21: Raw common bean process and value flow diagram ... 127
Figure 4. 22: Consumption of preferred bean varieties ... 129
Figure 4. 23: Reasons for the consumption of beans ... 130
Figure 4. 24: Satisfaction with bean attributes (Rural)...133
Figure 4. 25: Satisfaction with bean attributes (Urban) ... 133
Figure 4. 26: Map of the activities performed along the bean household value chain ... 134
Figure 4. 27: Relationship between preferences identified along the HVC and food security indicators ... 140
Figure 5. 1:Framework for the analysis ... 150
Figure 5. 2: Map of inputs used along the common beans value chain ... 159
Figure 5. 3: Value chain stages ... 161
Figure 5. 4: Common bean value chain map ... 163
Figure 5. 5: Marketing channel ... 163
Figure 5. 6: Cost components along the chain ... 164
Figure 5. 7: The influence of agents and factors on activities by producers ... 171
Figure 5. 8: The influence of different factors on the activities performed by traders ... 171
Figure 5. 9: Relationship between agents ... 172
Figure 5. 10: Flow of knowledge along the common bean value chain ... 175
Figure 5. 11: Impact of knowledge on price (producers)...177
Figure 5. 12: Impact of knowledge on price (traders) ... 177
Figure 5. 13: Producer knowledge value chain (bold marginal effects represent significant relationships) ... 179
Figure 5. 14: Trader knowledge chain ... 180
Figure 5. 15: Material flow of common beans along the chain ... 180
Figure 5. 16: Corroborating views about changing factors along the value chain ... 189

Figure 5. 17: Source of information for farmers 192
Figure 5. 18: Changes in color over 5 months of storage 197
Figure 5. 19: Changes in cooking time over 5 months of storage 199
Figure 5. 20: Average performance scores across dimensions used in the estimation of the availability score 203
Figure 5. 21: Average performance scores across dimensions used in the estimation of the accessibility score 206
Figure 5. 22: Average performance scores across dimensions used in the estimation of the affordability score 208
Figure 5. 23: Average performance scores across dimensions used in the estimation of the acceptability score 209
Figure 5. 24: Average performance scores across dimensions used in the estimation of the consumption and utilization score 211
Figure 5. 25: Percentage scores for food security indicators 213
Figure 5. 26: Correlation between food security indicators and food security score (FSS) 216
Figure 5. 27: Dendrogram for Cluster Analysis 217

Figure 6. 1: Percentage of consumers who indicated preferences for different levels of attributes (A description of the attribute levels are provided in Table 6.1). 235
Figure 6. 2**:** A description of the attributes (levels) of beans found in the market. Percentage of consumers who indicated different levels of attributes of beans in the market (A description of the attribute levels are provided in Table 6.1). 235
Figure 6. 3: Changes in color (lightness) for Kabulangeti beans; at 15°C (6.3a); 25°C (6.3b) and 35°C (6.3c) 249
Figure 6. 4: Changes in color (lightness) for Sugar beans; at 15°C (6.4a); 25°C (6.44b) and 35°C (6.4c) 250
Figure 6. 5: Changes in cooking time with increasing storage time for sugar beans; (6.5a) 15°C (6.5b) 25°C (6.5c) 35°C 259
Figure 6. 6: Changes in cooking time with increasing storage time for sugar beans; (6.6a) 15°C (6.6b) 25°C (6.6c) 35°C 259

Figure 6. 7: Changes in cooking time considering storage time and temperature are considered 261

Nomenclature

CBA	Cost Benefit Analysis
HVCA	Household Food Value Chain Analysis
FAO	Food and Agriculture Organization
FSI	Food Security Indicator
FSS	Food Security Score
FVC	Food Value Chain
FVCA	Food Value Chain Analysis
HVCA	Household Value Chain Analysis
SDG	Sustainable Development Goals
TSF	Three Stone Fire
VC	Value Chain
VCA	Value Chain Analysis

CHAPTER 1 Introduction

1.1 Background

Malnutrition, undernutrition, and overnutrition have been characterized as a triple burden (Pinstrup-Andersen and Watson, 2011) and have become a global challenge. They affect millions of people in the world and have been found to lead to the incidence of diseases and conditions such as diarrhea, obesity, anemia, respiratory diseases, growth retardation, etc. (FAO, 2013). Although there are several causes of the triple burden, the diet of consumers plays an essential role (Gomez and Ricketts, 2013). Food consumed by individuals goes through a set of processes before getting to their tables. The processes and stages, in conjunction with the series of agents who work together to provide the products are known as the value chain. The kind of food (type, quality, composition) that reaches the consumer or the lack of it thereof is mainly influenced by the nature of the existing food value chains (FVC). Thus, the nature of the food value chains influence availability, accessibility, acceptability, physical and nutritional quality and utilization of food. These factors are directly linked to consumer preferences and needs. Therefore, when food value chains meet consumer preferences and needs, they ultimately have a positive impact on food security.

Consumer preferences and needs are rapidly changing as a result of changing socioeconomic situations, increasing level of awareness on diet-related illnesses, increasing incomes and knowledge, work schedules, social class, urbanization etc. Coupled with the changing needs and dietary habits, there are the countless agricultural-based programs undertaking nutrition education interventions among vulnerable households/communities. These factors are leading to higher demand not only for certain foods such as fish, dairy, vegetables, but easy to cook meals and highly nutritious foods (Hawkes and Ruel, 2011).

To address the current and changing needs and preferences, FVC will have to transform its activities to meet consumer demands. For FVCs to efficiently achieve this, researchers and policymakers would have to give attention to how FVCs are analyzed. The concept of value chain analysis has been applied within different fields including food and agriculture, for many years to address different objectives. It has become one of the important tools in guiding development interventions by bilateral and multilateral aid organizations (Folke et al. 2010). Value chain analysis of agri-foods usually focuses on the current state of food production, prices and market accessibility (Hawkes and Ruel, 2011). It is therefore centered on the structure, political, institutional and governance framework of the chain, product flow and financial analysis (Wilson, 2015; USAID, 2015; Sharma et al. 2010; Asiedu et al. 2015; Babu and Verma, 2010).

The analysis goes further to determine the factors that may be hindering such achievements. While these factors are important to the consumer, the analysis is geared toward improving the livelihood of the producer without the consumer in view. The analysis is not consumer-focused and not geared towards how the activities along the value chain are meeting consumer preferences and even more influencing food security indicators. Furthermore, the analysis focuses on the production tier of the chain and does not take into consideration other stages along the chain in a holistic manner. This may explain why crop and livestock production patterns have not been seen to positively affect the nutrition and health of vulnerable groups, although they are expected to do so (Maestre et al. 2017).

1.2 The rationale of the study

Agri-food value chains are made up of linked and complex processes through which products flow from the producer to the consumer (Flynn and Bailey, 2014). These activities are performed to deliver value to the consumers. Food produce goes through different processes such as post harvest handling, storage and distribution. These processes can affect not only food availability but, food attributes which are considered important to consumers (Hawkes and Ruel, 2011). In the long run, these impact demand and nutritional outcomes.

Though, value chain analysis (VCA) presents itself as a tool that can be employed for different performance assessments; most VCAs are not applied from the consumer perspective. Agri-food value chains need to lead to consumer satisfaction with the ultimate goal of meeting consumer needs profitably. However, development programs have applied the value chain approach focusing primarily on profitability. Policy makers have used it mainly to identify areas where interventions can be targeted to improve the profitability of the chain and improve the living standards of the value chain actors (Humphrey and Navas-Alemán, 2010; Chagomoka et al. 2014).

Although the output of value chain activities is targeted towards the consumer, yet their satisfaction is largely ignored in value chain analysis. Policy interventions have to focus on improving profitability through the lens of creating and delivering value to consumers effectively. VCAs should be undertaken to determine how activities affect consumer preferences and food security indicators as opposed just to costs and profits. This consumer consideration should not only focus on how the product gets to them but also the kind of product (in terms of quality, safety and nutrition). This has indirect value (profit) for value chain actors which is necessary to ensure that they stay in the market (Fan and Zhang, 2016). It can also contribute directly to the economic growth of the nation (Badar, 2014). For rural folks who are dependent on FVCs for sustenance, this has rippled benefits for poverty and food insecurity reduction.

Recently, there has been a need to introduce other aspect such as social and environmental dimensions to agri-food value chains to ensure sustainable development. It has been suggested that these dimensions, as well as the economic dimension, should be integrated into value chain activities (Mitchell et al. 2009; Fritz and Schiefer, 2008). Food value chains thrive on the environment and affect the society in terms of health. While these dimensions are important and need to be considered, a shift in focus from the purpose of the value chain and the target end-users of the products will lead to very little success in the long run. Therefore, it is important to ensure that every activity that is performed is geared towards not only addressing environmental, economic and social needs but altogether consumer needs and preferences.

An economically viable production practice that reduces environmental impact yet is unacceptable to the consumer is out of balance (Capper, 2013). Value chains with inadequate focus on the consumer are more likely to fail (Hult, 2011). For instance, while there are numerous challenges that limit economic viability such as lack of technology, inability to enter certain markets, changing climate (McCullough et al. 2008; Wognum et al. 2011), the lack of knowledge of consumer preferences and inability to adjust to changing consumer needs are significant contributing factors. If all these challenges mentioned above are addressed without adequately addressing the concerns and needs of consumers, economic viability will still not be achieved.

Beyond economic benefits, food value chains can create challenges or opportunities for food security and nutrition in developing countries (Gomez and Ricketts, 2013). However, there is a need for a careful understanding of the activities performed, the conditions within which these value chains operate and an assessment of how they impact consumer preference and food security indicators. Without this, policymakers at the risk of having unintended consequences when they introduce policies along food value chains seeking to improve its performance without addressing the core issues pertaining to primary beneficiaries.

The study argues that how these challenges and opportunities can be identified and addressed is dependent on the technique applied to assess FVCs. With in these in view, the study seeks to answer an important question "how can VC assessments be made more consumer-focused and produce results from which inferences can be made for food security?" This would involve undertaking food value chain evaluations that would understand consumer choices, existing and changing preferences and factors limiting consumption. Such information would then be used as a guide to determine how the activities along the value chain are either providing or reducing consumer desired preferences. Based on this, the measures required to align value chain activities to meet those preferences and food security indicators can be designed and implemented.

The study does not only take a consumer-based approach but considers a value chain such as the common bean value chain which has the potential of contributing to reducing micronutrient undernutrition. Common beans (Phaseolus vulgaris) is a common grain legume in most parts of the world and contributes positively to diets due to its high protein content, vitamins, important minerals such as iron and zinc (Sitko et al. 2011). Zambia has been chosen as the study area due to its high food insecure population, with stunting rates at 45%, rate of underweight at 15% and the prevalence of micronutrient deficiencies (Sitko et al. 2011). Diets are mainly carbohydrate-based with low consumption of protein sources (Mofya-Mukuka and Kabisa, 2017). Further, beans are one of the crops that have been targeted to achieve the food security objective in Zambia (Mwala et al. 2008). One recommendation for achieving the 2nd Sustainable Development Goals (SDG2) in Zambia is to increase availability and affordability of nutritious foods, demand for nutritious foods and promote good diets (Chapoto et al. 2017). Enhancing the common beans value chain to meet consumer needs and preferences can contribute significantly to achieving this goal. The study, therefore, seeks to formulate a new FVCA methodological framework from a consumer perspective and apply it to the common bean value chain in Zambia.

1.3 Research questions

The research problem to be addressed is; how can VC assessments be made more consumer-focused and produce results from which inferences can be made for food security. In order to address this problem, the following questions are answered;

1) How should agri-food value chains be assessed from a consumer-centered perspective to achieve food security indicators?
2) What are consumer preferences and their implication for the common bean value chain?

3) What is the structure and performance of the common bean value chain and how does it contribute to meeting food security indicators?
4) What is the economic benefit of adjusting value chain activities to meet consumer preferences?
5) How can value chain activities be aligned to meeting consumer demands and food security indicators?

1.4 Objectives

The main objective of the study is to redefine food value chain assessment within the consumer-food security nexus and ascertain its validity using the common bean value chain. The specific objectives of the study are listed below and shown in figure 1.

a) To formulate a methodological framework for agri-food value chain analysis based on a consumer-food security nexus.
b) To assess consumer preferences and the factors influencing demand, preparation, and consumption of common beans.
c) To assess the structure and performance of the common bean value chain in meeting consumer preferences and food security indicators.
d) To determine the economic benefit of adjusting value chain activities to meeting consumer value preferences.
e) To provide recommendations on the measures required to align value chain activities to meeting consumer preferences and food security indicators.

1.5 Justification of the study

The value chain approach has been applied to improve the performance of firms over the years and recently in agri-food value chains (Macharia et al. 2013). However, in agri-food value chains, they have not been applied with a consumer focus. In cases where it has been applied to address food security related issues, the focus has been one dimensional (economic) and concentrate on specific indicators such as availability and accessibility through increasing production at the household level and integrating into markets. There is limited applied research generally with this focus and even more considering agri-food value chains in developing countries. Considering the potential of the common bean value chain, understanding and improving its performance in this regard will enable it to reach its full potential and provide socio-economic benefits.

Meeting the food and nutrition-related goals, such as the SDG2 and SDG3, is to ensure that the factors likely to inhibit the consumption of nutrient-dense foods among different consumer groups are greatly reduced. The SGD3 states that by 2030, all forms of malnutrition should end with particular attention to under five, adolescent girls, pregnant and lactating women (FAO, 2018). This can be achieved if value chain actors, researchers, and policymakers can effectively determine how the food value chain is influencing food security and nutrition by meeting consumer preferences. The study has key applied contributions.

The study is looking to establish a consumer-food security nexus from a value chain perspective. The study will be useful to different stakeholders in these ways;

a) For producers, the results will provide recommendations on how they can improve their activities to meet consumer preferences and reap economic benefits in doing so.
b) For policymakers, it will aid in the design of policy briefs and interventions set out to improve the demand for and consumption of targeted foods. It will also be useful for designing programs to help improve the performance of agri-food value chains to reach their full potential across different dimensions. By evaluating the role of the FVC in impacting food security indicators, policymakers and other stakeholders will be able to create an appropriate environment that will shape value chain operations to benefit target consumers and improve food security. The results of the study will help provide a new dimension to how approaches to achieving SDG2 and SDG3 should be viewed.
c) For scientists and researchers, it will be useful for identifying potential areas along the value chain where they could assist value chain actors improve their activities to ultimately meet consumer needs. Assistance could be provided through the development of tools, equipment, procedures, and seeds which are not only disease tolerant but with marketable attributes. The model and framework can also be applied to understand the performance of other value chains.

Specifically, for the common bean value chain, the study will be useful in;

a) Identify priorities for future research related to common bean utilization and consumption towards food and nutrition security.
b) Identify cost-saving and profit earning opportunities through the elimination of non-value adding activities.

c) Enable policymakers to construct a desirable collective vision of what the bean value chain could look like in meeting the preferences of diverse consumers and increase utilization and consumption.

d) Understanding consumer experience with the product and preferences will reveal other means to increase consumption and commercialize the product by developing new bean-based products.

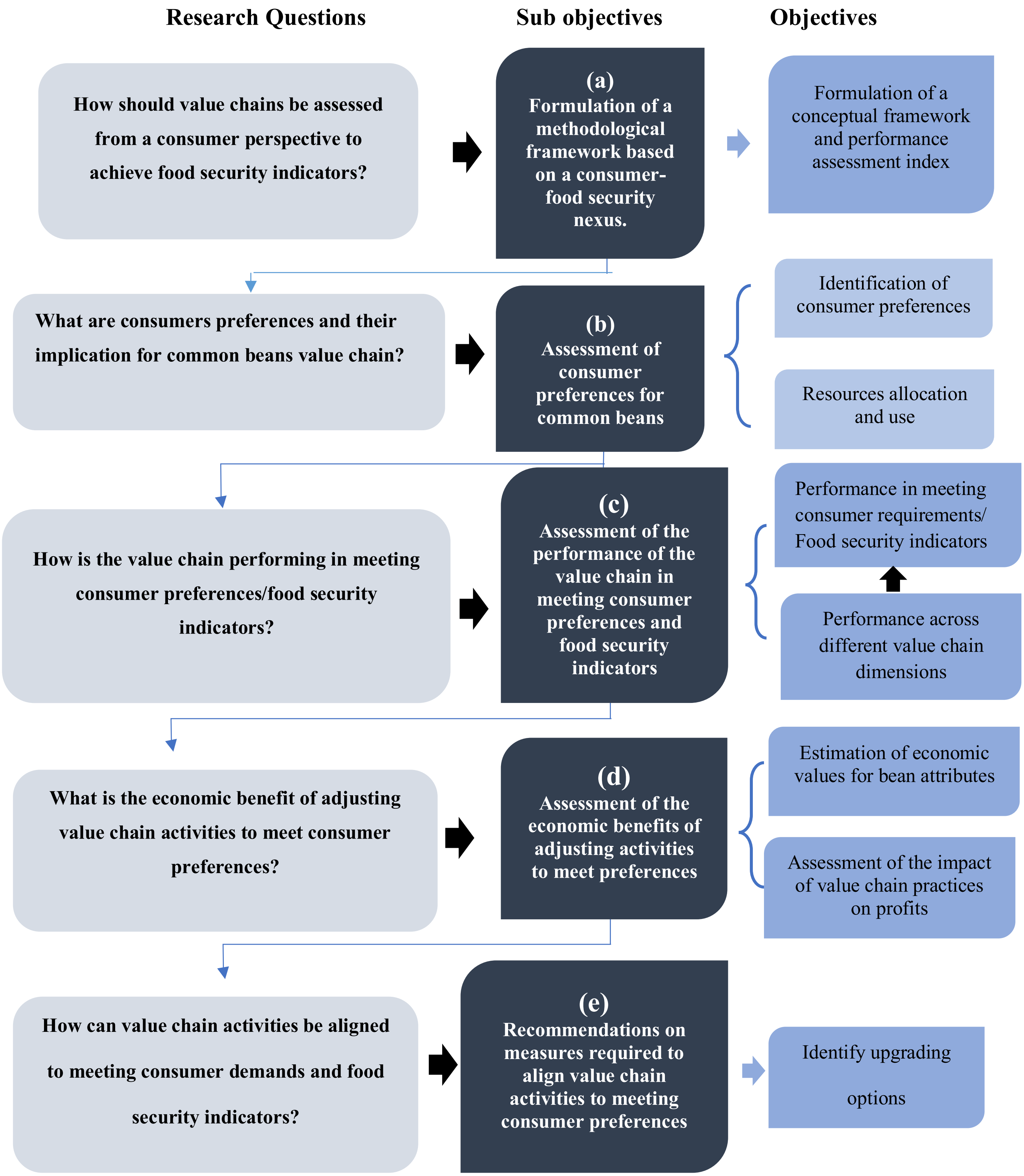


Figure 1. 1 Flow representation of research questions and objectives

CHAPTER 2 Literature Review

2.1 Introduction

A value chain is a set of interdependent economic processes undertaken from the production of a product to the consumption of the finished commodity. The concept of the value chain has been influenced by different subjects and usually described based on two concepts. The first being the French filière concept and Wallerstein's concept of commodity chain (Raikes et al. 2000; Bair, 2005). The 'filière concept' was developed for empirical agricultural research in the 1960s by the Institut National de la Recherche Agronomique (INRA), and the Centre Internationale en Recherche Agronomique pour le Développement (CIRAD). The goal of the concept was to understand economic processes within a production and distribution system mainly for agricultural commodities (Raikes et al. 2000) at the domestic level (Kaplinsky and Morris, 2002).

The concept of the commodity chain was developed by Wallerstein (1974) in the 1970s to understand the distribution of the activities within a value chain at the internal level. It focuses on labor division between different regions at varying levels within production and manufacturing systems. Coase (1937) was the first to study the vertical integration of agents and activities by emphasizing on the substitution of firms with each other. It was explained that if the cost of a production input is lower when produced in the firm than when obtained externally through market arrangements, then it will be internally produced within the firm. The existence of firms was explained based on this concept. Coase's work was further expanded by Williamson (1971), who investigated the internal organization of production processes and their relationship with the functioning markets.

Thus, the concept of the value chain has been in existence for quite some time but was promoted by Porter (1985) in the conceptualization of the value chain of manufactured products. The focus of Porter's work was to achieve a competitive advantage by assessing the activities that create value in a company, though only at the firm level. The research was then developed along the lines of quantitative analysis of inputs, outputs, prices, and value addition based on the views of agents along a chain. After the popularisation of the concept by Porter, it has been applied in other areas such as professional services, industries, and organizations (FIAS, 2007). The approach has also been applied to production processes at the global level in the mid-90s and initiated by Gereffi (1994). This idea is made up of four elements with the focus on governance due to the presence of dominant agents, which determine upgrading opportunities, knowledge dissemination, and interactions within a chain.

Joskow (2005) researched the governance and efficiency implications of vertical integration among agents. As a result, environmental concepts have also been introduced into value chain analysis through the assessment of the resource consumption and emissions along the chain. Value chain analysis has, therefore, evolved over time concerning its description, scope, and application.

Value chain analysis (VCA) consists of three main elements, which are the value, value chain, and the analysis of the chain. The interpretation of these elements has influenced the different techniques applied in VCA. A discussion of each of these elements and their variations, the application of the VCA concept, limitations and how they can be addressed are discussed below.

2.2 Variations in the description and definition of value chain elements

2.2.1 Variations in the description of value

Value chain analysis has its focus on the term and concept of value, which is one of its distinguishing features from a supply chain. Francis et al. (2014) argued that "value," though often used as with many other words, has not been properly defined to come up with a standard term to be universally used. The problem of a feasible interpretation of both terms expressed by Van de Ven (1992) is shared by Francis et al. (2014). This is due to the fact that the understanding and definition of the 'value' and 'value add' have an effect on the research questions posed by the researcher, the methodology adopted, results obtained, and its contribution to literature (Van de Ven, 1992).

Value in most VC studies is viewed as monetary value, which is the value (price) the consumer pays for a good (Porter, 1985). Value is added to a product to increase the consumer's willingness to pay for it. Porter (1985), however, explains that the cost of value addition mustn't exceed the amount paid by the consumer. Thus, most studies (Tesfaw, 2015; Wilson, 2015; Kirimi et al. 2011; Jaligot et al. 2016; Wang, 2015; Dahlstrom and Ekins, 2006), include an analysis to determine if the chain is profitable. In literature, value has been defined in various ways, such as benefits relative to cost (Wang, 2015), this being regarded as the value of profit margin. Dahlstrom and Ekins (2006) defined value for their study as the actual monetary values of the materials passing along the value chain. Lie and Yang (2000) defined value as the amount customers are willing to pay for what is provided to them. The actual activities performed along the product chain instead of the final monetary value of the product is viewed as the source of value by Deng et al. (2016). Most of the studies viewed value in financial terms from a cost-benefit or profit perspective. Hence, the differences in the perception of value was found to influence VCA objectives and techniques.

Variations in value chain definition and description

Porter (1985) was the first to introduce the term value chain and defined it as the range of interlinked activities that a business uses to make and sell its products/services, and to attain a competitive advantage. However, there are still numerous definitions of value chain by different authors. This shows how perspectives concerning markets and industries have evolved over time. Table 2.1 provides a list of authors and their definitions for value chain.

Table 2. 1: Definitions of value chain by different authors

Author	**Definition**
Evans and Berman (2001)	It's an approach used to disintegrate the activities of a business into its individual and related parts.
Walters and Rainbird, (2006)	A system that creates satisfaction for the final consumer with an emphasis on the roles of different stakeholders.
Wilson (2015)	The range activities necessary to move a product from the point of production to the point of consumption.
De Silva (2011)	Receiving of raw materials and, adding value to the material through different processes before selling the end products to consumers.
Nguyen (2014)	A sequence of activities required to turn a product or service from its primitive form into a finished version that delivers value to customers.
Mvumi and Matsikira (2016)	A vertical link between independent businesses which include processing, packaging, storage, transportation, and distribution.
Macfadyen et al. (2012)	A sequence of related enterprises conducting activities to add value to a product from its primary production through to the final sale of the product.
Francis et al. (2016)	Process activity steps for a specific product; involving different participant organizations; from the consumer selecting a product to the supply chain producing and supplying it.
Barnes (2002)	Every product or service is comprised of a number of actors in a chain who engage in value-adding activities, which end with the customer.

Source: Author compilation

Most studies do not provide a clear definition of value chain; however, the basic concept of value chain is consistent among the few studies (Wang, 2015; Dahlstrom and Ekins, 2006; Deng et al. 2016) that defined it. The common elements in the definitions are the movement of the product from one point to the other, with the initial point being the production point and the destination being the consumer. The distinct difference among the definitions is that some studies emphasize only on activities undertaken in the movement of the product while others highlight value creation or addition through the transformation of the product along the chain. Only a few definitions draw attention to the creation of value with the emphasis on satisfying the consumers. Based on the various definitions in the literature, VC can be defined as a system within which different actors work together to perform different activities and transform raw materials into final valued products delivered to consumers by moving them along the chain.

2.2.2 Variations in value chain analysis definitions

Diverse definitions and descriptions of value chain analysis have been provided in the literature. Chagomoka et al. (2014) and Guabiroba et al. (2017) described a VCA as a tool used to assess the efficiencies of value-added activities and competitiveness along a supply chain. Deng et al. (2016); Macfadyen et al. (2012) defined it as an effort to comprehend the activities of agents, creation of value, and financial performance along the chain. El-Sayed et al. (2015) defined VCA as the multi-dimensional assessment of the performance of value chains, including the analysis of product flows, information flows and the management of the value chain. A VCA is described by Lie et al. (2012); Jaligot et al. (2016); Kaplinsky and Morris (2001); Rieple and Singh (2010) as an approach that examines all the actors involved in the chain, the linkages between them, and the activities within each link.

The description of value chain analysis spans from being either a descriptive, economic, and/or performance assessment tool in the literature. For performance, several authors view value chain analysis as a tool to determine the financial performance, efficiency, competitiveness, or management structure of the chain. Embedded in the definitions are the different purposes for undertaking a VCA, as expressed by each author. This has led to variations in the VCA techniques employed by authors in the literature. For instance, studies that described a VCA as a tool to assess the financial performance were more likely to focus their analysis on profit or cost-benefit estimations. Generally, the common element in VCA is the breakdown of the chain and assessment of the activities, agents and their functions.

The basic understanding of all the definitions can be summed up in the description provided by Fearne et al. (2012). “VCA is a tool for examining the current state of the chain and identifying an improved future state,”. It can be clearly seen as a performance assessment tool for different elements. Porter's (1985) goal for a VCA was to identify and assess the firm's sources of competitiveness and differentiation by breaking down the chain into its different units. In this sense, it was used to evaluate the performance of the chain in terms of competitiveness. In other instances, it has been used to assess the performance of value chains for knowledge management (Lee and Yang, 2000) and environmental protection through emission reduction (Dahlstrom and Ekins, 2006 and Nikodinoska et al. 2017).

2.3 Application of the VCA concept in Agri-food sector

Value chain and value chain analysis (VCA) techniques have been used by businesses and corporations for many years to determine strategies needed to improve competitiveness. Value chain analyses have been conducted with a combination of qualitative and quantitative methods using primary surveys, focus group discussions, and secondary data. The VCA framework has been applied widely in literature in fields such as economics, business, engineering, natural resource management, agriculture and aquaculture, tourism, health, development, technology, and others. It has been applied to recognize innovative products and processes, reduce waste and costs, evaluate bottlenecks impeding productivity and highlight opportunities for increased performance (Webber and Labaste, 2010).

Value chain analysis has also been applied to numerous studies involving agricultural products. Agri-food chains fulfill food requirements for consumers by undertaking a range of activities within different stages to make a profit (Pimbert et al. 2001). They are a chain of agribusinesses engaged in activities that create value for the consumer. They are dependent on natural resources; their products are biological; they are complex and heterogeneous (Trienekens et al. 2012). In these assessments, value is mainly attributed to profitability (product price should not exceed cost of value addition) (Tesfaw, 2015; Wilson, 2015; Kirimi et al. 2011; Jaligot et al. 2016).

Agri-food value chain studies focus on different objectives, ranging from informational and activities flows, supply chain efficiency, linkages, governance, cost efficiency, resource and capacity constraints, operations and planning, profitability etc. (Macfadyen et al. 2012; Sinh et al. 2014; Anane-Taabeah et al. 2016; Jaligot et al. 2016). For instance, Anane-Taabeah et al. (2016), Kilimo Trust (2012), and Lie et al. (2012) focused on assessing the constraints along a product chain by understanding the physical, economic, and informational activities. Value chain governance was the main objective being addressed in studies conducted by Ouma et al. (2016), Nguyen, (2014), and Hara, (2014). The assessment of the financial performance of agricultural value chains has received much attention and covers different chains ranging from agriculture to aquaculture (Macfadyen et al. 2012; Odero et al. 2016; Sharma et al. 2010; Sinh et al. 2014). The studies evaluate the relationship among costs, income, profit creations and their distribution among the actors along the chain.

Researchers paid much attention to quantity-cost-delivery improvement. The primary trend among the studies is an assessment of the value chain from the producer/production perspective. That is to increase output and revenues. There were hardly any studies that were conducted from a consumer perspective to provide more value for them while improving economic benefits for value chain actors (Zokaei and Simons, 2006).

2.3.1 Value chain approaches employed in agri-food literature

Though there are differences in the value chain analysis techniques used in the literature, the fundamental considerations of these techniques have been the same for most studies. This is observed to be the traditional approach to value chain analysis for agri-food chains. These considerations include a three-step approach; the first step involves mapping the actors, identifying the flow of the product, the volumes handled by each agent, and assessment of the relationship among actors. The second involved the estimation of the financial returns (marketing margins, cost and benefits) for each player in the chain. And the third step focused on the identification of the challenges and opportunities along the chain (Dalipagic and Elepu, 2014; Kelemework, 2015; Tesfaw, 2015; Qing Jing et al. 2012; Rieple and Singh 2010; Kumar et al. 2012; Kilimo Trust, 2012; Kumar and Kapoor, 2010; Bidogeza et al. 2016; USAID, 2015; Anane-Taabeah et al. 2016; Wilson, 2015; Pambo, 2014; Kirimi et al. 2011; Pussep et al. 2011; de Souza and D'Agosto, 2013). Wang et al. (2019) focused on mapping the diary food system in Nairobi. The main goal of the value chain analysis was to identify the major chain segments, activities undertaken, sources of inputs and marketing of the product. They focused on content and descriptive analysis. Compared to Porter's (1985) the focus of the analysis wasn't to attain a competitive advantage but to assess the profitability of the production business.

Table 2. 2 Variations in VCA techniques

Distinct feature	Description	Author(s)
	No modification to traditional VCA approach	
No distinct feature	Value chain mapping, description of agents and constraints	Dalipagic and Elepu, (2014); Kelemework, (2015); Tesfaw,

		(2015); Qing Jing et al. (2012); Rieple and Singh (2010); Kumar et al. (2012); Kilimo Trust, (2012); Kumar and Kapoor, (2010); Bidogeza et al. (2016); USAID, (2015); Pambo, (2014); Pussep et al. (2011); de Souza and D'Agosto, (2013); Wang et al. (2019); Asiedu et al. (2016)
No distinct feature	Profitability Assessment	Tesfaw, (2015); Wilson, (2015); Kirimi et al. (2011); Anane-Taabeah et al. (2016); Dizyee et al. (2017); Antonio and Griffith (2017); Islam et al. (2014); Sharma et al. (2010); Babu and Verma (2010); Andayani et al. (2017); Prayugo et al. (2012); Imamai et al. (2013)
	Modification to traditional VCA approach	
Governance structure	Evaluation of the leading enterprises, stakeholder and agent requirements	Hara (2014); Nguyen, (2014); Ouma et al. (2016); Lie et al. (2012); Abel et al. (2019); Watabaji et al. (2016)
Governance and Sanitary risks	Evaluation of associations, rules, incentives, animal health services and slaughter practices	Caroon et al. (2017)
Governance and economic analysis	Assessment of interrelationships within the chain and its effects on profits	Camanzi et al. (2018)
Losses and loss factors	Quantification of physical and economic losses and, the factors contributing to losses	Mvumi and Matsikira (2016)
Waste assessment	Quantification of waste and its source along the value chain.	Francis and Simons (2016)
Employment and profitability	Assessment of major stakeholders along the chain, their roles and the profitability of the chain.	El-Sayed et al. (2015)
Financial performance and quality evaluation	Evaluation of revenue generation, certification, pesticide residue and traceability.	Yao et al. (2018)
Institutional and environmental roles within a system	Identification of the people and organisations within the chain as well as the rules governing operations within the system	Irvine (2015)
Constraints and opportunities with a focus on nutrition and food safety	Assessment of production practices along the chain and their impact on food safety and nutrition	Hasler et al. (2019)
	A shift from traditional VCA approach	
Multifactor approach with three dimensions: Ecological, economic, social elements	Assessment of the performance of the chain across social, ecological, and economic dimensions	Christensen et al. (2010)
Multifactor approach with three dimensions	Assessment of the performance of the chain across resource conservation, food safety and landscape dimensions	Fagioli et al. (2017)
Multifactor approach with 2 dimensions	Assessment of the performance of the chain across environment, and economic dimensions	Savino et al. (2015)

Multifactor approach with 4 dimensions	Assessment of the performance of the chain across environment, governance, economic and social dimensions	Bachev (2017)
Agricultural sector VCA strategy	Mapping of the chain and identification of connections between activities and flow of products	Jaligot et al. (2016)
Market and poverty perspective (M4P approach)	Assessment of product flows, profit distribution, collaborations and upgrading elements	Nguyen (2014) and Simon et al. (2014)
Structure, Conduct, Performance Analysis	Assessment of the scale and ownership of the chain, behaviour of actors and efficiency of the chain	Belton et al. (2016)
Income estimations and market services	Quantification of earnings and identification of market outlets and services	Chagomoka et al. (2014)
Knowledge sharing	Evaluation of knowledge sharing among value chain actors	Boshkoska et al. (2019)
Integrated approach with five dimensions	Assessment of the performance of the chain across environment, health, ethics and social dimensions	Shmitt et al. (2016)
Consumer value introduction in product value chain analysis	Assessment of consumer preferences and activities along the value chain	Labuschagne et al. (2010); Veira et al. (2013); Ariyawardana and Collins (2013)
Perception of chain performance	Evaluation of value chain actor's perception on costs, prices, efficiency and profitability	Kataike et al. (2018)

Source: Author Compilation

Studies which focused on financial performance were undertaken either for the whole value chain or specific aspects of the chain (Islam et al. 2014; Sharma et al. 2010). Profits, prices, revenues, and costs are the indicators for the financial evaluation. Irvine (2015) extended VCA to evaluate health surveillance systems. It was employed to understand the institutional environment and roles of the system. This approach was slightly different from the traditional approach. A category matrix based on the supply and value chain components of the broilers was developed for chain mapping. El-Sayed et al. (2015) analyzed the aquaculture feed value chain. The analysis took four different phases: describing the agents within the chain, assessing the performance of the chain in terms of employment and profitability, determining the strengths and weaknesses and providing upgrading suggestions. The traditional approach to VCA was applied in this study; however, the analysis was tailored towards employment, constraints and profitability.

Nguyen (2014) and Simon et al. (2014) applied the Making Market Work for the Poor (M4P) value chain analysis approach in assessing food value chains. The first aspect involves the flow of products, volumes, and destinations. Other stages included estimation of profit distribution, identification of agent collaborations, and upgrading elements. Lie et al. (2012) determined the competitiveness and possibilities of upgrades along the milk chain. As a result, this approach comprised of activity mapping, assessment of governance structure and distribution of benefits. The last stage, which is the author's modification, involves the review of the assets since it influences the ability of the agent to capture value. Dizyee et al. (2017) assessed the economics of animal and meat marketing using an integrated system dynamics model. The approach used by the authors went beyond a descriptive and financial assessment to capture feedback loops within the system based on different scenarios. Thus, the economic system within the beef sector was assessed to determine how environmental pressures impact the system. Compared to the traditional approach, the financial performance of value chain actors was evaluated based on how the system reacts to different demands. Yao et al. (2018) applied value chain analysis to determine the financial performance in terms of revenue generation along the chain and went beyond that to include the influence of the value chain on the quality. Indicators of quality included traceability, certifification, control, pesticide residue and sulfur residue.

Belton et al. (2016) undertook a VCA based loosely on a structure, conduct, and performance framework. Based on this guideline, the aquaculture value chain was first segmented into four with respect to the timeline of value chain development. This was the only component of the analysis, which was in line with the traditional approach of breaking down the chain into different activities. The different phases of development of the value chain were then assessed based on the framework described above. The sequence of steps involved in the value chain analysis of vegetables by Chagomoka et al., (2014) included mapping a vegetable chain, quantifying the earnings of the actors, identifying market services, and finally, the evaluating of the constraints and opportunities along the chain. The focus of the analysis was on limitations, market outlet identification, and income estimations of agents along the chain with no inference to cost, differentiation, or competitive advantage.

Hara (2014) studied the governance of the chain by determining the leading enterprises and control by agents. The study focused on who and how the value chain is governed to determine if the governance structure can be reshaped to benefit agents along the chain. Similarly, Ouma et al. (2016) determined how enterprises within the chain operate. The firms' ability to exercise some control by either setting product standards or supporting institutions enforcing rules and regulating the activities of agents along the chain. Carron et al. (2017) employed a value chain framework to assess governance themes (challenges, associations, rules and incentives, dominance) and sanitary risks (animal health services, slaughter practices, disposal) in the broiler chicken system. This included mapping of the production and marketing chains and the different themes within the chains. Camanzi et al. (2018) assessed governance (interrelationships) and the financial performance (profits) of the dairy sheep industry. The causal effects between the governance structures, the structure of the chain, and the financial performance were assessed with the structural equation modeling analysis. Such effects are often not analysed by studied that employ the traditional approach.

On the other hand, Labuschagne et al. (2010) undertook a consumer-based value chain analysis to determine whether the beef value chain is positioned to meet the changing demands of consumers. The consumption trends and changes in the consumer needs were first examined. After that the strengths, constraints, weaknesses, and opportunities (SWOT) were studied to determine if the product chain was meeting the changing demands. Although the authors included the consumer in the analysis, the impact of value chain activities on consumer needs and preferences were not determined. The SWOT identified were not also linked with meeting specific consumer needs.

Vieira et al. (2013) analyzed the organic food chain from the consumer perspective by understanding consumer preferences and the activities undertaken along the supply chain. Understanding consumer preferences was to reveal consumer purchasing decisions. Though supply chain management and consumer analysis were undertaken in the same study, there wasn't a connection between how the identified preferences are being met or otherwise. A similar approach was also taken by Ariyawardana and Collins (2013) in studying Australian red lentils.
In another study, Kataike et al. (2018) evaluated the perception of value chain actors on the performance of the chain across several indicators. These indicators were not measured but based on the responses provided by the value chain actors. The indicators selected included efficiency, profitability, flexibility, and food quality and safety. Thus, the performance was not assessed based on economic indicators but on ranked responses on costs, prices, employment etc. Boshkoska et al. (2019) evaluated the knowledge sharing within an agricultural food value chain specifically, brassica, Chinese leaf and tomato.

The review shows that the majority of the studies have concentrated on addressing similar objectives. However, there have been a few studies that have incorporated certain distinct elements and perspectives into their techniques. Some of the different aspects include; evaluating emissions and energy requirements for a particular product, assessment of governance structures and upgrading elements, tracking of losses and waste, assessing competitiveness and knowledge sharing and, an evaluation of the value chain on consumer demand factors. The different variations of VCA techniques based on the modifications or otherwise to the traditional VCA strategy are presented in Table 2.2. There have also been integrated studies where authors have accessed more than one element/aspect within a value chain analysis.

For instance, Christensen et al. (2010) employed an integrated approach in understanding the impact of management interventions on the ecosystem, economy, and food availability. The integrated model is a composition of an ecological and economical approach. The VCA was incorporated as a product flow analysis to distinguish between the agents, the flow of products, and values of the agents. It was also applied to identify production parameters and quantify of production volumes, revenues and costs of the enterprises. The ecological approach was employed to describe trophic levels in the system and estimate the losses along the chain by determining the weight (live) equivalents for a given enterprise. The societal aspect of the chain was investigated by evaluating employment, income and gender diagnostics along the chain.

Hasler et al. (2019) applied participatory rural appraisal to evaluate the production, safety, and nutrition along a dairy value chain. An integrated approach was therefore used to obtain and evaluate information gathered from both producers and consumers. This is also one of the few studies which include the consumer in assessing the food value chain. The study focused on describing practices and attitudes regarding the production and consumption of dairy to identify constraints and opportunities.

Fagioli et al. (2017) asserted that the dimensions of multifunctionality in a value chain are centered on economic, social, and environmental aspects. Thus, the authors assessed the level of multifunctionality by identifying and aggregating indicators into an evaluation framework. The indicators were based on non-commodity categories and included food safety, rural style, resource conservation, and rural landscape. After that, the Multiple Criteria Decision Aiding was used to assigns importance to each indicator in an evaluation process. A multidimensional (economic, social, environmental, health, and ethical) assessment was also employed by Shmitt et al. (2016) to study the performance of local and global milk chains in meeting five dimensions (environment, health, ethics, social, economy). Fabinyi et al. (2018) undertook a similar study but included relational dimensions such as training, governance, and information sharing. Savino et al. (2013) also undertook an environmental and economic assessment of a fresh fruit value chain to evaluate the sustainability of the chain. The environment assessment included evaluating carbon emissions and carbon footprints, while economic evaluations comprised of the financial cost estimations

Although different dimensions have been studied in the literature, three main dimensions are observed in the agri-food literature. These are the social, economic, and environmental dimensions. Agri-food value chain analysis has mainly focused on financial performance, as seen in the literature, thus concentrate on the economic dimension. Since agri-food value chains are depended on by rural populations in developing countries. Its contribution to the livelihoods and welfare through economic gains have been considered essential (Thompson et al. 2007). Traditionally, the goal of analyzing value chains is to identify areas where benefits can be leveraged, and constraints can be eliminated. Agri-food development operations have focused on increasing agricultural production and profitability. VCA approaches were therefore centered on the goal of determining constraints to food availability and profits. Recently, environmental and social dimensions have become importance because the strong linkages of agri-food industries to the society and the environment (Marsden and Morley, 2014; Neven, 2014) and the failed quest to meet them (McCullough et al. 2008).

Social dimensions have become necessary due the impact of agri-food value chains have on the welfare of participants. Thus, issues related to worker safety, gender imbalance concerning employment, access to inputs and services, labor issues (Ndanga et al. 2013; Kruijssen et al. 2018) and welfare impacts of participating individuals are assessed. Environmental challenges such as land degradation, water scarcity, climate change as a result of the abuse of natural resources (Nellemann et al. 2009) and the emission of gases (Soussana, 2014; Fdorova and Pongracz, 2019) have created the need for environmental assessments. These multidimensional assessments are captured within sustainability studies. Such studies focus on ensuring that the agri-food sector is transformed to sustainably feed growing populations (Fritz and Schiefer, 2008).

Generally, value chain analysis has been applied as an essential tool to improve the performance of agri-food and fiber systems by aiding in the identification of areas where growth can be enhanced (Da Silva and De Souza Filho, 2007). Different methods have been applied in VCAs, ranging from descriptive, framework and thematic content analysis, material flow accounting and financial accounting methods. Others also include, participatory rural appraisal methods, price transmission analysis, environmental models, life cycle assessment, system dynamics, and structural equation modeling. However, the approach has been predominantly economically centered. It is also focused on the production stage of the value chain, that is producing households. The final consumer of the products produced along the value chain and meeting their preferences and needs have been given limited attention.

2.4 Research gaps and opportunities in value chain analysis

Although the concept of VCA has been widely adopted, developed, and used, it still has the potential to be extended even further. The different gaps and opportunities for further inclusions into VCA approaches have been categorized into dimensions and discussed.

2.4.1 Research gaps in agri-food value chain analysis

a) *Dimensions 1: Boundary of analysis*

In individual or integrated studies, the entire value chain is mostly not assessed. Specific parts of the value chain are analyzed and thus do not provide a holistic view of the performance of the whole value chain. This is important since the development in an aspect or some aspects of the chain may not lead to an overall improvement in activities along the chain and may limit the achievement of objectives (Fritz and Schiefer, 2008). Since agri-food VCA studies focus on individual stages of the value chain, the influence of the activities of one stage on another is usually not discussed. Lambert and Cooper (2000) argue that there is a need to shift the focus from analyzing conditions in one stage or value chain to between stages and value chains. In cases where the value chains of two or more different products have been studied (Uddin et al. 2019; Bush, 2019), they have been done separately. The points at which one chain influences the other, especially within the same farm (in the case where more than one product is produced on the same farm) is not determined.

b) *Dimension 2: Analysis beyond the supply chain (Lack of consumer focus)*

Most of the analyses such as by Lie et al. (2012); Chagomoka et al. (2014); Prasetyanti and Simatupang, (2015); Belton et al. (2016) and de Figueiredo Junior et al. (2016) ended after the production or sale of the produce. The consumer is not the focus of the assessment to better understand how the activities along the value chain affect consumer needs and preferences for specific product attributes beyond price. The consumer is the target of the activities undertaken along the value chain, and thus, agri-food value chain assessments need to make the consumer and their needs the guideline for performance evaluations. Overall, the literature emphasizes the supply side of the value chain and not the demand side, with a specialized focus on the exchange value.

From the review, the questions researchers focused on addressing were mostly supply related, such as: what is the flow of the product? How is the product marketed? What are the challenges along the chain? Who are the actors, and what are the activities performed along the chain? Are agents gaining from engaging in value chain activities? etc. These are essential for the efficient performance of the value. However, assessments should be undertaken from the consumer's perceptive to determine how to provide them with desired products. Value chain analysis should expand further to address questions such as these: Are products being processed in ways that are valuable to the consumer? Are raw materials being purchased only based on cost or other features that add value for the consumer? How are products being designed, transported, handled, marketed? Do these have any negative or positive impact on the product attributes consumers prefer? How can the consumer's experience with the product be made better? etc.

Beyond agri-food value chain literature, other value chain studies have also not made the consumer the focus of assessment (Zokaei and Simons, 2006). Value chain analysis is being approached with the notion that effective supply chain and cost efficiency will lead to adequate consumer satisfaction. This approach is not adequate because there is a loss of consumer focus, which will result in production activities not meeting the shifts in consumer expectations (Walters and Rinbird, 2004; Thublier et al. 2010). There is, therefore, the need to incorporate the consumer into VCA models. Few studies were found which presented some consumer-based value chain analysis models such as by Walter and Rainbird (2006), Lord Sainsbury of Turville (2007), Thublier et al. (2010), and McMillan and Grath (2013). However, all these are conceptual models, and their application empirically to study specific value chains has not been found. The models do not provide detailed information on how to measure key elements along the chain based on which consumer needs can be identified and improved. The models discussed have also been made in such a way that they apply more easily to customers such as retailers than final consumers, and do not focus on food and agricultural products.

c) Dimension 3: Value measured

In the review, value is viewed from an objective instead of a subjective perspective. Value is, therefore, generally considered as the price that emerges from and settled on in an exchange along a product value chain. Value-added has mainly been estimated as the price minus the cost incurred in producing the good, which, according to Shank and Govindarajan (1992) and Dekker (2003), is narrow. Value in the objective sense is when the object has value inherent in itself. The cost of producing a good, for instance gives a good some value. With the subjective view, the value depends on the individual/ group having or using the good. The understanding of the concept from this perspective is however, not observed in the literature.

Though adding value increases consumers' willingness to pay for a product, the price paid by the consumer does not necessarily indicate that the consumer is receiving products that meet their preferences. For the consumer, the value includes the taste of the product, color, size, nutritional content, safety, convenience with use, etc. Therefore, from the subjective point of view, the true value of the good being offered cannot be inferred from assessing value as the benefit-cost ratio. Most studies focused only on determining whether the producing enterprises are getting some value from producing the good (the profit accrued by the agents along the chain) with no link to the consumer. There were only a few studies, such as by Alioni et al. (2013), which assessed value from the consumers' perspective. Limited attention has been given to evaluating non-monetary benefits in a value chain analysis.

VCA needs to go beyond assessing efficiency to effectiveness (creating value for consumers through differentiation). This is because the value of the product or service must be perceived by the consumer receiving and using the product. According to Feller et al. (2006), the argument on supply chain management and value chain management focuses on the former being related to cost evaluation (reduce cost and offer goods at a lower price) while the latter deals with value (i.e., consumers willingness to pay based on quality preferences and not just the price). Thus, in analyzing value chains, efficiencies should be evaluated based on the value to the consumer (subtle and intangible product attributes such as color, taste, safety, nutrition, packaging, size). Based on such analysis, activities that do not create or add value from the consumers' perspective should be eliminated or improved.

The core of a VCA is to break down the chain activities into relevant segments to understand cost behavior and the sources of differentiation (Shank and Govindarajan, 1992). However, due to the focus on cost/price as value, only one component (i.e., cost and profit estimations) is addressed in the literature. The second component, which is the identification of the sources of differentiation has received scant attention. This second component has implications for the consumer and meeting their revealed and stated preferences and needs.

d) Dimension 4: Multidimensional agri-food value chain analysis

While different dimensions are considered in agri-food value chain analysis, there is still the need to include other dimensions to have a broader and more in-depth understanding of the chains. Considering other non-traditional components in value chain analysis will help to improve the performance of the agri-food chains (Arato et al. 2015). The introduction of different aspects such as governance, social relationships, knowledge sharing and coordination, cultural, political and environmental aspects have been suggested (Tallontire et al. 2011; Peterson, 2013; Marsden et al. 2010; Arato et al. 2015).

For instance, nutrition assessment by identifying the loss of nutrients along the value chain based on how the activities affect food nutrient composition is not studied. Also, understanding the chain to find potential points where the nutritional value of the food product can be enhanced either through value addition or preservation is limited in the literature. This stems from the lack of consumer focus in agri-food chain studies because the consumer will be the direct benefit of nutritional value. Beyond the inclusion of other dimensions, there is a need for more multidimensional studies that take into consideration the assessment of more than two dimensions. Such studies should also go beyond economic, environmental, and social dimensions to include others such as nutrition/quality, knowledge, loss and waste management, governance etc.

Further, most of the multidimensional studies assess the individual performance of each of the dimensions without trying to understand how the performance of one dimension impacts the other. There is a need to go beyond the linear approach to value chain analysis to understanding interconnections between different dimensions and how those interconnections influence the performance of the chain. This will reveal hidden insights and underlying factors to performance. Overall, the critical focus of those studies should be to address consumer needs and provide them with satisfaction. Thus, assessment of the performance of any dimension within the agri-food value chain should be ultimately geared towards improving the performance of the value chain in meeting consumer needs and preferences. Therefore, the indicators chosen for assessment of the different dimensions should be ones which have a direct correlation and/or relevance to meeting consumer requirement.

e) Dimension 5: Focus of agri-food value chain analysis

The focus of agri-food value chain analysis has mainly been centered around the description of the activities and agents in the chain, assessment of constraints, and financial performance. Agri-food value chains have not been assessed to determine their effectiveness in aiding meet food security indicators such as availability, accessibility, utilization and stability. Value chain indicators that have direct links with food security indicators need to be developed for agri-food value chain assessments. Considering that there has been a consensus about the potential of agri-food value chains in achieving food security (Alkire et al. 2014), there should be studies that evaluate the performance of agri-food value chains in doing so. In cases where such studies have been undertaken, the focus has been narrowly on producing consumers. Thus, the actors along a food chain and their households have been the target. Non-food producing consumers have not been considered in the analysis although they also make up food insecure households in developing countries.

Even with regards to producing consumers, they are not self-reliant thus do not produce everything they need. They constitute a part of the non-producing consumers when they are not actors, of the food value chain understudy. This buttresses the need for agri-food value chains to be evaluated with a consumer focus because it targets all consumer groups. And more importantly, agri-food value chain assessment should take a food security approach in understanding how value chain features can be aligned to address the needs of consumers and food security indicators. This is because it determines whether food produced is available and accessible when required and affordable. It also determines if the product is acceptable based on consumer preferences and whether consumption and nutritional needs are being met consistently.

2.4.2 Opportunities for further improvement

There is a need to consider the assessment of agri-food value chains beyond the production stage since there are other stages that the product goes through before it reaches the consumer. This will mean going beyond simply mapping them out or describing the activities within each stage. It will require an in-depth understanding of how the activities influence each other and the performance of the value chain in meeting different goals and standards. In assessing the agri-food value chain performance, there is a need to focus not only on cost reduction but areas where differentiation can be leveraged for the consumer.

The goal of agri-food assessments will be to make the consumer the focus because all the activities performed are geared towards providing them with satisfaction. This should be done by critically looking at each stage of the chain and its contribution to meeting consumer requirements. However, such an assessment cannot be adequately done when consumer requirements are not known by the agri-food value chain actors. Thus agri-food value chain analysis should include an assessment of the consumers of their products to understand their needs, preferences, and concerns. This should then be used as a guide in assessing the product chain to determine whether it is meeting consumer requirements and how the value chain can be aligned to meet these requirements.

There is the need not to consider just the consumer needs but even more, on a broader scale, link food value chain assessment to food security. That is assessing the value chain to understand how it is helping meet food security indicators. The food security indicators have been set out to meet consumer needs, preferences and concerns and thus encapsulate the consumer wholly.

2.4.2.1 Importance of consumer focus in agri-food value chain assessment

Making consumers the focus of agri-food value chains is important because consumers are currently concerned with tangible (taste, nutrition, flour, size, color, convenience) and intangible (safety, animal welfare, environment) product attributes (Collins, 2009; Akkerman et al. 2010; Trienekens et al. 2012). The purchasing decisions of consumers are therefore centered around these factors. Food is no longer to meet a basic need but to fit into a particular lifestyle (Costa and Jongen, 2006). Thus, it's always changing and expanding.

Long term sustainability of the agri-food value chain should be centered on giving adequate consideration to consumer requirements and satisfaction without neglecting the others. In any case, if consumers are being considered in sustainable agri-food chains, the concentration has only been on particular aspects of consumer preferences which is the environmental concerns and animal welfare without taking into consideration other value preferences. Depending on the target consumers such as those in developing countries, majority are not particularly concerned about the environment and animal welfare but require products that possess other valued attributes specific to the product such as taste, size, freshness, convenience, nutritional value, attractive packaging etc. (Gagnon, 2012).

Increasing changes in consumer preferences and dietary patterns towards non-staple foods, processed and convenient foods and, high quality foods require changes along the agri-food value chain to align its activities to meeting these consumer requirements (Gehlhar and Regmi, 2005; Grunow and van der Vorst, 2010). Meeting these requirements is becoming challenging for agri-food industries because there is little attention to consumer requirements in food value chain assessments. Consumers' requirements have not been translated into product features and value chain measures. This makes it difficult to determine a way of adequately measuring the performance of the value chain in meeting consumer needs and identifying how these requirements can be addressed. This is essential to staying profitable which is the target of every business of which an agri-food value chain is one.

"If a production practice is economically viable and reduces environmental impact yet is unacceptable to the consumer, the system is out of balance" Capper (2013, p. 157). Value chains with inadequate focus on the consumer are more likely to fail (Hult, 2011). Consumer centred assessment and interventions are therefore important. The ultimate reward of every value chain or business is to have their products do well on the market measured by high demand, increased consumer satisfaction and continuous purchase. A better sustainability reputation will amount to less if this reward is still lost. Agri-food sectors currently need to upgrade to address new, diversified and expanded consumer demand for high quality, safe, nutritious and convenient foods (Kennedy et al. 2004; Hazell and Wood 2008).

2.4.2.2 Importance of food security focus in agri-food value chain assessment

Food insecurity and malnutrition are caused by challenges at the demand side (consumer) and supply-side (food value chain). Lack of income, employment problems, women inequality, household food diversity problems, low awareness of nutrition, etc. (Arimond et al. 2010; Black et al. 2013) have been found to be the leading causes at the demand side. However, what is made available to the household, its state, form, desirability, price and quantity as well as when, where, and how the food is made available based on which the household makes food choices are impacted by the value chain. Thus, activities along the food supply chain influence what is provided to consumers and, therefore food security indicators. Much attention has been paid to understanding and mitigating food insecurity at the household level. Measurements have focused on dietary diversity, food consumption frequency, spending on food and consumption behavior (Pérez-Escamilla and Segall-Corrêa, 2008). While this is important, it is also necessary to transform the agri-food sector (Maestre et al. 2017).

Although crop production is expected to have a positive impact on nutrition, such evidence has not been conclusive. Studies have found that an increase in food production and availability does not necessarily imply consumption or improved nutrition (Maestre et al. 2017). This implies that food security will not be fully achieved if the challenges and the activities along the food value chain, which impacts all other food security indicators are not identified and mitigated. Achieving food security and nutrition should be approached from both ends and not skewed towards understanding only farming households as is mostly done (Maestre et al. 2017). This will aid in addressing food security through agri-food chains for all groups of people, producing or not, and also leverage on the economic benefits obtained from providing satisfaction to consumers by meeting their needs and preferences.

2.4.2.3 Proposed approach: VCA towards consumer satisfaction and food security

A consumer-based multidimensional framework is vital to help agri-food value chains determine their performance in meeting consumer requirements. It will also guide the identification of the processes required to align value chain activities to meeting consumer requirements. A consumer-based assessment can also be employed in evaluating agri-food value chains with a food security approach. From the literature review, it has been found that there has been the need to pay more attention to the consumer in agri-food value chains. However, there hasn't been the development of a framework that can be used to achieve this. A consumer-centered initiative that places consumer choices first, understands their demands and integrates them into value chain activities is essential (Hult, 2011). Thus, the development of agri-food value chains requires a consumer-centered approach (Figure 2.1), which can lead to more satisfied consumers and returns to participants and the environment.

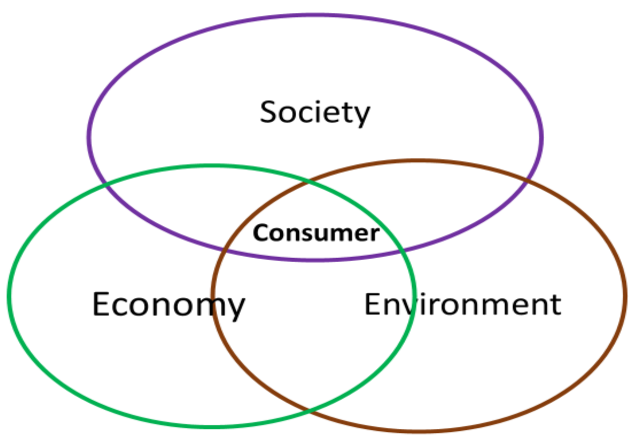


Figure 2. 1 A consumer-centered approach to value chain analysis

The study proposes a framework that starts with understanding the consumption chain to be able to identify consumer needs and preferences. Studied on understanding consumer preferences have been undertaken by numerous authors such as Reddy, 2004; Gigonta, 2013; Legato, 2014; Vaino et al. 2016; Langyintuo et al. 2004; Mishili et al. 2009; Quaye et al. 2011; Hella et al. 2013; Mishili et al. 2009; Mazur, 2011). These studies are separate and not embedded within a full VCA study where there is a merge between the supply and demand chains. They do not study the consumers experience with the product, but mostly the factors considered when purchasing a product. The information on consumer requirements obtained is then grouped as sub-indicators under the food security indicators. This is to identify the association between consumer preferences/needs and the food security indicators (FSI) and link them. In the framework, the consumer requirements linked to FSI are translated into measurable value chain measures. Based on this the value chain is assessed to determine if consumer preferences and needs, and inherently FSI are being met.

There are a number of factors that influence the activities and the environment within which an agri-food value chain function. These, in turn, also affect its performance in meeting consumer requirements. Therefore, the framework involves an assessment of how the chain is performing in those aspects and how they individually and altogether influence the food security indicators. This introduces different dimensions into the value chain analysis and goes beyond the linear approach to understanding interconnections between different dimensions and the consumer.

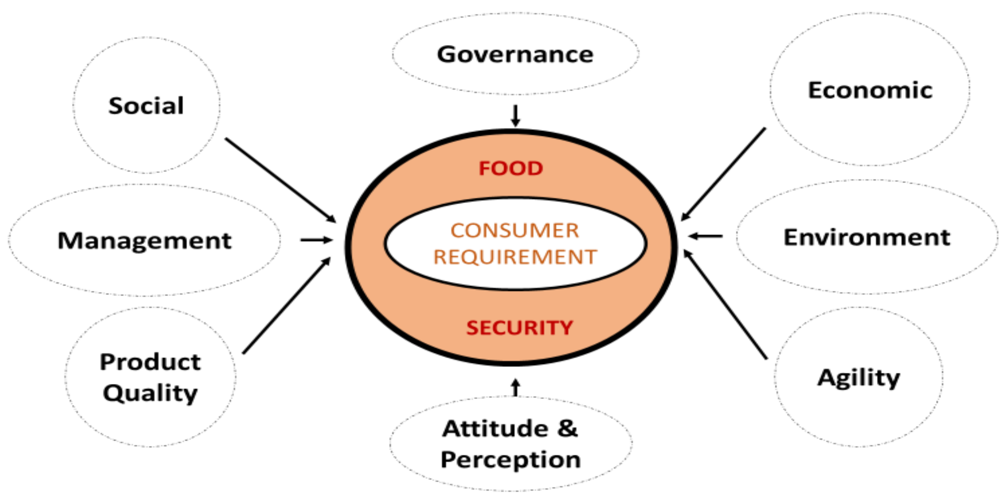


Figure 2. 2 Multidimensional consumer-centered agri-food VCA framework

An integrated framework that goes beyond the assessment of economic, environmental, and social dimensions to include governance, management (losses, waste, and knowledge), food quality assessment, and value chain agility evaluation is proposed (Figure 2.2). The dimensions are discussed below.

Governance structure and agility are often ignored in agri-food value chains. Value chains are not going to be sustainable without an efficient governance structure and ability to adapt quickly to changing systems and conditions even if, at a point in time, they were socially responsible, and environmentally friendly (Bachev and Terziev, 2018). Studies on governance have been undertaken in the agri-food literature by Uddin et al. 2019; Carron et al. 2017; Abel et al. 2019; Tienekens et al. 2018; Ouma et al. 2017. However, these have been separate studies and not included in understanding agri-food value chains.

There is also a wide range of studies on loss and waste management (Ambler et al. 2017; Mvumi and Matsikira, 2016; Martins et al. 2014); however, these are also assessed as individual studies without understanding its influence on consumer requirements. Nutritional losses along the chain, for instance, is not largely considered. Understanding knowledge management within the agri-food value chain is not often analyzed and therefore, there are limited studies on them (Radhakrishnan and Srinidhi, 2005; Macau et al. 2016; Galappaththi et al. 2016). These are mainly centered on information sharing and, other information management practices are not studied. Food quality assessment, which involves understanding the impact of activities on the quality attributes consumers prefer, is often not assessed in agri-food value chain evaluations. This is important for demand and consumption and requires the introduction of food engineering principles to better understand these factors better.

Agility focuses on understanding if and how the agri-food value chain is able to adjust quickly and adequately to the changing socio-economic environment within which it functions. It should also possess the capacity in terms of assets holdings to be able to adjust adequately. Such studies in the agri-food literature are often not found but rather in business and information systems literature (Ganguly et al. 2009; Chakravarty, 2013; Samdantsoodol et al. 2017). Value chain actors' attitudes and perceptions shaped by their experiences and culture are also underlying factors to their performance and should be assessed. While such studies are available in the literature, they are mainly focused only on consumers and not value chain actors. The goal for introducing the different dimensions is to achieve a better alignment between resource allocation, consumer value and management towards sustainability and profitability.

The proposed framework assesses the performance of the chain in meeting consumer requirements within a food security context. It is also a holistic assessment of the agri-food value chain, which will lead to consumer satisfaction, economic viability and food security achievement. This will aid value chain actors, policymakers and other stakeholders design and implement strategies that are effective, applicable, and adapted to the dynamic nature within which the agri-food system functions. Such a framework will be useful to assess the effectiveness of the chain in delivering consumer needs and contributing to food security and nutrition. It is also important for a developed framework to move from a conceptualised form to practical use in evaluating a selected value chain. Hence the framework was applied to the common bean value chain.

Common beans production in Zambia is mainly by smallholder farmers who cultivate local varieties. Average yields range from 0.30 to 0.50 tonnes/ha, which are low compared to 2.0 tonnes per hectare when high yielding and resistant varieties are used (Mwansa, 2004). The marketing system is uncoordinated and largely informal with uneven power distribution between traders and producers (Amanor-Boadu et al. 2004). The industry is characterized by information asymmetry and no price transparency (Mwansa, 2004). For poor households, beans are usually the closest substitute for protein sources such as meat and fish (Beebe, 2008). Pele (2007) found that consumers in Zambia allocated a small proportion of their food expenditure to beans indicating that it was not significant in the food basket. Bean consumption is low; however, this can be improved if activities along the value chain are adequately undertaken within the right policy environment (Birachi, 2012; Mwansa, 2004). While the industry has the potential to contribute to socio-economic development greatly, it is plagued with production, consumption and marketing related challenges. This has implications for demand and food security.

In conclusion, the literature shows that varied approaches, largely influenced by the field of study, chain understudy and the objective, have been used in VCA. Although, the concept of VCA has been widely adopted, developed and used, a consumer perspective has been ignored in the assessment. Agri-food value chains and especially the common bean value chain can contribute to development due to their nutritional and social benefits. Introducing a consumer and food security focus into agri-food value chain analysis can contribute to improving its performance in providing these benefits. Improvement should be directed towards providing adequate quantities of nutritious, safe, acceptable and affordable food to growing populations within a dynamic environment (Marsden, 2014). Applying the value chain concept to achieving this is advantageous because it allows for a systematic evaluation of the different stages and processes in the chain to be able to identify discrepancies.

Connecting Text

The literature review presented in chapter 2 provided an understanding of the concept of value chain analysis and its application over the years. The modifications to value chain approaches, the gaps and opportunities for further improvement were also discussed. From the literature, it was found that concept of VCA has been widely adopted, developed and used. However, there is limited consumer and food security focus in agri-food value chain analysis.

Chapter 3 addressed this gap by presenting a methodological approach to assessing food value chains from a consumer perspective. The proposed framework is designed to improve consumer and food security focus in agri-food value chain analysis. The framework includes a system set out for an appropriate selection of criteria, indicators and dimensions for assessing the performance of the value chain in meeting consumer preferences within the context of food security. Such a framework will be useful to assess the effectiveness of the chain in delivering consumer needs and contributing to food security and nutrition.

CHAPTER 3 A methodological framework for agri-food value chain analysis based on a consumer-food security nexus

Abstract

Optimizing agri-food value chains is essential for addressing food security issues since they are closely linked to satisfying human needs. Within the agri-food sector, the concept of value chain analysis has moved from production to a broader perspective that considers social, environmental, and economic dimensions. Irrespective of the inclusion of other dimensions, a consumer focus, which is essential for the success of any value chain, has been excluded. The study presents a methodological approach for the development of consumer-focused indicators for assessing a value chain and its correlation to food security. In this approach, consumer-focused value chains are designed to perform activities that meet consumer needs and preferences efficiently and maximize their impact on food security. The framework analyses the following broad dimensions (made up of indicators) for different stages along the chain: social, environmental, economic, operational, quality, perception and attitude, agility, governance, and management dimensions. The tool calculates performance values for each broad food security indicator (FSI) using the value chain dimension scores. An easy to use and adaptable data-oriented approach (qualitative and quantitative) is employed. The strengths and limitations of the method have also highlighted.

3.1 Introduction

Optimizing agri-food value chains is essential for addressing food security issues since they are closely linked to satisfying human needs. Agri-food value chains have important implications for food and nutrition security (Alkire et al. 2014) within which consumer preferences and needs are embedded. Production and consumption patterns are constantly changing, but there is a need always to ensure that they are aligned. There are assessment frameworks covering the social, environmental and economic aspects of agri-food value chains; however, there isn't any developed with a consumer focus. Agri-food value chains are usually centred on activities at the production stage and a disconnect with consumers who are often the target of functioning value chains. There are no tools, methods or frameworks which adequately assess the impact of agri-food value chains from a consumer perspective in line with achieving food security. This section illustrates how value chains are linked and embedded within an environmental and socio-economic system. It further argues for the importance of a consumer focus in agri-food value chain assessments and presents a methodological framework for such an assessment. First, a holistic framework for a consumer-centered value chain assessment is outlined. Further, a system for the selection of criteria, indicators and dimensions for the performance assessment is outlined. Based on this, the method of assessment for each dimension and the correlation between dimensions is presented.

3.2 Value chain concept

Value chains are complex in nature in two folds. First, they are a set of linked activities put together to produce a specific desired product. Secondly, they work within a system characterized by a continuous dynamic interaction between social, economic and environmental systems.

Value chains are made up of activities undertaken from production to consumption of a product (Kaplinsky and Morris, 2001). There are various aspects of product value chains, including material flow, monetary flow, informational flow, governance structures and institutions, relationships. Beretta et al. (2013) define a food value chain as "the system of people, and activities involved in moving food from its producer (farmer) to the consumer". Agri-food value chains have activities that are interrelated and interdependent (Flynn and Bailey 2014). Due to the system of linked activities, it has been proposed that value chains should have sustainable development as its core to foster consumer satisfaction, contribute to society, the environment and economic viability (Mitchell et al. 2009). Even though this proposal has been made, only the primary sustainable development dimensions (economic, social, and environment) have been integrated into the food value chain assessment. There is, therefore, a need to design assessment tools to measure how agricultural systems are performing in these dimensions including consumer satisfaction. Assessment tools are often based on indices that are structured to assess performance levels, with measurable sub-areas and indicators. There have been different indices that take into consideration different dimensions ranging from 2 to 5 or more. Some indices are more complex than others and include more than 60 broad parameters (Sulewski and Kloczko-Gajewska, 2018). The indices have different methods of calculation and are undertaken with a focus on the local, national or regional levels.

Although the major dimensions in sustainability assessments are social, economic, and environmental, the latter has received more emphasis (Hayati, 2017). When the economic dimension is assessed, the variables considered are revenue, costs, profits, farm income, liquidity, productivity in terms of the ratio of output to input, diversification of income and dependence on subsidy. The social dimension focuses mainly on education, living and working conditions, physical wellbeing, health, gender equality, including agricultural skills, family status, involvement in social affairs, and safety (Atruffe et al. 2016; Hayati, 2017). At the society level, the opportunities for employment, acceptable practices for the environment, animal welfare, cultural, spiritual and aesthetic values have been considered (Gauwenbergh et al. 2007; Lebacq et al. 2013). Particular to the environmental dimension, land management, emission, biodiversity, soil quality, nutrients, pesticides, soil erosion, crop rotation, quality of farming practices, and non-renewable resources are also considered (Lebacq et al. 2013; Hayati, 2017).

The development of indicators can be dimension based, policy objective-based, sector-based and cause, and effect based (Birkmann, 2004). For sustainability studies in the agri-food sector, the focus has been dimension based indicators. These indicators have been measured by weighting methods, scoring and benchmarks created by recognized organizations. The limitation of these assessments is that their neither interactions nor effects on consumers are not studied. This raises questions about the benefit of a sustainable food value chain that does not meet consumer needs. Agri-food value chains contribute to an essential human need—food; continuous satisfaction in this regard is therefore essential. Consumers are not only concerned with getting their stomachs filled but instead they want to consume foods that meet their preferences. Meeting consumer needs can be achieved by understanding what those needs are, and how the value chain is impacting them. This requires a holistic and comprehensive framework that aggregates different indicators and dimensions to understand the factors influencing consumer preferences.

3.2.1 Consumer-based assessment of agri-food value chains

Consumer satisfaction and the ability to predict consumer needs should be the goal of every sustainable business (Zokaei and Simons, 2006). Consumer-centred initiatives that place consumer choices first, understand their demands and needs, and integrate them into their activities are essential (Hult, 2011). In this study, consumer-focused value chains are defined as those chains which perform activities in a socio-economic and environmentally efficient way to meet consumer needs and preferences.

Food security is achieved based on availability, accessibility, affordability, acceptability (tangible and intangible product attributes preferred by consumers), safety, and nutrition. Meeting consumer preferences falls within the mandate of achieving food security. The development of agri-food chains has been limited to making foods available and affordable. However, for such chains to be sustainable, they should be able to provide food that is also safe, nutritious, and acceptable. This has to be translated into concrete, measurable results and recommendations to guide value chain actors.

While the literature suggests the need to pay more attention to the consumer in agri-food value chains (Hult, 2011) and better link agri-food chains to food security and nutrition (Maestre et al. 2017), no framework has been developed to achieve this. An integrated framework has, therefore, been designed to meet this need. In this framework, consumers are the primary voice influencing the activities performed in the agri-food value chain. Their preferences and needs are determined and fed back into the value chain to improve its performance. The complex system within which the value chain operates and its effect on meeting consumer preferences and food security indicators are studied. This is achieved by integrating different dimensions into the assessment.

The dimensions integrated into the approach include social, environmental, economic, operational, quality, perception and attitude, agility, governance, and management dimensions. The goal for introducing different dimensions is to achieve a better alignment between resource allocation, consumer value, and management. The framework serves as a communication tool to provide decision-makers with measurable ways of addressing consumer needs in line with achieving food security. Such an approach will be useful in improving profitability by focusing on creating and delivering value to consumers (Soosay et al. 2012) and identifying points for policy interventions.

The conceptual and assessment framework presented takes into account demand and supply and, considers the whole food value chain from production to distribution through to utilization and consumption. The consumer-based value chain analysis framework and assessment are set to accomplish four objectives.

1) Effectively capture final consumer requirements (explicit and implicit attributes) and categorized them to fall within each food security indicator. In doing this, the study proposes going beyond listening to the consumer to understanding the consumer's experience with the product.
2) Translate consumer preferences into measurable value chain features that value chain actors can understand. This will enable value chain actors to have a clear way of incorporating consumer requirements into their activities.
3) Identify indicators that are output parameters to evaluate the performance of the chain in meeting consumer requirements and food security indicators.
4) Present a detailed map of the product value chain, assess its structure, functions and performance in meeting consumer requirements and food security indicators are evaluated.

3.3 Design and application of the consumer-based VCA model

The approach adopted in the study focuses on evaluating the effectiveness of agri-food value chains in meeting consumer preferences, along with achieving food security and nutrition. Based on this, a conceptual framework was developed as well as a performance index. The framework aids in identifying requirements for agri-food chains to be successful in meeting consumer requirements holistically within a food security context. It reveals the constraining and limiting factors within the agri-food system and provides policymakers with a more efficient way of designing and implementing strategies to create an appropriate environment for value chains to operate. It will be useful in determining the extent and capacity within which different stakeholders can contribute to helping agri-food systems meet consumer requirements in line with achieving food security and nutrition?

3.3.1 Conceptual model of a consumer-food security nexus for agri-food value chain analysis

The model begins with identifying consumer requirements by understanding their preferences and needs at the household level. It introduces a household value chain analysis (HVCA) which focuses on the consumer and their experience with the product. It involves evaluating consumer preferences for food attributes and resource utilization (energy, water, time) during preparation. It also considers factors influencing consumption, including constraints and satisfaction with product use. The analysis helps to identify known or spoken consumer needs as well as demands that not spoken by consumers. This is useful in helping value chain actors create or improve on products to meet demands of consumers before they could explicitly define them.

Knowledge of the HVCA will shape the activities performed by value chain actors through process optimization and product development to ensure the sustained demand and consumption of targeted foods. This approach starts with the consumer/household level and then the information gathered is fed back into the food value chain to meet identified preferences and needs. The information on consumer preferences and needs are then linked to each food security indicator. Food security indicators have been outlined to meet the needs of consumers. However, connecting specific consumer preferences to each indicator helps to determine measurable ways of improving food security by meeting consumer requirements. Hence consumer preferences serve as sub-indicators of food security indicators. They are useful in identifying ways of measuring and tracking food security by meeting consumer preferences.

Conceptual model

Figure. 1 represents a consumer-based value chain model made up of the product supply and demand chains. The demand chain is the consumption stage, which emphasizes the activities performed by the consumer after the purchase of a product. At this stage, the demands of consumers are defined. They are then used as a guideline or standard in evaluating the performance of the value chain in meeting consumer preferences and needs. The information will be utilized by actors such as producers, processors, and marketers along the product supply chain. The supply side of the chain then focuses its capabilities on shaping, satisfying and sustaining consumer demands. However, since consumer demands are linked to food security indicators, satisfying consumer demands will have implied positive impact on food security.

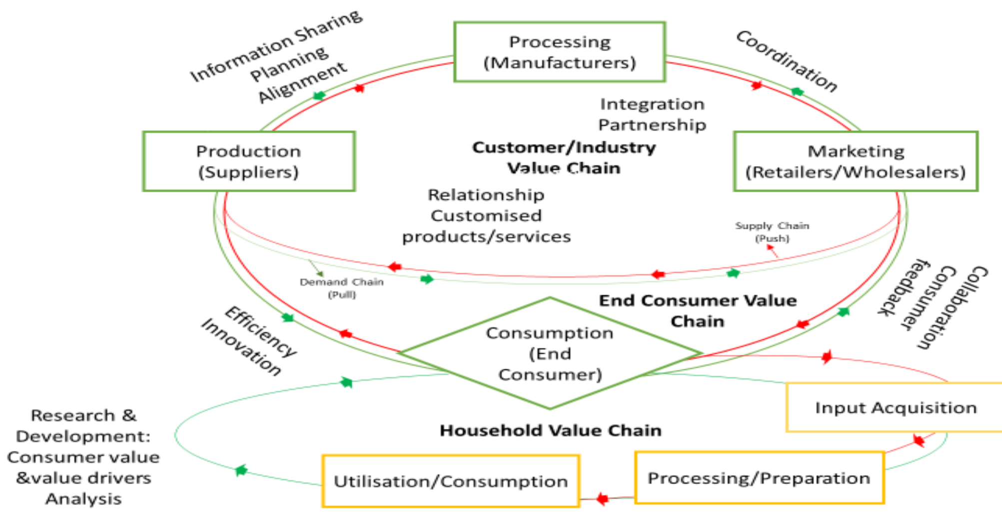


Figure 3. 1 Consumer-based value chain

Along every product chain, consumers pull for the product and push money to the suppliers while suppliers push the product and pull for money. To better provide products that meet the current and future needs of consumers, suppliers can identify the pull factors before product chain activities are undertaken. Such information can be gathered adequately by taking into consideration the consumption stage of the chain.

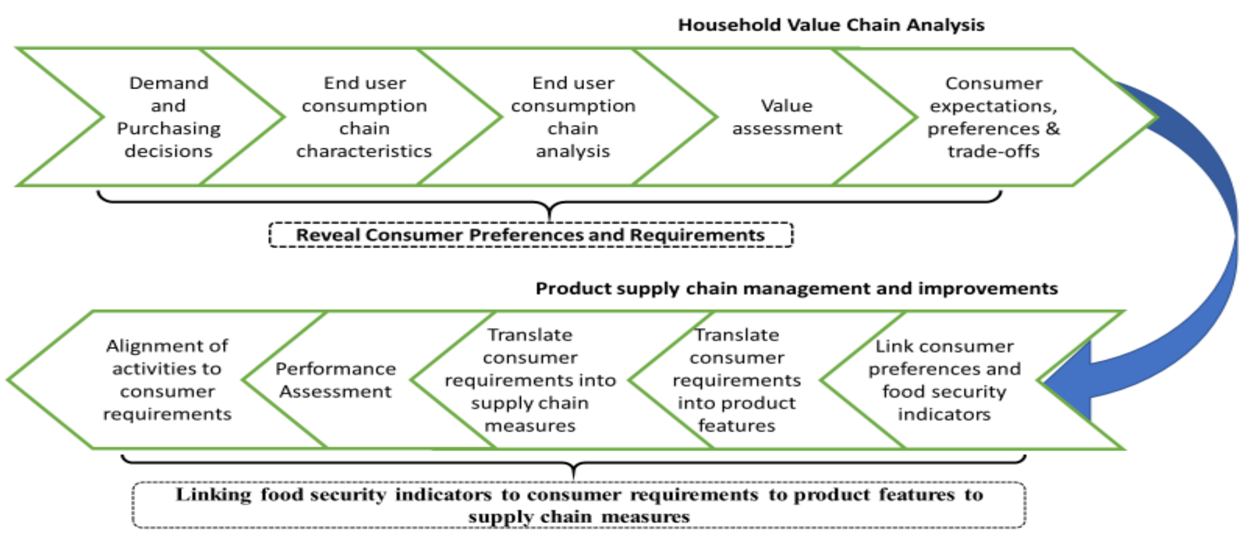


Figure 3. 2 Flow of Consumer-based Value Chain Analysis

Figure 3.2 represents the consumer-food security nexus for agri-food value chain analysis. It also presents the factors to be considered in the analysis, including aligning activities, to improve performance. The overall concept centres around the determination of consumer requirements (revealed preferences and potential benefits), linking consumer requirements to food security indicators, performance assessment of the supply chain in meeting consumer requirements and food security indicators, and the identification and implementation of strategies to close the gap (Figure 3.2). The focus is on addressing the following: What are consumers' preferences, challenges, and desired value from product use? How are these preferences, needs and desired values linked to food security indicators? How can profitable operations along the value chain be adjusted to provide the desired value along with impacting food security?

3.3.2 Application of the consumer-based model

3.3.2.1 Analysis of the consumption chain

Different forms of assessment can be performed in assessing the consumption stage of the product value chain. These include;

1) An assessment to determine what consumers prefer and how they rank different food products and qualities within a food product through assigning scores. The factors influencing their preferences and the value expected to be derived from the use of a product are also identified. This answers questions such as; what do they do with the product? how do they use it? why do they use it that way? and What do they prefer? etc.

2) Identify and assess the different activities performed, and resources (time, energy, etc.) used for each process during the utilization of the good and the factors influencing the different activities performed.

3) Assess how consumers trade off different product attributes by having consumers rank the bundle based on varying levels of the same or different value elements in the same product. Supply chains make a lot of trade-offs in determining how to create more value for consumers. Instead of making such decisions based only on industry capacities and time frames, this information can enable industries to make sound and profitable trade-offs.

4) Identify constraints and satisfaction of the product at different levels of the consumption chain?

3.3.2.2 Connecting consumer preferences with food security indicators

Consumer preferences obtain from the consumption chain assessment are linked to food security indicators. The food security indicators considered in the framework are availability, accessibility, acceptability, affordability and utilization/consumption. The consumer-food security linked indicators are explains below:

1) Availability: The food must be available physically through farm production and easily accessible to traders and processors who purchase for redistribution and value addition. Consumer preferences in relation to accessibility with respect to frequency/seasonality, quantity and variety can be linked to this indicator.
2) Accessibility: The food must be physically accessible to consumers at a relatively low cost in the locations in which they reside or perform livelihood activities. Consumer preferences in relation to accessibility with respect to time, frequency/seasonality, quantity, variety, distance to market and the availability of different types of markets can be linked to this indicator.
3) Affordability: Consumers should have the capacity economically to purchase foods. The ability for value chains to provide low-cost foods is dependent on the availability of price incentives (Hawkes et al. 2012). Consumer preferences or concerns with the price and their implications for purchase can be linked to this indicator.
4) Acceptability: Food must be acceptable to consumers in meeting their tastes and preferences. These preferences include physical appearances, ease of preparation, meeting cultural norms, and consumption patterns. Consumers do not want to trade-off preferences during the purchase of specific foods even if those happen to be nutrition dense. Consumer preferences for taste, size, gloss, freshness, convenience, colour, packaging, cleanliness etc. can be linked to this indicator.
5) Consumption/Utilization: At the point of consumption, food must be safe, nutrient-dense and in different forms which meet the needs and preferences of diverse groups of consumers ranging from infants to adults. Consumer preferences for safety, nutrition, value-added products etc. can be linked to this indicator.

Food production, stability in supply through efficient storage and distribution systems, reduction in losses as well as the costs and margins at the production and marketing stage of the chain affect food security indicators. Value chain activities can also affect consumer-preferred attributes, safety and nutritional value of food. This affects the acceptability and utilization indicators of food security.

3.3.2.3 Consumer-based performance assessment index for agri-food value chains

3.3.2.3.1 Translate consumer requirements (linked to food security indicators) into product features

The consumer preferences can be used to define product features which consumers desire on the market. Thus, after linking consumer needs and preferences to food security indicators (FSI), they are further translated into product features (obtained based on consumer preferences).

3.3.2.3.2 Translate consumer requirements (linked to food security indicators) into supply chain features

It is important for consumer requirements to be translated into measurable value chain measures. Information gathered on consumer requirements is thus translated into product and process features. The framework allows consumer preferences to be linked to food security indicators which are also linked to product features and value chain measures (Table 3.1). For each FSI, the question asked is what does the consumer require and value with respect to the product? Then, how will this preference be translated into a product feature? Then, how will this attribute be measured along the value chain? The goal of translating consumer requirement to product supply chain measures is to determine the factors and activities along the value chain that are required to meet the preferences. The supply chain measures are used as indicators to assess the performance of the chain in meeting consumers.

The study developed a performance index based on a system for the selection of indicators, criteria and dimensions with a consumer and food security focus. For each dimension, there is a corresponding set of value chain indicators which are made up of supply chain measures. The dimensions are further linked to food security indicators which have consumer preferences as sub-indicators. The value chain indicators are measurable parameters of the different dimensions. The tool is a multidimensional performance-based index that does not only determine how the chain is doing across the different dimensions but how they influence consumer and food security indicators (Figure 3.3). It considers more than one dimension and takes into consideration more than one value chain stage and actor, that is, producer and trader, both performing activities at different locations. The food security indicators and dimensions are areas of possible impact, while the indicators are the practical measures of assessment. Their scores determine the performance of the dimension and food security indicators (Shnitt et al. 2014).

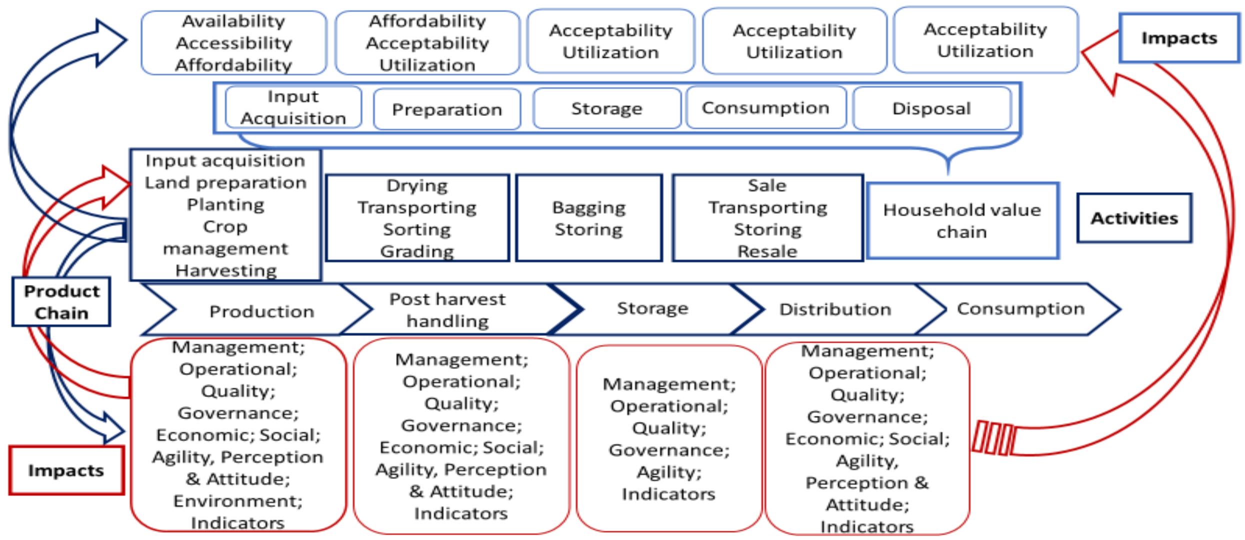


Figure 3. 3 The influence of value chain activities and their operational environment on consumer activities (requirements) and FSIs.

The significance of the framework is to go beyond recommending production and quality improvement in specifying what should be improved and produced. Quality can be grouped into four: the first is meeting with standards and specifications; the second is satisfying known consumer needs; the third is appropriate pricing and the fourth is meeting demands that are not spoken by consumers (Shiba et al. 1993). At the end of the assessment, all activities should be grouped into value-adding and non-value adding activities, and those that impact consumer value and food security indicators negatively should be removed or adjusted, if possible. Further, a future state of the value chain can be generated based on recommendations. It can also guide the upgrading process; recommendations could range from short-term to long-term interventions.

3.3.2.3.3 Determination of indicators, criteria and dimension

The dimensions are premise factors to be assessed and linked with measurable indicators. Indicators provide information that can be used as a benchmark in decision making. Indicators need to be clearly linked to the objectives. They should be reliable, appropriate within a particular location and context, easy to identify and acceptable to a wide range of stakeholders (Meszaros et al. 2015). They should also be practical, that is, measurable and representative of the phenomenon. A set of indicators have also been recommended as opposed to single indicators. These indicators should, however, be few, consistent and sufficient to jointly answer the question (Lebacq et al. 2013). These factors were taken into consideration in the selection of indicators (Table 3.1). The individual indicators were obtained from survey data and aggregated to get a composite indicator. Aggregation was achieved through sums, and normalisation techniques (Finn et al. 2009).

Consumer preference indicators were selected based on information gathered from consumer studies and categorised as sub-indicators within each food security indicator. The indicators selected for this framework can be applied to other food value chains, although slightly tailored to the common bean consumers and value chain. The value chain indicators were selected with the demand side indicators in mind. This was to ensure that they were directly linked and have implications for the consumer and food security indicators.

The process of identifying the indicators was based on both literature and subjective decisions because the indicators provided in the literature were not all relevant to assessing the performance of value chains with a consumer and food security focus. Thus, some of them were based on existing studies (Lui, 2019; Bochav, 2017; Sulewski and Kloczko-Gajewska, 2018; Meszaro, 2015; RTG, 1666; Fedrova and Pongracz, 2019, Bevilacqua et al. 2019; Matias et al. 2018; Watabji et al. 2016) and others created based on survey (interviews and data gathered from stakeholders along different stages of the chain). These groups are able to provide adequate information on activities and challenges along the value chain. Indicators considered in the index also include those, such as public-private partnership, value addition, policies to promote agribusiness and food value chains, proposed by FAO as important in achieving food security.

Making the consumer the focus of the analysis requires the inclusion of other indicators beyond social, environmental and economic dimensions. A conceptual approach mainly used in the social sciences was adopted to develop the indicators (Kuhndt et al. 2004; von Gleich et al. 2006; Giebler et al. 2010). The approach requires the breaking down of the concept into dimensions, categories, aspects and then indicators. The indicators selected for each segment were clearly specified with different units of measurements (percentages, ratios, quantities and averages). Quantitative indicators are easier to measure; however, qualitative indicators were also chosen when required. Some indicators may be relevant only for specific consumers and food security indicators because they do not have an impact on the others. In the end, there will be four different links, consumer requirements to FSI, FSI to product features (based on consumer preferences), product features to value chain actions, and product value chain actions to dimensions.

3.3.2.3.4 Selection of food supply chain assessment indicators

Agri-food value chains can be simple or complex. It comprises of persons, processes and products. The processes are the activities that are required to transform materials into outputs (products) by persons equipped to perform those activities. The activities performed, the interactions of actors, the flow of information, costs, benefits, social incentives, and governing structures, among others, influence the performance of the chain (Maestre et al. 2017). Thus, understanding the functioning of the product chain along different dimensions and their implications for meeting food security outcomes is essential. The dimensions were selected based on different factors and are explained below;

Environment Dimension

The food value chain needs to be able to conserve the natural environment (land, water, and atmosphere) to ensure its continuous use. Overexploitation of land and water (Soussana, 2014) impact food security indicators because natural resources are inputs to agri-food activities. Without them, consumer needs and preferences cannot be fulfilled sustainably. Currently, consumers place importance on industries that have lower pollution and contribute less to climate change by having lower emissions. (Gagnon, 2012). This dimension addresses the effect of value chain activities on environmental factors.

Quality Dimension

Quality attributes vary on a wide range for consumers who require products that meet their preferences and lifestyles (Trienekens et al. 2012). Consumers are also more aware of the need to have safe food that does not cause any illness and increase the costs of medical care (Gagnon, 2012). Low-value addition leads to the low diversity of products for consumers and low levels of utilization. These quality attributes influence the acceptability of the product and its consumption. This dimension addresses the effect of value chain activities on physical, nutritional, and safety attributes.

Social Dimension

The agri-food value chain needs to perform activities that ensure the conditions and health of the agents are not negatively impacted. Functional social networks, trust and working conditions are necessary for agents to perform their activities consistently along the chain (Milagrosa, 2007). They lead to lower labour costs, prices and increase work efficiency. These translate into productivity and higher economic performance and impact food security positively. They ensure that products that possess valued attributes are available, easily accessible, affordable and acceptable to consumers. This dimension evaluates safety, trust, employment, collaborations and social networks along the chain.

Economic Dimension

The agri-food value chain has to be productive and profitable to ensure financial stability. Value distribution along the value chain is a reflection of the economic power of the agents. High costs and unequal value distribution can translate into high prices for consumers. This can affect affordability, acceptability and utilization. In cases where there are significant costs in meeting consumer requirements and food security outcomes, these costs should be reduced or eliminated to ensure affordability.

Management Dimension

The management dimension primarily considers two factors, post-harvest loss management, and knowledge management. A significant amount of food losses affects the availability and accessibility of food for human consumption (Gustavsson et al. 2011). It, in turn, affects affordability when supply is not able to meet demand. Losses can also be in terms of quality, where certain products do not meet consumer requirements. This affects acceptability, and in cases where losses are in terms of nutrients, consumption and nutrition are impacted. Losses are often due to a lack of knowledge of management practices. Thus, integrating knowledge and loss management dimensions into agri-food value chain analysis plays a role in determining strategies to sustain growth. Knowledge acquisition and application play a key role in efficiently managing activities to produce and deliver products that satisfy consumer requirements. Access to knowledge on activity performance, consumer requirements, waste and cost management, etc., on a timely and frequent basis as well as its management, is evaluated.

Governance Dimension

There should be functional governing structures that ensure maximum efficiency in the performance of activities within the chain and strengthen relationships. Efficient coordination and sharing of information are essential to ensure that all operations are performed in a manner that adequately contributes to meeting consumer requirements. Failure in one part of the value chain can limit overall success. Also, the environment within which agri-food value chains function are affected by policies, standards, regulations, and systems which affect the overall performance of the chain. The value chain environment can increase costs, contribute to uncertainty, limit entry into the chain or not encourage consumer-centred activities (Maestre et al. 2017; Camanzi et al. 2018). These factors are considered in this dimension. Interactions between public and private organizations are also considered.

Awareness and perception Dimension

Given that the actions of agents along the agri-food value chain are dependent on their perceptions and awareness, it is important to include such variables in assessing the performance (Sabiha et al. 2016). The knowledge of consumer requirements, their attitudes about them, perception and willingness to meet them affect their value chain activities and FSIs.

Agility Dimension

The agri-food value chain should be able to adjust quickly and adequately to the changing socio-economic environment within which it functions to meet needs, preferences and challenges. Resilience in the system is necessary to provide the desired products amid disturbances, recover from shocks and adapt to ongoing changes (Biggs et al. 2015). In value chains, there should be stable access to markets, production of nutritious, diverse and quality foods for consumers in the face of shocks (Tendall et al. 2015). Agri-food chains are embedded within complex social, environmental, political, economic systems. They are also impacted by a dynamic natural and resource acquisition system, be it physical, financial, or human institutions that govern these systems (Mahoney et al. 1992). This is coupled with changing consumer demands. The value chain actors should also have the capacity to be agile through the ownership of productive assets. Furthermore, agility is necessary when the food security indicator, stability, is taken into consideration. Stability requires that all FSI are stable throughout the year which is dependent on the ability of the chain to adjust adequately to changes.

Operational Dimension

Activities performed along the chain from farming to marketing and the processes involved in each activity affect product features and consumer requirements. The efficiency with which they are performed or otherwise affects FSIs.

Different indicators are specified within each dimension and are presented in Table 3.1. A breakdown of the dimensions constituting each food security indicator in the performance index is presented in Fig. 4.

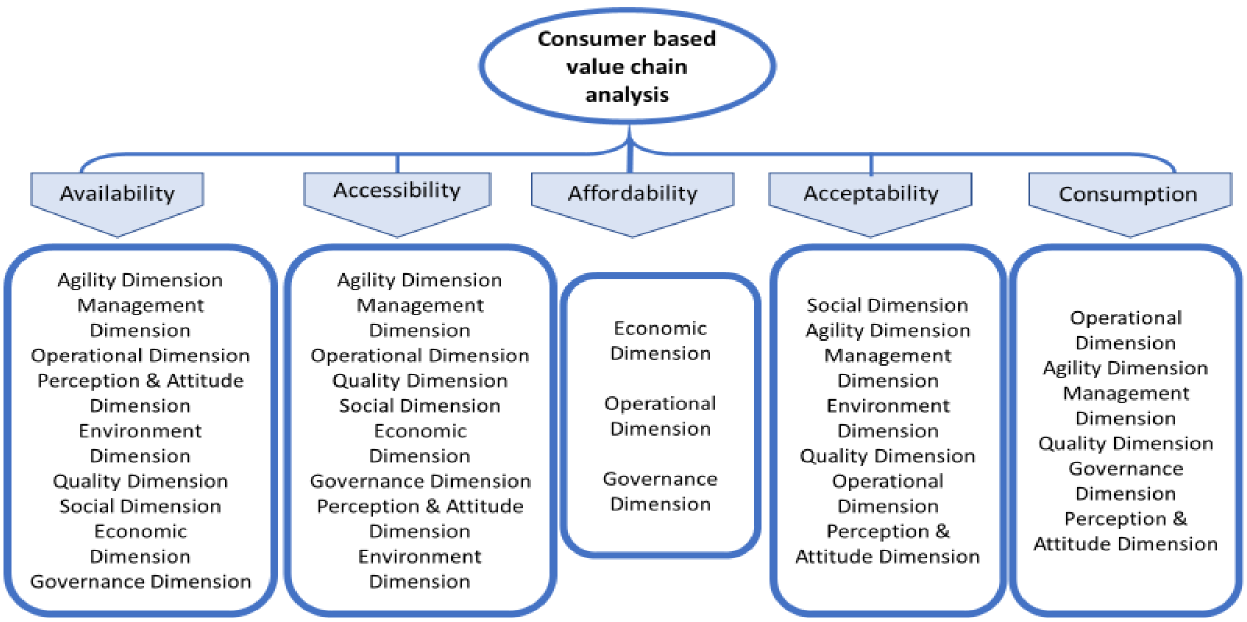


Figure 3. 4 Dimensions used in the assessment of food security indicators

3.3.2.3.5 Methodology

Following the selection of dimensions, criteria and indicators, data was gathered to measure the indicators. The next step is the normalisation of indicators for comparison, followed by aggregation. In the index, there are 9 dimensions, 35 criteria, and 51 Indicators. Some studies have combined different dimensions to understand agricultural systems, with a varied number of indicators ranging from 12 to 41 indicators and up to 60 parameters (Kania and Kapłon, 2014; Harasim and Włodarczyk, 2016; Feledyn-Szewczyk and Kopiński, 2015; Bojarszczuk et al. 2017). The dimensions were assessed through a sum of indicators, multiple weight method and assigning scores through expert assessment.

Indicators that could be measured and represented the context within which the study was being undertaken were selected for the index. The procedure and the relations between the dimensions, criteria and indicators are presented in Figure. 3.5. The selected indicators, though clearly defined, did not have a uniform measurement unit. The indicators also did not have weights according to their importance; instead, it was assumed that all indicators, categories and dimensions had equal weight for simplicity of analysis.

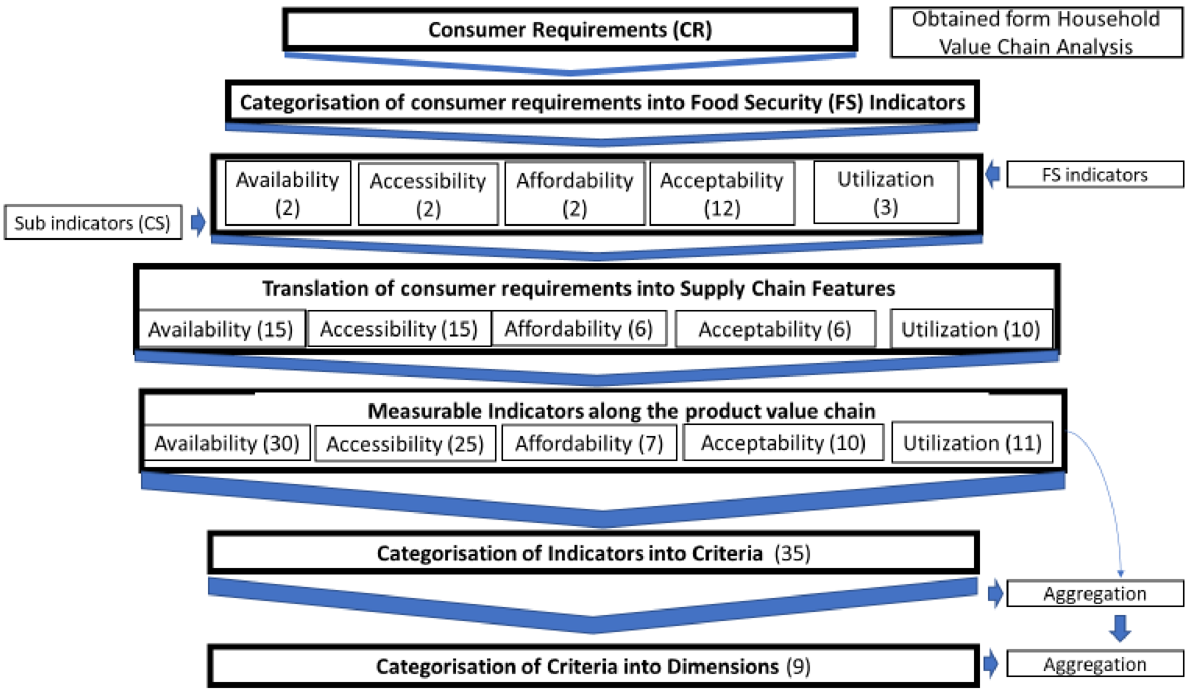


Figure 3. 5 Pictorial view of the framework

In the process of normalisation, various methods can be employed to reduce outliers. These methods could range from rescaling, percentage relations, mathematical transformation and distance measurements (Salzman, 2003). Aggregation can also be performed through addition, factor analysis, means, and the use of weights and rules (Mazziotta and Pareto, 2013). The normalisation and standardisation techniques used in this study were based on Sulewski and Kloczko-Gajewska (2018). A mathematical transformation was employed for normalisation and additions and means were used in aggregation. The output parameters for the indicators were scaled to the 0 to 1 range. Data on different subjects was gathered through varied types of measurement. For continuous variables such as yield values, they were transformed into the 0 to 1 range based on the quantiles (deciles) method; that is, the distribution is segmented into 10 sections. After being sectioned, they are then provided with scores ranging from 0 to 1. This means that for values falling within the ninth and tenth decile, a point of 1 is assigned, if they fall within the eighth and ninths decile, they are given a value of 0.9.

This method helped to assign points to variables which would have been difficult to value objectively. With this method, the need for expert assessment of the level of the indicator is eliminated. The approach by Ostasewicz (2011) is applied in estimating the value of individual deciles:

$$Q_k = X_{Qk} + \frac{N_{Qk} - \sum_{i=1}^{k-1} n_i}{n_m} i_{Qk} \qquad \text{eqn (3.1)}$$

Q_k – symbol of the k-th decile; X_{Qk}- lower limit of a given range; N_{Qk}- position of a given decile calculated based on $kN/_{10}$; $\sum_{i=1}^{k-1} n_i$- the number cumulated to the range preceding decile; i_{Qk}- span of the range in which the right deciles are located; k- number of range in which the corresponding decile follows; N- collectivity size.

In cases where ordinal variable were measured, through the use of a Likert scale, the distance between the ranks is divided into equal sections. The sections are divided to be within 0 and 1, with equal distances between the ranks. For instance, if a four-level scale is used, the correct answer or the highest score is given a point of 1 and then 0.75 and so on. In cases where the variable is dichotomous, such as cases with “yes” and “no”, the expected response is assigned 1 and the other 0. After normalisation of the indicators, they were aggregated through summation to obtain performance scores for the different dimensions. However, care was taken to ensure that an average was not estimated for parameters which are not comparable with each other. Aggregation was performed by estimating sums and means of the various indicators and criteria as follows:

$$Perfromance\ of\ Criteria(PC) = \sum(Sum\ of\ indicators, SI)/_n \qquad \text{eqn (3.2)}$$

$$Performance\ of\ Dimension\ (PD) = \sum(Sum\ of\ Criteria, SC)/_n \qquad \text{eqn (3.3)}$$

$$Perfomrance\ of\ Food\ security\ indicator\ (FSI) = \sum(Sum\ of\ dimensions, SD)/_n \qquad \text{eqn (3.4)}$$

Where n= number of indicators, criteria and dimensions.

The dimensions were employed in measuring the food security indicators. Thus, the dimensions scores corresponding to each food security indicator were also aggregated to obtain the value chain performance score in meeting each food security indicator. The performance scores were interpreted on levels such as high (0.83-1), Good (0.5-0.82), Low (0.22-0.49) and poor (0-0.2). The performance of the product supply chain in meeting each FSI was assessed based on standards (Figure 3.6). These standards are the levels or states that the dimensions being assessed are supposed to attain.

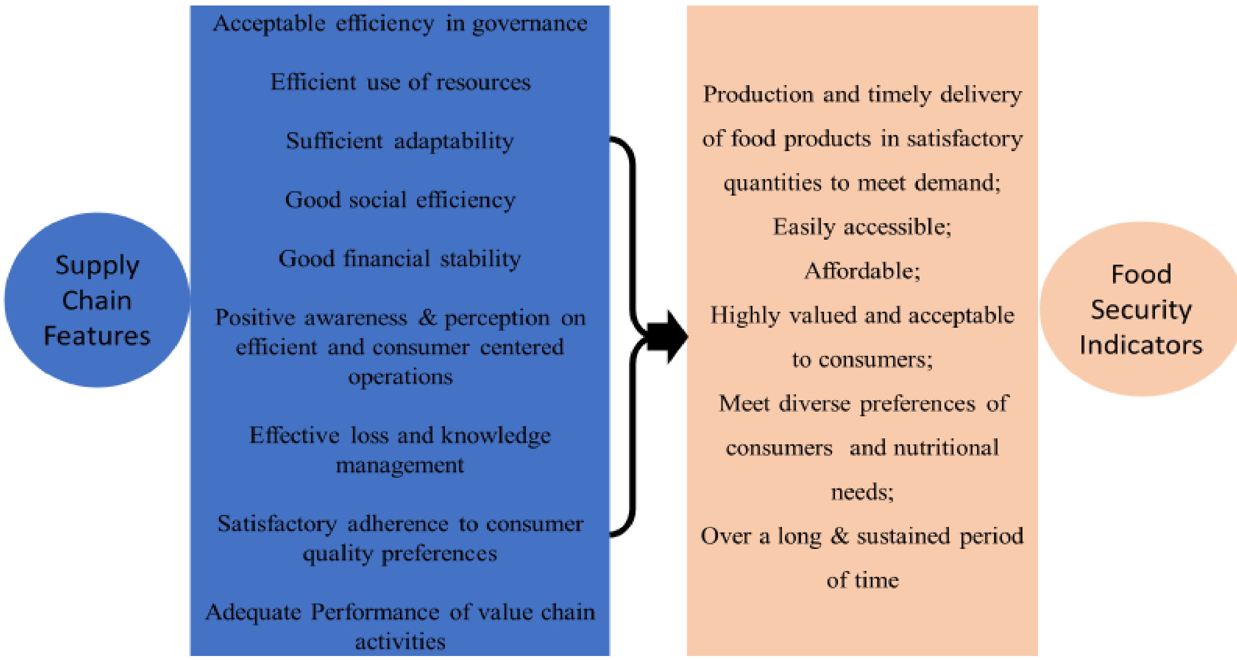


Figure 3. 6 Standard states that the dimensions in meeting FSIs

The quantile method was used to transform the data to ensure that they were all having the same scale with a minimum score of 0 and a maximum score of 1. The scores for each dimension and food security indicator were standardised by dividing by the number of indicators that made up each parameter (total possible score to be attained). This ensures a comparison could be made. In the performance index, performance levels for the dimensions and food security indicators were made based on percentage ranges, the closer the score is to 100% the better it is. However, for the indicators, such as best cropping practice, efficient management techniques, effective climate change mitigation practice, amount of fertilizer and pesticides to be used on-farm, references from the literature were used. The literature provided information on the best techniques, practice or quantities per farm which were used as standards to determine the deviation from the expected.

For variables such as income, profits, processing times, losses, yields, value chain actors with higher amounts had higher scores. They had scores which approached the maximum. For variables that required ranking, responses that leaned towards the most positive response or expected response had higher scores. Consumers performance ratings are also used to determine the performance of the value chain in meeting their requirements. The scores obtained from the consumers were compared to those obtained from the assessment of the value chain to determine how closely related they were. This was also to serve as a means of verification. Indicators included in the consumer-based performance assessment includes the availability of beans all year round, the availability of desired varieties at all times and easy access to beans traders. Other indicators included the level of damage of beans and level of satisfaction with bean attributes such as colour, packaging, size, cooking time, quality (presence of infested seeds and foreign materials). Other indicators include satisfaction with market services, affordability of beans, availability and preference of value-added products, the substitution of bean with other products, the safety of beans for consumption, ability to purchase desired quantities etc. These indicators were categorised into the different food security indicators to be assessed. The complete value chain is assessed in the performance index because understanding and tackling issues affecting food security and nutrition will not be comprehensive if only one stage of the chain is studied.

3.3.2.3.6 Test of correlation

The variables included in the design of an index are required to be as comprehensive as possible and should be correlated with the index. This is because poorly correlated variables may be measuring something different than expected (Babbie, 1995; Sulewski and Kloczko-Gajewska, 2018). Thus, an analysis of correlation matrix was used to determine the variables to be included in the index, after which poorly correlated (lack of statistical significance) variables were removed (Sulewski and Kloczko-Gajewska, 2018). This was achieved with the use of Spearman's correlation analysis to estimate the coefficient between indicators and dimensions scores as well as dimension scores and food security indicator scores. This was done to ensure that the indicators used in assessing the performance of the chain in meeting food security indicators are correlated to the measurement index.

3.3.3 Alignment of value chain activities to consumer requirements and food security indicators

Following the performance evaluation, strategies should be put in place to align value chain activities to product features defined based on consumer requirements. At this stage, activities are adjusted to physically bridge the gap between the potential and actual value that the consumer could derive from the product. By doing this, the food value chain draws closer to closing the gap between current food security achievements and desired goals.

Table 3. 1: Indicators and their measurements

FSI (consumer req.)	Product features	Supply chain features	Assessment questions	Type of data	Indicator	Criteria	Dimension
Availability							
			Crops cultivated per ha	Objective/ Quantitative			
		Have high production yields progressively of different varieties	Max./Avg yields per season	Objective/ Quantitative	Production capacity		
			Number of varieties produced per season	Objective/ Quantitative		Production	
			Estimated share of seeds from various sources	Objective/ Quantitative			
			Cropping system	Subjective/ Qualitative			
		High production capacity	Ratio of current yields to total production capacity	Objective/ Quantitative	Land productivity		
			Rate status of soil (extent of erosion)	Subjective/ Qualitative			Operational
		Access to productive assets and infrastructure	Level of efficiency of technology for performing activities	Subjective/ Qualitative	Technical capability	Technology	
			Assessment of productive resources available	Assessment based/ Qualitative			
			Mode of transportation	Subjective/ Qualitative			
			Processing time between production and sale of product	Objective/ Quantitative	Speed to get product to the market	Market	
Product should be always available on the market.	Good quantities of products	Meet delivery schedules	Rate ability to meet delivery schedule	Subjective/ Qualitative	Delivery reliability		
The desired variety of product should be available on the market	Good quantities of different varieties		Quantity sold after harvest	Objective/ Quantitative	Market surplus	Market	
		Have low levels of losses	Percentage of low-quality products	Objective/ Quantitative	Product quality		
			Application of loss management techniques	Assessment/ Qualitative	Loss management	Loss management	
		Have and apply knowledge on	Easy access to information on changing attribute preferences	Subjective/	Market knowledge	Knowledge/ Communication	Management

	consumer preference/market	(rank) / presence of avenues for information (yes or no)	Qualitative			
		Rate knowledge of the market/consumers	Subjective/ Qualitative			
		Number of training sessions in a year	Subjective/ Qualitative	Information access		
	Efficient access to knowledge and training	Rate usefulness of training and information	Objective/ Quantitative	Information access		
		Knowledge of plant and process needs (Rate)	Subjective/ Qualitative	Information access		
		Apply rules for the management of resources	Subjective/ Qualitative			
		Climate change mitigation strategy adopted (how many)	Objective/ Quantitative	Production practices	Production	Operational
		Rate efficiency of climate mitigation practice	Objective/ Quantitative			
		Method of harvesting	Assessment/ Qualitative			
	Apply best production practices	Practice of crop rotation	Subjective/ Qualitative			
		Amt or freq. of fertilizer used/ha	Objective/ Quantitative	Agro- technique	Agro-technique	
		Proportion of area with pesticide	Objective/ Quantitative			Environment
		Amt of organic matter applied/ha	Objective/ Quantitative			
		Proportion of legume to other crops	Objective/ Quantitative	Diversity of production		
		Irrigation (Yes/No)	Subjective/ Qualitative	Irrigation	Irrigation	Operational
		Method of product storage	Subjective/ Qualitative	Storage techniques	Storage	
		Level of trust among actors (Rate)	Subjective/ Qualitative	Governing activity	Activity management	

Have an efficient governing system	What is the system of governance? (Who dictates prices, purchasing and sale activity/ % control)	Subjective/ Qualitative	Governing activity	Activity management	Governance
	Assessment of tendency of local community to help each other	Subjective/ Qualitative	Relationship		
	Presence of contract farming (Yes/No)	Subjective/ Qualitative	Governing activity		
	Number and level of stakeholder involvement in activities (private and public)	Subjective/ Qualitative	Stakeholder involvement	Institution	
	Policies to increase availability (yields, training) (Yes/No)				
	Stakeholder requirement				
	External Support				
	Income per worker	Objective/ Quantitative	Income	Profitability	
	Profit	Objective/ Quantitative	Production value		
Financial stability to invest	Assessment of income stability by agent	Subjective/ Qualitative	Stability of income		Economic
	Subsidies to farm income	Objective/ Quantitative	financial support	Financial capability	
	Access to credit	Objective/ Qualitative	financial support		
	% new agents with 5 years	Objective/ Quantitative			
Easy entry into the chain	Rate the level of ease of entry into the chain	Subjective/ Qualitative	Employment		
	Easy access for young people and women (Rate)	Subjective/ Qualitative		Employment	
	Level of labor productivity (average hours of work)	Objective/ Quantitative	Efficiency of worker		
	Competence level	Subjective/			Social

			Qualitative			
	Low levels of injury and high levels of safety	Assessment of health	Subjective/ Qualitative	Health	Health and safety	
		Frequency of injury /per	Objective/ Quantitative			
		Rate seriousness of injury	Objective/ Quantitative			
		Attitude towards safety/ Training on safety	Subjective/ Qualitative	Safety attitude and practice		
		Rate willingness and ability to adapt to changing market	Subjective/ Qualitative	Consumer adaptability		
		Rate speed of adaptation to changing market				
	Ability to adapt quickly to changing natural and market environment	Rate willingness and ability to adapt to changing natural environ.	Subjective/ Qualitative	Consumer adaptability	Adaptability	Agility
		Rate speed of adaptation to changing natural environ.				
		Awareness of the impact of changing climate (Rate)	Subjective/ Qualitative	Environment adaptability		
	Positive perception about the importance of efficient performance of activities	Attitude and perception assessment based on selected questions regarding practices towards efficient performance activity	Assessment based /Qualitative	Actor attitude and perception	Attitude and perception	Perception and attitude
Accessibility	Have high levels of stock of different product varieties to meet demand	Max./Avg. quantities of products purchased for sale	Objective/ Quantitative	Delivery reliability	Market	
		Ratio of product varieties in a bulk				
		Ability to meet seasonal demands (Rate)				

		Meet delivery schedule	Processing time between purchase and sale of product Average delay time Rate ability to meet delivery schedule	Objective/ Quantitative Subjective/ Qualitative	Delivery reliability	Market	Operational
			Time and difficulty to get to market Out of stock time	Subjective/ Qualitative			
		Deliver products in an acceptable and creative way	Type and purpose of packaging material used	Subjective/ Qualitative	Product delivery		
		Adequate trading facility	Ratio of facility in use to the total capacity of the facility	Objective/ Quantitative	Market facility and capacity		
		Apply best practices	Level of efficiency of technology/methods for performing activities	Subjective/ Qualitative	Technical capability	Technology	
			Method of product storage	Subjective/ Qualitative	Storage techniques		
		Access to productive assets and infrastructure	Assessment and rating of assets available to traders	Assessment based/Qualitative	Technical capability	Technology	
		Have low levels of losses	Quantity sold after accounting for losses/retention	Objective/ Quantitative	Marketed surplus	Market	
			Percentage of low-quality products	Objective/ Quantitative	Product quality	Market	
			Application of loss management techniques	Assessment/ Qualitative	Loss management	Loss management	
Product should always be accessible at the market	Good quantities of products	Have and apply knowledge on consumer preference/market	Easy access to information on changing attribute preferences (rank) / presence of avenues for information (yes or no) Rate knowledge of the market/consumers	Subjective/ Qualitative	Market knowledge	Knowledge/ Communication	Management

The desired variety of beans should be accessible at the market	Good quantities of different varieties		Number of training sessions in a year	Subjective/ Qualitative	Information access		
		Efficient access to knowledge and training	Rate usefulness of training and information	Objective/ Quantitative	Information access	Knowledge	
			Knowledge on product and process needs	Subjective/ Qualitative	Information access		
			Level of knowledge sharing between and among actors.				
			Level of trust among actors (Rate)	Subjective/ Qualitative	Governing activity		
			What is the system of governance? (Who dictates prices, purchasing and sale activity/ % control)	Subjective/ Qualitative	Governing activity	Activity management	
		Have an efficient governing system	Assessment of tendency of local community to help each other	Subjective/ Qualitative	Relationship		Governance
			Number and level of stakeholder involvement in activities	Subjective/ Qualitative	Stakeholder involvement	Institution	
			Policies to increasing accessibility (linking to markets) (Yes/No)				
			Stakeholder requirement External Support				
			Income per worker	Objective/ Quantitative	Income	Profitability	
			Profit	Objective/ Quantitative	Production value		
			avg. transportation cost & avg. storage cost				
		Financial stability to invest	Assessment of income stability by agent	Subjective/ Qualitative	Stability of income		Economic
			Subsidies to farm income (% of income put into production)	Objective/ Quantitative	Financial support	Financial capability	
			Access to credit (Yes/No)	Objective/ Qualitative	Financial support		

		% new agents with 5 years	Objective/ Quantitative			
	Easy entry into the chain	Rate the level of ease of entry into the chain	Subjective/ Qualitative	Employment		
		Easy access for young people and women (Rate)	Subjective/ Qualitative		Employment	
		Level of labor productivity (average hours of work)	Objective/ Quantitative	Efficiency of worker		
		Time and difficulty to get from farm to hospital	Objective& subj/ Both	Location		Social
		Assessment of health	Subjective/ Qualitative			
	Low levels of injury and high levels of safety	Frequency of injury /per	Objective/ Quantitative			
		Rate seriousness of injury	Objective/ Quantitative	Health	Health and safety	
		Access to insurance	Subjective/ Qualitative			
		Attitude towards safety/ Training on safety	Subjective/ Qualitative	Safety attitude and practice		
		Rate willingness and ability to adapt to changing market				
	Ability to adapt quickly to changing natural and market environment	Rate speed of adaptation to changing market	Subjective/ Qualitative	Consumer adaptability	Adaptability	Agility
	Positive perception about the importance of efficient performance of activities	Attitude and perception assessment based on selected questions regarding practices towards efficient performance activity	Assessment based /Qualitative	Actor attitude and perception	Attitude and perception	Perception and attitude
Affordability						

		Use cost efficient methods	Assessment of the cost efficiency of processes	Assessment based/ Quantitative	Cost efficient methods	Cost efficient methods	Operational
		Have price incentives	Policies to increase affordability (price incentives) (Yes/No)	Subjective/ Qualitative	Price incentives	Price incentives	Governance
Product should have affordable prices	Cheap/affordable product	Set prices accurately and truthfully	Do actors have the interest of consumers at heart? (Rank)	Subjective/ Qualitative	Trust	Trust	
The desired variety should be at an affordable price			Assessment of pricing scheme/ margins (Is it fair?)	Assessment based/ Quantitative	Fair pricing	Fair pricing	Operational
		Low production cost	Total variable costs (logistic and maintenance cost)				
			Average purchasing price (weighted per quantity)	Cost assessment/ Quantitative	Cost	Cost	
			Range of purchasing price (price fluctuation)				Economic
			Price stability				
		Good profit/gross margin	Profit/ gross margin	Profit analysis/ Quantitative	Profit margin	Profit margin	
Acceptability							
		Apply production practices that provide consumers with products that meet their preferences	Assessment of the impact of each process on selected food attributes	Scientific data/ Qualitative	Adherence to consumer quality preferences	Product reliability	Quality
			Grading of products to obtain homogenous and satisfactory product attributes	Subjective/ Qualitative			
			Application of loss management techniques	Assessment/ Qualitative	Loss management	Loss management	Management
			Use of biodegradable or recycled materials (Yes/No)	Subjective/ Qualitative	Eco design	Eco friendly processes	Environment

			Comply with animal welfare norms (Yes/No)	Subjective/ Qualitative	Animal welfare	Animal welfare	Social
The product should have consumer desired qualities and satisfy their needs and preferences	Product with desired gloss, size, taste, flavour, freshness, appearance, packaging, color, low time and resource use	Have access to a quality control system	Level of efficiency of quality control system (Rate)	Subjective/ Qualitative	Quality control system	Efficiency of system	Operational
		Make products that have low defect rate	Level of efficiency of infrastructure to make products with low defect rate	Assessment based /Qualitative	Defect rate		
			Percentage of unqualified product	Objective/ Quantitative			
		Have a positive perception about meeting consumer requirements	Attitude and perception assessment based on selected questions regarding meeting consumer preferences	Assessment based/ Qualitative	Actor attitude and perception	Attitude and perception	Perception and attitude
			Actor perception of quality (Ratio of similarity with consumer)	Subjective/Quantitative			
		Have the willingness and ability to adapt quickly to changing product preferences	Rate willingness and ability to adapt to changing demand	Subjective/ Qualitative	Consumer adaptability	Adaptability	Agility
			Rate speed of adaptation to changing demand				
			Easy access to information on changing attribute preferences (rank) / presence of avenues for information (yes or no)	Subjective/ Qualitative	Market knowledge	Knowledge acquisition	Management
Consumption			Level of awareness of the demand for value added products (Rate)	Subjective/ Qualitative	Market knowledge	Knowledge acquisition	Management
			Access to the technical know-how and infrastructure for value addition (Rank)	Subjective/ Qualitative		Technology and Asset	

			Financial capacity to invest in venture (credit, sufficient income or profits)	Subjective/ Qualitative	Technical and financial capacity		
			Percentage/Ratio of value added products on the market	Objective/ quantitative			Operational
			Number and quantity of varieties available			Adaptability	
		Diversify into the production of other products	Actor involvement in value addition (Does actor add value to product based on assessment)	Objective/ Qualitative	Consumer adaptability		
Utilisation/diversity			Level of value addition to product (select option based on assessment)	Subjective/ Qualitative			
Product should be available in different forms to appeal to different consumer groups	Value added products		Presence of rules and restrictions to value addition (are there?)	Objective /qualitative	Governing of activity	Activity management	Governance
			Collaboration with public and private industries (Yes/No, No.)	Subjective/ Qualitative	Stakeholder involvement	Stakeholder involvement	
			Awareness creation on value addition	Subjective/ Qualitative			
		Constantly updated about the shift towards value added products	Easy access to information on market demand for value added products (rank) / presence of avenues for information	Subjective/ Qualitative	Market knowledge	Knowledge acquisition	Management
		Have a positive perception about the performance of activities to meet changing preferences	Attitude and perception assessment based on selected questions regarding meeting consumer preferences	Assessment based /Qualitative	Actor attitude and perception	Attitude and perception	Attitude and Perception
		Have the willingness and ability to quickly adapt to demand for specific products	Rate willingness and ability to changing demand	Subjective/ Qualitative	Consumer adaptability	Adaptability	Agility

			Rate speed of adaptation to changing demand				
		Constantly updated about the shift towards nutrition and safety attributes of food	Easy access to information on safety	Subjective/ Qualitative	Market knowledge	Knowledge acquisition	Management
		Have a positive perception about the performance of activities to meet changing preferences	Attitude and perception assessment based on selected questions regarding practices towards food safety and nutrition	Assessment based /Qualitative	Actor attitude and perception	Attitude and perception	Perception and attitude
Nutrition Product should be nutritious and safe	Product with high nutritional value and safe	Produce and apply processes which provide food with high nutritional value and safety	Assessment of the impact of each process on safe levels of substances and nutritional content	Qualitative/ Objective	Adherence to consumer quality preferences	Product reliability	Quality
			Ability to recall products- traceability (Yes/No)	Objective/ Qualitative	Product traceability	Traceability	
			Application of safety tests	Subjective/ Qualitative	Safety tests	Safety	
			Level of efficiency of infrastructure to improve on nutrition and safety	Subjective/ Qualitative	Efficiency of system	Efficiency of system	Operational
		Have the willingness and ability to quickly adapt to demand for specific product attributes	Rate willingness and ability to changing demand Rate speed of adaptation to changing demand	Subjective/ Qualitative	Consumer adaptability	Adaptability	Agility
		Engage with stakeholders to improve nutrition and safety	Number and level of stakeholder involvement in activities Awareness creation programs on nutritious foods	Subjective/ Qualitative	Stakeholder involvement	Institution	Governance
Storage			Ability to detect infested seed	Subjective/ Qualitative	Efficiency of system	Efficiency of system	Operational

Product should be stored for long without losing its quality	Product with long storage length	Produce and apply processes which ensure high storage length	Evaluate the efficiency of removal of infested seed. Quality check before every sale (How often)	Assessment based/ Qualitative Objective/ Quantitative

3.4 Conclusion

Agri-food value chains have an essential role to play in contributing to achieving food security. Realising food security is inherently linked with meeting the requirements of consumers which are based on their preferences. There is a need for assessment methods that have a consumer and a food security focus. The study presents a conceptual framework, and a performance index that focuses on the requirements of the consumer and are tailored towards food security. It also includes a broad range of variables. It is very comprehensive and the selected variables apply to other value chains, although it was designed for the bean value chain. The framework also introduces a way to link consumer requirements with value chain activity features and makes it easy to identify improvement opportunities. Convenience, speed, physical wellbeing, etc. have been translated into agri-food chain characteristics such as sales, volume, quality, and efficiency. This has the potential of changing the way products are designed, developed and delivered to consumers while meeting other requirements. This study adds to the literature on assessing the performance of agri-food value chains in meeting consumer requirements (Dekker, 2003; Simons and Zokaei, 2005).

The selection and the measurement of variables are difficult, especially since it is best to use different variables to measure a specific indicator, given that no particular indicator can be used to adequately explain a dimension. The use of information from different sources can be used to deal with this challenge. The limitation with some of the variables selected for the index is that they require laboratory and survey data, which can be costly and time-consuming. Access to benchmarks to evaluate the performance of the indicators was difficult to obtain. Overall, the framework is a measurement tool to quantify performance and understand the food system. The assessment comprises of three stages; understanding the target consumer, understanding the value chain structure and analysis of the chain's performance based on set indicators to determine upgrading options. It is useful in determining causes and consequences, what, where and which action is required along the product value chain, and the challenges limiting the capacity of the agri-food chain to meet consumer requirements and food security indicators.

Connecting Text

In Chapter 3 a methodological approach of consumer-centered value chain assessment is presented. The proposed framework is designed to understand the preferences of consumers and connect them to food security indicators, translate consumer requirements into product attributes and supply chain features, evaluate performance of the product value chain based on identified consumer preferences and identify strategies to align food value chain activities with consumer requirements and food security indicators.

The consumer-based value chain framework and performance assessment index is applied to understanding the common bean value chain. In chapter 4, the first stage of the assessment is undertaken to determine the preferences and needs of common bean consumers by studying the consumption chain. The analysis includes identification of consumer preferences, factors influencing consumption and purchasing of beans, consumer value for bean attributes, resource utilization assessment and consumer attitude and perception assessment. The information gathered from this section serves as the guideline for the value chain performance assessment.

CHAPTER 4 Assessment of consumer preferences along the common bean consumption chain

Abstract

The activities of a value chain are inherently dependent on the satisfaction it provides to the consumer in addressing its needs. This is important since the product provided by the value chain is the input in the consumer's value chain. The study, therefore, presents a methodological approach that is tailored to revealing and understanding consumer preferences. It undertakes a household value chain assessment which views the consumer beyond just a buyer by understanding its own value chain within which the product fits. This is to determine the areas along the consumption chain where the production chain can have a greater influence on the consumer. The common bean value chain was used as a case study due to its nutritional benefits and significance in addressing food security issues. The study evaluated consumer preferences for common bean attributes in Zambia. The findings show that the activities along the beans consumption chain include product acquisition, preparation, storage and consumption. Purchase frequency and quantity were influenced by price, income and availability. Consumers had different definitions for bean quality and considered attributes such as safety, taste, price, quality etc. when purchasing beans. Conjoint based choice analysis revealed that consumers were likely to trade-off different levels of bean attributes when making purchasing and consumption decisions. Urban consumers placed more importance on tasty, low priced, and medium-sized beans while rural consumers placed more importance on beans with lesser cooking time and larger sized beans.

Cluster analysis revealed three consumer clusters based on similarities in their preferences. The findings show that 44.7% of the consumers fell within the cluster, characterised by taste, price, and level of bean damage. To determine how much value consumers placed on the bean attributes preferred, hedonic price analysis was undertaken. The results revealed that consumers were willing to pay premiums for larger size beans (0.3% of the average price), bright-coloured beans (17.5%), and packaging (10.6%). Discounts were paid for beans with a higher level of damage (11.3%), shiny beans (7.7%), and beans, which causes flatulence (10.4%). At the preparation stage, bean preparation was found to require lengthy preparation time and high consumption of energy. These factors were influenced by the preparation method used, the bean variety and cooking stove used. At this stage, consumers undertook different practices to improve the flavour, taste and cooking

time of beans. Regarding beans consumption, 45% of the consumers were willing to substitute beans with other food products due to limiting factors that reduced overall satisfaction for the beans. Overall, the findings show that affordability (price), accessibility (desired varieties), acceptability were important factors to consumers. With regards to acceptability, factors such as convenience (cooking time), appearance (colourful and larger size), taste, quality beans (not broken or infested) and low flatulence were considered important. Information on consumer preferences has implications for value chain activities because they influence the variety, price, quality and value-added products available to consumers. Strategies that focus on increasing the value of the beans beyond the price is likely to aid in increasing the consumption of the beans.

4.1 Introduction

Common beans are essential food crops due to their high protein content, excellent source of fibre and micronutrients (FAO, 1999). With regards to protein content, an ounce of chicken, beef, or fish is equivalent to a half-cup serving of beans (USAID, 2015). Despite the economic and nutritional importance of beans, consumption is however low in Zambia (Government of Zambia, 2013). About 10kg per capita is consumed in Zambia compared to 40 to 60 kg per capita in Eastern and Central Africa (Ugen et al. 2012). Common beans will be a good alternative as a rich and cheaper protein source for the 48% of undernourished individuals, 40% stunted children, (FAO, IFAD and WFP, 2014), and 10% underweight women in Zambia (CSO, 2015). Bean consumption like that of other crops, is influenced by different factors mainly consumer characteristics and product attributes, which could be visible or invisible. Their purchases are based on perceived and expected benefits.

Conversely, the perceived benefits a consumer receives from a product is termed as consumer value (Woodruff, 1997; Walters and Lancaster, 2000). Consumer value is directly linked to preference and the degree of importance for different product attributes. The various qualities consumers' desire in a product varies and is, therefore, a complex issue. This is because it is influenced by different socio-economic characteristics, attitudes, behaviour, and culture (Schiffman and Kanuk 2009). Producing and delivering consumers with foods that have attributes that are preferred and valuable is essential (Kinsey, 2001). This is because consumer preferences have significant implications for the success of a product and the performance of the value chain.

The majority of consumer studies have focused on understanding consumer preferences at the point of purchasing. The consumer is, therefore, positioned only at the end of the production chain as a purchasing agent. However, the consumer has its value chain where the product purchased is used in different processes to obtain value. Hence, it is important to understand the process that the product goes through and also the consumers' experience with the product to have a more in-depth understanding of consumer preferences.

Consumer preference and choice have been studied using different approaches. These include measuring willingness to pay with hedonic pricing methods, which is a revealed preference approach (Mishili et al. 2009a; Sichilima et al. 2016). Others have also employed choice modelling based on random utility theory (Alphonce and Alfnes, 2017; Medard, 2017). Preference elicitation in utility theory has also been employed in understanding preferences with the two most utilized being conjoint analysis and analytical hierarchy process (Helm et al. 2008). In studies related to food, conjoint analysis has been applied by Wirth (2014) and Baglyas (2013). There have been studies by Wilson (1990), MacMillan and McGrath (1997) and Hawkes (2009) who have also designed tools that would assist in gathering information on the customer needs before product development. Understanding consumer preferences can be a source of competitive advantage since it reveals value creation opportunities for value chains. A win-win situation can be achieved by providing consumers with more value and increasing profits.

There is an increase in the number of value chain analysis (VCA) guides being developed for different objectives (Staritz, 2012). However, there isn't any guide that focuses on the final consumer at the household level (household value chain). While value chain analysis has been applied to food systems, it hasn't been employed to affect food consumption at the household level. The study, therefore, presents a framework to understand what is valuable to the consumer and the areas along the consumers' chain where agri-food chains can have a greater influence on consumption of the target product. The framework can be useful in addressing particular development goals that focus on understanding household food and nutrition issues.

Food and agriculture have been viewed as an important sector for addressing poverty, food, and nutrition security (Alkire et al. 2014). The Government of the Republic of Zambia and other developing partners have been designing policies to improve the consumption of nutritious foods such as legumes and pulses (Pele, 2017). Common bean is one of such target crops because it is an affordable source of protein for a wide range of consumers (Beebe, 2008).

While most efforts may be directed towards increasing production and availability, that is not a guarantee for increased consumption. When consumers rarely receive the desired value from products, it implies that supply is not aligned with consumer requirements. This affects demand, and ultimately the achievement of desired developmental goals. Consumer's needs should be made the driving force in agribusinesses (Soosay et al. 2012).

A range of postharvest activities and marketing inefficiencies can have a significant influence on the product brought to the market. This, therefore, requires that agents along the value chain have adequate knowledge about consumer value preferences for each consumer segment (Gao et al. 2011). Based on such information, activities along the change can be modified to provide consumers with the desired value. The study, therefore, seeks to understand preferences for common beans by different groups of consumers. It also assesses the factors influencing bean purchasing, value attributed to different bean attributes, and consumer satisfaction with the product.

4.2 The household value chain analysis

A household value chain analysis (HVCA) is an approach that enables suppliers of a product to comprehensively understand the users of the product, their relationship with each other, and the use of the product. It is tailored to the final consumers within a household. In doing this, the concept of a value chain analysis has been extended to the household (figure 4.1).

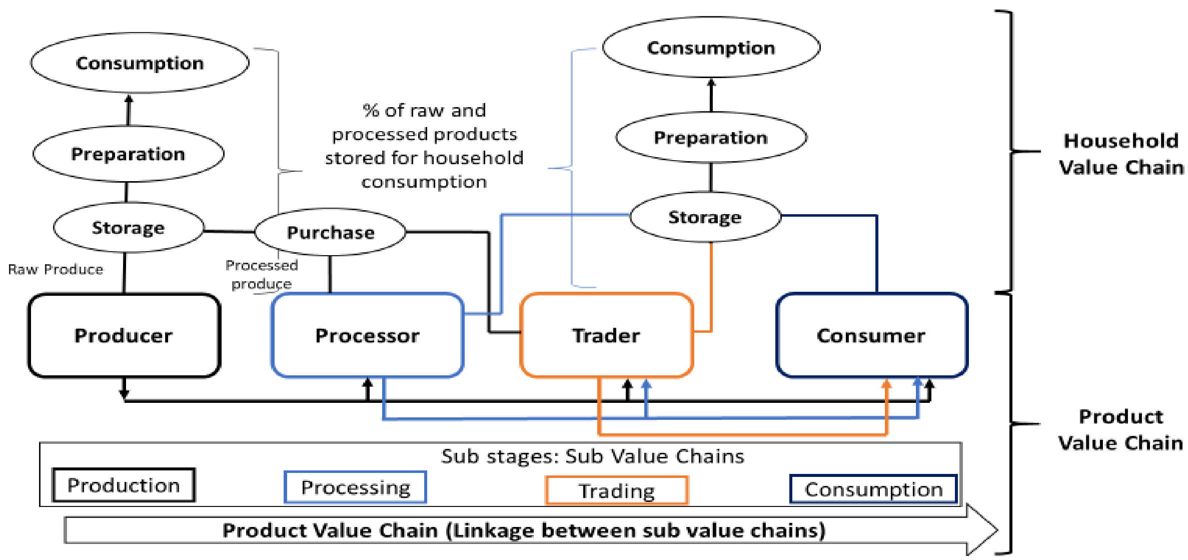


Figure 4. 1 Household value chain as a component of the product value chain

The HVCA is a visual mapping tool that identifies the final users and the processes that a product goes through along the consumer's chain. Consumers are important actors along every product value chain. They are usually the final users of the product; however, they also have their value chain. A value system of a product is made up of the suppliers' value chain and the consumers' value chain. (Porter, 1985). However, only one part of the value system is often studied.

An HVCA provides a wide range of information such as purchase location, delivery, purchase options, price, availability, accessibility and marketing strategy. It also provides information on household preferences, constraints with the utilisation of the product and product quality available to the consumer. HVCA can be applied for different purposes depending on the product and the objective of the analysis. It can be conducted at the earliest stage of product development to identify the consumers and their needs. It can also help agencies communicate ideas to households to optimize the use of the product for the entire household or targeted members. It can further be applied with the objective of optimizing the supply of particular products to target groups within the household.

The study introduces the concept of the household value chain and how the analyses can be done. Although it can be applied to all products, the study focuses on food products. It then applies it to the common bean consumption (consumers') chain.

Household value chain

The concept of a value chain analysis has been extended to the household to evaluate the main characteristics of a household value chain. It is based on the idea that the product purchased is an input which is transforms into different valued commodities (outputs) within the household to obtain maximum utility. Every household performs a wide range of activities such as eating, cleaning, entertainment, storage, and many others. These activities either generate cost or create value for the household. The consumers could also be either an agent along the product chain (producing consumers) or final consumers who perform no activity along the product chain. Depending on the kind of final consumer, there may be variations in consumer preferences. To adequately undertake HVCA, the definitions of value, value chain and value chain analysis concerning the household has to be taken into account.

Value

Value is usually defined as the willingness to pay by the buyer for the product. The buyers' willingness to pay for a product is an important initial step in understanding the meaning of value from the consumers' perspective. However, this product possesses value not only in the sense of the cost (price) but what it can do. Value within the context of HVC is distinguished from value in terms of price (monetary value) and the value in use to the user (addressing the specific need to which the product was purchased). The actual number of currency that the product is sold only surfaces in the first stage of the chain. It fades away as the product is being modified and utilized along the chain. Value along the chain, therefore, focuses on the actual service provided by the product, which could be in different forms. Value then transforms from being an objective value to subjective value.

Value is defined based on Woodruff (1997) and Smith et al. (2012) understanding of value. Value is the perceived preference for a product, the perception of the degree of its importance in meeting one’s need and the evaluation of those product attributes, attribute performances, and consequences arising from the use, that facilitate (or block) achieving the consumer’s purposes in use situations.

4.2.1 Household food value chain (HFVC)

A household typically goes through a series of processes with respect to purchasing and using a product, as shown in Figure 4.2. A product or service is always obtained to serve a need and to derive some satisfaction from the need being met by the utilization of the product. The household food value chain includes the processes a household performs to add and obtain value from a purchased food product.

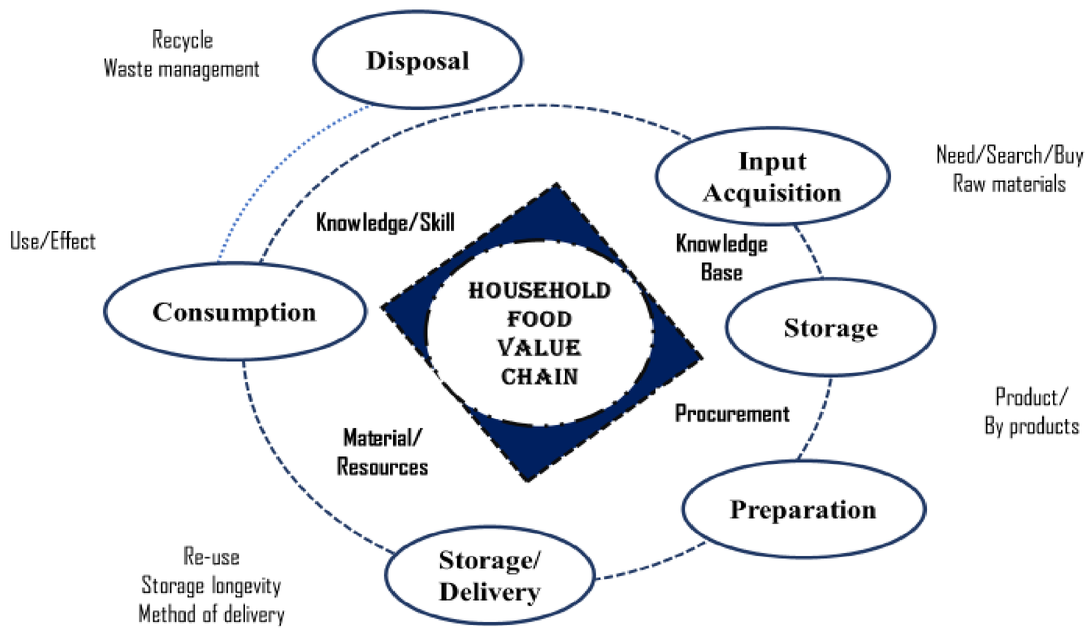


Figure 4. 2 Household food value chain

The utilization component of the household value chain consists of a sequence of activities that a household and its members perform into which the product or service fits (Porter, 1985). The input in the HVC is the purchased product from the firm. The household typically performs different activities within which the product is involved. Therefore, it is essential to break down the activities of the household in sequential order. The household value chain is made up of two main groups of activities: primary activities and secondary activities. The primary activities are directly concerned with the creation of the final product while secondary activities assist in the performance of primary activities.

The chain also focuses on three elements, and these are the people, the product and the process. The people are those interacting with the product and involved in the process. The product comprises the features of the product. The process comprises of how the activities are performed and the interaction of the three groups. The primary activities are made up of:

Input Acquisition: This focuses on the need, search, and purchase activities of the consuming household. This, therefore, includes financing, transportation, and delivery. It deals with pre-purchase and purchase issues. Questions include: What is the process required to obtain the product? What influences the product purchased? What are quality attributes consumers prefer, and what value do they place on those preferences?

Preparation: This focuses on the activities the household performs after the product is purchased and the effect of the activities on the product. Questions include: What are the different processes food preparation goes through? What are the various resources used in preparation? What is the effect of the activities on value creation? What influences the ways by which the activities are performed?

Storage/Delivery: This focuses on the distribution of food to the household members, the quantities per member, and how leftovers are stored. Questions include: How is the raw produce and food stored? What is the effect of storage on the physical and nutritional constituents of the food?

Consumption: This focuses on the actual benefit from the product, that is whether the product provides the desired satisfaction or addresses the intended purpose for which it was purchased. Questions include: How do the activities undertaken along the household chain affect the nutritional constituents and safety of the product? Is the product consumed in adequate amounts to meet the dietary needs? Are preferences and quality needs of consumers met (consumption quantities and frequency, tastes, preparation practices, ease of preparation)?

Disposal: This stage of the chain depends on whether food can be disposed of or replaced and depends on the product being studied. Questions include: Is it easy to dispose of? Is it reused? Are there any challenges or environmental consequences with disposal? Is there an opportunity to change or return a product or make complaints?

The secondary activities are made up of:

Procurement: These are factors around the selection, purchase, and delivery of the product.

Materials/Resources: This includes the materials required to make the product ready for use. These include resources such as time, energy, and water used during the process of preparation, storage, and disposal.

Knowledge/Skill/Culture: Value is not created only through the transformation of the product but also the skill and knowledge required for the purchase and use of the product. Questions include: What are the habits, perception and attitude of the household about the different foods, their nutrients and benefits?

Knowledgebase: The knowledge base is focused on the sources of knowledge on food purchases, preparation, and consumption. Questions include: Where do households obtain information to become aware of their needs? What are their sources of information? etc.

4.2.2 Household Food Value Chain Analysis

Household value chain analysis is defined as an evaluation of the different activities undertaken by the household, the processes within each activity, and its effect on the value expected to be received by the consumer. The analysis focuses on understanding the structure and dynamics of the chain. The structure consists of the activities (primary and secondary) within the chain, the household structure, the linkages, and the immediate supply market. The dynamics deals with the determinants of activities and behaviours and their effect on operations, output and value. The steps include:

Step 1: Define the objectives of the HVC

The aim of a household value chain analysis is to understand consumer preferences, how value is obtained from a product, and whether a maximum value is obtained.

Step 2: Product Definition: Objectives and Benefits

In this step, the characteristics of the product are defined. This aids in assessing the benefits to be derived from the product. It focuses on addressing questions such as: What is the purpose and attributes of the product? Who produces and sells the product? Is the product likely to be used by the household in other settings away from home?

Step 3: Determine the consumers of the product (Identifying chain participants):

Identifying the chain participants needs to be done from a perspective of the chain members who influence value creation and consumption. In comparison with other value chains, the household value chain consists of members that are closely knitted. In the network of the HVC, the participants do not necessarily have specific roles. In cases where there are particular roles, these change with time.

The consumer who purchases the product may not directly consume the product, e.g. a child and mother. Thus, the household structure of the purchaser should be analyzed. This reveals other consumers who are not directly observed on the market. This stage of the analysis focuses on addressing questions such as: Who purchases and consumes the product? Who finances the purchase? Why do they purchase? What is the role of each household member in the HVC (how do each participate in the chain)? How often is the product purchased? What is the share of their income used in the purchase of the product? In understanding the household and needs, the factors which inform the purchase of the product, the quantity purchased, the frequency of purchase, the form of delivery chosen etc. are studied.

Step 4: Identification of activities and linkages within the chain

This involves the identification of the different activities the household performs concerning purchasing, processing, and use of the product. The categorization of the activities, as well as the linkage and inter-linkages between activities, is also assessed. At this stage, the constraints with the use of the product are also identified.

Step 5: Determine the functions of the household members in relation to the product

Functions are defined and evaluated in two ways. A function is first defined as its contribution to the objective and need with which the product was purchased. The second definition is based on the roles different members play in performing activities.

Step 6: Map out the flow of the product within the HVC

After identifying the different actors within the HVC and their relationship with each other, the different stages the product goes through are identified and mapped out. The function (activities) of every member in the household who can be classified as actors within the HVC are clearly defined and included in the HVC map. Mapping the value chain aids in determining the flow of the product (product cycle) and presents a visual representation of the household consumption chain.

The HVCA framework outlined is applied to the common bean consumption chain among consumers in Zambia. The consumption of legumes is observed to be declining in many developing countries (Hawkes, 2009). While there could be multiple reasons, understanding the household consumption chain for common bean can reveal some of the constraining factors and provide incentives to increase its consumption within the household. At the end of the HVCA, there should be a clear understanding of what is valuable to the consumer. An outline of the analysis is presented below (Figure 4.3);

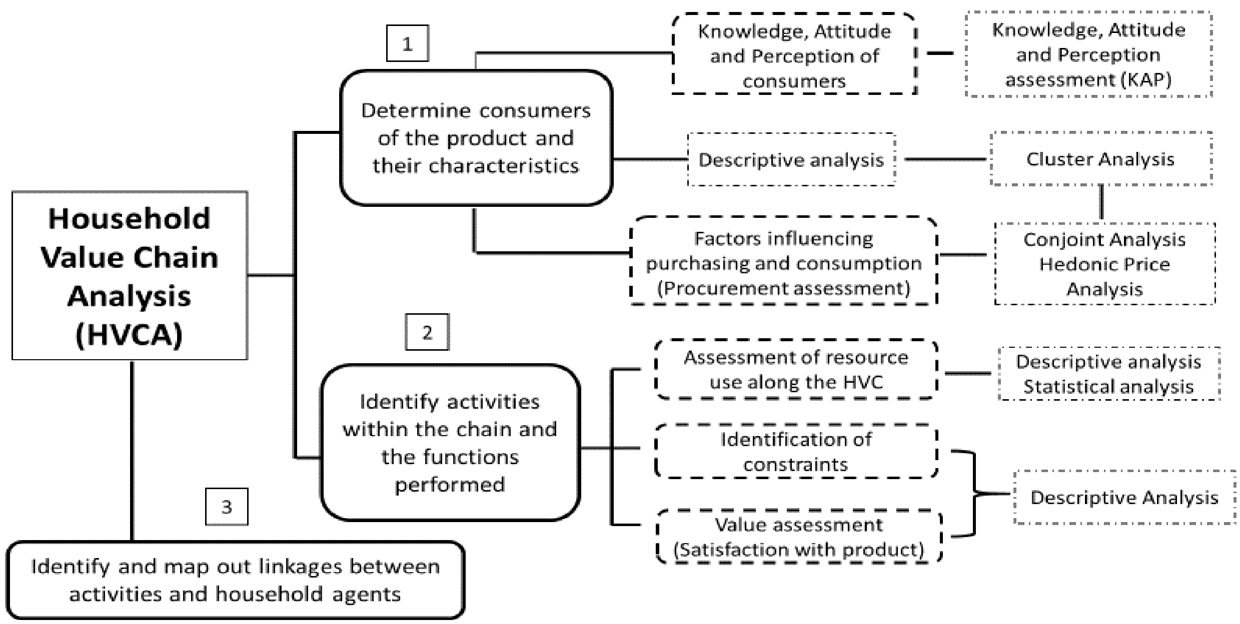


Figure 4. 3 Framework for analysis

4.3 Materials and Methods

4.3.1 Study area

The study was undertaken in rural and urban Zambia. In the rural area, the Northern Province, Luwingu district was selected while in the urban area, Lusaka Province was the chosen for the study. The first set of data was collected during a five-week-long field visit in Zambia after which additional data was collected. The Northern Province was selected because it is characterized by high levels of undernourishment due to the low intake of plant and animal-based protein products and high maize-based foods (Chapoto et al. 2010). The Lusaka province was selected as the urban site because it is the largest city in the country and more developed with numerous economic opportunities.

The Luwingu District lies between longitudes 30^{o}C and 32^{o}C East of the Greenwich Meridian and latitudes 9^{o}C and 11^{o}C South of the Equator. Luwingu lies in the high rainfall agro-ecological region of Zambia, with an average annual rainfall of 1200 mm. Approximately 39.7% of the total population is involved in agriculture as their main source of livelihood. Females make up about 70.5% of 53,408 farmers in the district (CSO, 2012). The majority of the inhabitants in the communities are smallholder farmers who earn a higher percentage of their income from farming activities. The climate and environment are ideal for cultivating crops such as beans, cassava, groundnuts, finger millet, abmbara nuts, and maize. Primary livestock kept includes goats, sheep, chickens, and pigs. Homes are made of earthen blocks and thatch roofs. There is limited access to electricity within the communities; thus, fuel for energy is mainly sourced from wood and charcoal (CSO, 2012).

The Lusaka district has a population of 3,002,530 (CSO, 2018) and the most populated province in Zambia. The primary source of employment is informal and/or formal jobs as opposed to farming. About 34% of the population lives below the national poverty line. Lusaka is the capital city of Zambia with a good range of economic opportunities (processing, manufacturing, and commercial activities) and facilities such as banking facilities, hotels, restaurants etc. This leads to the migration of individuals from rural areas to the capital city (GoZ, 2017).

4.3.2 Data collection

The data was collected mainly through surveys and thus constituted mostly primary data. Questionnaires were used to collect qualitative and quantitative data from the sampled respondents. It was also utilized to obtain information on the attitudes and opinions of respondents. The semi-structured questionnaires contained closed and open-ended questions, scales, ranks and statements. The surveys were administered through face to face interviews and were administered to consumers in Zambia. The data gathered include beans preparation, resource allocation, and use, processing methods, bean demand and consumption patterns. Cooking experiments were also undertaken on the field to gather information on consumer use and experience with the product. Measurements of process parameters along household bean processing chains were undertaken. The visit involved (a) identifying the activities performed during the processing of different varieties beans (b) measurement of the energy, water and time use, (c) the impact of the respective resources on the processing activities and (d) the challenges faced by the respondents.

Informal observations were made during interviews with different groups of respondents. This is because they help to gather information on how activities are undertaken, the environment within which consumers live, and work and make inferences. The observations were noted and used as added information to cross-check responses and gain an in-depth understanding of the subject being studied. Data collected was analyzed using Statistical Package for Social Scientists (SPSS) Version 24.0, STATA 12, Microsoft Excel, JMP and XLSTAT 2019.

4.3.3 Sample selection

The sample size depends on the objective of the study, the available time and resources (Patton, 2002). However, a sample size with 30 to 100 cases is often regarded as adequate for statistical analysis irrespective of the population size (Bailey, 1994). In total, a sample of 439 respondents comprising of 259 in the Northern Province and 180 in the Lusaka province. The sample size was calculated based on a formula provided by Yamane (1967) at a confidence interval of 95% and a precision of 7%. Estimations were based on the population sizes in the Luwingu and Lusaka districts. The data was gathered through face to face interviews. Respondents were randomly selected with the main requirement being the consumption of beans.

A simple random sampling technique was employed. The communities were visited and the consumers who volunteered to participate in the survey exercise were interviewed. The interviews were undertaken at the point of purchase or within the homes of willing consumers. Data collection took overall three months with trained enumerators. The sample size was largely determined by the budget available and time-constrained. A convenient sampling technique was used to select focus group members.

Consumers were surveyed to obtain information on common bean consumption, and buying preferences (frequency of consumption, beans quality preferences, quantity purchased, preferred variety, the form of consumption, budget share). The importance of quality attribute preferences using a Likert scale (5= very important and 1 = not at all important) was also solicited. The attributes considered in the study were drawn from literature specific to legumes and common beans. They were then presented to the consumers to indicate their level of importance. The attributes were categorized into intrinsic and extrinsic quality attributes. Ranking of attributes by consumers is useful in determining the level of utility provided by the commodity. The same scale was also used to determine the factors influencing bean purchase.

Intrinsic qualities are those which are physical attributes of the product. These include search attributes such as colour, size, gloss, variety and freedom from damage. Experience attributes are those that consumers identify after they have an experience with the product, such as taste, aroma/flavour, and hardness (cooking time) (Mora et al. 2011). The extrinsic qualities are those which are not physical attributes of the product, but consumers consider them before they purchase a product (Jiménez-Guerrero et al. 2012). These include; safety attributes that cannot be easily determined without the consumer having information concerning it, such as pesticide-free and product free from insect infestation. Marketing attributes are the situations within which the product is sold such as price, retailer behaviour and packaging.

Other survey questions were centred on consumer concerns, preference for common bean quality attributes, knowledge on nutrition and food safety, income and expenditure shares for the common beans. Information on socio-economic characteristics was also collected from respondents. The questionnaires were developed in English and administered in the local language. The questionnaires were pretested and modified to ensure consistency and a high level of understanding. The study was undertaken according to ethical standards, and thus, respondents provided their consent to willingly participate in the study. Cooking experiments were also conducted with randomly selected consumers to determine the process the food goes through after purchase through to consumption.

4.3.4 Methods

Different kinds of analyses were performed on the data to address different objectives. Descriptive analysis was employed to describe the data to obtain facts and trends. Beyond the descriptive analysis, statistical analysis, cluster analysis, conjoint analysis and hedonic price analysis was undertaken to understand consumer preferences and how they influence the price of the product. A summary of the different forms of analysis is presented.

4.3.4.1 Descriptive analysis

Descriptive analysis was employed to describe the data and present results as frequencies, percentages, means, and standard deviations. The results were presented in tables and figures. Descriptive analysis was employed in describing the characteristics of consumers as well as the activities and functions along the household value chain. It was also applied in describing preferences of the consumers, bean consumption forms, purchase quantity, expenditure shares, consumption frequency and mapping of the chain.

4.3.4.2 Assessment of expenditure share on common beans

The study determined the factors influencing the share of expenditure on beans. The econometric method employed was linear regression. The technique used was selected based on the nature of the dependent variable. For the linear regression, the dependent variable is a continuous variable, which is the expenditure share for beans in a month, which is tied to the quantity purchased. Since the respondents were all consumers of beans, the counts are going to be continuous with no observations with a value of zero.

$$y_i^* = \beta' Z + \varepsilon_i \qquad \varepsilon_i / Z \sim N(0,1) \qquad \text{eqn (4.1)}$$

Z denotes the independent variables (socio-economic characteristics and preference indicators), β is the parameter to be estimated, ε is the vector of random component assumed to be randomly distributed with a mean of zero and constant variance ($0,\sigma^2$).

4.3.4.3 Knowledge, attitude and perception (KAP) assessment

The questionnaire was formulated to examine sources of information, knowledge, perception, and attitude on nutrition and consumption of common beans. The questions were categorised into four sections: information acquisition, knowledge on nutrient-dense foods, attitude and perception towards nutrient-dense foods and beans consumption.

A 5-point Likert (rating) scale (strongly disagree/never = 1; disagree = 2; uncertain = 3; agree = 4; and strongly agree/always = 5) type assessment was used to solicit the responses through face to face interviews. Descriptive statistics (frequencies, percentages, mean, standard deviations and relational graphs) are used to present a summary of the results. Spearman's rank correlation coefficient was used to evaluate the relationship between information, knowledge, attitude and perception scores of respondents, $p < 0.01$ was taken as significant for the correlation analysis. Questions were presented to consumers to determine the score for information access, knowledge, attitude and perception, with each correct answer scoring 2 points. Zero points were scored for incorrect or don't know answers. Positive responses were scored 2 points while negative responses were scored zero points for the attitude and practice sections. Information, knowledge and perception scores were categorized as insufficient when the total score was less than 70% of the maximum possible score. The scoring system used is based on Kunadu et al. (2016).

4.3.4.4 Conjoint analysis

A stated preference approach was utilized in gathering data from consumers. An experimental choice design was employed. Conjoint analysis was utilized because it can be used to assess trade-offs and reveal hidden utilities (Helm et. al. 2008). Conjoint analysis (Green and Rao, 1971) is used originally in marketing research to predict purchasing decisions but has been used in different fields (Gutsafsson et al. 2013). The conjoint analysis breaks down preferences into part-worth utilities. The importance assigned to attributes and their levels sum up to make up the aggregate part-worth utility. Large part-worth utilities are indications that the attribute and their level are most preferred (Kuthfield, 2005). To model preferences, the respondent's preferences with respect to different attributes at varied levels are determined based on a factorial design (based on ANOVA).

Setting up a conjoint analysis involves several steps, the first is the selection of attribute levels, second; generating profiles, third; questionnaire design and data collection and lastly, preference modelling. The attributes selected for the study and the levels were chosen based on literature and pretest survey to determine consumer preferences for bean attributes. Based on this, standardized questions were developed and presented to respondents and the attributes that had the most significant effect on the consumer were included. Thus, not all attributes were included in the analysis so as not to burden respondents. The number of scenarios presented to respondents was based on a fractional factorial design as opposed to a full factorial design, which is often utilized and preferred. Thus, a total of 324 (3 price levels, 2 damage levels, 3 size levels, 3 cooking time levels, 2 colour levels, 2 taste levels) main profiles were generated. Ten pairs of product profiles through orthogonal design were presented to consumers to minimize information loss and reduce complexity.

The Choice-based conjoint analysis was applied in the study because it's close to what consumers experience at the market (Ares et. al. 2010). The respondents were presented with different choices comprising of various combinations of attributes successively. In this study, each scenario has two choice sets and they are asked to choose the choice sets they were most likely to purchase in the market (Cerjack et al. 2010). After each choice, the respondent was presented with a new set of choices and asked which they were more likely to purchase. The choices are presented side by side. The exercise was repeated ten times based on comparisons. Price was included because variety type was not added as an attribute. Price was based on a kg of beans to be purchased. The selection allows utility scores to be generated for each attribute level and determines which attribute is relevant to consumers during a purchase (Cerjack et al. 2010). The attribute levels were chosen to have meaningful differences that were relevant. The data obtained was analyzed based on the OLS method using the XLSTAT software (Version 2019) in Microsoft Excel. The selected attributes and their corresponding levels used in the experiment are presented in Table 4.1.

Table 4. 1: Selected bean attributes and their corresponding levels

Bean attributes	Description	Attribute levels	Reference
Taste	It is an important attribute in purchasing a product. Consumers expect particular tastes when consuming beans.	Slightly tasty, very tasty	DeYoung et al. (2017); Katungi et al. (2011); Sichilima et al. (2016); Mishili et al. (2009a); Medard (2017); Magreta and Jambo (2012); Hella et al. (2013); Quaye et al. (2011)
Cooking time	The time required for preparation affects consumer decision since it affects convenience	60 mins, 120 mins, 180 mins	
Color	Appearance influences perception and appeal and ideas about sensory attributes (Lelievre et al. 2009)	Single color, multicolor	
Size	Size of beans corresponds to faster preparation time if small and increased quantity of food when large. Thus, influencing purchase.	Small, medium and large	
Seed damage	Damage can constitute insect infestation or broken seeds. The level of damage affects consumer preferences.	No damage or slight damage	
Price	Price of a product influences purchase because consumer make decisions with a budget constraint.	K5, K7, K10 K3, K4, K5	

NB: Due to the difference in prices in Luwingu and Lusaka, the price factor is the only different factor.

In the choice experiment, consumers were asked to choose between two alternatives, both of which had different combinations of varying attribute levels. A sample of the choice experiment set is illustrated in Figure 4.4

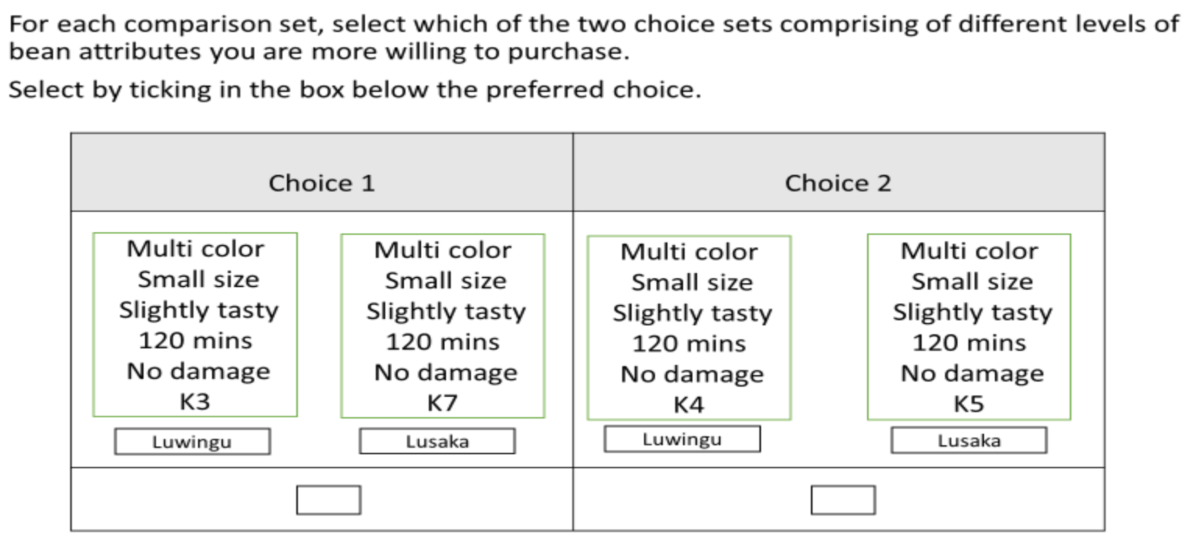


Figure 4. 4: A choice experiment sample card

The part-worth utilities were estimated for each attribute. The importance of each attribute was estimated as the difference between the maximum and minimum values of the estimated part-worths. The correlation between the profiles and the socio-economic characteristics were also determined. The results of the conjoint analysis were treated with the statistical treatment, and the utility scores are extracted by Hierarchical Bayesian (HB) estimation (Orme, 2010). This method estimates the average utility score for the whole sample and then determines how each respondent differs from the overall sample size. Utilities are then adjusted to be a representation of the respondents' choices and the total averages.

4.3.4.5 Cluster analysis

Cluster analysis was used to classify consumers into different homogenous groups based on defined characteristics (Gunden and Thomas, 2012). Consumers were segmented into different groups based on their preferences, socioeconomic and household characteristics. Consumer preferences obtained from the conjoint analysis was used in the analysis. Cluster analysis is a multivariate technique that enables individuals to be put into groups based on pre-defined characteristics. It has been employed for consumer segmentation in different studies (Adhikari et al. 2012 and Alamanos et al. 2013). Cluster analysis is grouped into two which is the hierarchical and the non-hierarchical clustering. Non-hierarchical clustering involves the assigning of objects into pre-specified clusters, while the latter consists of the formation of dendrograms. The hierarchal analysis is however mainly used in consumer preference analysis due to the simplicity in results interpretation (Schilling and Coggins 2007). The hierarchal analysis involves the construction of a hierarchy that serves as the basis for forming clusters. Generally, each case is considered a separate cluster, after which they are grouped into different clusters based on certain similarities (Hair et al. 2010 and Burns and Burns, 2009).

All the product attributes and choices were subjected to cluster analysis based on the distance between centroids. The number of clusters is chosen based on a careful examination of the dendrogram (a two-dimensional tree-like diagram). This is because there is no accepted method for selecting the number of clusters but based on the subjective judgment of the researcher (Hair et al. 2010). The dendrogram is often cut to examine the difference in fusion levels. Larger changes at any point between the fusion levels will be used to determine the appropriate number of clusters (Everitt and Dunn, 2001).

A careful examination of the fusion levels in the dendrogram produced from the study led to the conclusion that three clusters represented the common bean consumers. Mean ANOVA and Post-hoc tests with Tukey HSD was used to determine significant differences in clusters. A sample size of a minimum of 100 respondents is sufficient to perform a cluster analysis and thus, the study's sample size is enough to generate valid conclusions. Cluster analysis was performed using XLSTAT (version 2019).

4.3.4.6 Hedonic price analysis

Hedonic price analysis has been performed on a wide range of food and non-food products. (Langyintuo et al. 2004; Mishili et al. 2009). In this study, it is applied to determine the consumer preference for bean quality attributes. That is to determine the value attributed to products by understanding whether consumers are willing to pay a discount or a premium for particular attributes. Two main groups of data were required for the analysis, which are the price of the product and the product attributes. Consumers purchased beans from different markets and at different times within the day. The price at which beans were purchased was based on negotiations. Consumers presented ratings for bean attributes, yes or no responses, and percentages, weights or time responses where needed. Some bean attributes were ranked with a five-point Likert scale (1 being the lowest (poor) and 5 being the highest (best)), which also served as a sensory evaluation of the attributes.

The average price of beans per kg of bean paid for by consumers was reported in Zambia Kwacha. Consumers were first presented with the question of whether they purchased beans at the price at which it was offered. Due to negotiations, consumers did not always pay the offered price. This implies that they purchased the beans at the price which they were willing to pay for it. Although respondents provided different units for the quantities of beans, all the units were converted to kilograms. Based on this, the average price per kg was estimated. The attributes selected are those that are both observable and unobservable. Visual attributes have been shown to communicate functional characteristics, provide an impression of quality and present an idea of the ease of use. Thus, they are important in influencing consumer preferences (Creusen and Schoormans, 2005). Sensory characteristics are those that the consumer experiences with the product, such as taste and aroma. Other variables included in the study are bean damage, colour, cooking time, bean variety, purchase location, appearance (shiny or not), size etc. A description of the variables is found in the results section.

Most studies use retail data gathered from interviewing traders, or data gathered from lab analysis for hedonic price analysis of beans. Particular to this study, actual consumer surveys and ratings are used because consumers have direct experience with the product. Also, it's an accurate depiction of the value consumers place on different attributes of beans. The ratings represent the sensory, observatory and experiential experiences with the product on a scale of 1 to 5. A high rating indicates a high-quality experience, while a lower rating indicates a lower quality experience. Consumers indicated the most recent purchase, the quantity purchased, the price per that quantity and then ratings were provide based on the most recent experience with the purchase and use of the product.

The hedonic price model

The hedonic price analysis is applied in the study to estimate the implicit values associated with bean attributes based on Rosen's (1974) method. It is a method for valuing the individual attributes of a product. The hedonic price approach conducts a regression of price over certain product attributes to establish a relationship between the two. This is the partial derivative of the function concerning the attribute. A positive implicit price of an attribute signifies that the product is positively valued by the consumer and vice versa (Donnet et al. 2008). These implicit prices are also a means of determining the products consumers are willing to pay to have.

Goods and services are treated as providing a collection of attributes that are valued in different ways by consumers. The price of a product reflects the characteristics of the products (Lancaster, 1966; Rosen, 1974) which are traded as a bundle. This is the fundamental point in Lancaster's preference theory which argues that the satisfaction derived from good is not the consumption of the good as a whole but from the attributes of the good.

The consumer utility function is, therefore, a function of the attributes of the product instead of the product itself (Galleto and Rossetto, 2015). The utility is maximized according to the budget constraints, $\sum P^* + P_B^* B = M$, where P is the price of other goods and P_B is the price of beans and M is income. Each individual has a group of indifference curves, which represents the trade-off between different products they desire and how much they are willing to pay for them (Monty and Skidmore, 2003). Thus, the retail price of the product is the sum of the price component of each attribute (sum of the implicit prices of the product attributes). This is based on the Consumer Good Characteristic Model developed by Ladd and Suvannunt (1976). It states that the price is equal to the sum of the marginal monetary values (MMV) of the product characteristics. The MMV is equal to the number of characteristics obtained from the marginal unit of the product multiplied by the implicit price of the product characteristics.

The price components are estimated using a regression analysis where the price is a function of the product attributes. This is based on the assertion that the price that an individual is willing to pay is a function of the marginal implicit prices that the individual is willing to pay for each attribute (Berndt, 1991). Each product is composed of n attributes $A_1, \ldots\ldots, A_n$. These attributes together define the price of the product $P(A_1, \ldots \ldots, A_n)$. This implies that the price can be broken down into implicit prices (hedonic price) for each attribute. These implicit prices can be estimated by making the hedonic price a function of the attributes:

$$P(A_1, \ldots\ldots\ldots, A_n) = f(A_1, \ldots\ldots\ldots, A_n) \quad \text{eqn (4.2)}$$

The hedonic price is modelled as;

$$P_J(X) = P(x_1, x_2, \ldots\ldots, x_i, \ldots\ldots, x_n, u_i) \quad \text{eqn (4.3)}$$

Where P_J is the price of the product j, $X = x_1, x_2, \ldots\ldots, x_i, \ldots\ldots, x_n$ is a vector of n attributes which describe product quality and u_i is the error term.

The implicit price of the attribute i is the partial derivative of the hedonic price function, $\partial P(X)/\partial x_i$

Model specification and analysis

Ordinary least square (OLS) regression analysis was employed in analyzing the data. Prices of the product is regressed on the bean attributes. The bean pricing function can be shown as;

$$P = f(color, cooking\ time,) \qquad \text{eqn (4.4)}$$

The hedonic pricing model can be in different forms either linear as shown in Eqn. (4.4), log-linear, linear and double log-linear depending on the scale of the independent and dependent variables. The transformation of the model is important due to the different scales of the variable used in the analysis. A Box-Cox test was conducted to ensure that the approximate specification for the model. It is used to test which transformation is suitable, after which the hedonic regression is estimated using ordinary least squares robust estimation.

$$x^{(\lambda)} = x^{\lambda} - {}^{1}\!/_{\lambda} \qquad \text{eqn (4.5)}$$

The analysis is done conditionally in the linear form for a given value of λ, the model is then expressed as

$$y = a + \sum_{k=1}^{k} \beta_k x_k^{(\lambda)} + \varepsilon \qquad \text{eqn (4.6)}$$

Transformation can be done for the dependent and independent variables (Shazam, 1997). The functional form for that transformation can be expressed as

$$Y^{(\lambda)} = X^{(\lambda)}\beta + \varepsilon \qquad \text{eqn (4.7)}$$

By this, the same value of lambda transforms all the variables. The least-square values of λ are between -2 and 2 (Greene, 2003). Further checks included examining the associated correlation matrix for each regression mode to remove pairs of the variable, which has a pairwise correlation of 0.8 or more. This is stated to influence regression coefficients based on Hauser's (1974) rule of thumb. None of the variables was removed because the pairwise correlation was found to be less than 0.8. The white test showed no presence of heteroscedasticity in the residuals (prob > chi2 = 0.5438). Robust standard errors were still used in the analysis. to correct for heteroscedasticity.

Variance Inflation Factor for the explanatory variables used in the model was not above 6 indicating that multicollinearity was not a problem.

The final model specification is

$$In\ P = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon \qquad \text{eqn (4.8)}$$

Where P is the price which varied based on the variety of the bean, X_{1-4} are the variables (bean attributes, point of purchase factors, experience factors) to be estimated, β_0 is the constant. β_{1-4} are the estimated coefficients and also the implicit prices for the attributes, ε is the residual, which is the difference between the observed value and the predicted value of the dependent variable and In is the natural log. Attributes that are positively valued will have a positive sign in the hedonic price equation. The price is the mean price for an *ith* variety that consumers are currently paying for bean. The marginal implicit price (coefficient) is the amount consumers are willing to pay for a change in unit of attributes.

Coefficients were given by $\beta_1 = \frac{\partial P_i}{P_i} / \partial X_i$ eqn (4.9)

This is a percentage change in P_i due to a slight change in X_i holding all other regressants constant. Thus a 1 unit increase in $X_i$will lead to a 0.5% increase in P_i if $\beta_1 = 5$.

4.3.4.7 Resource Utilization

Data on fuel, water and time utilization during the processing of beans along the household value chain was gathered by employing different procedures.

Energy

Energy supply pathways were identified by determining the point at which the fuel is gathered to the household where it is being used (Table 4.2). The physical mode of transport, distance and time required to obtain fuel was estimated. The time estimation included the exchanges during wood collection as well as to and from the collection point. The distance was measured with the use of a handled GPS device (Etrex 10 Garmin GPS, Garmin International, Inc., Kansas, USA). The amount of fuel and corresponding energy utilized was determined for both wood and charcoal with much attention to the processing of beans, although they are used for other domestic activities as well. The type of wood, the mass of the wood collected, and the rate of the collection were also recorded. Wood samples made up of different species were gathered and analyzed to determine the heating values for each wood type.

Quantities of different varieties of beans, water, and fuel, were weighed before processing started. This was done with a 100 kg Camry two-dial platform scale - model FD100 (Zhongshan Camry Electronic Co. Ltd., China—Mainland) with a minimum capacity of 2kg and readability of 50g. The temperature of the cooking water was measured with a Patec Digital Instant Read LCD Screen Cooking Thermometer with a long stainless probe with a wide temperature measurement range of -50°C (-58°F) to 300°C (572° F) and with 0.1°F/°C resolution, ±1.5°F/0.8°C accuracy. Fuel consumption was estimated by determining the difference between the initial and final weight of the fuel used (wood and charcoal). The initial fuel mass is the mass of wood and charcoal planned to be used. The final fuel mass is the weight of the used wood unused, unburnt and charcoal generated after burning. For charcoal, the final weight is the mass of unused or unburnt charcoal (Table 4.2).

Water

The distance and time to fetch water and back were determined with the GPS device described earlier. The quantity of water per trip and the rate of water collection was also assessed. Water is generally collected for domestic purposes of all kinds. However, for this study, the quantity of water required for soaking and cooking of the beans was measured by determining the initial and supplemental quantity of water for each process. The quantities were determined based on the variety and mass of beans being cooked. The effect of the processing method (cooking with or without soaking) on water use was also determined.

Time

In assessing the claim of bean processing being time-consuming, the study evaluated the time required to obtain each of the resources (fuel and water) as well as the time used for each process separately. The overall time required for bean processing including time for resource supply through to the completion of the process was then determined for each bean variety, fuel type, and processing method. After the individual assessments, comparisons were made between the different factors.

Table 4. 2: Measurements recorded for resource supply and use

Type of resource	Measurement	
	Supply	Use
Energy - Wood	• Distance to collect wood • Head load per trip • Time for each trip • Rate of collection	• Amount of wood used during processing (initial, final and complimentary mass of wood for cooking) • Cooking stoves used
Energy - Charcoal	• Distance to obtain charcoal • Head load per time • Time for each trip • Rate of collection • Cost of charcoal	• Amount of charcoal used during processing (initial, final and complimentary mass of wood for cooking) • Cooking stoves used
Energy -Gas	• Rate of purchase	• Amount used during cooking
Water	• Distance to obtain water • Quantity per trip • Time for each trip • Rate of collection	• Amount of water used during processing
Time		• Soaking duration for two varieties of beans • Cooking duration for two varieties of beans • Overall processing duration for three different processing methods • Time of day for processing activities

Statistical analyses were carried out on fuel consumption, water and time utilization with linear regression models in the JMP software. Analysis of variance (ANOVA) was conducted, and the significance of differences among different bean processing systems was separated using the Least Significant Difference (LSD) at a 5% probability level. A comparison of means was achieved using the Turkey-Kramer HSD model.

4.4 Results

4.4.1 Consumers of the product and their characteristics

4.4.1.1 Product and Household characteristics

Common bean is mainly grown for its leaves, green pods, and dry seeds. The dry beans are, however, the most preferred although the leaves are dried, made into relish, eaten with foods such as Nshima. The beans have varied shapes ranging from spherical to oblongus with sizes ranging from 9mm to 16 mm in length. They are hard seeds with varying colours. The leaves are sometimes dried, made into a powder and added to dishes mostly for flavour. The bean husk is burnt and the ash produced is known as soda. It is then used in food to enhance the taste. Beans are consumed mainly as whole cooked beans among both rural and urban consumers in Zambia.

Rural consumers do not have processed bean products such as canned beans, which is the most popular form of processed bean products in the country. While this is available to urban consumers, the majority still prefer to consume beans cooked in its whole form at home. About 26.7% of the urban consumers purchased canned beans for consumption, although this was rarely done. This is because it was costly, although easy to use and tasty. Other consumers indicated that it wasn't safe to consume processed foods frequently. A small percentage (10%) of the rural consumers made beans into a bean porridge after making bean flour to feed their children. The preferred form of consumption was whole cooked beans, which are sometimes stewed or not and consumed with *Nshima* (a corn-based meal). Since the bean requires processing before consumption, they are often consumed within the home as opposed to other grains which can be consumed immediately when obtained.

4.4.1.2 Consumer and household characteristics

The majority of the respondents were females for both rural and urban consumers (>70%). Wives were mostly responsible for shopping for food products whereas the head of households when they are men rarely shop for food products.

Table 4. 3: Characteristics of consumers in Zambia and Malawi

Variable	*Category*	*Location (Zambia)*		*Significance*
		Rural	*Urban*	
Gender	Male	14.76	28.24	0.002
	Female	85.24	71.76	
Age	<30	40.48	56.49	0.004
	31-50	44.76	38.93	
	>50	14.76	4.58	
Mean		34.93	30.8	
Family size	<4	20.48	38.17	0.070
	4-6	53.81	46.56	
	7-9	28.10	15.27	
	>9	7.14	0	
Mean		5.93	4.34	
Marital status	Single	4.29	38.17	0.000
	Married	91.43	56.49	
	Other	4.29	5.34	
Income	<500	99.05	71.76	0.000
	501-1000	0.48	20.61	
	1001-3000	0.48	3.82	
	>3000	0	3.82	
Mean		60.26	394.05	

Savings	Savers	81.90	73.28	0.059
	Non-savers	18.10	26.72	
Education	No education	41.90	15.27	0.000
	Basic	48.10	19.85	
	Secondary	9.52	35.88	
	Tertiary	0.48	29.01	
Household head	Male headed hhs	20.58	14.50	0.000
	Spouse	77.14	44.27	
	Other	2.38	41.22	

Statistical significance; ***=1%, **=5%, *=10%

The majority of the respondents were in their reproductive age, which is within the age range of 31 to 50 years (Table 4.3). Although there was a higher percentage of urban consumers who were under 30 years. Most of the respondents have at least primary education with 29% of urban consumers having tertiary education. This corroborates with statistics in Zambia stating that there is a higher percentage of primary school age population in both rural and urban centres. This is followed by secondary school-age population and tertiary with the urban population having a slightly higher percentage (CSO, 2015). Consumers with high educational levels are often within the middle-income group who are often selective about food choices. Education has been found to influence food consumption because it shapes perceptions and habits (Bhurosy and Jeewson, 2014).

Family sizes among the respondents were mainly 4 to 6 individuals in a household, however, rural consumers had larger households with 7.1% having nine or more individuals in a household. The average household size in Zambia is 5.1 (CSO, 2015). Generally, a large percentage of the consumers were not savers, and income levels were quite low for rural households compared to urban households. This aligns with statistics in Zambia that reports that the majority of the urban population have higher incomes (CSO, 2015). Urban consumers were more likely to have higher-paying jobs compared to rural consumers. Consuming households are characterized by male-headed households, average family sizes, educated purchasers, etc. ANOVA and Chi-square results showed that there were statistically significant differences in gender, age, income, marital status, position and education of rural and urban consumers. Household size and savings were however statistically significant at 10% (Table 4.3).

These are the characteristics of the purchasers of beans, however, the product is consumed by other household members apart from the consumer. The household size, therefore, plays a critical role in the decision to purchase beans, the frequency of consumption and the quantity of the beans consumed. Apart from the household size, marital status, head structure and age distribution are also important. The processes along the household value chain also change based on these characteristics because households would require making beans into flour apart from raw beans for children. Female respondents are responsible for all activities from purchasing to disposal along the household food value chain for beans. However, other consuming household members also play different roles along the HVC.

4.4.2 Activities along the Household Food Value Chain

4.4.2.1 Input Acquisition

Input acquisition covers the decision to purchase, information access, search for the product, factors influencing the product choice (variety), and the quantity to be purchased. All these are affected by the availability of beans, socioeconomic characteristics, location, preferred attributes of the beans, income, expenditure share on food, the value attributed to preferred bean attributes etc. Beans are displayed in the local market according to their varieties and grades. Consumers are therefore able to examine the beans and make a purchase. After selection, the quantity is packaged in a polypropylene bag. In the supermarkets, specific quantities of the beans are already packaged in transparent bags. Purchases are made on the spot through an exchange of cash.

Beans are sold by local retailers and also modern retailers like supermarkets. Both rural and urban consumers purchase from local retailers in market centres. About 91% and 8.47% of rural consumers purchase from local markets and community stores respectively. However, more than 60% of the urban consumers purchase from local retailers in market centres and 33.3% in community centres. This is the preferred choice of the retailer because consumers often make bean purchases when other food purchases are being made which is usually at the market centre. The urban and rural consumers generally purchased beans in the same place all the time, less than 30% bought it at different places. A few urban consumers (6.7%) purchased beans from the supermarket. A supermarket is viewed as having expensive products which could explain the limited percentage of consumers who purchased from that source. Although a small percentage of the consumers used this avenue, there is an indication that consumers are gradually transitioning into patronising other modern markets. Purchasers indicated that services such as purchasing on credit (0.8%), on-time delivery (3.8%), and well-sorted beans (12.9%) provided by retailers were beneficial because it saves time and helps with payment.

Several varieties of beans are produced and marketed in Zambia. Some of the varieties include *kabulangeti*, *mixed*, *white*, *lusaka* and *solowezi* beans. The majority of consumers purchase and consume more than one variety of bean. The variety purchased at a point in time is dependent on the availability, price, quality and preference. About 39.6% of the respondents consumed only two varieties of beans, 25.2% consumed three varieties, 2.7% consumed four varieties, and 32.4% consumed only one variety of beans. Figure 4.5 shows that among consumers who purchased and consumed only one variety, *kabulangeti* followed by *white* beans were the most consumed.

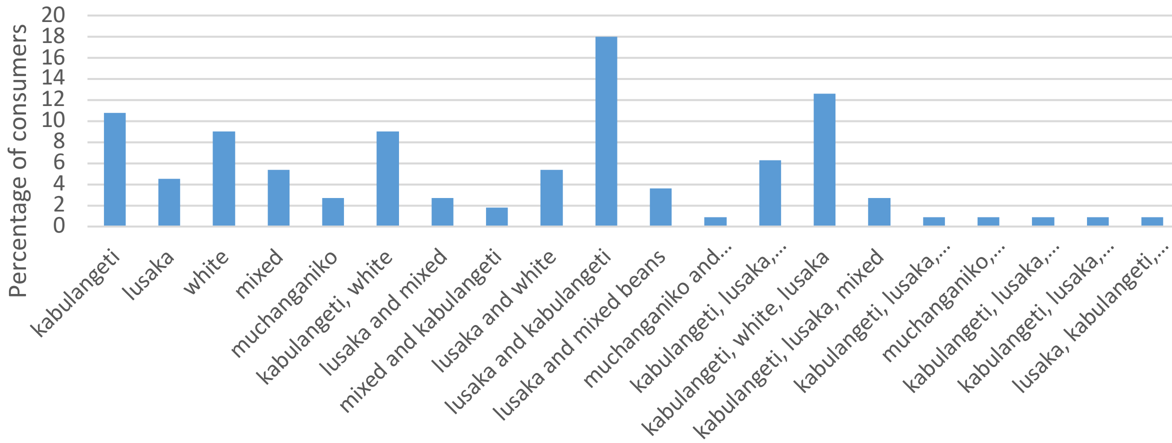


Figure 4. 5: Bean varieties consumed within a household (Rural consumers)

In situations where consumers purchased two varieties, *kabulangeti* and *Lusaka* beans were the most purchased. The varieties which are less consumed are sugar beans, *solowezi*, *muchanganiko* and *chipolopolo*. These varieties are found to be purchased by respondents who consumed three or more varieties as an addition to the popular varieties.

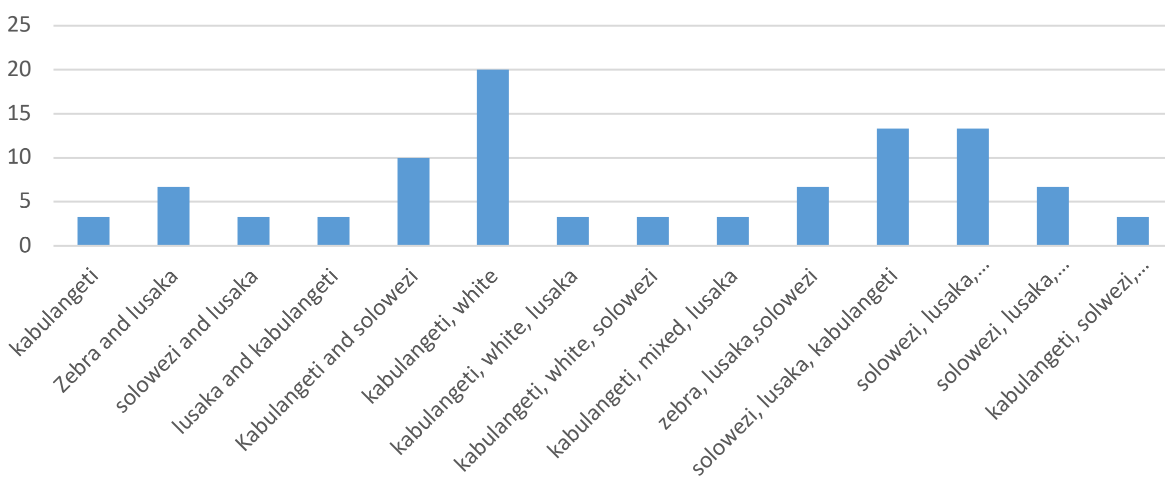


Figure 4. 6: Bean varieties consumed within a household (Urban consumers)

For urban households, *kabulangeti* was the only variety purchased by households who ate only one variety of beans (Figure 4.6). For households who consumed two varieties of beans, *kabulangeti* and *white* beans were observed to have a higher percentage (20%). Urban consumers were observed to purchase and consume more varieties compared to rural households. This could be attributed to a higher interest by urban households to have a more diversified diet even with respect to a single product with different varieties.

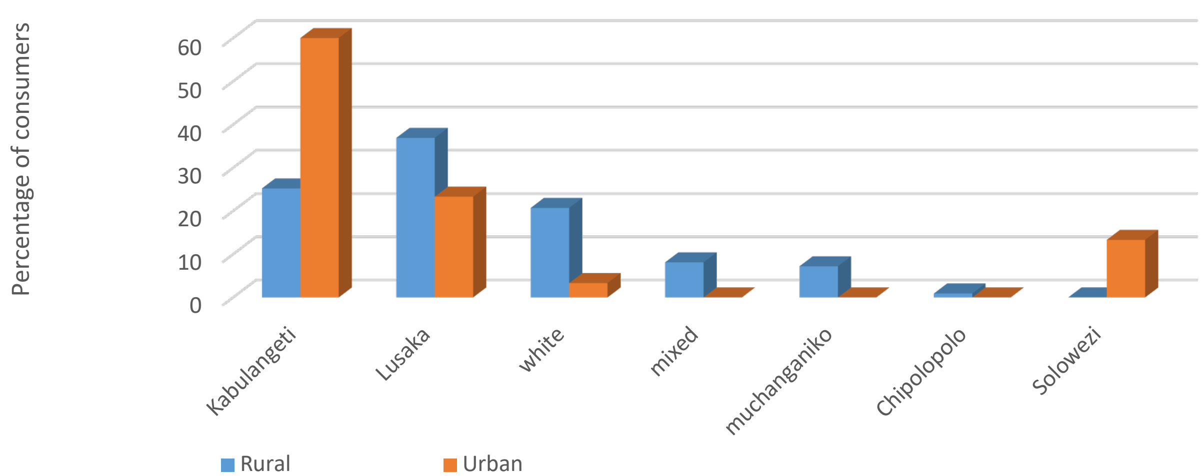


Figure 4. 7: Most consumed bean varieties

More generally, the findings show that 36.9% of rural consumers mainly consumed *lusaka* beans, 25.2% consumed *kabulangeti* beans, and 20.7% consumed *white* beans (Figure 4.7). Among urban households however, *kabulangeti* was the most consumed bean variety as indicated by 60% of the households, followed by *lusaka* (23.3%), *solowezi* (13.3%), and *white* (3.3%) beans (Figure 4.7). Differences in taste, preferences, and accessibility could be contributing factors to this difference.

4.4.2.2 Purchasing factors

4.4.2.2.1 Availability and price

Rural consumers (44.1%) indicated that beans were not available all year. During the seasons where beans were not available, these respondents rarely purchased and consumed beans. For consumers in the urban centre however, 90% indicated that they had access to beans all year round.

Apart from the inability to have beans all year, some consumers did not also obtain the variety of beans they preferred when and as often as they wanted. With respect to quantity, consumers did not have the ability to purchase the desired quantities due to the price of the beans. The results showed that rural consumers (55%) and urban consumers (50%) were not content with the price at which the beans were sold. They would have purchased more if the beans were sold at a lower price with rural consumers (24.3%) and urban consumers (10%) willing to double the quantity purchased. Rural consumers (28.8%) and urban consumers (23.3%) also considered buying often if the price of beans were lower than the current price. The results show that the availability of beans and the price influenced the purchase of beans and the quantity purchased for consumption.

4.4.2.2.2 Income and expenditure shares on food and beans

Purchasing is however mainly done by the spouse, although male respondents in rural Zambia (24.3%) and urban Zambia (43.3%) also purchased beans for consumption. A high number of consumers (38% in rural and 13.3% in urban Zambia) are housewives and thus do not work for income. Financing of food purchases is expected to be made by males except for female-headed households. The selection of beans and quantity is influenced by income and expenditure allocated for food and beans.

Food expenditure share is the total expenditure on food out of the total household expenditure. Based on the food expenditure, the expenditure allocated to beans, bean product, and other protein sources were estimated. Estimates were reported on a monthly basis.

Table 4. 4: Consumption and purchase frequency

Consumption	Categories	Location (Zambia)	
		Rural (%)	Urban (%)
Purchase frequency	Weekly	40.7	40
	2 -3 times a week	11.1	-
	Monthly	44.7	60
	2-3 times a month	3.7	-
Consumption quantity	1-2kg	28.3	13.3
	3-4kg	1.2	30
	≥5 kg	70.2	56.6
Consumption frequency	Daily	5.4	-
	Weekly	45.9	66.7
	Twice a week	34.2	-
	Every two weeks	-	16.7
	Monthly	12.6	16.7
	Twice a month	2.7	-
Expenditure share for beans	<5%	0.9	3.3
	6-10%	9.0	70
	11-20%	13.5	20

	20-50%	37.8	6.7
	>50%	38.7	-
Expenditure share for bean products	<5%	-	83.3
	6-10%	-	10
	11-20%	-	3.3
	>20%	-	3.3
Expenditure share for other protein sources	<5%	56.7	0
	6-10%	18.0	6.7
	11-20%	14.4	23.3
	>20%	10.8	70

For the majority (61.3%) of the rural consumers, the proportion of expenditure spent on beans in a month was <30% of their total food expenditure. The proportion of expenditure spent on beans out of the total food expenditure was between 6 to 10% for most (70%) of urban consumers. Generally, a higher proportion of food expenditure was spent on beans by rural consumers compared to urban consumers (Table 4.4). The high expenditure share does not necessarily imply a high consumption rate. Rural consumers purchased mainly starchy foods and green vegetables which were relatively cheaper than beans. Due to lower incomes, their expenditure shares for food was also lower than urban consumers and did not spend income on any processed products. Thus, beans was one of the higher-priced products compared to other products and this took up a high percentage of the income share. For the majority of the rural households, beans formed a major proportion of their protein sources as compared to urban consumers. About 33.3% of the urban consumers consumed other protein foods apart from beans on a daily basis and 66.7% on a weekly basis. However, for rural consumers, 35.1% had other protein sources once or twice in a year, and, 39.6% weekly.

About 70.2% of the rural consumers in Zambia purchased more than >3kg of beans in a month while 28.3% purchased <1kg every month (Table 4.4). A slight majority of the rural consumers purchased more than 3kg of beans every month compared to urban consumers. None of the urban consumers consumed beans daily however the majority (66.7%) purchased beans weekly. While a few of the rural consumers consumed beans daily (5.2%), the majority consumed beans weekly or twice in a week. For urban consumers, about 16% were found to spend 6 to 20% of their expenditure on bean products mainly canned beans. Overall, consumers who had lower expenditure shares for other protein sources and other bean products were more likely to spend a higher percentage of their expenditure on beans.

4.4.2.2.3 Factors influencing expenditure share on beans

Factors influencing the expenditure share of bean for consumers were estimated using linear regression. The dependent variable was a continuous variable, which is the share of expenditure on beans. The results are shown in Table 4.5.

Table 4. 5: Factors influencing expenditure share on beans (OLS results)

Variables	Coef.	Std. Err.	t	P
Socioeconomic characteristics				
Age	-0.00821	0.002472	-3.32	0.001
Education	0.070313	0.026614	2.64	0.009
Household size	0.007757	0.013732	0.56	0.573
Income	0.280395	0.074779	3.75	0.000
Point of purchase				
Location (country)	1.123856	0.124221	9.05	0.000
Place of purchase	0.003409	0.052981	0.06	0.949
Preference attributes which influence purchase				
Quality	-0.03578	0.021531	-1.66	0.099
Taste	0.020587	0.018565	1.11	0.27
Color	0.012166	0.017932	0.68	0.499
Price	-0.04535	0.025237	-1.8	0.075
Size	0.023548	0.019852	1.19	0.238
Safety	-0.05238	0.02095	-2.5	0.014
Special benefit offered by retailer	0.028001	0.021391	1.31	0.193
Constant	0.662526	0.225432	2.94	0.004
F (13,127)	46.09	Prob > F	0.000	
R-Squared	0.6472	Root MSE	0.30669	

Income, education, and age were statistically significant at a 5% level in explaining the expenditure share allocated to beans. All but age had a negative impact on the expenditure share allocated to beans. This implies that a percentage increase in household income resulted in a 28% increase in expenditure share allocated to beans, holding all other factors constant. Consumers are more likely to spend more on beans when income increases. Pele (2007) found that Zambian consumers in the lower to middle-income group allocated a higher percentage of their food expenditure on beans compared to consumers in other groups. The majority of the consumers in the study, however, were within low to lower-middle-income groups. This explains the positive correlation between income and expenditure share for beans.

An additional level of education is associated with an increase in the expenditure allocated to beans by 7%. Studies show that educated people tend to consume more pulses than uneducated people due to knowledge of the nutritional benefits (Mitchell et al. 2009a; Reddy, 2004). The findings also corroborate with Pele (2007). An additional year to the age of an individual decreased the expenditure allocated by 0.8%. Studies have established that the primary consumers of pulses were young people, with adults generally consuming lower amounts (Leterme and Carmenza Muñoz, 2002). Since the majority of the respondents were adults, this could explain the slight percentage decrease in expenditure share with an additional year.

Consumers who had obtained higher education were also more likely to have a higher share of their income for beans. These groups of consumers are more likely to have information about the nutritional and health benefits of beans and thus incorporate more of it into their diets. Rural consumers had a higher expenditure share for beans compared to urban consumers and were found to be statistically significant at 5%. Findings corroborate with those of Bentley and Griffiths (2003) Mitchell et al. (2009). This could be because rural consumers spend income mainly on cereals which are often much cheaper than beans. They do not spend income on other products such as fruits, processed foods, other expensive protein sources and varied types of vegetables compared to urban households. Thus, the percentage of expenditure spent on beans is much higher relative to their income level.

Preference or attitude towards safety, price, and quality had a statistically significant influence on the expenditure share for beans at 5%, 10% and 10% respectively. They all had a negative influence on the beans expenditure share. This implies that consumers who placed high importance on quality and safety are more likely to spend less on beans. This could be explained by the lower quality of beans available to them and negative perception about the safety of beans on the market. A percentage increase in price leads to a 4.5% decrease in the expenditure of beans (Table 4.5). Consumers are not willing to spend a higher share of their income on beans when the price increases. This is expected as with most food products. Quality, safety and price, therefore, influenced beans consumption.

4.4.2.2.4 Bean Quality

All consumers desired to purchase quality bean products. The definition of quality among the consumers was, however different as expected. Quality is often defined based on attributes desired by consumers (Verbeke et al. 2007). Consumers often examine these product characteristics before purchase. The differences in the perception of quality by the consumers show how diverse consumers can be as well as their individual preferences.

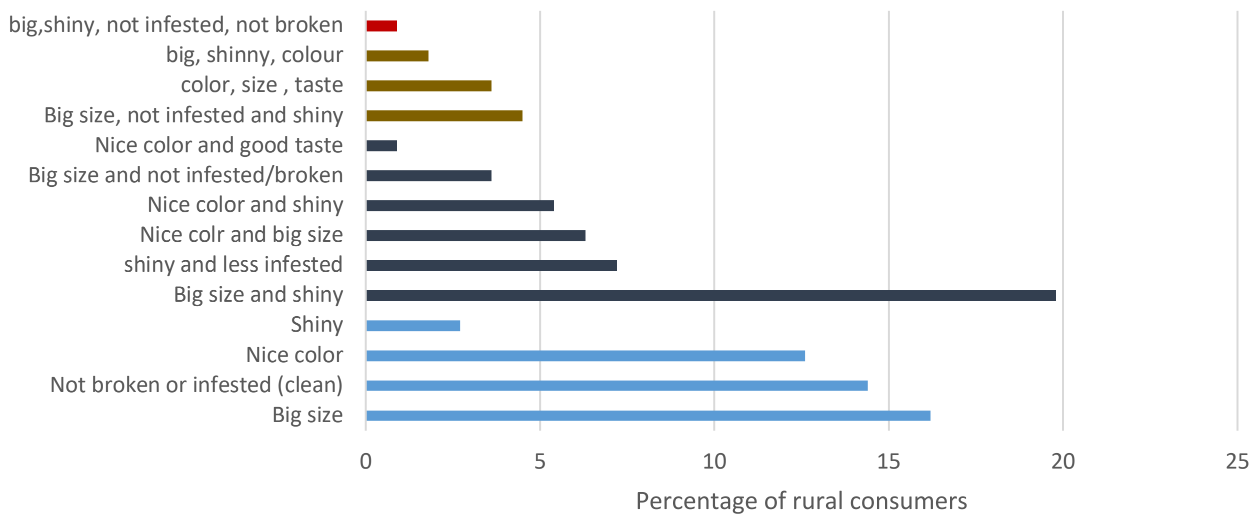


Figure 4. 8: Bean quality description by rural consumers

The graph (Figure 4.8) has been colour-coded based on the number of attributes consumers used in defining quality. Overall, quality was defined by the majority (19.8%) of the rural consumers as beans with big size and shiny (with a gloss). Next to the majority, 16.2% and 14.4% of the consumers defined bean quality based on the size and cleanliness (not broken or infested) respectively. Among the 1-attribute quality definition, the size and colour were the most mentioned. Size and gloss were the attributes that defined bean quality by consumers who defined quality based on two attributes. Generally, size, shine and clean beans defined bean quality by rural consumers.

Among urban consumers size, easy to cook, shiny and cleanliness were the defining attributes. Cleanliness was a key attribute defining quality by 72.9% of the urban consumers (Figure 4.9). It is interesting to find that easy to cook was a defining attribute by urban consumers. This is expected since most urban consumers have busy work schedules and prefer foods that take less time to prepare. Clean beans require less sorting time and thus reducing the already time-consuming bean cooking process. This is also an implication of the need for convenience.

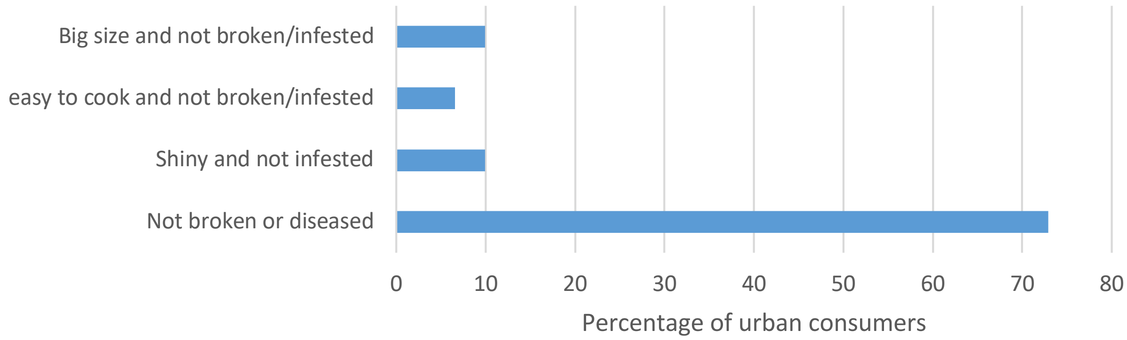


Figure 4. 9: Bean quality description by urban households

Most of the consumers purchase beans which were not to their preference with respect to the number of broken and infested that were available in their pack of beans. Although 39.6% of the rural consumers indicated that they had clean beans, 66% indicated otherwise. The high percentage of consumers who had their beans infested suggested that the quality of beans available to the majority of the rural consumers is not optimum. About 5.4% of the consumers usually had 20-30% of their beans broken and 35.1% had 5% to 15% broken. About 46.7% of rural consumers had 5-10% of beans infested. About 46.6% of urban consumers had 5% to 2% of their beans broken. Also, 47.7% had 5% to 15% of their beans infested while 8.1% had 20-35% of their beans infested.

4.4.2.2.5 Quality attributes considered during purchase

Consumers evaluate product attributes and choose the products that have attributes that provide them with the highest utility. Consumers considered both intrinsic and extrinsic attributes when purchasing beans. These attributes are classified as search (colour, size, and lack of damage), experience (taste), marketing (marketing strategy, price, and packaging) and safety attributes (Poole et al., 2007; Wirth et al., 2011).

Table 4. 6: Quality attributes considered during purchase

Quality attributes	Location				
	Rural (Mean)	St. Dev. (St. Err.)	Urban (Mean)	Std. Dev. (Std. Err)	t-value (sig)
Search attributes					
Quality (no insects)	3.57	1.36 (0.15)	4.4	0.86 (0.16)	-3.12 (0.002)
Quality (no breakage)	3.39	1.54 (0.17)	4.37	0.72 (0.13)	-3.32 (0.001)
Colour	2.81	1.47 (0.17)	3.43	1.50 (0.27)	-1.97 (0.052)
Size	2.73	1.39 (0.16)	3.07	1.28 (0.23)	-1.14 (0.26)
Safety attributes					
Safety	2.82	1.65 (0.19)	4.47	0.63 (0.11)	-5.29 (0.000)
Experience attributes					

Taste	3.78	1.32 (0.16)	3.97	1.30 (0.24)	-0.62 (0.54)
Marketing attributes					
Price	4.08	1.27 (0.14)	3.63	0.99 (0.18)	1.72 (0.089)
Packaging	2.86	1.80 (0.20)	3.23	1.22 (0.22)	-1.04 (0.23)
Marketing strategy	2.18	1.34 (0.15)	3.13	1.25 (0.23)	-3.39 (0.001)

Quality (no breakage), quality (no insects), and safety were observed to have relatively higher mean scores, which indicated that they were important to urban consumers when purchasing beans (Table 4.6). Taste and price were also important attributes considered by urban consumers. The mean scores for marketing strategy (3.13) and size (3.07) were, however low indicating that the consumers did not place much importance to these attributes when purchasing beans. For rural consumers, price (4.08), taste (3.78) and quality (no insects) (3.57) were considered important in the purchasing of beans because they had relatively higher mean scores. Comparable to the urban consumers, marketing strategy and size had relatively lower means indicating that less importance is placed on those attributes. Studies by Magreta and Jambo (2012); Hella et al. (2013) and Mfikwa and Kilima (2014), corroborate with findings from this study.

Independent t-test results showed statistically significant mean scores for quality, safety, colour, and marketing strategy. This indicates that urban consumers attributed more importance to these factors during the purchase of beans compared to rural consumers. Rural consumers, however, attributed higher importance to price compared to urban consumers. This was, however, significant at a 10% level.

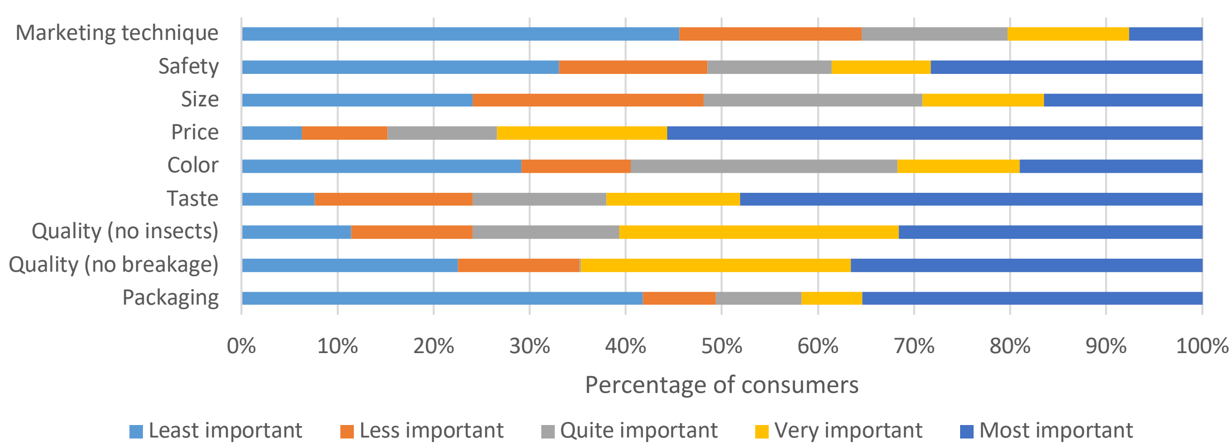


Figure 4. 10: Preference levels for bean attributes (Rural consumers)

Among the search attributes, the majority of urban and rural consumers considered quality as very important when purchasing beans (Figure 4.10 and 4.11). Price was considered as highly important among marketing attributes followed by packaging by both rural and urban consumers.

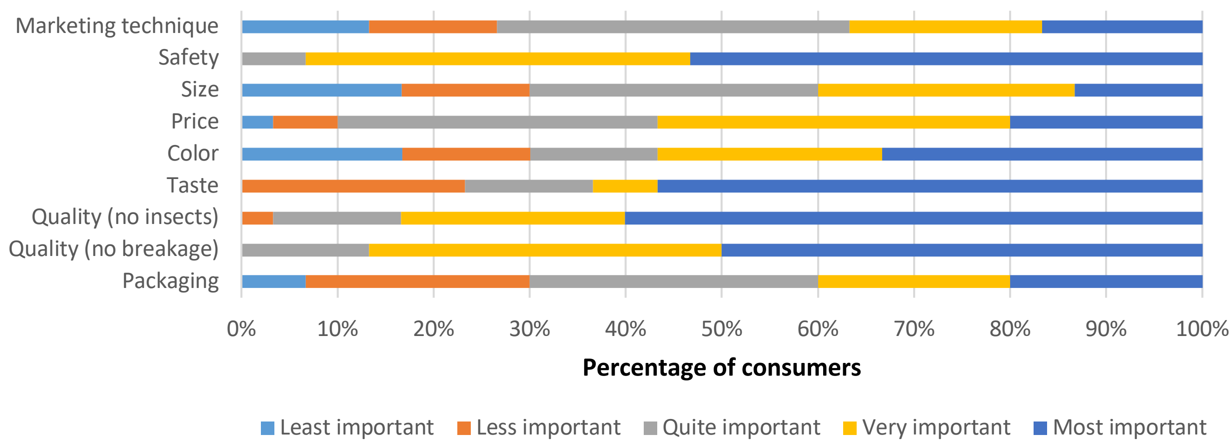


Figure 4. 11: Preference levels for bean attributes (Urban consumers)

4.4.2.2.6 Importance of bean attributes and attribute levels during purchase: Choice based conjoint analysis

In the previous section on quality attributes, consumers indicated their preferences for the different attributes separately without taking into considering other attributes. However, during a purchase, consumers would have to make a choice to purchase a product based on the bundle of attributes with different levels. Thus, a choice-based conjoint analysis was undertaken to determine how consumers choose between different products as a bundle of attributes and the trade-offs made. It's a means of understanding consumer behaviour and assessing the difference between what consumers say and what they do.

Conjoint analysis estimate utility scores to indicate how attractive and important an attribute level is to a consumer regarding their preferences. The utility scores are aggregated to generate relative importance. The levels that are most preferred by consumers are those with the larger part-worth utility scores. In Table 4.7, urban consumers view taste (30.7%) as the most important factor during the purchase of beans followed by price (18.7%), size (16%), cooking time (15.6%), level of damage (11.8%) and colour (7.2%). Among rural consumers, cooking time (29.9%) was considered the most factor followed by price (22.9%), size (14.9%), taste (12.7%), colour (10.3%), and level of damage (9.3%). The level of damage was linked with safety because consumers were concerned about the safety of the food when they looked unclean and damaged by insects or activities during handling.

Cooking time though not mentioned in the definition of quality by the majority of consumers, was still included in the choice experiment. This was to determine its overall influence when consumers make trade-offs among attributes. Taste was found to be important for urban consumers because they had access to a variety of foods including processed foods which had enhanced taste. Taste, price and level of damage were ranked higher by urban consumers. However, when consumers were required to make choices between products, the level of damage had the lowest utility score. This shows that they were willing to trade that off that for other attributes. Cooking time was however important for rural consumers not only with respect to the long preparation time but also the fuel cost associated with it. Rural consumers spend time and money to gather wood or charcoal respectively for cooking which can be costly with long preparation time. Rural consumers ranked price, taste and level of damage as important attributes. However, the cooking time had the highest utility score and taste had a lower score when choices and trade-offs had to be made.

Table 4. 7: Part-worth utilities and relative importance of attributes and levels.

Attribute	Levels	Urban consumers			Rural consumers		
		Part-worth utilities	Std. Err.	Rel. Imp. (%)	Part-worth utilities	Std. Err.	Rel. imp. (%)
Search attribute							
Color	Single color	-0.256	0.777	7.216	0.209	0.735	10.309
	Multicolor	0.256	0.777		-0.209	0.735	
Size	Small	0.742	0.796	15.936	-0.391	0.633	14.928
	Medium	-1.436	0.752		0.586	0.616	
	Large	0.694	1.237		-0.194	0.771	
Safety/Search attributes							
Damage	No damage	0.914	0.962	11.847	0.270	0.657	9.317
	Slight damage	-0.914	0.962		-0.270	0.657	
Experience attributes							
Cooking time	60 mins	0.503	1.340	15.607	-0.633	0.473	29.865
	120 mins	0.541	0.659		1.895	0.489	
	180 mins	-1.043	1.283		-1.262	0.694	
Taste	Slightly tasty	-3.10	1.537	30.650	0.408	0.898	12.690
	Very tasty	3.10	1.537		-0.408	0.898	
Marketing attribute							
Price (Urban)	K5	1.182	0.999	18.744			
	K7	0.937	0.717				
	K10	-2.119	1.518				
Price (Rural)	K3				0.126	1.336	22.892

K4	-0.699	1.062
K5	0.573	1.159

The results also provide the different levels at which each attribute is preferred by consumers. A high positive part-worth utility score indicates a high level of preference for the consumers. A negative part-worth utility explains less preference for that level of the attribute. A negative sign does not mean that the attribute level is not attractive, but in comparison to other levels, it is less preferred. For instance, among urban households, under the attribute labelled size, small-sized beans are preferred compared to large-sized beans; however, large-sized beans are preferred to medium size beans.

Urban consumers preferred multi-coloured (0.256) beans to single-coloured (-0.256) beans while it was vice versa for the rural consumers. Urban consumers are likely to have an interest in the appearance of the food after its cooked and multicoloured beans give a colourful and appealing look. Rural consumers preferred very tasty (0.408) beans to slightly (-0.408) tasty beans while it was vice versa for urban consumers (Table 4.7). Preference for slightly tasty beans does not imply preference for beans that is not tasty, however, urban consumers were willing to trade off some level of taste for more of another level of a different attribute. Rural consumers preferred medium-sized beans (0.586) to large or small-sized beans however large-sized beans (-0.194) were preferred to small-sized beans (-0.391).

Both groups had a preference for medium-sized beans. Both rural and urban consumers preferred beans with no damage to one with slight damage. Both consumers had less preference for beans with extended cooking time. Urban consumers had less preference for high priced beans (-2.119), while rural consumers had preference for high priced beans (0.573). Rural consumers were more likely to attribute high prices for quality beans while urban consumers are unwilling to spend a lot of money on bean (low-cost food) compared to other high valued products. A combination of the various attribute levels can be used to indicate the ideal bean that consumers prefer and are willing to purchase.

Based on trade-off among various attribute levels and their combinations, urban consumers can be viewed as preferring beans that are multi-coloured, small-sized, cooks for 120 mins with no damage and low price. Rural consumers prefer beans that are single-coloured, medium-sized, slightly tasty, cooks for 120 mins with no damage and high price. It is important to note that these attributes are most important based on trade-offs made among products with different attributes and attribute levels. The standard errors are the deviations of the sample mean from the mean of the entire population and explains the reliability of the sample mean. The HB Root-likelihood (Rlh) measures how well a choice model fits the data set with a higher value between 0 and 1 indicating a better fit. Rlh for the urban data and rural data was 0.926 and 0.843, respectively, indicating a good fit for both choice models.

4.4.2.2.7 Cluster analysis

The goal of the analysis is to determine whether consumer preferences for the product attributes vary across different socioeconomic groups of consumers. The clustering of consumers ensures that value chain actors produce and deliver products to specific groups of consumers that meet their needs. A three-group segmentation was employed for the study for both locations. Cluster 1 and cluster 2 were more similar compared to cluster 3 for both locations. Dendrograms of the clusters are presented in Figure 4.12 and Figure 4.13.

Among urban consumers, cluster 1 was associated with cooking time and level of damage while cluster 2 was associated with a size and 3 was associated with taste and price. Among the rural consumers, cluster 1 was associated with price and level of damage while cluster 2 was associated with the level of damage and size and cluster 3 was associated with price. Overall, cluster 1 are consumers who are time and safety conscious. Cluster 2 are consumers who are appearance (size) and safety conscious and cluster 3 are consumers who are price and taste conscious. The clusters were not however distinctly different from one another within and across locations. Comparisons were made across attributes and demographic characteristics.

Clustering is important to align production and marketing activities towards different segments of consumers (Pieniak et al. 2010). Based on hierarchical clustering, the dendrogram distinctly highlighted 3 clusters based on the distance from the centroid. Proportionally, among rural consumers cluster 1 make up 32%, cluster 2 make up 23.4% and cluster 3 make up 44.7%. For urban consumers, cluster 1 makes up 10.5%, cluster 2 makes up 24.2% and cluster 3 makes up 65.2 %. Table 9 provides a segmentation of clusters with respect to attributes and demographic characteristics. Results from the ANOVA test and post hoc means separation using the Tukey HSD test demonstrated that the three clusters differed significantly with respect to all attributes for urban consumers. There was a statistically significant difference for all attributes but colour and taste for rural consumers. Chi-square test revealed no statistically significant differences among demographic characteristics except income for urban consumers. No statistically significant difference between clusters with respect to demographic characteristics was observed for rural consumers (Table 4.8).Urban consumers in cluster 1 considered the level of damage as important because, besides safety, it would require more time for sorting before preparation, which adds to the overall cooking time. For urban respondents, consumers in cluster 1 had a higher percentage of females compared to other clusters and respondents within the age range of 25-50years. Cluster 1 had a higher percentage of consumers who had attained secondary education while cluster 3 had a higher percentage of consumers who had tertiary education. Compared to other clusters, cluster 2 had the highest percentage of consumers with higher incomes and large household sizes. Among rural consumers, the clusters were not statistically significant with respect to colour and taste. Consumers in cluster 1 had a higher percentage of females, larger household sizes, as well as high income earners, compared to other clusters. With respect to education, consumers in cluster 1 had a higher percentage of consumers with tertiary education. Cluster 2 had a higher percentage of consumers with secondary education. Cluster 2 also had more consumers within the age range of 25-50 years and averaged sized households.

All clusters had on average, a low importance score for colour compared to other attributes. Level of damage, price, cooking time, taste and size were the major attributes considered by different classes of consumers. For both groups of consumers, a larger percentage of them were in cluster 3. This implies that they were price and taste conscious as well as safety conscious (the level of damage) when rural consumers are considered. This group of consumers are middle to high-income earners, well educated, with larger household sizes and within the age of 25 to 50 years. Their preference for taste maybe as a result of their income levels. The importance attributed to price and level of damage maybe as a result of the larger household sizes and being an active working class who require convenience.

Table 4. 8: Average relative importance of bean attributes among clusters

		Urban				Rural			
		Cluster 1	Cluster 2	Cluster 3	Sig	Cluster 1	Cluster 2	Cluster 3	Sig
Attribute	Color	11.04a	7.91ab	6.0327b	0.006	10.74	10.17	9.94	0.9146
	Size	15.37a	24.59b	12.87a	0.000	11.37a	18.22b	14.21ab	0.0013
	Taste	13.77a	24.34b	37.08c	0.000	15.18	11.60	11.07	0.1190
	Cooking time	27.68a	19.51b	11.24c	0.000	6.22a	7.83b	16.31b	0.0000
	Level of damage	17.58a	9.75ab	11.24b	0.000	28.58a	35.49ab	21.84b	0.0000

	Price	14.56a	13.92a	21.54b	0.000	27.91a	16.70b	26.62a	0.0000
Sex:	Male	12.5	30.43	25.81		0	4.17	9.52	
	Female	87.5	69.57	74.19		100	95.83	90.48	
Mean		0.13	0.30	0.26	0.479	0	0.10	0.04	0.163
Age:	>25	25	45.45	48.39		114.71	25	23.81	
	25-50	68.75	54.55	51.61		52.94	62.5	52.38	
	>50	6.25	4.55	1.61		32.35	12.5	23.81	
Mean		33.47	30.52	28.05	0.1729	41.06	37.02	33.79	0.1474
Education	No educ.	31.35	0	11.29		79.41	75	83.33	
	Primary	31.25	21.74	25.81		14.71	20.83	7.14	
	Secondary	31.25	56.52	35.48		2.94	4.17	9.52	
	Tertiary	6.25	21.74	25.81		2.94	0	0	
	Vocational	0	0	1.61		0	0	0	
Mean		1.2	1.83	0.79	0.616	0.29	0.26	0.29	0.431
Marital Status	Single	26.09	19.35	50		8.82	0	0	
	Married	62.5	39.13	45.16		82.35	95.83	95.23	
	Other	0	8.70	4.84		8.823	4.17	4.76	0.218
Mean		0.73	0.83	0.55	0.293	1.03	1.05	1.04	
Position	Head	62.5	17.39	6.45		20.59	8.333	11.91	
	Spouse	31.25	39.13	43.55		79.41	91.67	88.10	
	Other	6.25	43.48	50		0.000	0.000	0.000	
Mean		0.87	0.96	1.22	0.654	0.21	0.12	0.13	0.531
Occupation	Business	6.25	30.43	12.90		11.76	12.50	7.14	
	Worker	62.5	4.35	4.84		0.00	0.00	7.14	
	Unemployed	31.25	65.22	82.26		88.24	87.50	85.71	
		1.2	1.91	1.85	0.254	0.26	0.79	0.58	0.315
Income	<500	87.5	78.26	87.10		97.06	100.00	97.62	
	501-1000	12.5	4.35	4.84		0.00	0.00	2.38	
	1001-3000	0	4.35	4.84		2.94	0.00	0.00	
	>3000	0	13.04	3.23		0.00	0.00	0.00	
Mean		114.67	784.78	293.55	0.0836	116.18	26.19	14.75	0.3546
HH size	≤3	100	34.78	38.71		13.33	9.09	11.90	
	4-6	0	34.78	50		43.33	63.64	59.52	
	>6	0	30.43	11.29		43.33	27.27	28.57	
Mean		3.93	4.43	4.19	0.750	6.18	6	5.92	0.9174

(US$1 = K); **Significant ($\alpha \leq 0.01$); *Significant ($\alpha \leq 0.05$); abc represents significant differences between clusters different attributes

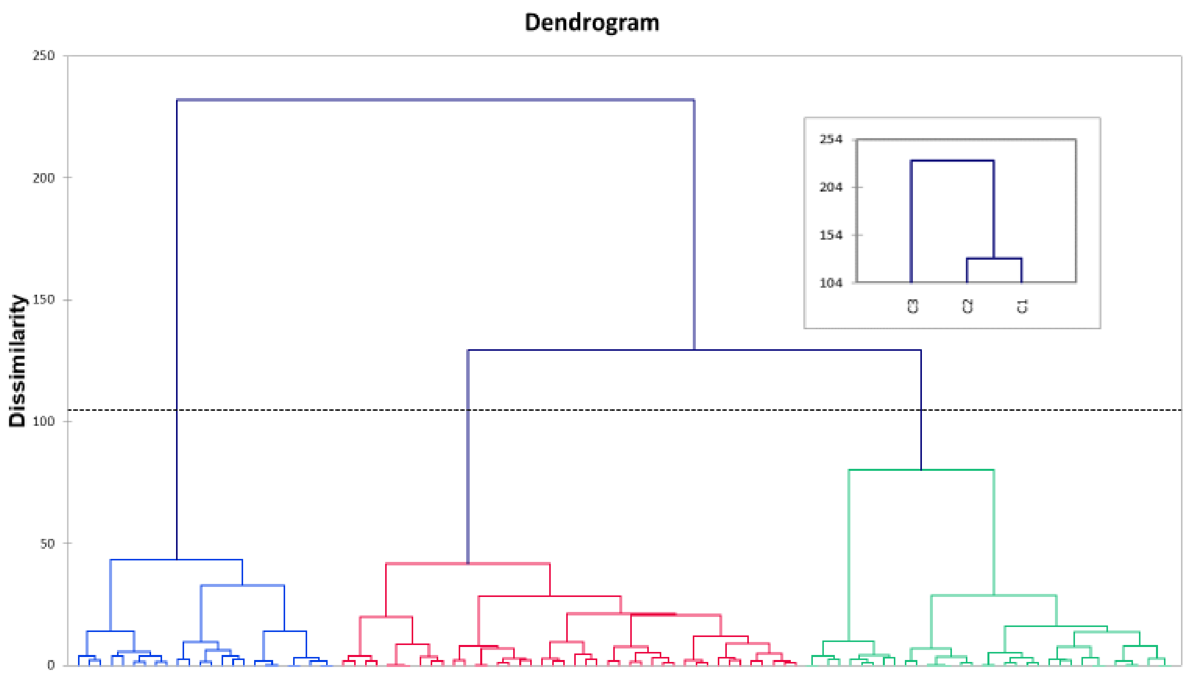


Figure 4. 12: Dendrogram of clusters by cases (Rural consumers)

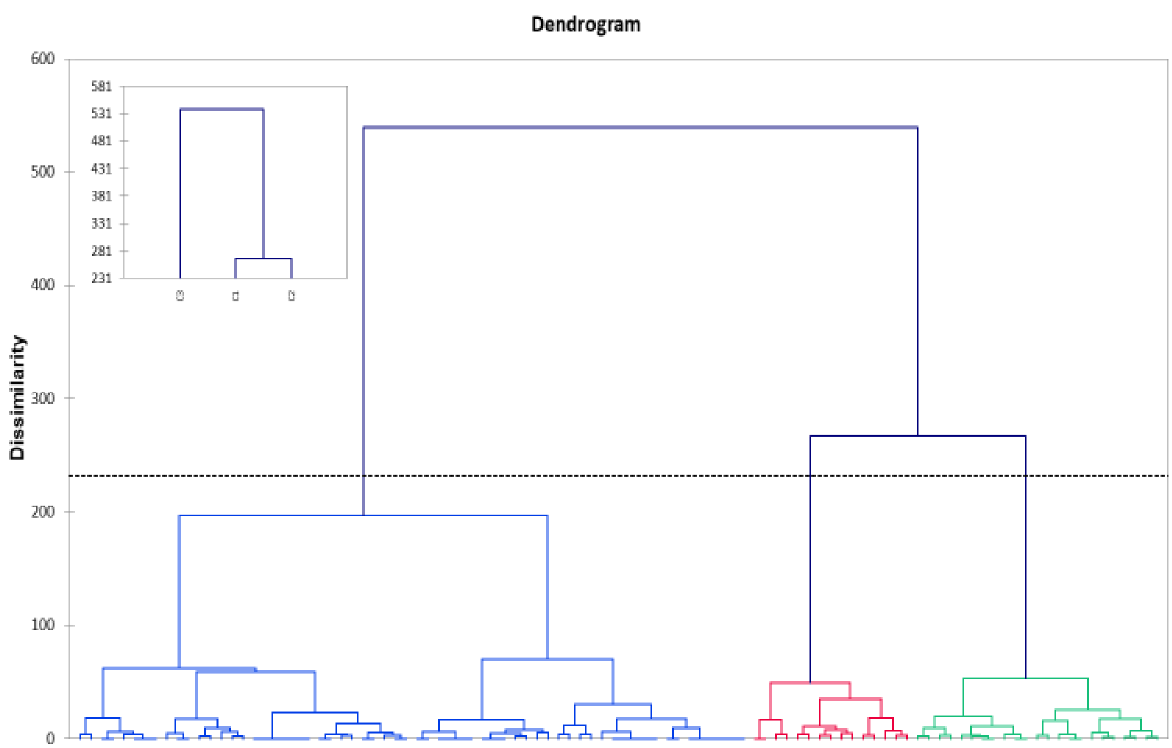


Figure 4. 13: Dendrogram of clusters by cases (Urban consumers)

4.4.2.2.8 Value attributed to quality attributes (premiums and discounts): Hedonic price analysis

Hedonic price analysis was undertaken to compare consumer preference with relative price responsiveness. It is based on the assumption that the price paid for the product is equal to the sum of the marginal value of all the product characteristics. It is to test the responsiveness of price to quality of the product by attaching monetary values to attributes. It is employed to determine attributes in which consumers were willing to pay premiums and discounts.

Functional form

The Box-cox test was used to determine the transformation required for the variables included in the hedonic price model (Rodr´ıguez, 2002). The results are dependent on the functional form which is determined by the statistical procedures utilized. The best functional form was selected based on theory and ease of interpretation (Donnet et. al. 2008). The likely-hood ratios presented for the estimation are tests for the hypotheses of the Box-Cox parameters. Box-Cox parameters, -1, 0 and 1 correspond to the transformation of the variable into a reciprocal, log or no transformation at all, respectively, if the p-value is significant. If the P-value is not significant then there is a need for transformation because the null hypothesis will be rejected. Square root transformations can also be made. Table 4.9 presents the results of the Box-Cox transformation suggesting power transformation.

Table 4. 9: Box-Cox test of functional form for the hedonic model

Test H_o	Restricted log likelihood	LR statistic x^2	P-value Probability> x^2
λ = -1	-769.81494	28.67	0.000
λ = 0	-768.49952	26.03	0.000
λ = 1	-866.41915	221.87	0.000

The test statistic is based on log likelihood model. P-values reported are for LR statistics. (*=10%, **=5%, ***=1%)

The results revealed that the null hypothesis for all forms of λ was rejected since they were all significant at a 5% level, indicating that there is no transformation required. Therefore, it was concluded that the linear form was the most appropriate for the analysis.

Descriptive characteristics reveal an average price of beans per kilogram as K6.91. The most popular variety was *kabulangeti* followed by Lusaka bean. Quality ratings ranged from 1 to 5 with an average of 3.8 depending on how consumers graded the different qualities from poor to best on average for each variety. Other quality attributes were either continuous, dummy variable or ranked from 1 to 3 such as size. The average perceived cooking time for bean preparation was 251 minutes and the percentage of damage (infested and broken) was 5% out of a kg of beans. The average household size for consumers was 6 people and the average income was K206.4 (Table 4.10).

Table 4. 10: Descriptive statistics of variables

Variable (description)	Mean	Std. dev.	Min	Max
Bean price (per kg)	6.91	4.48	2	20
Variety				
Kabulangeti	0.35	0.48	0	1
Lusaka	0.29	0.45	0	1
Zebra	0.02	0.13	0	1
Mixed	0.09	0.30	0	1
Solowezi	0.07	0.26	0	1
Purchase location				
Community store	0.57	0.50	0	1
Local market	0.32	0.47	0	1
Supermarket	0.06	0.25	0	1
Quality rating				
Taste	3.85	1.35	1	5
Appearance (shiny)	3.87	0.94	1	5
Flavour	3.81	0.93	1	5
Size	2.63	0.60	1	3
Packaging	0.46	0.50	0	1
Cooking time	251.4	92.53	60	480
Percent infested and broken	5.35	5.61	0	25
Flatulence	0.21	0.41	0	1
Color (bright or not)	0.89	0.34	0	1
Demographic and purchasing factors				
Education	1.51	0.39	0	4
Income	5	206.4	266.15	1000
Household size	5.59	2.11	0	12
Quantity purchased	3.51	2.23	0.2	20
Special feature presented by seller	0.24	0.43	0	1

Number of observations: 297

Interpretation of results

The parameter estimates for the attributes considered in the study and their robust standard errors are presented in Table 4.11. Explanations are made with the condition that all things are held to be equal for each covariate. Since consumers did not always pay for the price offered for beans it is important to determine how characteristics of the consumers will influence the price consumers are willing to pay for beans. While some studies exclude socioeconomic characteristics, it's been found that characteristics of consumers influence price (Terfa et al. 2013). This shows that markets are non-competitive (Sichilima et al. 2016). The study presents two models; the first model does not include socioeconomic characteristics while the second model does. The R-squared for the second model was found to be greater than the R-squared in the first model (68%), indicating that adding the socioeconomic characteristics improved the explanatory power of the model and explained about 80% of the variation in the price. The higher the R squared value, the better the model fits the data and indicates that the model explains 60-80% of the variability of the response data depending on the explanatory variables in the model.

Table 4. 11: Hedonic price model results

Variable	Coefficient	Std. Err.	t value	Coefficient	Std. Err.	t value
Variety						
Lusaka	1.567548	0.506546	3.09 (0.0020)	1.037488	0.347932	2.98 (0.0030)
Kabulangeti	1.399031	0.476493	2.94 (0.0040)	0.768945	0.32028	2.4 (0.0170)
Zebra	4.918846	0.828262	5.94 (0.0000)	3.125465	0.838514	3.73 (0.0000)
Solowezi	3.929159	0.810438	4.85 (0.0000)	2.273142	0.720595	3.15 (0.0020)
Mixed	-0.26065	0.528388	-0.49 (0.6220)	-0.08899	0.370802	-0.24 (0.8110)
Place of purchase						
Community store	-4.46754	0.879462	-5.08 (0.0020)	-2.17308	0.721066	-3.01 (0.0030)
Local market	-2.72271	0.875497	-3.11 (0.0000)	-1.33685	0.703834	-1.9 (0.0590)
Supermarket	6.806359	1.046825	6.5 (0.0000)	7.284618	0.854689	8.52 (0.0000)
Quality ratings						
Color	1.217469	0.356073	3.42 (0.0010)	0.717136	0.281799	2.54 (0.0110)
Size	0.239213	0.141363	1.69 (0.0920)	0.020649	0.087603	0.24 (0.8140)
Cooking time	-1.36325	1.031439	-1.32 (0.180)	1.15218	0.564291	2.04 (0.0420)
Taste	0.069327	0.126769	0.55 (0.5850)	-0.02599	0.085146	-0.31 (0.7600)
Flavour	0.261726	0.200425	1.31 (0.1930)	0.269653	0.149014	1.81 (0.0710)
Appearance	-0.53106	0.241798	-2.2 (0.0290)	-0.39924	0.177179	-2.25 (0.0250)

Percentage broken and infested	-0.77964	0.417908	-1.87 (0.0630)	-0.01441	0.015263	-0.94 (0.3460)
Flatulence	-0.72047	0.409283	-1.76 (0.0800)	-0.0747	0.295757	-0.25 (0.8010)
Packaging	0.727494	0.374484	1.94 (0.0530)	0.414754	0.27095	1.53 (0.1270)
Retailer value						
Special feature	1.817692	0.528151	3.44 (0.0010)	1.005773	0.389893	2.58 (0.0010)
Quantity purchased	-0.04393	0.081484	-0.54 (0.0900)	-0.10441	0.059385	-1.76 (0.0800)
Socioeconomic characteristics						
Marital status				-0.47317	0.26424	-1.79 (0.0740)
Education				0.264553	0.195991	1.35 (0.1780)
Household size				-0.0431	0.063805	-0.68 (0.5000)
Income				0.006328	0.000926	6.83 (0.0000)
Constant	11.05823	2.760638	4.01 (0.000)	3.584003	1.772703	2.02 (0.0440)
R square	0.6821			0.8129		
Prob> F	0.000			0.0000		
N	238			297		

Statistical significance; ***=1%, **=5%, *=10%

With respect to varieties, consumers were willing to pay a premium for all varieties compared to *white* beans ($p<0.01$). They were willing to pay a discount for *mixed* beans (not statistically significant) compared to *white* beans. This is corroborating with findings by Mishilli et. al. (2009) who found that mixture beans had an overall negative effect on the price. Consumers prefer to have pure varieties. While the conjoint analysis showed that urban consumers had more preference for multi-coloured beans, this had a low utility score indicating that it is not as important. Also, in comparison with other varieties that are either tastier or cheaper, *mixed* beans are likely to have a negative impact on price.

All purchase locations were statistically significant at a 1% level; however, purchase at the community store or local market had a negative impact on price while there was a positive impact on the supermarket. Consumers were willing to pay a premium for beans in the supermarket possibly because it was cleaner and had some form of reputation attached to it. Only urban consumers purchased beans in the supermarket. Market location or type of market is an important determinant of price because there are different prices at different locations (Sichilima et al. 2016). The price could be determined by transportation costs and demand (Akoten and Otsuka, 2007). Products in supermarkets often have some form of value addition which attracts higher prices.

Quality attributes are based on the average bean attributes consumers are exposed to at the market. Bean damage is reported as the average percentage of beans infested and broken in the quantity of beans purchased. A statistically significant and negative effect ($p<0.10$) on price was observed, indicating that consumers discount damaged bean grains. This was found to be consistent with Mishilli et al. (2009). Beans damage caused by weevils or broken due to threshing and other postharvest activities has implications for the price because they affect quality. A high percentage of damaged beans negatively affected appearance. It fuels the perception that the food is unsafe for consumption. It also increases sorting time, which adds to long cooking time. Bean size had a positive sign and was found to be statistically significant at the 10% level. Consumers are therefore willing to pay a premium for larger beans which is consistent with other studies (Temu and Lowenberg-DeBoer, 2005; Hella et al. 2013). This was also consistent with the conjoint results where consumers had a preference for medium to larger sized beans. Larger bean size increases (premium) the price of beans by K0.24 while damaged grain lowered (discount) price by K0.78.

Consumers also discounted beans that require more time to cook and caused a lot of bloating and thus flatulence ($p<0.10$). Consumers were willing to pay a premium for colour ($p< 0.05$), flavour and packaging ($p<0.10$) but a discount for appearance (shiny beans) ($p<0.05$). Long preparation time and flatulence have been found to be major factors deterring the consumption of beans and thus explains the discount. Consumers were willing to pay a premium for beans that had bright colours. Considering that a discount was paid for mixture beans, consumers desired to have bright coloured beans which were of pure varieties. These factors are mainly related to desirability.

For instance, Magreta and Jambo (2012) found that dark red beans are desirable to consumers in Southern Malawi. Yellow beans fetched a higher price in the Zambian market (Sichilima et al. 2016) and also in Uganda (Kilimo, 2012). Consumers paid K1.22 more for beans with bright colours, K 0.53 less for shiny beans and K0.72 more for packaging. Different bean varieties have different tastes and consumers were willing to pay a premium for beans which adds flavour (K0.26) to their dishes and had good taste (K0.07). *Solowezi* beans was found to have more flavor compared to other varieties (Sichilima et al. 2016) and may attribute to the premium price for *solowezi* in the study as well as other varieties such as *kabulangeti* beans.

Consumers were willing to pay a premium for beans from traders who provided a special service. But there was a discount when large quantities of beans were purchased. Consumers expected to pay a lower price for purchasing large quantities. Consumers were willing to pay K1.81 more for beans from sellers who provided special features such as credit, sorting or early delivery. They were willing to pay K0.04 less when they purchase a kg more of beans. Marital status had a negative and statistically significant effect on price ($p<0.05$) while income had a positive and significant on price ($p<0.01$). Married consumers paid a discount for beans and consumers who had higher incomes were willing to pay a premium for beans. Married consumers are more likely to have larger households and thus will purchase large quantities based on which they would want to pay a discount.

The percentage of the price per unit change in quality characteristics are shown in Table 4.12. Only percentage implicit prices for significant variables are presented.

Table 4. 12: Estimated percentage price change per kilogram a unit change in the independent variables

Variable	Percentage change	
	Model 1	Model 2
Color	17.5	10.42
Size	0.33	-
Appearance	-7.67	-5.79
Percentage broken and infested	-11.29	-
Flatulence	-10.42	-
Flavour	-	3.76
Packaging	10.56	-

The percentage change in price as a result of a changing variable is calculated as $(\beta_i/Average\ price) * 100$ with β as the coefficient of the variable (Mishilli et al. 2009).

In Model 1, consumers offered price discounts for shiny beans at 7.7% of the average price per kilogram. Consumers paid a premium for packaging at 10.6%, size (larger size) at 0.3% and colour at 17.5% of the average bean price per kilogram. Prices were, however, discounted at 11.3% and 10.4% for damaged beans and beans which cause bloating and flatulence.

In model 2 however, certain variables did not influence price such as packaging and bean damage, while flavour had a positive effect. The percentage price effect was also lower for colour and appearance, with appearance having a negative effect. The results are due to the introduction of socioeconomic characteristics. The price premium of 3.8% were paid for beans with flavor and the price discount for shiny beans was 5.8% (lower).

Descriptive analysis indicates that consumers prefer shiny beans; however, they were not willing to pay a premium for it. This could be because there is an awareness that beans are polished with oil which could be of poor quality. This introduces the problem of safety and makes beans difficult to clean since it attracts dirt. This, therefore, has a negative effect on price although consumers will desire shiny beans but with a natural shine. The difference in the model suggests that providing products tailored to consumer segments is necessary as opposed to providing the same product with the same attributes. The price effect and significance are likely to be different even if the preferences are in the same direction. Overall price premiums ranged from 0.3% to 17.5% while price discounts ranged from 8% to 10% of the average bean price per kilogram. Consumer preferences for bean attributes revealed from the conjoint analysis do not only influence purchase but the price at which the product is purchased. The premiums and discounts show what consumers are willing to pay for which inherently affect input acquisition (quantity, variety, frequency) along the household value chain.

4.4.2.3 Preparation

Food after being purchased is either consumed at once or portioned for later use. The beans are either soaked overnight or for a few hours before cooking or cooked without soaking. To save cooking time, salt or potash is used during cooking. Preparation activities are dependent on the time, ingredients, resources, the final consumer within the household, the complimentary food to be consumed with beans, experience and knowledge. The choice of the process can influence the overall time required for preparation as well as the nutritional composition of the food. This is important when nutrition and convenience, as well as flatulence, are important value elements. To improve the flavour of food consumers used oil, salt and vegetables when available. Rural consumers used charcoal or wood to cook beans.

For urban households, the gas stove is mainly used for food preparation. However, since beans is fuel consuming, 50% of the urban consumers used charcoal (36.7%) or firewood (13.3%) to specifically cook to beans. Thus, the study focused on the use of charcoal and the three stone firewood. The results, therefore, apply to both rural and urban households since the same preparation processes are utilized. The main factors to be considered during bean preparation is time, energy and water which are influenced by the preparation method and cooking stove. A resource acquisition flow diagram is shown in Fig. 4.14.

4.4.2.3.1 Processing Equipment

The Three-Stone Fire (TSF) is the main type of stove used in rural household for processing activities. It is owned by all households within the community. A household can own more than one TSF since it can easily be put together when different cooking tasks need to be performed.

Hand-crafted metal 'coal pot' is used for burning charcoal. For rural consumers, ownership and usage of the charcoal stove come with a social prestige that is associated with having a higher income. Though the TSF can easily be put together, several studies have shown its negative impacts on the health and the environment. Smoke and emissions from the TSF have been known to contribute to respiratory diseases among TSF users. It also indirectly contributes to deforestation and climate change (Bond and Sun 2005; Muzar et al. 2011). Pots for processing beans are usually aluminium pots with varying sizes and thus, varying capacities. The resource acquisition flow diagram is shown in Fig. 4.14.

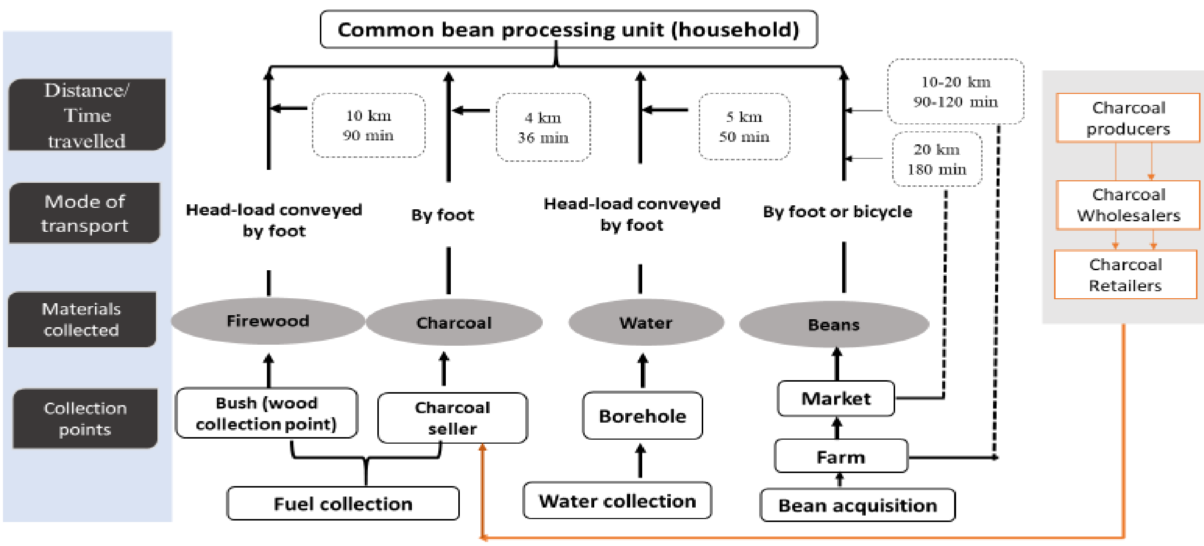


Figure 4. 14: Resource Acquisition flow diagram

4.4.2.3.2 Bean preparation methods

Soaking

Soaking is not a mandatory process undertaken during bean processing. It is an optional step performed by consumers who have the understanding that it reduces cooking time. Soaking is commonly used to soften texture, improve nutritional quality and speed up the cooking process (Huma et al. 2008). The process of soaking causes the beans to absorb water and increase in weight (Prodanov et al. 2004). Prior to soaking, the beans are manually sorted to remove debris, disease and pests infested beans from the lot. Soaking is done with water at room temperature at a bean to water ratio of 1:3-5. The soaking duration varies among households; however, most consumers soak beans overnight (10±2 hours). In this study, the maximum water ratio and soaking time were used.

Cooking

The cooking of beans is a simple process and involves boiling beans in excess water until the bean is soft. For a bean cultivar, variation in cooking duration is dependent on whether the beans are pre-soaked or not. Where soaking precedes cooking, the water is drained and the soaked beans are transferred into a pot of boiling water at temperatures of 95±5 °C. The pot is covered and allowed to boil for a duration of time. Covering of the beans during cooking is necessary to maintain cooking temperature. The water level is monitored with intermittent water addition until beans are fully cooked.

Besides soaking, another parameter that influences the cooking duration is the temperature of the intermittent water added. Ordinarily, cold water at room temperature is used, however, to reduce the cooking time further, boiling water from a second stove is used. This method, although reduces time, considerably increases overall fuel used. The average cooking temperature is 94±1°C. Furthermore, the bean variety being processed influences the cooking time. Finger pressing beans determined fully cooked beans.

4.4.2.3.3 Energy supply and use

Wood is the primary source of fuel in the preparation of beans and also for domestic and economic activities when rural consumers are considered. Women and children are usually involved in the collection of wood for household activities (Smith et al. 2012). Although wood fuel is available for free, its use comes with a non-monetary cost with respect to time, human energy (travelling long distances to obtain wood) and health risks. It takes them about a 10km round trip to gather wood ranging from 10 to 15 kg per person per trip from wood collection points. It takes about one and a half hours for a round trip of wood collection including the time for harvesting wood and exchanges among persons.

Common wood species available in the study area included *Mpasa (Julbernardia globiflora), Chimpampa (Monotes africanus), Mulombwa (Pterocarpus angolensis) and Muombo (Brachystegia longifolia)* (Smith et al. 2012). Wood collection rates were found to vary on a daily, weekly or monthly basis depending on the preparation activities being performed or the season. Wood can be collected and stored in bulk in the dry season awaiting the wet season when it is quite difficult to do. An alternative fuel source used in the communities was charcoal. The relatively high cost of charcoal makes it an unpopular choice among rural households.

4.4.2.3.4 Determinants of bean processing energy consumption

Energy consumption was estimated using the heating value and amount of fuel. Heating values for the different types of fuel used were obtained experimentally. Proximate analysis of charcoal and wood samples was determined with the standard test method for compositional analysis by thermogravimetry [(ASTM E1131) (ATSM 2010)]. The heating values were estimated according to a non-linear correlation (Nhuchhen and Abdul Salam, 2012) expressed in MJ/Kg. An average of the heating value of the different types of wood was estimated using Eqn. 1

$$HHV_{fuel} = \sum_{1}^{4}\left(HHV_i \times m_i\right) \qquad (1)$$

HHV_{fuel} represents the heating value of the bulk fuel, m_i and HHV_i represent the mass fraction and the heating value, respectively, of a wood species. The heating value for wood and charcoal used for the analysis were 18.11 and 29.6 kJ/kg, respectively (Table 4.13).

Table 4. 13: Wood species for bean processing

Wood Species	Average fraction in a pile	HHV (kJ/kg)
Mpasa	12	18.83
Chimpampa	19	17.31
Mulombwa	23	17.93
Muombo	46	18.35

a) Effect of cooking system on bean processing fuel and energy consumption

The fuel consumption between the two systems was found to vary significantly as shown in Fig 15. The TSF was observed to use 374.2% more fuel than the charcoal system. Estimations of the energy consumption for the different fuel types were made with their respective heating values of the fuel used. The specific energy consumption for the TSF was estimated to be 14.43kg (186.3% more than for the charcoal). Since the same quantity of beans was processed, this variation in energy consumption may be attributed to the relatively higher amount of wood used in the processing of beans. The difference in system efficiency also contributed to the wide variation.

TSF stoves are typically 13–15% efficient compared to handcrafted stoves which have efficiencies up to 28% (WHO 1992; Wiskerke et al. 2010).

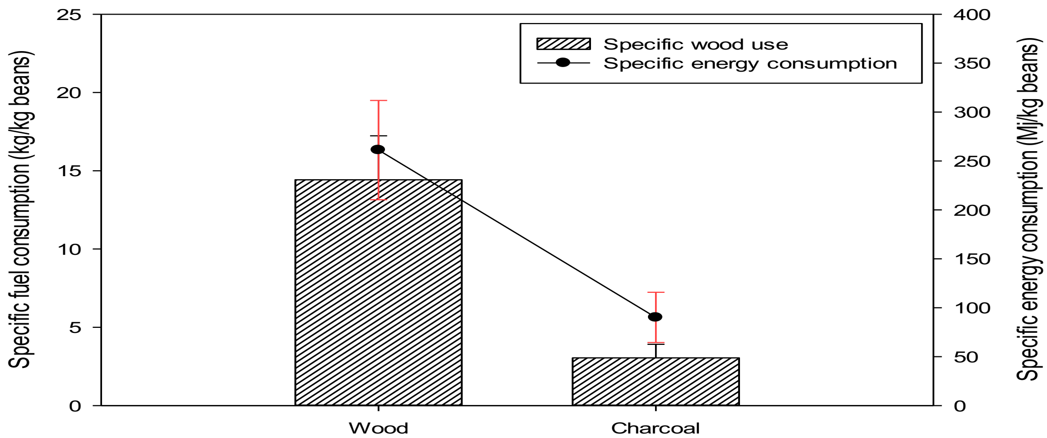


Figure 4. 15: Effect of cooking system on bean processing fuel and energy consumption (*Kabulangeti*)

The fuel consumption variations with respect to bean type were assessed and graphically presented in Figure 4.16. Two types of beans were processed using two fuel types and their respective cooking systems. For both varieties of beans, it was observed that the specific fuel consumption of the TSF was more than the charcoal system. This is expected because the three-stone stove has a high wood fuel consumption due to its thermal inefficiency (high heat loss) (Chagunda et al. 2017). While for the *Kabulangeti* beans specific energy wood consumption of the TSF was 15.57kg/kg, the specific wood consumption for the processing of the *mixed* bean was 13.29kg/kg. Thereby, the results show that the processing of the *Kabulageti* beans uses 17.2% more wood than when *mixed* beans was being processed. This finding was not contradictory to the specific charcoal consumption for both varieties. *Kabulangeti* beans was found to use slightly more amount of charcoal than *mixed* beans, however, the difference between the two is almost negligible. Studies have found that firewood use is dependent on the bean cultivar and the cooking method (Sinh et al. 2014).

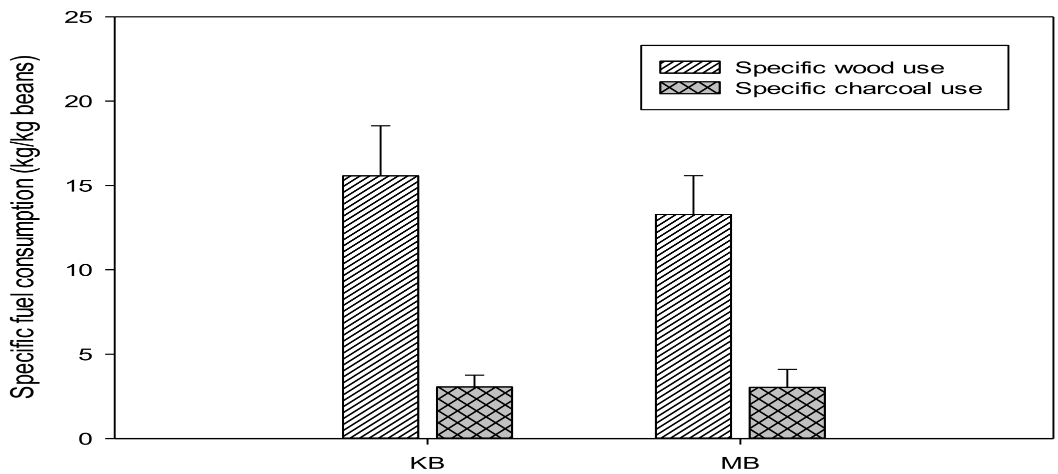


Figure 4. 16: Effect of bean type on bean processing energy consumption

b) Effect of soaking on energy consumption

Soaking of beans is known to soften the bean seed hence reducing energy consumption. Comparative energy consumption for cooking soaked and un-soaked bean shows that a significant amount of fuel could be saved by soaking the beans. Figure 4.17 shows the energy consumption variation between soaked and un-soaked beans. From the graph, less energy is consumed for cooking soaked beans regardless of the bean type or fuel used. A comparison of the mean energy consumption shows the difference is not statistically significant ($p<0.05$) when the charcoal stove is used for both bean cultivars. The TSF, on the other hand, requires 17.13kg per kilogram of un-soaked beans.

The reduction in fuel consumption is a result of the fact that during soaking, the beans absorb water which increases its moisture content and thus reduces the level of hardness. This implies that less time is required to soften the beans through the cooking effort. With this, there is a reduction in the overall amount of energy required to cook. Consumers' observed that the soaking process reduced the cooking time for beans. This has not only been proved by the study, but it has also revealed that soaking before cooking enables consumers to save on fuel use. Saving on fuel use also translated into an added benefit of reduced time spent in wood collection or money spent on purchasing charcoal.

Replenishing cooking water with hot water when cooking un-soaked and soaked beans further reduces energy consumption by 6.2% and 28.8%, respectively, without accounting for the water heating energy. The energy consumed during the cooking of beans is 329.4MJ/Kg and 304.1MJ/Kg for a kg *Kabulangeti* and *mixed* bean, respectively, while that total (including the energy for heating water) is 447.8MJ/Kg and 369.2MJ/Kg for each respectively. Overall, a 21.3% increase in energy consumption was observed when energy for heating water is accounted for during the processing of beans. This loss of energy may result in a gain of cooking time.

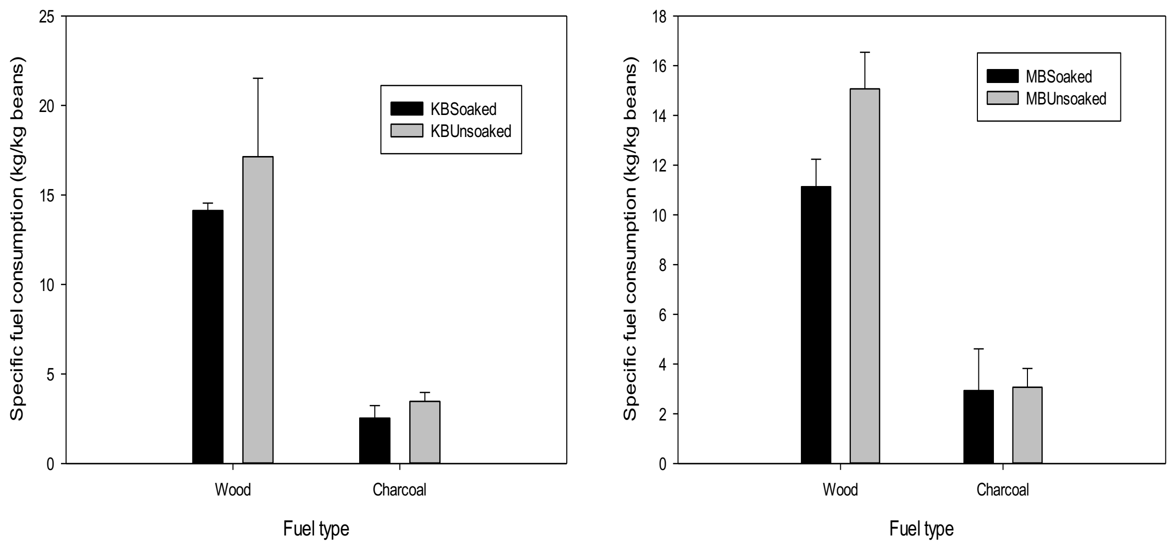


Figure 4. 17: Effect of soaking on fuel consumption for (a) *Kabulangeti* beans (b) *Mixed* beans

4.4.2.3.5 Water supply and use

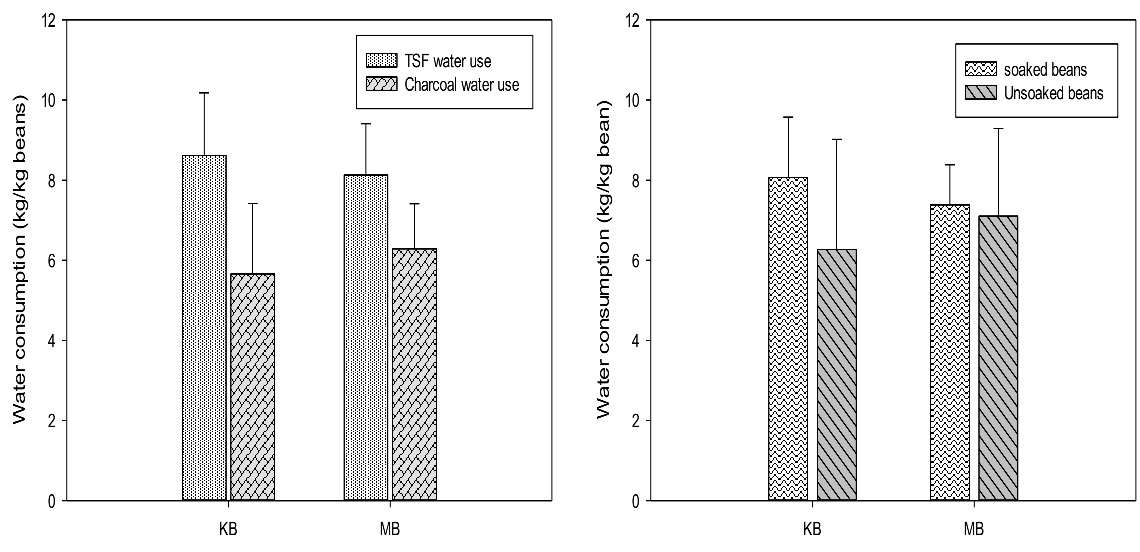
a) Water supply

Water is supplied for domestic bean processing from boreholes dug around the communities within a 5 km distance. Water is collected with either a 5 or 7-gallon buckets and stored in the household in larger containers up to 20 gallons capacity. A round trip water collection takes up to 50 mins including time for exchanges along the way. The typical water collection rate is two sessions per day and at least two trips per water collection session. Urban consumers usually have direct access to water within their homes.

b) Water consumption and factors influencing it

Bean processing is a water-intensive activity. The typical bean-water ratio for cooking beans is 1:4. Although, this may vary depending on other factors. One of such is the cooking system. The results of the study show that processing of beans with the TSF consumed more water than with the charcoal system irrespective of the variety of the bean. For instance, *Kabulangeti* bean processed with the TSF used 52.1% more water compared to the charcoal system. Similarly, 29.3% more water is needed to fully cook *mixed* bean using TSF than the charcoal system. This may be attributed to the fact that heat generation is higher when the wood is used (Kubler, 1982) which implies a higher rate of water loss by evaporation and a corresponding higher rate of replenishing the water. Comparing water use for the two cultivars using the TSF as shown in Fig 18a shows *Kabulangeti* bean uses 5.9% more water than the *mixed* bean cultivar.

Soaking is another factor that influences total water consumption for bean processing. Figure 4.18b shows the influence of soaking on water consumption during bean cooking. The results show that although soaking decreases cooking time and energy, it increases the overall water use irrespective of the bean variety. For instance, the processing of soaked *Kabulangeti* beans consumed 28.7% more water than the un-soaked *Kabulangeti* bean (KB). Comparing the two cultivars, soaked *Kabulangeti* beans consumed 9.3% more water than soaked *mixed* beans (MB).



(a) (b)

Figure 4. 18: Effect of processing systems and conditions on water consumption during bean cooking (a) cooking system (b) soaking

4.4.2.3.6 Time allocation and use

In addition to being energy and water demanding, bean processing is time-consuming. The overall time required for processing was estimated in this study as the sum of the total time required for water and fuel supply, and bean cooking. The type of bean variety, cooking system and soaking have all been determined to influence the overall processing time. Consumers highly desire foods with less time for preparation. The reduction in the cooking time, reduction in the use of wood and water during processing will provide labour-saving benefits, which translate into less exertion of human energy.

Generally, processing beans with TSF requires 44±2 min less than charcoal for both cultivars, primarily due to the excess heat from the TSF. From the results, the two ways of reducing overall cooking time are soaking before cooking and the intermittent addition of hot water. Soaking beans reduces the cooking by up to 40 min depending on the cultivar and the type of fuel being used.

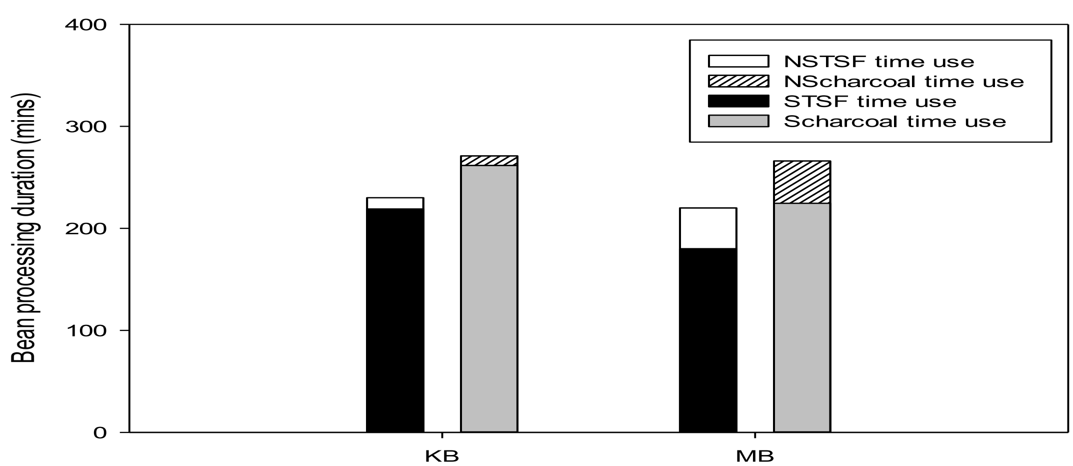


Figure 4. 19: Effect of processing method on bean processing time

The total time required for the bean processing preceded by soaking would include the time for soaking and the time for processing. This would be an added 12hrs (overnight) to the average cooking time after soaking. However, this time is not regarded as being significantly crucial for productive work since the beans are soaked after the day's work when families retire to bed, and it does not require close attention. Figure 4.19 presents the overall time consumed for the processing of beans segregated by the different individual activities (wood collection, water collection and bean processing). The addition of hot water during cooking was found to save 33 and 42 mins when cooking un-soaked and presoaked beans, respectively.

The time allocation for bean processing cannot be clearly understood if each activity was assessed individually. Wood and water collection time allocated for bean processing was estimated as a quarter of the overall time taken to collect water and wood. This ratio was based on the fraction of these resources used for bean processing. The overall time segregated into different activities is shown in Figure 4.20.

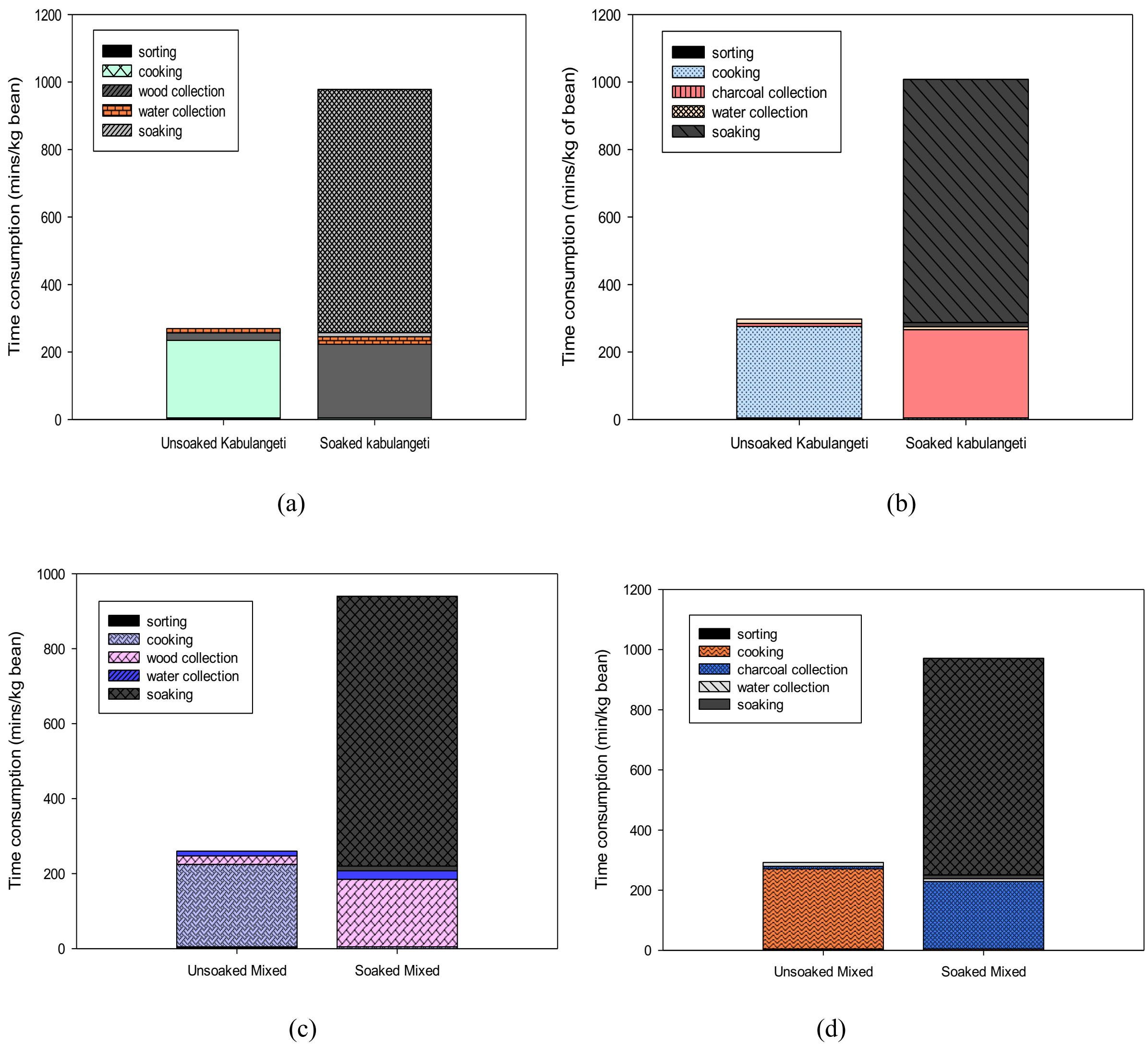


Figure 4. 20: Time distribution during bean processing (a) *Kabulangeti* on a TSF system (b) *Kabulangeti* on a charcoal system (c) *Mixed* beans on TSF system (d) *Mixed* beans on charcoal system

The average total time required for the processing of a kg of un-soaked beans is 279.8 mins, while that of soaked beans is 254.2 mins. Soaking beans before cooking thereby saves about 25mins of cooking time.

Information gathered from the survey revealed that beans were the only food consumed among the interviewed participants which required a lot of water, wood and time. Though beans are less expensive compared to other nutrient-dense foods, the study shows that its processing is time and material resource consuming. This could deter people, particularly, vulnerable groups from consuming it as frequently as desired. Raw beans (1kg) have been found to consume an average of 233.8 mins of time, 7.2kg of water, 3kg of charcoal and 14.4kg of wood. This, however, differs based on the bean variety and processing method. Comparing the different types of raw bean, 1kg of *Kabulangeti* bean consumes 23 mins more time, 1.4% more water and 15.5% more fuel compared to *mixed* bean. A flow diagram of the three different measured values for the processing of raw bean into cooked edible food is presented in Figure 4.21.

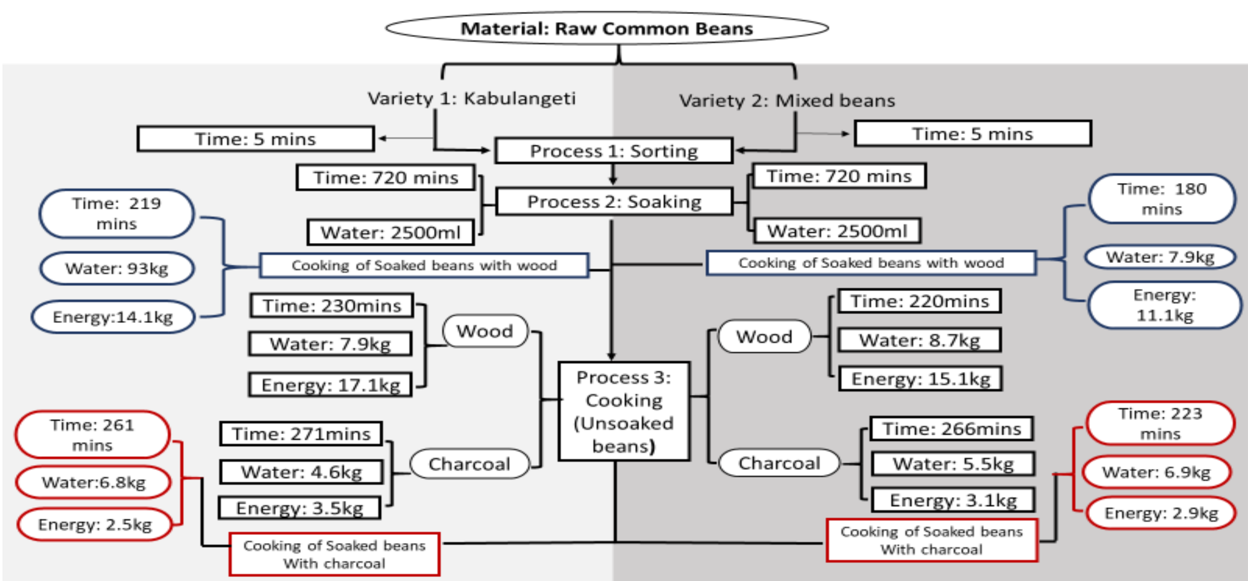


Figure 4. 21: Raw common bean process and value flow diagram

Average time for cooking beans ranged from 180mins to 261 mins, water used ranged from 6.8kg to 9.3kg and energy used ranged from 2.5kg to 14.1kg for a kg of beans depending on whether soaking was done or not and the cooking stove used. These estimates were made based on the cooking of beans in a day. Taking into account the number of days which beans is consumed in a week/month and the overall quantity cooked will imply that the energy, time and water use will be more than estimated.

4.4.2.4 Storage/Delivery

The raw produce is stored mainly in a bucket, plastic bag, jute bags or basket for two weeks to two months. In urban households (13.3%), raw beans are also stored in the refrigerator which also increases the storage length. Raw beans, when not stored properly, can result in insect infestation and thus losses. After food preparation, leftover food is stored in the refrigerator by urban consumers for up to four days or in cold water for one or two days by rural consumers. Urban consumers can store products for more extended periods. Rural consumers desired proper storage ability, which will enable them to cook larger quantities at a time for storage and thus not go through all the time and resource-consuming processes. Improper storage can lead to contamination and making food unsafe for consumption; this in effect, nullifies the nutritional value of the food. It also leads to food waste, which for rural households, can be very costly.

4.4.2.5 Consumption

Common beans is consumed to derive nourishment which is to meet caloric and nutritional needs. Satisfaction with the product was determined in the study by assessing whether consumers were willing to substitute beans for other products. The study revealed that more than 45% of both rural and urban consumers were willing to substitute, showing that they were not totally satisfied with the product due to limiting factors. This has negative implications for nutrient intake within the household. The preparation of the food is likely to reduce the nutritional value of the food. Studies show that cooking common beans for long hours reduces antinutritional factors, which have a positive effect but also a slight loss in proteins and nutrients (Prodanov et al. 2004; Huma et al. 2008).

Beans is usually consumed with cereal which could be rice by 20% of urban consumers, though mainly with Nshima by 70% of both urban and rural consumers. To reduce uneasiness after consumption and flatulence, consumers took medication, reduced or stopped eating beans, added sugar to beans or drunk a lot of water. These strategies were efficient for about 70% of consumers. Beans are often consumed for lunch or supper at any time of the week. Figueira et al. (2019) found that beans were consumed mainly at dinner or lunch but also at breakfast by a few consumers because they had recipes that required the use of beans. This is not the case for rural consumers and the majority of urban consumers. Knowledge of consumption times is necessary for the future development of value-added products.

Consumption is influenced by knowledge on the importance of beans in the diet as well as the household demographics since the food must conveniently meet the needs of the majority of the household. Figueira et al. (2019) found that non-consumption of beans was a result of the preference of family members, and if some did not consume, they were not willing to purchase. The choice for beans is also influenced by the dishes (Gitonga, 2013) prepared within the household. Diversity in the dishes made with beans for consumption at different times in the day can increase consumption.

Although consumers had preferences for specific varieties, findings show that the consumers did not always consume their preferred varieties. About 49.5% of the rural consumers indicated that they mainly consumed their preferred varieties, and 41.4% stated otherwise. (Figure 4.22). This could be because consumers didn't always find the varieties they preferred on the market, the quality of their desired varieties were not appreciable, or they chose a cheaper variety. A higher percentage (70%) of the urban consumers consumed their preferred varieties compared to rural consumers. This reduces the overall level of satisfaction obtained from the consumption of beans.

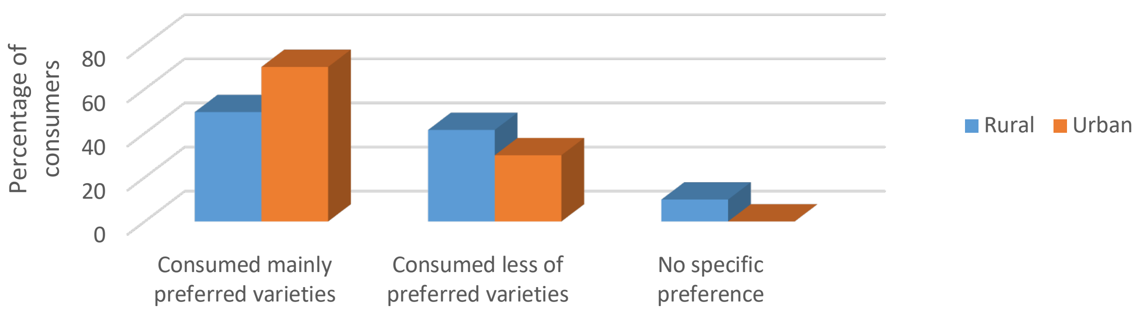


Figure 4. 22: Consumption of preferred bean varieties

Apart from the reasons stated above for the consumption of beans, consumers also had other reasons (Figure 4.23). About 45.9% of the respondents consumed beans because it was available, 28.2% consumed it because it was nutritious and 15.3% because it was tasty. Studies such as Figueira et al. (2019) have also reported nutrition and health reasons, tasty and cheap as major reasons for the consumption of beans.

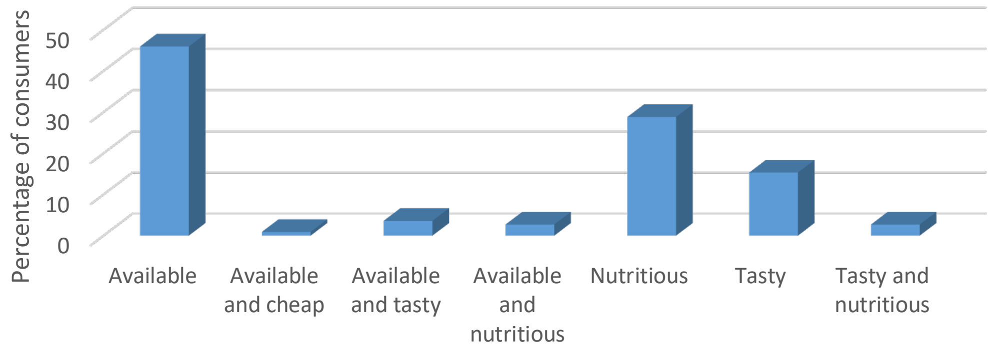


Figure 4. 23: Reasons for the consumption of beans

4.4.2.5.1 Knowledge, Attitude and Practice Assessment of consuming households

Information access, knowledge, attitude and perception with respect to nutrition and bean consumption was evaluated to determine how they influence bean consumption. Information is often passed down over the years or newly acquired from family, friends and external individuals. Preferences for product attributes were also influenced by family and other external individuals who dictate or influence what consumers are to look out for. For instance, consumers who make beans into flour and thus into porridge have their needs, preferences and processes impacted by NGOs. These non-governmental organisations made households aware of the needs of their children, the food product and the process by which the food can be made for children. Due to the nutritional importance of beans, the questions on knowledge focused largely on nutrition.

a) Information on nutrition

More than 80% of both rural and urban consumers had obtained information on nutrition. Approximately 60% of the consumers received information 3 years and more ago while <20% had received information some months ago. Though consumers received information mainly from family and friends on food and purchases, information particular to nutrition was received also from health facilities among rural folks (40.8%). The media was a good source of information on nutrition for more than 80% of urban consumers. The information is acquired mainly through unintended acquisition or learning, as indicated by 42.6% and 51% of the consumers respectively. The information is presented mostly by informal means and often to solve a problem. Consumers had insufficient access to information on nutrition with a mean score of 5.67 ± 2.95. This represents 47.3% of the maximum possible score.

b) Knowledge on nutrition

Consumers were asked to rate their knowledge on nutrition and nutritious foods. The majority (36.7%) of the consumers had a fairly good knowledge on nutrition. About 60% of rural consumers indicated incorporating less than 50% of the knowledge acquired into their activities, while more than 80% of urban consumers incorporated > 50% of the knowledge into their activities. Consumers were not expected to give in-depth descriptions of what nutritious food is. Definitions within the lines of nutritious foods being foods that contain substances (proteins, vitamins, minerals) that keep the body healthy were accepted. Consumers who provided definitions close to the recommended definition were about 50% of the total number of consumers.

Consumers were requested to mention foods that were rich in proteins, minerals and vitamins with less carbohydrates. Foods that were mentioned included beans, groundnut, soybean, meat, fish, eggs, milk and vegetables. More than 50% of both urban and rural consumers were not aware of beans helping with the prevention of diseases or being one of the protein-dense foods. Only 32.5% of the consumers had knowledge of anti-nutrients present in beans; however, just 28.6% indicated that cooking removed or reduced anti-nutrients in beans. The findings show that consumers had sufficient knowledge on the types of nutritious foods and their importance with a mean score of 16.98 ± 4.43 representing 60.6% of the maximum attainable score

c) Attitude about nutrition

There was a generally positive attitude towards the consumption of nutrient-dense foods. More than 50% of the consumers indicated the necessity to consume nutrient-dense foods and include them in daily portions of food. Although 70% of consumers indicated ensuring that their children are fed with nutrient-dense foods only 28% of consumers paid attention to having nutrient-dense foods at home. The need to consume nutrient-dense foods was spurred on by information gathered through training for rural consumers and the media for urban consumers. Consumers had a positive attitude towards the consumption of nutrient-dense foods and beans with a mean score of 14.59 ± 2.57, representing 81.1% of the maximum attainable score.

d) Bean consumption perception

About 87.5% of the consumers indicated that there was a positive perception of eating beans in the community. These perceptions varied from bean being a healthy food, having a good taste and providing proteins and healthy for children. Only 20.4% of rural consumers felt embarrassed when people saw them eat beans too many times. This was not indicated by urban consumers. There was a likelihood for some individuals in the rural community to consume beans when there isn't enough money to purchase other foods. Less than 10% of urban consumers viewed beans consumption as a poor man's food. There was generally a positive perception about the consumption of beans among consumers with a mean score of 7.84 ± 2.67 representing 78.4% of the maximum possible score.

Correlations were observed between information access, knowledge, attitude and perception regarding nutrition and practice (consumption of beans).

Table 4. 14: Association among IKAPP scores on nutrient dense foods and their consumption

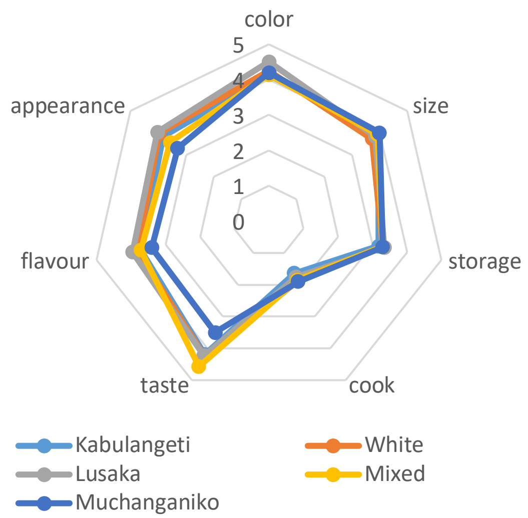
Level	Spearman's rho	sig
Information vs practice	0.1413	0.3328
Knowledge vs practice	0.5017***	0.0002
Attitude vs practice	0.4959***	0.0000
Perception vs practice	-0.5767***	0.0000

*p<0.1, **p<0.05, ***p<0.01

Consumers who are particular about consuming nutrient-dense are more likely to consume beans when they are aware of the nutritional value. There were significant positive correlations between attitude, knowledge, and perception with practice (Table 4.14). There was a positive correlation between information and practice though not found to be significant. This implies that access to information on the consumption of nutrient-dense foods is likely to influence the consumption of low-cost nutrient-dense food such as beans. Lack of knowledge has been found to deter consumption (Figueira et al. 2019).

4.4.2.5.2 Level of satisfaction with bean preparation and consumption

Satisfaction with bean preparation and consumption are directly linked to attributes of different varieties of beans. Thus, consumers ranked for each bean variety purchased, the level of satisfaction with each of seven attributes (size, colour, cooking time, flavour, appearance after cooking, length of storage and taste). The Likert scale was employed in the ranking of the attributes on a scale of 1 to 5, where 1 is least satisfied and 5 is highly satisfied.



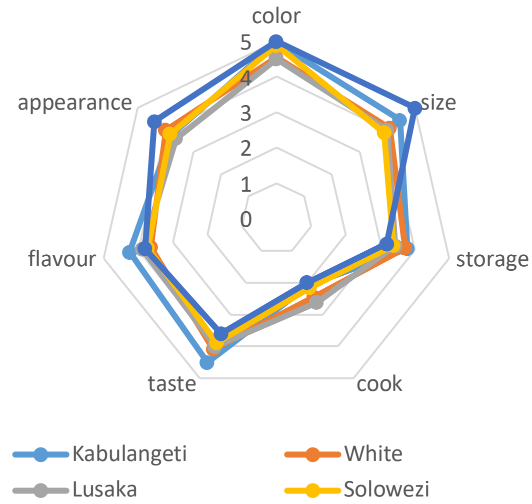


Figure 4. 24: Satisfaction with bean attributes (Rural)

Figure 4. 25: Satisfaction with bean attributes (Urban)

Urban consumers had low ratings for cooking time for all varieties while taste and colour had high ratings (Figure 4.25). *Lusaka* beans had higher ratings for colour, appearance after cooking and flavour compared to all other varieties. Appearance after cooking relates mainly to the quality of the broth (thickness). *Kabulangeti* also had a high rating for taste and colour which explains the preference for that variety. *Muchanganiko* had the highest rating for size compared to all the other varieties. Rural consumers had higher ratings for colour for all varieties while cooking time received a low rating (Figure 4.24). Taste and flavour received the highest rating for *kabulangeti* compared to other varieties. The level of satisfaction was generally between average and high for all attributes except cooking time and storage length. This implies that consumers were dissatisfied mostly with the long cooking time for beans which is an attribute linked to food preparation yet has implications for consumption.

4.4.2.5.3 Post Consumption evaluation: Satisfaction of household members with respect to bean consumption

Consumers' indicated the intention to purchase more if the beans were sold within the desired price range. This implies that the beans are not consumed in adequate amounts on a continuous basis as required. Information on portions in terms of distribution within the household was, however, not collected. Also, the indication of coping strategies being used to enhance taste and flavour (>79%), reduce time (>69%) and fuel use (>50%), reduce the feeling of uneasiness (>70% of both groups of consumers), possible substitution, provides an indication of the need to offer more satisfaction for consumers with respect to these attributes. Also, consumers (55% rural consumers and 26.7% urban consumers) were willing to purchase bean flour based on reasons such as easy to carry, easy to cook, and change in the form of consumption. This has implications for value addition and product transformation.

4.4.2.6 Disposal

Improper storage of raw and cooked beans can lead to spoilage and disposal. It is not difficult to dispose of cooked or raw produce, although it can contribute to environmental consequences through food waste (Tonini et al. 2018).

4.4.3 Map of the Household food value chain

The map reveals the activities performed and the resources utilised as well as the agents involved. From the map (Figure 4.26), the needs of consumers can be identified. Consumers desire to purchase beans at their convenience and thus, they shop at different places based on the closest location to the product.

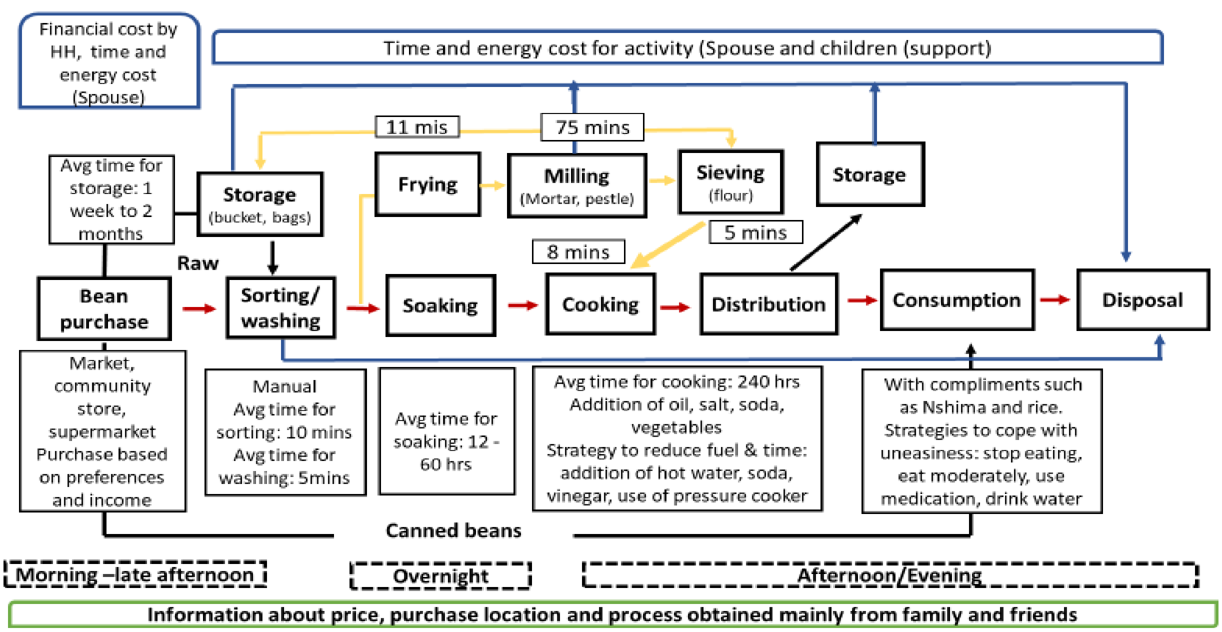


Figure 4. 26: Map of the activities performed along the bean household value chain

Cooking time and soaking time makes time requirements for bean preparation tedious. Sorting of beans as a result of inferior quality of beans uses up time, which consumers would want to forego. Cooking time also makes beans less appealing as it's not a convenient food and used up resources.

When beans are already infested before purchase, storage time reduces for consumers and can lead to physical, nutrient and monetary losses. Milling and sieving of beans to make flour for bean porridge takes a lot of time and results in significant losses. However, it has the advantage of less cooking time and nutritional value for children. The findings reveal that consumers require a product that does not create discomfort, has a high level of diversity and possess preferred intrinsic and extrinsic attributes to increase purchase and consumption.

4.4.3.1 Correlation among activities along the chain

Correlation measures the strength and direction between the activities undertaken along the chain. Specific variables were chosen as indicators to measure the correlation. The indicator chosen for input acquisition was the frequency of purchase and expenditure share on beans. For preparation indicators chosen included cooking time and frequency of consumption; for storage, the indicator is storage period, and for consumption, the indicators are a satisfaction and uneasy feeling. Only significant correlations at 5% level have been reported.

For urban consumers, Spearman's correlation shows a strong positive correlation between satisfaction obtained from the consumption of beans and the expenditure share. A similar correlation was observed for expenditure and cooking time (0.585). There was also a significant negative correlation between uneasiness and cooking time (-0.436) as well as purchase and cooking time (0.744).

For rural consumers, however, statistically significant correlations at 5% were not obtained; however, positive correlations were observed between expenditure share and cooking time as well as uneasiness and cooking time. Negative correlations were also observed for the frequency of purchase and cooking time. The more money spent on beans, the more quantity is likely to be purchased and thus the more time required for cooking. Urban consumers who had better feeling after consumption used lesser time in cooking, which was vice versa for rural consumers. This was probably due to perception and also coping strategy. Urban consumers mentioned using medication to deal with uneasiness while rural consumers mainly mentioned drinking water and cooking for more extended periods. As cooking time increases purchasing frequency was found to decrease for consumers.

4.4.4 Value Assessment: Overall satisfaction with product

Consumers were asked to indicate if there was a need for improvement of different factors (both extrinsic and intrinsic) considered in the purchasing of beans. This will also be an indication of the areas along the chain and the product which needed improvement. The lower the percentage of consumers requiring improvement in a factor, the higher the level of satisfaction with that factor. Among all the factors considered, a higher percentage of rural consumers indicated a need for improvement of taste (49.4%), quality (39.2%), and colour (32.1%) (Table 4.15).

The reason for the need for improvement could be due to the low availability of tasty bean varieties and lack of awareness on different dishes for beans to enhance the taste. This would require the development of value-added products such as processed bean products, which would introduce variety and an improved taste for the consumers. Improvement in color is dependent on the variety and will be a useful consideration during breeding and seed development. Value chain actors have an important role to play in providing consumers with quality products (no broken grain, clean, and uninfected grains). A need for improvement implies that a change is required in the performance of activities along the value chain.

A high percentage of urban consumers indicated the need for improvement with respect to packaging (63.3%), marketing strategy (53.3%), and level of damage (36.7%). Urban consumers require bean products that are packaged possibly because it is more presentable and appealing (Table 15). This could also be influenced by the growing supply of packaged products on the market. Retailers can provide innovative services that increase the demand for their products and meet the needs of consumers. The findings indicate that this is a requirement.

Table 4. 15: Improvement of factors influencing purchase and consumption of beans

Attribute	Percentage of consumers	
	Rural	Urban
Level of damage	39.24	36.7
Color	32.91	16.7
Size	17.72	10
Safety	15.12	26.7
Taste	49.37	6.7
Price	15.19	20
Packaging	24.05	63.3
Marketing strategy	22.78	53.3

4.4.5 Constraints and concerns with product use along the HVC

Consumers expressed concerns with bean prices with the majority indicating that the price of beans was quite high. Consumers indicated reducing the quantity purchased and the frequency of purchase due to the price of beans. Safety wasn't an issue of concern for consumers who believed that the beans on the market were all safe for consumption. The availability of desired varieties when needed was however indicated as being a problem. Consumers did not always find the desired variety of beans on the market and thus would have to purchase other varieties or avoid making a purchase altogether.

Consumers indicated that beans on the market were sometimes of a low quality which requires them to sort out beans before preparation and consumption. Almost all consumers mentioned long preparation time as a concern with the consumption of beans. Consumers also expressed concern with uneasy feeling and flatulence after the consumption of beans which also deterred consumption. Long preparation time and flatulence have been seen to prevent consumption (Msukwa, 2017; Figueira et al., 2019). Perception of beans as an inferior product also limits consumption and corroborate with findings by Msukwa (2017) and Figueira et al. (2019).

Due to these and other constraining factors, 45.1% and 75.3% of the rural and urban consumers respectively indicated that beans could be easily substituted with other food. Rural consumers, however, want to substitute beans with fish, chicken, vegetables, sweet potatoes, rice and soybean. These foods were mentioned because consumers wanted cheaper food, diversified diet and quick-cooking foods. The large difference in the percentage implies that urban consumers have more options for substitution. The price of the substitutes was, however not considered to be cheap in comparison to beans by most rural consumers. This means rural consumers are likely to reduce the intake of beans and substitute with energy-dense foods, which has a negative effect on the malnutrition problem.

4.5 Discussion and conclusion

The study assesses the household value chain for common beans, the activities undertaken, and the underlying factors to understand consumer preferences and needs. Consumer value should be studied at length because consumers are the driving force of agri-food chains. Information on consumer valued preferences is, therefore, an important resource (Mahbubi et al. 2019). The knowledge of consumer preferences and segmentation of consumers based on their preferences and socioeconomic characteristics is an important factor to innovation and competition within the agri-food sector with implications for economic gains (Handayati et al. 2015).

The results reveal that urban consumers purchased more varieties compared to rural consumers, which means that urban consumers require variety concerning bean purchase. Bean purchase was found to be influenced by availability and price. Shortages in beans at the market affected consumption. Consumers did not consume beans when they didn't have access. Also, consumers did not purchase their desired quantity and as frequently due to the price of beans, which they found expensive. Consumers were sometimes compelled to purchase what is just available on the market. Shortages in highly demanded beans leads to the lack of preferred varieties for consumers; this has implications for prices and purchases. Constraints with availability and price of beans are directly linked to availability, accessibility and affordability of food, which contribute to food insecurity. This has implications for poor and food insecure consumers who cannot afford other nutrient-dense foods at affordable prices.

The results reveal the different valued attributes consumers require when purchasing beans. Conjoint results show that in situations where trade-offs had to be made, taste, price, size and cooking time were important for urban consumers. For the rural consumer, cooking time, price and size were particularly important with higher utility scores. The results show that apart from affordability, acceptability was an important factor influencing the consumption of beans. Mainly, convenience and appeal (colour and size), as well as taste was important to consumers. Hedonic analysis results show consumers paid a discount for varieties that required long cooking times, inferior quality beans, and flatulence producing varieties. Premiums were paid for taste, packaging, colourful, and larger sized beans.

Premiums for purchases at the supermarket implies that consumers perceive higher quality products at that purchase point and are willing to pay more to have them. Flavour has been found to be an important attribute that consumers require when consuming beans and corroborate with studies by Van Boekel et al. (2010) and Yoo et al. (2012). Enhancing the flavour of beans through cooking is likely to increase its consumption (Poelman et al. 2013). These attributes influence the acceptability and utilisation of beans. The findings further reveal that different groups of consumers prefer different attributes. This is important for product development and marketing. A larger share of food expenditure will be allocated to beans when incomes increase as well as education and are made awareness of the benefits of beans by both older and younger people. These groups of consumers including consumers with large household sizes had a high preference for taste, quality (level of damage) and price. Quality was an important factor because it reduced appeal, increased preparation time and decreased the confidence of consumers concerning safety. Assessment of the preparation, storage, delivery, and consumption stage of the household value chain reveals that beyond cooking time, consumers consider bean preparation as a fuel and water consuming process. The availability of bean products that are convenient, ready to eat or require less processing but can be stored without cold storage would be particularly beneficial to rural consumers.

Price was found to have a negative correlation with the quantity consumed by households and the frequency of consumption. This is however important with regards to adequate nutrient intake to meet the nutritional needs of household members especially when beans are the only protein source. Efforts by consumers to reduce uneasiness and flatulence, as well as enhance the flavour of beans indicate these factors need to be addressed to improve consumption. The willingness to purchase beans flour is an indication that consumers desire to buy new products. This is an opportunity for value chain actors to introduce new products into the market. These factors affect the utilization and consumption of beans.

The dissatisfaction of consumers shown through the need for improvement in selected factors implies that, to some extent, there are activities that need to be performed better along the product supply chain. There is, however, a good demand for beans, which indicates that there is an opportunity to grow demand more to achieve economic, food security and nutrition goals. This, however, depends on the efficiency and effectiveness of value chain actors and other sectors in understanding the requirement of consumers and meeting their preferences.

Consumer preferences and needs revealed from the assessment influence food security because they affect food security indicators (Figure 4.27). Efforts should be directed towards improving activities such as production, storage, postharvest handling, and marketing to enhance acceptability by consumers.

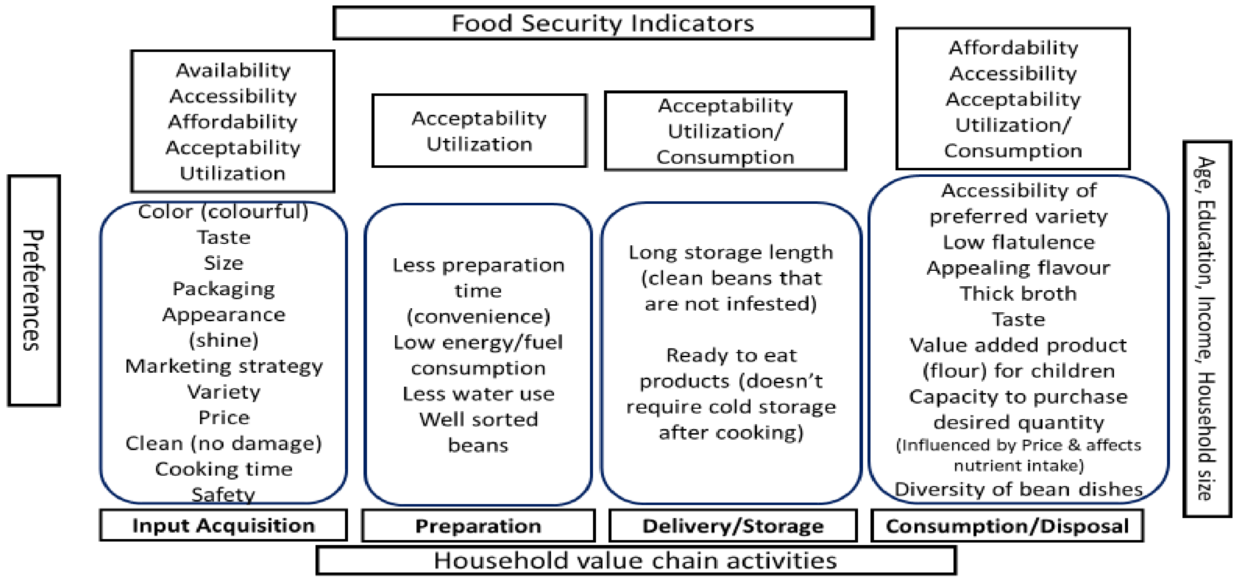


Figure 4. 27: Relationship between preferences identified along the HVC and food security indicators

Strategies that focus on increasing the value of the beans beyond the price are likely to aid in achieving the goal of increasing the consumption of beans. These strategies should focus on the reduction in processing time which would translate into reduced energy use. Also, strategies that focus on transforming the beans into products with enhanced taste, flavour and storage length. Seed variety development that meets consumer preference for colour, size and appearance (shine) should be considered. More importantly, value chain activities affect the majority of the qualities consumers prefer and would pay premiums to have. Thus, they have a significant role to play in the demand and consumption of beans. This implies that they aid in the achievement of food security by making nutritious, low-cost beans with desired attributes available to consumers. External agents have a role to play with regards to awareness creation on nutrition and the preparation of different meals to obtain maximum nutritional benefit.

Connecting Text

In chapter four, consumer needs and preferences for bean attributes, the value attributed to those preferences and the factors influencing the consumption of beans were examined by studying the consumption chain. The assessment revealed that purchase and consumption of beans are influenced by availability, quality and price of beans. Consumers expressed concerns and dissatisfaction with bean damage, cooking time, flatulence, price, packaging, marketing strategies and constraints with accessibility. This affects demand and consumption. The findings imply that activities along the product supply chain need to be performed better to meet consumer preferences.

Based on the results from this chapter, the activities along the common bean value chain which produces and delivers the product to consumers is assessed. In the next chapter (five), a multidimensional performance index is applied to assess the performance of the value chain in meeting consumer preferences within a food security context. This is the second stage of the consumer based value chain assessment framework and includes an assessment of the common bean value chain structure and dynamics.

CHAPTER 5 Performance of the common bean value chain in meeting consumer preferences and food security indicators

Abstract

Agriculture has been put at the forefront in dealing with the issue of food and nutrition. Activities along the value chain can create challenges or opportunities for food security and nutrition. The study sought to assess the performance of the chain in meeting consumer preferences within the context of food security. The multidimensional performance index developed in the study was applied in evaluating the performance of the common bean value chain. The structure and dynamics of the chain were also assessed. The findings show that bean production is characterised by the use of primitive tools and recycled seeds, manual and time-consuming activities, inefficient storage, threshing, and loss management techniques. These, therefore, lead to low yields, low quality of products, and losses. The common bean value chain posses strong buyer power, minimal supplier power, a considerable threat to entry, intense rivalry among actors and a minimal presence of substitutes. Knowledge transfer was largely informal and unidirectional, internal and centred mainly on farming practices. Results revealed that agility along the chain is very low because value chain actors do not have the necessary assets to respond adequately and quickly to the dynamic environment within which they operate. The quality assessment revealed that threshing, sorting and storage conditions led to a lack of homogenous and clean beans, broken beans, darkening of beans, increased cooking time, reduced shine and damaged beans.

Consumers' preferences and needs were not found to be adequately met because performance assessment revealed low scores of food security indicators. The common beans value chain scored below average for all indicators, 36% for availability, 48% for accessibility, 46% for affordability, 41% for acceptability and 39.48% for utilization. The low-performance scores can be attributed to inefficient performance and management of activities along the value chain, low stakeholder involvement, lack of financial and technical capacity, low trust lack of value creation opportunities. These factors are reflected in the low performance scores for the value chain dimensions used in measuring the efficiency of activities and their effect on food security indicators. The value chain obtained lower scores for agility (37%) and management (39%)

dimensions and a higher score for the economic dimension (54%). Correlation analysis revealed correlations between dimensions and food security indicators. Cluster analysis revealed similarities among value chain actors based on performance scores. The majority of actors were found within the cluster characterized by higher scores in affordability and accessibility. Application of product and process quality improvement mechanisms will strengthen the capacity of value chain actors to produce optimum amounts of quality beans that meet consumer preferences.

5.1 Introduction

Agriculture is an important sector in Zambia's economy due to the high proportion of individuals who derive their livelihood from it (USAID, 2009). It is depended on as a source of income, employment and food (Mwanamwenge and Harris, 2017). The country's food and agriculture system have not provided food security or nutrition for all. Undernutrition rates among children under the age of five in Zambia range from 35.7% to 47.3% in the Lusaka province and the Northern province respectively. The country's effort to address the problem have been through agricultural production and trade, production diversity in farming households, and prices. However, its agricultural policies have focused on staple grains neglecting other crops and focused less on nutrition (Tschirley et al. 2015). Considering the widespread presence of malnutrition and stunting, it is therefore not surprising that agriculture through the introduction of nutrient-dense food such as legumes is being targeted in the fight against food security and malnutrition (Mwanamwenge and Harris, 2017). Consumption of legumes is still low among the population compared to starchy foods and vegetables (Chisanga and Zulu-Mbata, 2017).

Inadequate consumption of nutritious foods leads to deteriorating health, which affects productivity, income generation and household welfare. There is a growing interest in common beans because of its health benefits and its affordability. Beans are viewed as nearly perfect food because it is nutritionally rich in proteins, folic acids, dietary fibre and carbohydrates (FAO, 1999). Therefore, it has an important role to play in food security and malnutrition reduction. It is grown in different parts of the world and grown mainly for subsistence in Africa. And thus, like other agricultural value chains, it is plagued with numerous constraints which limit its potential to help achieve economic, food security and nutrition goals.

Also, though there are numerous benefits in relation to producing and consuming common beans, these benefits are likely to be impacted either negatively or positively by several factors along the product chain. There will be a need for efficient management of activities along the value chain to adequately meet the country's goals in ensuring the increased consumption of legumes such as beans. Evaluating the performance of agri-food value chains have focused on financial performance, the rate of adoption of practices, operational constraints and the mitigation of production and agronomic problems. Improvement programs are therefore tailored towards increasing yield, reducing waste or losses and ignoring other factors that directly affect the demand and consumption of the crop.

Analyzing the food value chain to identify ways to improve its contribution to meeting consumer preferences and needs with a food security focus is critical. It can provide insights on challenges which could otherwise not have been easily identified due to the limited focus on production and profits. Reliable and in-depth information from the analysis can be used to develop appropriate and effective management strategies. Thus, the study applies a multidimensional performance index in evaluating the performance of the common bean value chain with a consumer and food security focus. In doing this, four sub-objectives were studied. The first is to map out the chain and identify the actors, activities and the value-added at each step of the chain. The second is to present a brief description of the different dimensions within which the chain operates. Understanding the structure and dynamics of the chain helps to map out and assess the processes through which value is created for the consumer (Prowse and Moyer-Lee, 2013).

The third is to assess the performance of the common bean value chain in meeting consumer requirements. The fourth is to evaluate the performance of the different dimensions of the chain, their correlation with each other and their influence on consumer requirements and food security indicators. The common bean value chain in the Northern province of Zambia was used as a case study. This information can be useful in guiding the development of frameworks to improve the production and marketing of nutritious crops such as common beans.

5.2 Study Area

Zambia has a size of 750,000 kilometers including waterbodies and has a population of 12.896 million. Agriculture's share of GDP fluctuates and ranges from 9.4% to 12.2% between 2005 to 2008. Agriculture provides employment to over one million and four thousand individuals, most of whom depend on it as a primary source of income (USAID, 2009). The district of Luwingu, Northern Province of Zambia is the selected location for the study because it is one of the major bean producing provinces apart from North-Western Province (USAID, 2009). It accounts for 70% of the area under beans cultivation in Zambia (Hamzakaza et al., 2014). The district is within a high rainfall area characterised by subsistence farming and low productivity (FEWSNET, 2004). The province is also characterised by high levels of undernourishment and malnutrition due to the low intake of plant and animal-based products and high maize-based foods (Chapoto et al. 2010).

A two-stage cluster random sampling design was used in the study. Two communities in the Luwingu District of the Northern Province of Zambia, Ibale, and Ipusukilo were selected for this study. The district lies between longitudes 30ºC and 32ºC East of the Greenwich Meridian and at an average altitude of 1500m above sea level. Temperatures can range from 21 to 24 ºC from August to October with humid and partial rainfall. Luwingu lies in the high rainfall agro-ecological region of Zambia, with an average annual rainfall of 1200 mm. The district has a population of 134,426 and approximately 39.7% of the total population are involved in agriculture as their main source of livelihood. Females make up about 70.5% of 53,408 farmers in the district (CSO, 2012).

5.3 Methodology

The agri-food value chain is multifaceted with multiple relationships and thus it can be assessed in different ways. This required mixed methods to obtain quantitative and qualitative data which are both subjective and objective. Employing mixed methods is useful to obtain a deeper understanding of the subject being investigated and produce more valid results. Methodologies, therefore, involve surveys, focus group discussions and lab experiments. The study was tailored to a specific case (Zambia's common bean industry). The methods and methodologies selected were selected based on the objectives of the study.

5.3.1 Data collection

The study gathered data through interviews with key agents (producers and traders) along the common bean value chain. The data collected were both primary and secondary data. The primary data were collected from the actors along the chain while secondary data was collected from government and online reports. This was necessary to ensure that the findings are reliable and valid as it aids in triangulation. The different data collection methods are discussed below;

Interviews and surveys

Surveys were used to collect quantitative data from the sampled respondents. It was also utilized to obtain information on the attitudes and opinions of value chain actors. Questionnaires which contained close and open-ended questions, scales, ranks and statements were used. The surveys were administered through face to face interviews and were administered to common bean producers, traders and consumers in the Northern Province of Zambia. Separate questions were prepared for each of the respondents. Semi-structured interviews were employed to gather information regarding the common bean industry in the province from agricultural officials.

The data gathered included; socioeconomic and demographic characteristics, production/trading activities, yield, losses, production/trading knowledge and practices, constraints, governance structures, beans processing, resource allocation and use, processing methods and equipment used, bean demand and consumption etc. Self-reported information on post-harvest losses based on the previous harvesting season was gathered at three stages: between harvesting and storage (during handling and including transportation, drying and shelling), during storage (from storage till sale or consumption) and during marketing (specifically for traders from transportation to storage and sale). All quantities were mainly reported in Kilograms, bags or gallons; however, they were standardised to kilograms.

Data was also gathered on common bean production and storage activities and quantities, quantity of low-quality beans and quantity completely damaged, activity costs and market prices, farm characteristics, asset ownership, resilience factors, socioeconomic and demographic characteristics of respondents as well as the challenges. Likert scale assessment of the level of awareness of losses and the factors likely to influence losses was also undertaken. To ensure that errors are reduced, the study was conducted as thoroughly as possible by undertaking a pilot study to test the questionnaire and the ability of the enumerators. Interviews were also conducted diligently to ensure that the respondents understood all the questions. The questionnaire was further refined to ensure effective data collection. Four enumerators were trained to aid in data collection due to the large sample size.

Focus group discussions

This technique was employed to obtain qualitative information from a group of value chain actors. It is useful for gathering in-depth information and studying behaviour as the target group share their experiences, opinions and beliefs. The information was gathered on specific topics under investigation with purposively selected respondents. This technique was used in conjunction with surveys to enhance the validity of information gathered.

Laboratory experiments

Different forms of data were collected in the lab. The physical product and cooking qualities of beans were tested over varying storage lengths. Approximately 10kg of two bean varieties, *kabulangeti* beans and *sugar* beans were collected after harvest from smallholder farmers in Luwingu, in the Northern Province of Zambia on February 2019. The beans were placed in airtight bags and transported to the lab for the storage tests. The beans are stored in polypropylene bags (jute) over a period of 5 months at 35℃ and a constant relative humidity of 60-65% RH. The relative humidity was maintained by using concentrated sulphuric acid (O'Brien, 1948). The relative humidity was selected considering the average relative humidity in the Northern Province of Zambia. The temperatures and duration of storage were chosen to reflect the conditions in the province and practices by value chain actors. The samples were packed and stored in an incubator maintained at the desired temperature.

Observations

Informal observations were made during interviews with different groups of respondents. They are important because they help to gather information on how activities are undertaken and the environment within which agents work based on which inferences can be made. The observations noted was used as added information to cross-check responses and gain an in-depth understanding of the subject being studied.

Document search

Reports and government publications on agriculture and the common bean industry were studied to obtain facts and add to findings from the study. Statistics and documents on production, marketing, trade yields/volumes, production trends, inputs and product prices, preferences and exports were gathered.

5.3.2 Sample selection

Both qualitative and quantitative data were used for this study. The quantitative data was gathered through the surveys and the qualitative data was gathered through interviews and focus group discussions. In total, a sample of 280 value chain participants, 25 focus group participants and 5 public stakeholders were interviewed. The sample size was calculated based on a formula provided by Yamane (1967) at a confidence interval of 95% and a precision of 7%. Estimations were based on the population sizes of producers and traders in the Luwingu districts. The sample size depended on the objective of the study, the available time and resources (Patton, 2002). Each group of respondents were purposively selected to be able to obtain information on the multifaceted nature of the common bean value chain. A convenient sampling technique was used to select focus group members.

A two-stage cluster sampling method was used in selecting respondents for the survey. The Ibale and Ipusukilo villages were purposively selected based on recommendations made by Self Help Staff to ensure that the study sites are bean producing areas. A list of communities in the Ibale and Ipusukilo villages were constructed, 5 communities (clusters) were randomly selected

from the list prepared for both villages and respondents were randomly selected in each cluster. The heads of the village wards were met and the purpose of the survey explained. Based on the village registers (common bean producers) for each ward, the number of respondents per each village were randomly selected mainly based on their availability. The criteria for selection of respondents from each ward was that the individual produced any variety of the common bean commonly found in the district. A similar criterion was used in selecting districts and communities. The farmers were thus randomly selected from the listed population to be interviewed. The farmers were made up of both males and females of varying ages, income levels and farming experience.
Retailers and wholesalers of common beans were randomly selected based on their willingness to participate in the survey. The traders were interviewed in the major market centre in Luwingu. It was challenging to interview traders because they were in the market performing their normal activities and thus, the interview process seemed to be a distraction. Due to this, more traders could not be interviewed, but it was observed that the activities performed by the traders were more likely to be similar.

The public stakeholders were surveyed last after all the other respondents were interviewed to better obtain a generalised view of the common bean industry. These officials are government officials who deal with agricultural issues within the Luwingu district. Ethical clearance was obtained from McGill University before the survey was conducted. This ensured that only willing respondents participated in the studies and their information would be confidential.

5.3.3 Data analysis

Different kinds of analysis were performed on the data collected to address different objectives. Descriptive statistical analysis was employed to describe the data to obtain facts and trends in frequencies, percentages, means, standard deviations. Other financial assessments and statistical models were applied. The results were presented in tables and figures. A summary of the different forms of assessment (Figure 5.1) is presented below.

The validity of the study was achieved through triangulation where different methods of data collection were used. Semi structured questions which allowed for the collection of in-depth information were also utilized. Questions that were relevant to the subject being studied were included in the questionnaire and the respondents chosen were directly linked to the common bean value chain and thus could provide valuable information. Questionnaire testing, training of enumerators, and monitoring to ensure that the questions were clearly presented and understood ensured that the data gathered was reliable.

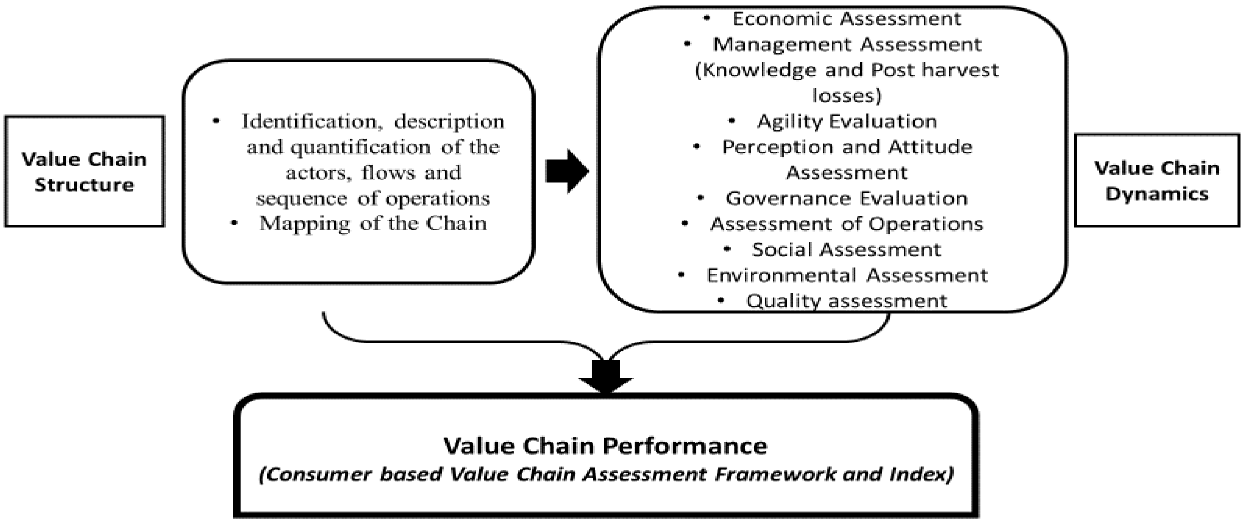


Figure 5. 1:Framework for the analysis

5.3.3.1 Assessment of chain structure

This involved identification of the economic agents along the chain from production to marketing, their socioeconomic characteristics, functions and major inter-correlations. A mapping of the chain was presented to provide a visual representation of activities, the flow of goods, the linkage between actors, value flow and payment flow.

5.3.3.2 Assessment of chain dynamics

Economic assessment

Economic assessment

A financial assessment (cost-benefit analysis) was undertaken to assess the financial situation of the participants along the chain. These estimations were made separately for each actor within the value chain. The analysis covers the assessment of cost components and estimation of profitability at each stage of the value chain. The financial indicators calculated are presented in Table 5.1. The questionnaires provided to respondents gathered information on sales volumes, prices, operational and fixed costs. Operational costs are those costs which vary depending on the output being produced e.g. seed. Fixed costs are those costs that do not vary such as rent for buildings or land.

The costs were grouped into five (5). The first cost is the marketing costs which includes all costs related to the marketing of produce. Cost 2 is the supply cost which includes the cost of raw materials and inputs to the enterprise. Cost 3 includes production costs which are the cost of transforming raw materials into the final output. Cost 4 is the delivery costs which includes the transport, handling and storage cost with other services. Cost 5 is the cost of supporting activities which includes management, training etc. After the costs were established, the total revenues, profits and losses were estimated. The revenue was estimated by determining the quantity of products sold in a month and its sale price (prevailing prices in 2017). The benefit-cost ratio (BCR) for the various respondents were reported as a measure of profitability. BCR was calculated without discounting revenues and costs. A benefit-cost ratio above 1.00 indicates profitability for the actor within the enterprise (Campbell and Brown, 2003). When the BCR is less than 1, the activity is not concluded to be unprofitable but that the profitability of the activity was constrained with fiscal factors. Data were presented as means, percentages and ratios.

Table 5. 1: Financial performance indicators

Indicators	Definitions
Total Cost	Operational Cost + Fixed Cost
Revenue	Sales revenue- Operational cost
Net Profit/Gross Margin	Sales revenue -Total cost
Gross margin (%)	Profit / Total revenue
Net Margin	Profit /Quantity harvested or purchased
Return on investment	(Total revenue – Total cost)/ Total cost
Benefit cost ratio	Total revenue / total cost
Marketing profit	Marketing margin – marketing cost
Value share (%)	(Selling price – purchasing price) *100

Source: Author compilation based on Tesfaw et al. (2012); Kilimo Trust (2012) Islam et al. (2014); Deng et al. (2016)
NB: TGMM: Total Gross Marketing Margin, NMM: Net Marketing Margin, GMM: Gross Marketing Margin

Governance assessment

This involved assessment of the environment within which actors performed their activities, regulatory frameworks and institutions, power relations, interaction and linkages, and the governance structure. Porter's (1985) five forces model which focuses on factors such as the threat of substitutes, bargaining power of buyers and suppliers, threat of new entrants and intensity of rivalry were also assessed. To determine the strength of each force within the value chain, the actors were required to provide their level of agreement on a 9-point scale from strongly disagree (-4) to strongly agree (+4) for each element. The level of agreement was then measured between 0% to 100% depending on the percentage of agents who agreed to the statement. Rating on the agreement scale was between +1 and +4 for positive agreement and -4 and -1 for negative agreement (Bull et al. 2016). The data were subjected to descriptive statistics with the application of the Statistical Package for Social Scientist (SPSS).

Assessment of Operations

Assessment of practice focused on determining how the different activities were performed along the chain. Close-ended, open-ended and Likert scale type (A 5-point Likert (rating) scale (strongly disagree/never = 1; disagree = 2; uncertain = 3; agree = 4; and strongly agree/always = 5) questions were formulated to examine common beans production and trading practices.

Management assessment

Postharvest loss assessment

Material flow analysis was undertaken to understand the movement of the food along the chain. Food loss estimations were however made based on beans remaining after that reserved as seeds and for consumption were deducted. FS_i is the beans available for sale and i is for the different stages along the supply chain i.e. production and marketing stages.

$FS_i = Food\ production_i - \sum seed_i + consumption_i + other\ purposes_i$……….. (1)

The amount of food loss at each node was quantified in physical units. Economic loss was estimated based on the cost of food lost at each stage of the chain. The weighted average representative prices were estimated for the produce at each stage of the chain. Quality losses were assessed by determining the quantity of beans with breakages, insect infestation and foreign materials. Nutrient losses were assessed by estimating the quantities of the different nutrients lost as a result of the quantitative losses in bean produce. The protein, carbohydrate, caloric and mineral contents in the beans determined based on lab analysis for the local varieties of the bean were used. The study determines the loss factors along the chain and the farmers' role in managing and taking records of losses. Farmers were questioned to find out if they measured their losses or otherwise. Further, farmers were requested to rank the awareness of the factors likely to cause post-harvest losses on a scale of 1 to 5.

Knowledge assessment

A qualitative case study design approach was employed in gathering information on knowledge acquisition, transfer and utilization. This technique was useful in capturing the views of persons directly involved in the process of knowledge acquisition and transfer. Information was gathered to understand the knowledge infrastructure, process (acquisition, innovation, sharing, integration) and performance. The performance was measured based on a financial (able to sell the good at a higher/lower price due to the acquisition of knowledge or a lack of it) and non-financial measure (number of people who have received training). The actual value created or lost by knowledge management was estimated as the difference in the final price of the beans sold with price knowledge and the initial price at which the beans would have been sold without knowledge.

The study hypothesises that there were potential complementary and substitution between knowledge management activities and knowledge types. The relationship between the different knowledge management activities and their determinants were obtained with the logistic regression model. The dependent variables were all dummy variables which lend themselves well to the logit model. The results were expressed in marginal effects to show the direction and strength of the determinants of the factors on knowledge sourcing, process and performance. Marginal effects are more straightforward with the use of simple modelling frameworks (Roper et al. 2008). The model allows for easy reflection and interpretation of the marginal effects and relationships between knowledge management activities. A latent variable y* which defined the logistic regression model is represented by the relationship equation;

$$Y = \alpha + \sum \beta_1 X_1 + \sum \beta_2 X_2 + \cdots + \sum \beta_n X_n + \varepsilon_i \text{ .... (eqn 5.1)}$$

Where Y= dependent variable (the agents knowledge management activity), this is a dummy variable with 1 being participation in the activity or otherwise, α is the intercept,$\beta_1,\dots,\beta_n$ are the coefficient of the independent variables, $x_1 ,\dots,x_n$ are independent variables, and ε is the error term assumed to follow a multivariate normal distribution with mean zero. The independent variables considered include producer characteristics and relationships along the chain.

$$Log\left(\frac{P}{1-P}\right) = \alpha + \beta(Agent\ characterisitics\ and\ knowledge\ factors) \text{..............(eqn 5.2)}$$

If β is positive, it would suggest a complementary relationship between the knowledge management activities and if negative a substitute relationship. The model explains the probability that an agent will obtain a particular kind of information and perform one of the knowledge processes based on given a combination of factors.

Agility Evaluation

In assessing the agility of the value chain, three major factors were analysed. These included assessment of the dynamic environment within which the value chain operates, the ability to respond to change (agility) and the asset endowment of value chain actors necessary to adjust quickly to changing demands. Information was gathered on the awareness of value chain actors about the changes in the environment within which they function. Open to close-ended questions were asked about the decisions made to respond to the changes, how long it took to make necessary adjustments, the constraints and costs involved with the change. The availability and usefulness of available assets were also determined. At the end of the analysis, it was possible to determine how much agile the chain was and stages along the chain where agility was higher or lower.

Perception and Attitude Assessment

This assessment focuses on understanding perceptions and attitudes of value chain actors with respect to common beans production and trading practices. A 5-point Likert (rating) scale (strongly disagree/never = 1; disagree = 2; uncertain = 3; agree = 4; and strongly agree/always = 5) type assessment was used to solicit the responses through face to face interviews.

Social Assessment

The assessment was based on injuries and safety of the value chain actors, training and skill acquisition as well as employment opportunities along the chain. Knowledge and attitude about work safety procedures and practice of safety were also assessed. The questionnaire also had questions relating to the types of injuries, the severity and occurrence of the injuries. The severity of injury was determined by categorising the injuries based on whether they resulted in permanent disabilities or fatality and those that do require hospitalisation or medical treatment. Farmers were asked to indicate their level of agreement with a different set of questions based on a 5-point Likert scale (Likert, 1961). The responses for this section were strongly disagree/never = 1; disagree = 2; uncertain = 3; agree = 4; and strongly agree/always = 5. Means and percentages of responses were estimated and presented.

Environmental Assessment

This was assessed based on chemical and fertilizer use, deforestation and burning. The questionnaire, therefore, included questions in this regard.

Quality Assessment

Quality was assessed by determining the knowledge of value chain actors on consumers preferences with respect to bean attributes, food safety procedures, value addition along the chain and the impact of activities on selected bean attributes. The attributes considered include cooking time, size, appearance, colour, bean damage, storability and safety. Data was gathered through surveys and laboratory work. Beans were stored and analysed in the lab over a period of 5 months to determine how storage influences consumer preferred attributes. The data was analysed using descriptive and statistical methods. Details are specified below;

Cooking time

One hundred dry unsoaked beans were selected for the cooking test. The beans were cooked in 200 ml of distilled water in a water bath at 96℃ until beans were fully cooked. Cooking time was determined as the overall time when more than 50% of the beans were considered cooked. This was based on a subjective cookability test which is the local beans softness assessment practiced by consumers. The cooked beans were pressed between the thumb and the forefinger to determine its cookability. The beans were considered cooked if the cotyledons disintegrate upon pressing. This subjective criterion for bean hardness evaluation has also been used by other researchers (Kinyanjui et al. 2015; Vindiola et al. 1986).

Colour

The colour was measured using a colourimeter. The measurement was done using CEILAB colour scale (L*a*b*) which is widely used (Yousif et al. 2007). L*is lightness, a* (chromaticness in the direction of green (−) to red (+)) and b* (chromaticness in the direction of blue (−) to yellow (+)), C ($[a^{*2} + b^{*2}]^{1/2}$) is chroma or colourfulness and h^0 is hue and $dE^* = \sqrt{dL^{*2} + da^{*2} + db^{*2}}$ is defined as the colour distance (sphere around the actual target value). Colour change for each of the samples was tested after storage at 35℃ over time. The instrument was calibrated using standard white plates before measurements were taken.

Seed damage

The conditions of storage could lead to insect maturity and multiplication as well as mould formation. The presence of insects was, therefore, determined every month, an approximate number of live and dead insects as well as bored seed were noted. This was achieved primarily by observation and counting was done manually for both live and dead insects (Tripathy et al. 2001).

Statistical Analysis

Statistical analyses were made with the JMP Pro (version 13.0) software package for Windows (SAS Institute Inc., Cary, NC, 1989-2016). Significance differences among samples were separated using the Least Significant Difference (LSD) at a 5% probability level. Comparison of means was done using the Turkey-Kramer HSD model.

5.3.3.3 Total Performance Assessment

The performance was assessed based on the framework described in Chapter 3. Qualitative and quantitative data were gathered which corresponds to different dimensions and indicators to obtain performance scores. A multidimensional performance index was used to determine the performance of the chain in meeting consumer preferences and its contribution to achieving food security indicators. The indicators were formulated into questions which were presented to the different stakeholders to gather information through face to face interviews. The indicators are measured differently; however the scores were normalised for easy interpretation, comparison and assessment. Spearman's correlation analysis was employed to estimate the correlation between the value chain indicators and the dimensions scores as well as the dimensions scores and the food security indicators.

Cluster analysis was used to classify value chain actors into different homogenous groups based on their performance scores. Cluster analysis is a multivariate technique which enables individuals to be put into groups based on pre-defined characteristics. The hierarchal method is however mainly used due to the simplicity in results interpretation (Schilling and Coggins, 2007) and thus applied in the study. All performance scores obtained by value chain actors were subjected to cluster analysis based on Ward's method. The number of clusters was chosen based on a careful examination of the dendrogram (Hair et al. 2010). The dendrogram is often cut to examine the difference in fusion levels and thus larger changes at any point between the fusion levels will be used to determine the appropriate number of clusters (Everitt and Dunn, 2001). Mean ANOVA and posthoc tests with Tukey HSD were used to determine significant differences in clusters. Cluster analysis was performed using STATA 12.

5.4 Results

5.4.1 Structure of the value chain

Characteristics of farmers

The farmers were made up of 54.2% females and 39.9% males. The mean age was 42.4 years and 98.8% had primary (64.6%) and secondary (34.2%) education. However, 42.4% of the participants were not able to read and write. On average (19%), the majority of the participants live in a household with 7 members. Farming was the major source of income for all the participants; however, 14.6% of the participants engaged in other activities such as trading, fishing, brewing alcohol etc. to earn additional income. The mean income for producers was K134.6. The majority (62.3%) of the producers had more than 5 years of farming experience. Land sizes for bean cultivation ranged from a minimum of 1ha to a maximum of 9ha, though 65.8% farm on less than 2ha of land (Table 5.2).

Table 5. 2: Demographic characteristics of value chain actors (producers and traders)

Variables	**Summary of statistics**	
	Producers	*Traders*
Farmer characteristics		
Sex (females %)	54.2	93.3
Age (years)	36	37.7
Educational level (educated %)	98.8	66.7
Family size	6.28	5.7
Income	K134.6	K517
Ownership of bicycle (%)	56.7	43.3
Production Characteristics		
Farm size (less than 2ha) (%)	69.8	-
Farm experience (> 5years) (%)	62.3	73.3
Production of other crops (%)	70.9	70
Number of varieties planted (more than one) (%)	77.2	76.7
Job classification (retailer) (%)	-	73.3
Classify enterprise (small scale) (%)	-	53.3
Harvesting duration	500hrs	-
Post harvest duration	284.3 hrs	-
Storage duration	2962.2 hrs	-
Transport duration	5.3hrs	-

Overall activity duration		
Total number of labour (persons)	5.8	4.25
Percentage of hired labor (% out of total)	11.1	-
Farm Ownership (owned) (%)	64.9	-

The farmers produced different varieties of beans though others produced only a single variety. Only 22.8% of the farmers produced one variety, 77.2% produced two or more varieties. Varieties produced were *kabulangeti*, *lusaka*, *white*, *mixed* and *lyambai* beans. About 70.9% produced beans and other crops such as maize, cassava, soya etc. for sale and home consumption. Most farms (64.9%) were owned while few were rented or sharecropped (Table 5.2).

Characteristics of traders

Females made up 93.3% of the traders. The majority (43.3%) of the traders had ages between 30 to 50 years with a mean age of 37.7 years. About 66.7% had primary education yet only 50% could read and write. Household sizes ranged from 1 to 11 with the majority (20%) having households with 6 members. Monthly income ranged from K130 to K1500, with an average of K517. About 53.3% were small scale traders, 46.7% medium scale and 90% of them were however full-time traders. The majority of the traders have a good experience with the trading of beans with 50% having more than 10years experience. The traders sold different varieties of beans, while others sold only one variety, others sold up to 4 varieties. The varieties on the market were *Lusaka*, *Kabulangeti*, *Mixed* and *White* (Table 5.2).

5.4.1.1 Value chain activities

Production

Common bean was primarily grown on small scale lands with few inputs and hardly any mechanisation. Production of beans was undertaken from February to May when harvesting begins. Approximately, 3 to 4 bags (110kg) of beans was averagely produced on a hectare of land; however, this is rarely obtained by the farmers. Generally, the majority (46.8%) of farmers produce beans on less than 2ha of land. The highest yield produced by farmers is 1000kg of beans and the lowest being 20kg. The majority (9.5%) of farmers, however, produced 20 gallons in the recent past season. Higher yields were associated with larger farm sizes and the production of more than one variety. In the Northern Province, beans are usually intercropped with maize, groundnuts or cassava or by itself (USAID, 2009) which was found to be the major practice within the visiting communities. While the local varieties have yield between 300 to 500kg per ha, the resistant varieties could yield as high as 2500 kg per ha (USAID, 2009). The farmers did not grow new resistant varieties.

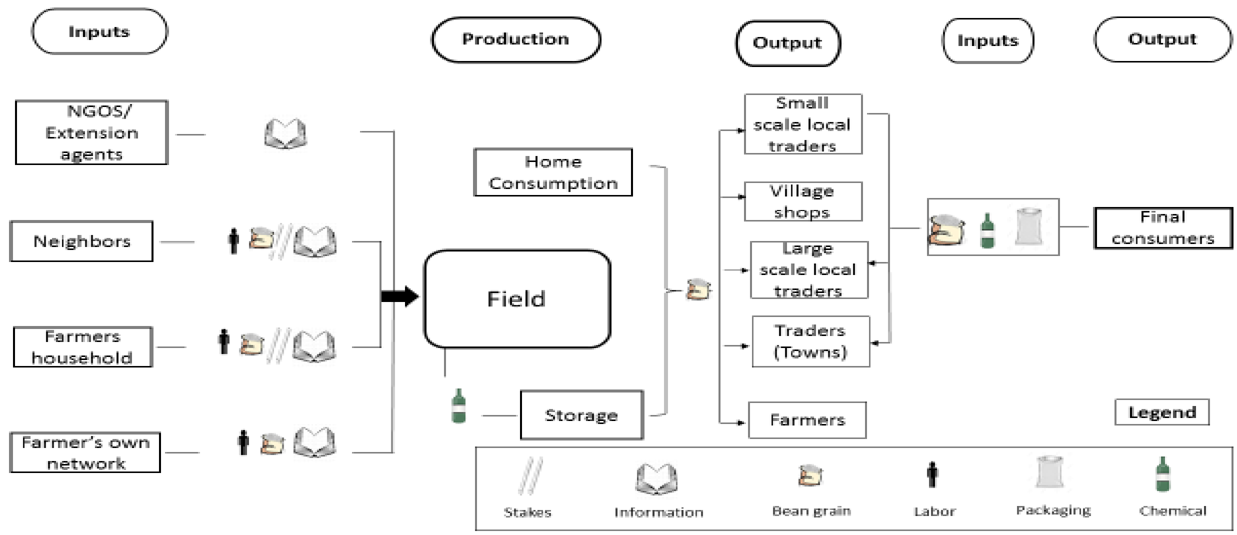


Figure 5. 2: Map of inputs used along the common beans value chain

Apart from a hoe for weeding, no other equipment is utilized during the production of beans. The seeds used for planting were usually recycled from the previous harvest. Farmers did not apply insecticides and thus control of pests is left to nature. Farmers hardly paid for labour since the whole family is usually involved in farming activities (Figure 5.2). Farmers also had organised groups where a known number of community members come together to work on each others farm. Labour, when hired, was paid with cash or in kind. There were labour divisions between males and females, where females help with planting, threshing and sorting. Males were however responsible for land clearing although women were sometimes involved. Irrigation of the farm was dependent on the rainfall and thus changes in climate had a very significant influence on the farm yields.

Harvesting

Beans, when matured, was left to dry partially on the field for about 7 days before harvesting was undertaken. The beans were observed to be dried when there was a change in colour from green to yellow, white or brown depending on the variety of bean. Harvesting was undertaken by both men and women without mechanisation. Harvesting took a period of 1 to 30 days depending on the size of the farm, the yield, the number of people harvesting and their pace. About 45.7% took more than three weeks and 18.1% took a month or more to harvest.

About 47.6% of farmers had average yields less than 150kg, 32.4% between 150-300kg, and 20% >300kg. Comparing farmers average yields to current yields, it was found that 33.3% of the producers had yields lower than the average. However, 31.4% had yields higher than the average. Thus, yields were not increasing as much across the years especially since farmers reported producing their highest recorded yields very sparingly.

Transportation

The beans were transported from the farm mostly by foot with the beans carried on the head and rarely by bicycle. Tibagonzeka et al. (2018) also made similar observations. The farms were situated in different locations some of which were farther from farming households. The farthest distance from the farm to the house was 3 to 4km while the shortest distance is less than 200m.

Pre-processing: Drying, sorting and grading

Threshing of beans was mostly performed on the farm after which the beans were transported home for sorting and bagging. The beans were threshed by beating the beans with sticks to separate the seeds from the pods. This method has also been reported by Tibagonzeka et al. (2018). The beans were further allowed to dry thoroughly under the sun during the early hours of the day.

The beans were cleaned by picking through to remove undesirable seeds which could be smaller seeds, discoloured seeds, disease or pest-infested seeds. The seeds were also tossed to allow the natural current of the wind to blow off any unwanted material. This activity is time-consuming and inefficient since attaining thoroughly cleaned and sorted seeds can be very difficult to achieve. About 32.1% of the producers indicated that sorting and cleaning took 7 days, 14 days by 15.1%, and 30 days by 12.3% depending on the number of people performing the activity. The beans after being cleaned were bagged in polypropylene (jute) sacs and kept for storage. A pictorial description of the stages is presented in Figure 5.3.

Storage

Farmers did not have storehouses thus the seeds were kept in the house. Beans were stored to maintain the quality, as seed for the next growing season and to speculate selling price. About 64.8% of the farmers stored up a portion of their beans to sell at a later date. The grains were stored for not more than 8 months. Farmers were sometimes reluctant to store seeds to speculate selling prices because cash was required for immediate expenses.

Beans were stored with ash to prevent insect infestation by the majority of the producers who were not able to purchase the pesticide. The pesticides, Doom and Chilinda Matula were used only by a few producers since they are expensive though it was more effective in the storage of beans. Approximately, 25% of farmers applied pesticides to beans while 85% applied ash during storage. About 200g of the pesticide was applied to a 50kg bag of beans. No measurement was however performed when ash is being applied. Application of ash prevents insect attack for 3 to 4 months while that of pesticides can last for at least 7 months. The toxicity of the chemical for human consumption was however unknown.

Based on experience, farmers indicated that consuming beans stored with pesticides after 3 months was safer. This information was, however not communicated to traders who purchase beans and are likely to sell to consumers within a few days. Beans were sometimes (43.8% of farmers) graded after sorting and either sold at a lower price to traders or retained for home consumption. About 63.8% of the farmers indicated increasing the price of the beans when there are significant losses to make up for lost sales.

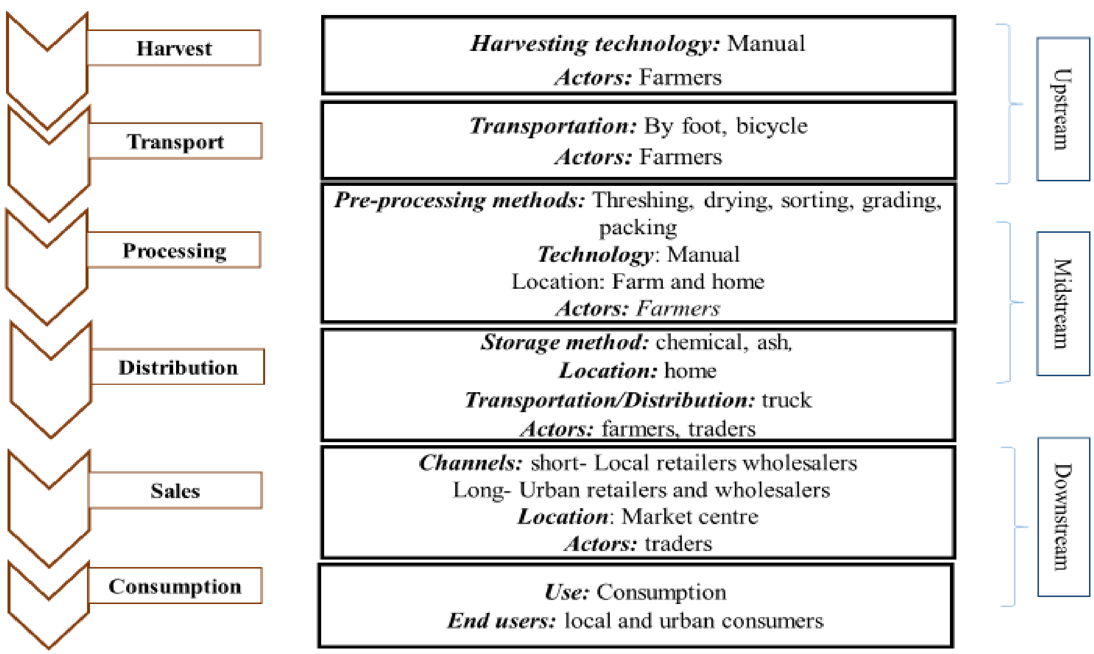


Figure 5. 3: Value chain stages

Marketing

The different stages of the chain interrelate with one another to meet the need of the consumer through an exchange process. Farmers faced the difficulty of connecting with traders to sell their beans. Farmers did not spend time to search for traders since they come to the farming communities to purchase the beans and transport it to marketing centres. Prices of the beans varied depending on the time of purchase. Thus, during or immediately after harvesting the 1gallon beans was sold for k20 to K30. After the beans are stored for more than 4 more months, the price ranges from K40 to K50. The farmers sold to traders who could either be wholesalers, retailers or village collectors. The distinct towns and communities from which traders journey to the farming communities were not known due to the informal nature of the marketing system. Thus, beans were likely to be sold in the markets within the nearest communities, Luwingu market (at least 78km from the producing communities), Kasama market (212.8km from the Luwingu), towns and communities in Southern Zambia, the copper belt (859.9km from Luwingu) or even across the border to Congo from the Copper belt.

Traders purchased bulk quantities from a single producer or from different producers in the community. The beans were transported by traders from the producing centres with the use of a vehicle. The beans were sold either in open sacs or in small piles on the tabletops, trays or basins. This was to enable consumers to easily access the quality of the beans and determine the variety to purchase based on the colour. Traders were also likely to sort and grade beans depending on the quality available to them. The traders stored beans at their respective homes or at the market centre.

Beans were mainly sold to consumers in their raw dry form. Beans were not processed in any form for sale. Prices of beans were determined based on different factors such as the quality of the beans, time of the season, the kind of buyer and the variety of beans. The flow of produce and payment was simple and based on spot market transactions. The market structure was a perfectly competitive market where there are many buyers and sellers. Negotiation power from both ends usually determines how high or low the price of a product was sold. A visual representation of the linkages between activities and the actors, losses and form of transaction is depicted in Figure 5.4.

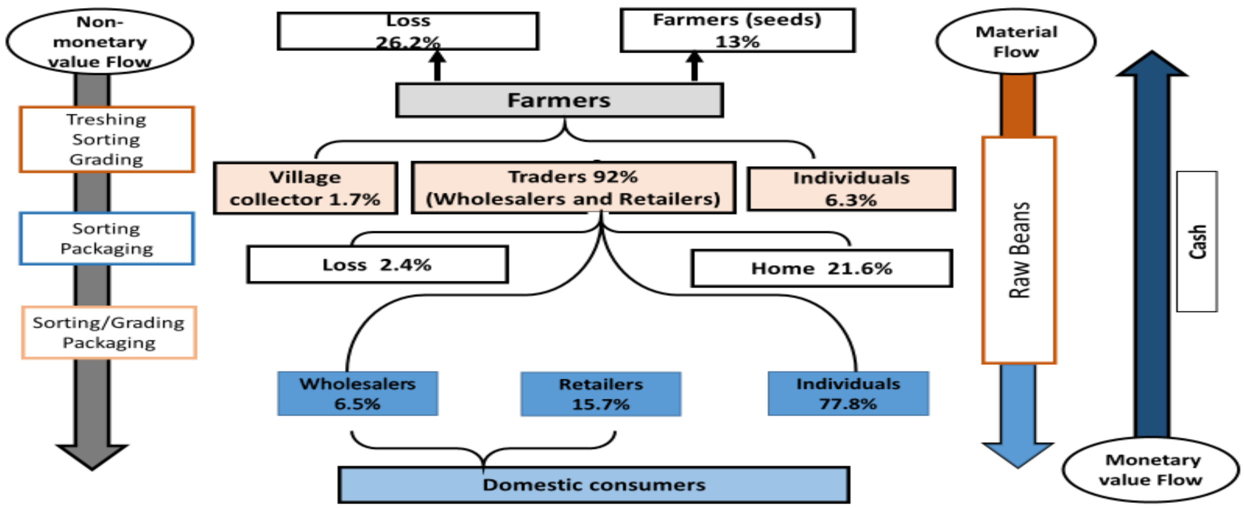


Figure 5. 4*:* Common bean value chain map

5.4.2 Value chain dynamics

5.4.2.1 Economic assessment

Market structure

The main markets within the chain are the intermediate, wholesale and retail markets. The produce was handled by different individuals along the chain; however, the chain is not very long and thus does not involve numerous intermediaries. The marketing channel is presented in Figure 5.5

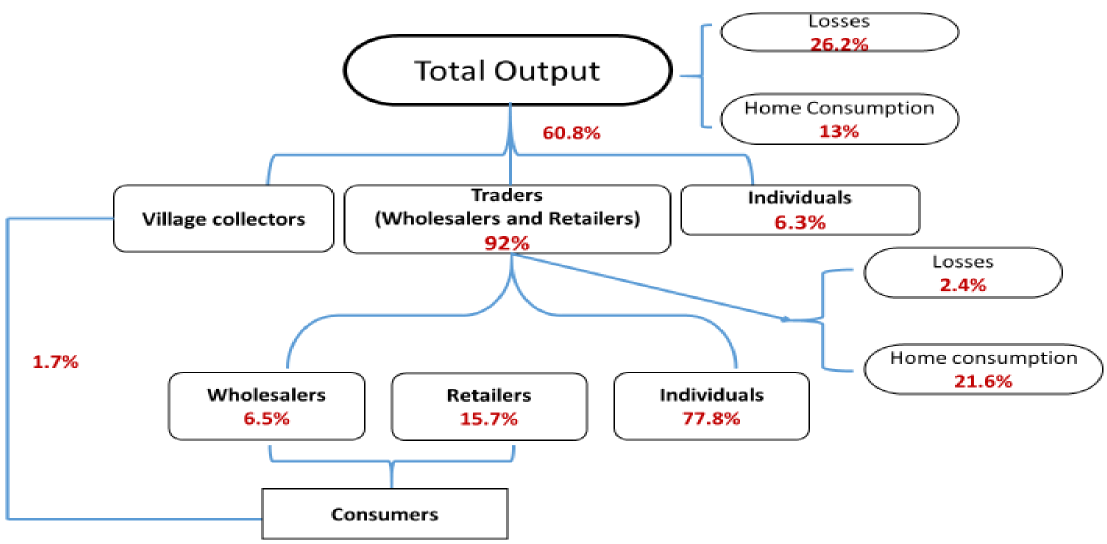


Figure 5. 5: Marketing channel

The financial assessment was made to determine profitability using a cost and benefit analysis. Computation the costs and earning for the different actors are presented in Table 5.3. Different prices were used in the estimation of revenues and profits, that is prices at harvest and after storage. This was done to achieve accurate estimations of profits.

Cost Structure

The cost components for the production and marketing stages of the common bean value chain were categorised into 5 groups. These costs are presented in Fig.6. The cost components for both producers and traders were found to be very few. The components for the producers mainly constituted seeds, land, labour, pesticides and sacs (Figure 5.6). Producers did not use any inputs such as fertilizers or insecticide, seeds were recycled and a few (18.4%) purchased pesticides. Supply costs constituted 100% of the total cost for approximately 54.4% of the farmers. Production and delivery cost did not constitute a major portion of the total cost. About 86.1% and 88% of the farmers had production and delivery cost constituting less than 30% of total cost respectively. Generally, the percentage of operational costs were found to be higher than the fixed costs. About 8.9% of the producers, however, did not invest any amount into farming activities.

Supply cost constituted the major proportion of costs for traders with 90% of the traders having the supply cost constitute more than 50% of the total cost. Delivery cost consisted of the cost of pesticides and packaging for 75% of the traders.

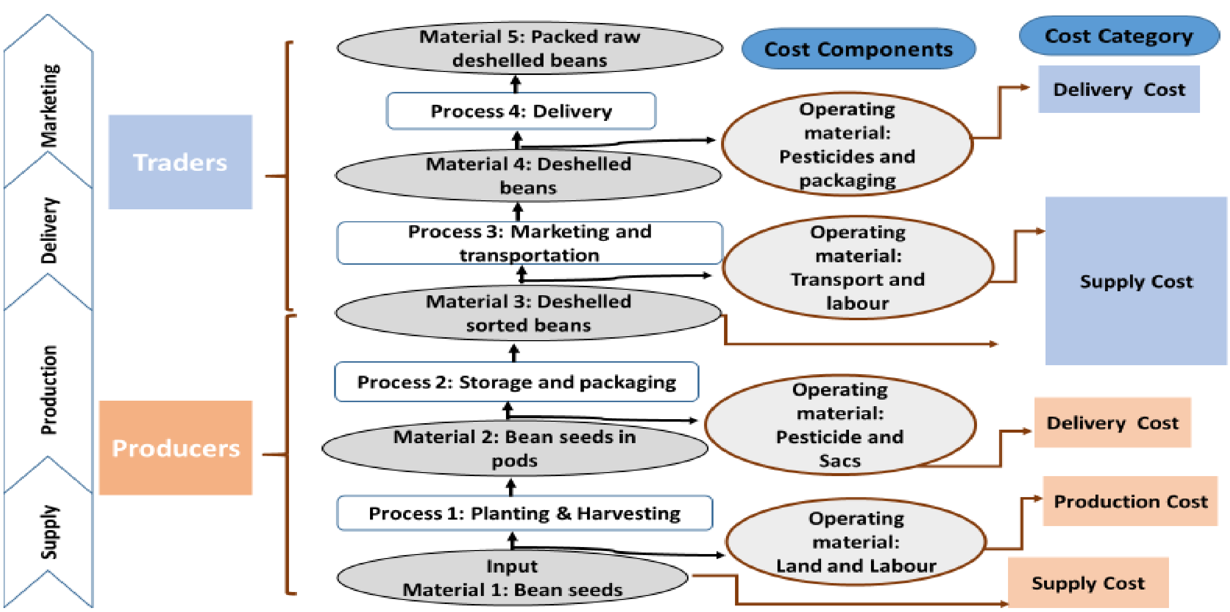


Figure 5. 6: Cost components along the chain

Estimation of Revenues

Beans were sold immediately after harvest or after storage for up to 8 months. The price of the produce was affected by production and transportation costs, seasonality, kind of buyer, variety of produce, the quality of the bean, consumer preferences, location of the market, characteristics of producers and traders, quantity purchased, among others. Popular varieties such as *Lusaka* beans and *Kabulangeti* beans had much higher prices, usually 20% higher compared to *white* and *mixed* varieties.

Financial Analysis

Table 5. 3: Financial performance for producers and traders

Variables	Farmers	Traders
Supply Cost (avg.)	K49.9	K561
Production cost (avg.)	K20.9	
Marketing/ Delivery costs (avg.)	K8.8	K37.5
Total costs (avg.)	K218.7	K551.7
Average harvest	28.4 gallons	
Average price		K35
During harvest	25	
At storage	40	
Average Revenue		K899.25
During harvest	K364.2	
After storage	K576.0	
Total revenue	K940.2	
Net Profit	859.9	440.1
Benefit cost ratio	14.8	2.37
Gross Margin	0.80	0.22
Net margin	27.6	9.65
ROI	13.9	1.37
Percentage value share (%)	73.3	26.7
Marketing profit	32.69	10.39

NB: All costs are reported in Kwacha (Zambian currency)

Considering the financial performance with respect to net profits, producers were the best performing actors compared to traders which is expected because they had the lowest cost of production. Due to the high cost of production for traders and the lack of value addition, the traders had lower profits. Costs were generally higher for traders compared to producers. Higher revenues obtained by producers after storage of the produce was due to the high price charged for the produce. This, therefore, contributed significantly to the revenues and profits obtained by the producers.

Even though traders dictate prices of beans, they still earned low profits. Consumers expectation of beans being low-cost produce may be influencing the need for traders to keep the price of beans low. Affordability, particularly with respect to beans, is key to increasing purchase by consumers. The lack of value addition to improve the quality and appearance of the produce may also be contributing to the expected low prices. Net profit is the money left over after all expenses have been deducted and also reflects the profitability of the business. The results show that net profits were higher for producers compared to traders. This is as a result of the low selling price of the beans. The net margin for producers was estimated to be 27.6 and that of traders to be 9.65. The low profits for traders explain the low net margins.

The benefit-cost ratio was employed as a measure of profitability (Table 5.3). A BCR greater than one for each actor leads to the conclusion that the actors are operating a profitable business. The BCR for both producers and traders were found to be positive, though that of producers (14.8) was higher than traders (2.37), thus the business is operated by both actors are profitable. About 88% of the producers were operating above breakeven point (>1), 1.3% were operating at breakeven point (=1) and 10.76% were operating below breakeven point (<1). It should be noted however that labour which is a significant input in the production of beans was not valued and included in costs. Considering that producers spent the majority of their hours on the production and handling of beans, labour costs were expected to be high which could decrease profits. This will, therefore, corroborate with producers and traders view of low profitability of the business since incomes from these activities were not sufficient. About 42.4% and 66.7% of farmers and traders respectively disagreed to incomes from bean production and trading being sufficient with 51.9% and 66.7% respectively indicating that it was becoming less profitable.

Particular to traders, 30% were operating below breakeven point, and 70% above the breakeven point. Rate of return on investment (ROI) determines the worthwhileness of a business (Farayola et al., 2012). A higher rate of return indicates a more profitable business. ROI was estimated to be higher for producers (13.8) than traders (1.37) and thus, producers have been shown to be engaging in a more profitable business than traders. Common bean production was also found to be profitable by Musimu (2018).

The financial position of the actors was computed by estimating the value share of each actor based on the purchasing price, selling price and marketing cost. In the common bean value chain in Luwingu, a large percentage of the value share was obtained by the producer which is 73.3% (Table 5.3). The farmer had lower costs and high profit margins. The trader received only 26.7% of the value share with much higher costs. Farmers in Uganda were also found to have a higher percentage of value share compared to traders (Kilimo Trust, 2012). While most interventions focus on the producer, there should be projects targeted at the trader to improve marketing of common beans. Making the trade attractive has a positive implication for producers in terms of market access and sustainability.

5.4.2.2 Governance assessment

The type of governance existing between producers and traders was market governance. This type of governance is characterised by simple product specifications which are often very easy to communicate and understand and transactions are easy to arrange. The key governance medium is price (Gereffi et al. 2005). The governance structure is highly buyer-driven where buyers are the traders. Though buyers are not entirely large retailers or wholesalers but the small-scale town and local traders, they dictated product specifications. These are not strictly enforced though largely considered during purchase. The existing system is a spot market where transactions are made immediately with no contractual agreements. Several studies have revealed that spot market transactions exist among value chain actors in developing countries (Chagomoka et al. 2014; Sichilima et al. 2016).

Threat of entry into Chain: Entry into the different stages of the value chain was not restricted by government or cultural regulations. Particular to bean production, the access to land, capital to purchase seeds and hire labour, as well as the skills in the production of beans, may be the limiting factors to entry. The capital to purchase beans and secure a spot at the market place was also the limiting factors to trading beans.

Threat of Substitutes: About 43% of farmers indicated that there were no substitute crops to beans while 96.7% of traders agreed to the same view. Due to the different varieties of beans, one variety is more likely to be substituted for another. *White* and *mixed* beans are more likely to be substituted for *Kabulangeti* and Lusaka beans since they are tastier. Thus, producers and traders of the less popular varieties are likely to have their produce substituted by other varieties of beans. Thus, shifting to the production and trade of more popular varieties is expected. Also, farmers were more likely to substitute the production of beans for that of groundnut or reduce the amount of land allocated to bean production. This crop was preferred because it can easily be consumed at the household, and large quantities can be easily sold for income. Traders indicated that they were less likely to substitute the sale of beans for other produce. Overall, there is no significant threat.

Supplier Power: The inputs used by farmers were mainly recycled bean seeds and simple, primitive tools (Table 5.4). Thus, the power of input suppliers on the activities performed by farmers was non-existent. The major group of suppliers of beans to traders were the producers; however, these suppliers have very little or no power compared to the buyers. Farmers had no means of transporting their produce to market centres and thus rely solely on traders. The traders, therefore, determine the price at which the beans are to be sold with very little bargaining power for farmers who are crippled by the probability of not having a purchase. The power is fueled by searching costs for traders who would have to go around looking for producers to purchase beans. There was no switching cost when traders move from one producer to another.

Table 5. 4: Response rate by producers for each factor under the 5 forces

Forces	Mean	S. D	Overall positive response (%)	Strength
Potential entrants				
Capital requirement	4.84	2.671	44.3	A moderate extent
Difficult to entry	4.37	2.409	55.7	A moderate extent
Government policies	5.72	2.611	31.1	A moderate extent
Easy assess to inputs to start a business	4.11	2.500	60.2	A moderate extent
Buyers Power				
Highly differentiated produce	3.87	1.748	69.6	A moderate extent
Different marketing strategies	4.40	2.506	60.2	A moderate extent
Suppliers Power				
Easy assess to input suppliers	3.84	2.270	62	A moderate extent
Availability of differentiated inputs	4.76	2.471	51.3	A moderate extent
Threat of Substitutes				
There are other produce that can be substitutes	4.89	2.568	43	A moderate extent
Substitutes are relatively cheaper	5.02	2.558	41.8	A moderate extent
Intensity of rivalry				
Farmers are highly competitive	4.70	7.102	62.1	A moderate extent
High demand for beans than producers	3.77	1.935	76	To a great extent
Beans produced are different	4.35	2.760	55.7	A moderate extent

Ranges 100%- To a very great extent, ≥75%-A great extent, 25-75%-A moderate extent, ≤25%-To a little extent

Buyer Power: In comparison to farmers and traders, the traders who are the buyers, in this case, had power over the sellers. In comparison to traders and consumers, however, the traders who are the sellers still have considerable power over the buyers. They determined the price at which the beans were sold based on some varied quantities. The degree of negotiation between traders and consumers however determined the final price. There were price reductions when beans did not meet consumer quality expectations. Due to the different variety of beans on the market indicated by 70% of traders, consumers were likely to substitute one product for the other which gave them some power over traders (Table 5.5).

Policies: The country has in place policies to help promote agriculture particularly among smallholder farmers. Some of these policies include the development of irrigation capacity, subsidization of inputs and advance conservation farming techniques (USAID, 2009). The Food Security Pack is one of the subsidized programs which is aimed at the poor and provides seed and fertilizer for subsistence farming to families with one lima of land (0.25 ha). It has been found to beneficial to the needy and thus has expanded to support 534,000 farmers in the coming years. These support programs have been geared towards other crops such as maize and rice. Programs geared towards securing seeds and fertilizer as well as the food reserve program which buys produce from farmers for reserves are also geared towards maize. Thus, the majority of farmers tend to shift production to maize.

Table 5. 5: Response rate by traders for each factor under the 5 forces

Forces	Mean	S. D	Overall positive response (%)	Strength
Potential entrants				
Capital requirement	2.55	1.753	90.9	A great extent
Difficult to exist	2.73	1.555	90.9	A great extent
Government policies	7.45	0.688	0	To a little extent
Easy assess to inputs to start a business	3.10	2.514	63.7	A moderate extent
Buyers Power				
Highly differentiated produce	3.45	2.067	81.8	A great extent
Different marketing strategies by traders	2.36	1.120	81	A great extent
Suppliers Power				
Easy assess to producers	3.27	3.003	63.6	A moderate extent
Availability of different varieties of beans	3.45	2.816	54.6	A moderate extent
Different marketing strategies by producers	2.91	1.375	91	A great extent
Threat of Substitutes				
There are other produce that can be substitutes	2.18	1.328	90.4	A great extent
Substitutes are relatively cheaper	3.36	2.111	81.9	A great extent
Intensity of rivalry				
Traders are highly competitive	2.18	0.874	100	To a very great extent
High demand for beans than traders	2.27	1.104	72.8	A moderate extent
High demand for beans than producers	3.36	2.203	100	To a very great extent

Ranges 100%- To a very great extent, ≥75%-A great extent, 25-75%-A moderate extent, ≤25%-To a little extent

Intensity of rivalry: There was a moderate level of competition among farmers and traders, however, individual farmers and traders view this differently. Quality and price influence consumer purchasing decisions and are the major factors driving competition among traders.

About 75.3% of the farmers (Table 5.4) and 40% of the traders' view competition as a positive influence since it encourages them to produce and sell quality beans. However, 24.7% of farmers and 60% of traders indicated that the rivalry that exit among the agents was not healthy. The overall positive response for the 5 forces was generally higher for all competitive forces (Table 5.5). However, it was much higher for buyers' power, threat of substitutes and intensity of rivalry for common bean value chain actors. The presence of buyer power and lack of suppliers limits the financial performance of the producers. The threat of substitutes posses a challenge for the agents with respect to profitability. Generally, the environment within which the value chain operates is limiting participation into the value chain to an extent and can also limit the expansion of the production and marketing of beans. The lack of inputs for the production of beans and adequate infrastructure for postharvest handling of beans may constraint value addition and reduce produce quality.

There are unknown, unclear and unenforced formal institutional regulations with respect to common bean production and trading. No evidence with respect to the application of rules and regulations governing production activities and quality standards were observed. Production and marketing of beans were not coordinated. Agents cooperate mainly with family or friendship relations and conform to the findings obtained by Van der Lans et al. (2012).

Farmers and traders indicated the factors which influenced the activities they performed. The majority (70.3) of the producers indicated that collaboration and interrelations with other producers had a major influence on the activities performed (Figure 5.7). About 20% of the producers, however, indicated that none of the agents had any influence on the activities performed. This indicates that quality requirements provided by traders may not be strictly adhered to. Between the need to earn profits from the activities and the resources available to efficiently perform activities, the former had a major influence on activities performed by producers. Similar results were indicated by the traders which is an indication that consumer preferences do not drive their activities although it's essential for profits (Figure 5.8).

Figure 5. 7: The influence of agents and factors on activities by producers

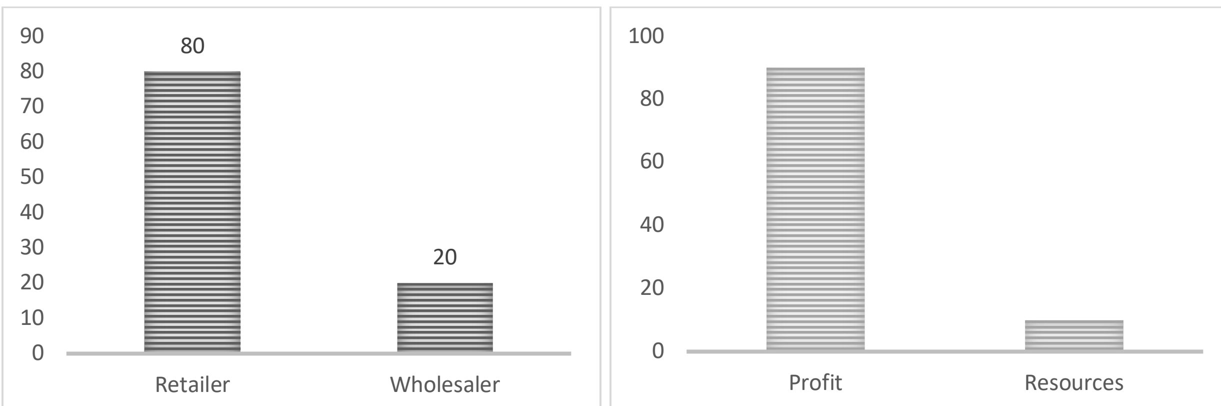


Figure 5. 8: The influence of different factors on the activities performed by traders

Relationships: The agent to agent relationships along the common value chain are those between farmers and farmers, farmers and traders, traders and traders and, farmers/traders and consumers. This type of relationship is at arm's length, little information is exchanged, limited interactions and no technical assistance was provided (Dunn, 2005). Farmers work individually or mainly with other farmers. Farmers rarely collaborate to perform different activities, except labouring on farms. Farmers had no collaboration with traders since they were perceived as thieves who dictate lower prices. There is, therefore, the lack of trust between farmers and traders. Traders neither collaborate with other traders to perform activities. Both value chain actors have limited contact with external stakeholders. Figure 5.9 presents the strength of the relationships among agents along the chain.

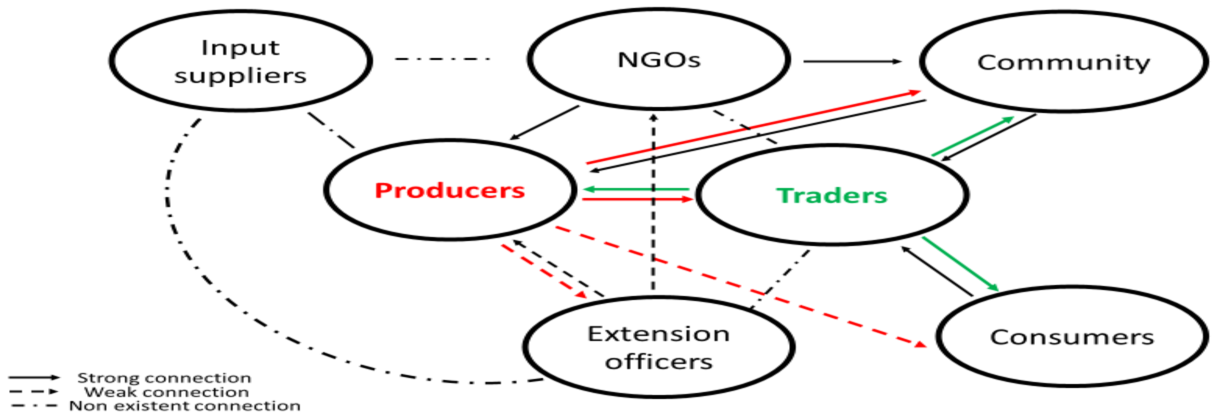


Figure 5. 9: Relationship between agents

5.4.2.3 Assessment of Operations

Sorting is necessary for providing quality beans; however this was not done by 68.5% of value chain actors and occasionally by 18.5%. Due to this, 56.3% did not sell quality beans frequently. The percentage of quality beans was < 50% for 37.6% and 50-80% for 60.5% of the actors. Adequate storage of beans was a challenge to actors with 57.2% indicating that the lack of storage facility was a major problem. About 35.2% and 7.6% however, indicated the lack of know-how as a contributing factor. Only 14.6% agreed to using inputs that increase yield and 8.3% agreed to using resources efficiently to reduce cost. About 45.8% tried to handle beans in ways which reduced waste. Also, to ensure quality seeds, actors indicated the need to plant at the right time, have good quality seeds, use fertilizer and equipment and store grains well. However, actors (57.4%) indicated that they were not able to put these into practice because of numerous challenges. Also, a conscious effort in incorporating those factors will require investing time (8.3%) and money (91.7%).

This is due to several challenges which limit value chain actors from operating efficiently to contribute to food security. These were identified and ranked by value chain actors (Table 5.6). One major concern was that the yields were below their potential. This was influenced by challenges such as the lack of finance, poor farming and harvesting practices. Poor quality seeds, pests and diseases, inadequate technical knowledge and management practices were also key challenges facing producers. There was a lack of access to markets, limited bargaining power, limited market knowledge and orientation which poses a significant challenge to producers.

Weather and climate changes were not excluded, resulting in losses during production and drying. Table 5.6 presents a list of challenges ranked by farmers and their impact on productivity.

Table 5. 6*:* Challenges ranked by farmers

Challenges	*Rank*	*Climate related challenges*	*Rank*	Impact
Lack of inputs and protective clothing	7			Reduced yields
Lack of the capacity to hire labor	1			Reduced yields
Inaccessibility to market outlets	3			Increase losses, reduced profits
No means of transport to the market	4			Increase losses
Lack of quality seeds	5			Reduced yields
Pricing	6			Reduced profits
		Drought	2	Reduced yields
	2	Changing rainfall pattern	1	Higher losses
Changes in climate		Flood	3	
		Increasing temperatures	4	

Farmers undertook different measures to respond to constraints such as climate change and its resulting crop losses. Farmers responded by planting and harvesting early; however there were significant risks and cost involved in making such adjustments. Such adjustments included setting aside capital to hire labour to harvest and plant on time. Working longer hours may be required when there isn't capital to hire more labor. Other adjustments included replanting to reduce the effect of bad weather on crops and diversifying by producing other crops such as cassava.

The results show that the farmers did not pay very close attention to the quality of beans since none of them mentioned their inability to work efficiently to provide beans that meet consumer preferences as a major constraint. The focus was mainly on yields (quantity) and price. Improving quality has a direct positive effect on price and can limit the overall profitability and success of the venture if not considered. Traders face the challenge of receiving cleaned and good quality beans from farmers for sale to consumers. Also, the lack of credit facilities to expand their businesses and the difficulty of searching for farmers to make purchases were some of the challenges mentioned by the traders.

5.4.2.4 Management assessment

5.4.2.4.1 Knowledge assessment

Information source: Information on production of beans were rarely obtained from extension agents except for maize. There wasn't a functioning cooperative for beans farmers. Thus, information relating to bean production were obtained mainly from families and friends (33.3%)

and also rarely form non-governmental agencies (4.4%) mainly Self-Help Africa. Interactions and knowledge were mainly informal and uncoordinated. Summary Statistics of variables included in knowledge management assessment are presented in Table 5.7.

Table 5. 7: Summary Statistics of variables included in knowledge management assessment

Variable description	Mean	S. D
Knowledge performance		
Information from trained personnel (0/1)	0.36	0.482
Improve sales (0/1)	0.85	0.358
Improve operations (0/1)	0.95	0.218
KM infrastructure		
Knowledge holder (Score)	4.78	2.698
Agent-Agent relationship (0/1)	0.91	0.281
KM process		
Knowledge acquisition (0/1)	0.70	0.461
Knowledge innovation (0/1)	0.84	0.372
Knowledge protection (0/1)	0.04	0.192
Knowledge integration (0/1)	0.83	0.378
Knowledge dissemination (0/1)	0.88	0.326

Knowledge management: Knowledge possessed by farmers and traders on the performance of value chain activities have mainly been passed down from generation to generation (Figure 5.10). Knowledge is therefore stored and reused by producers and traders with very little modifications through experience or observation from other agents. When new information is obtained, producers reuse them across seasons.

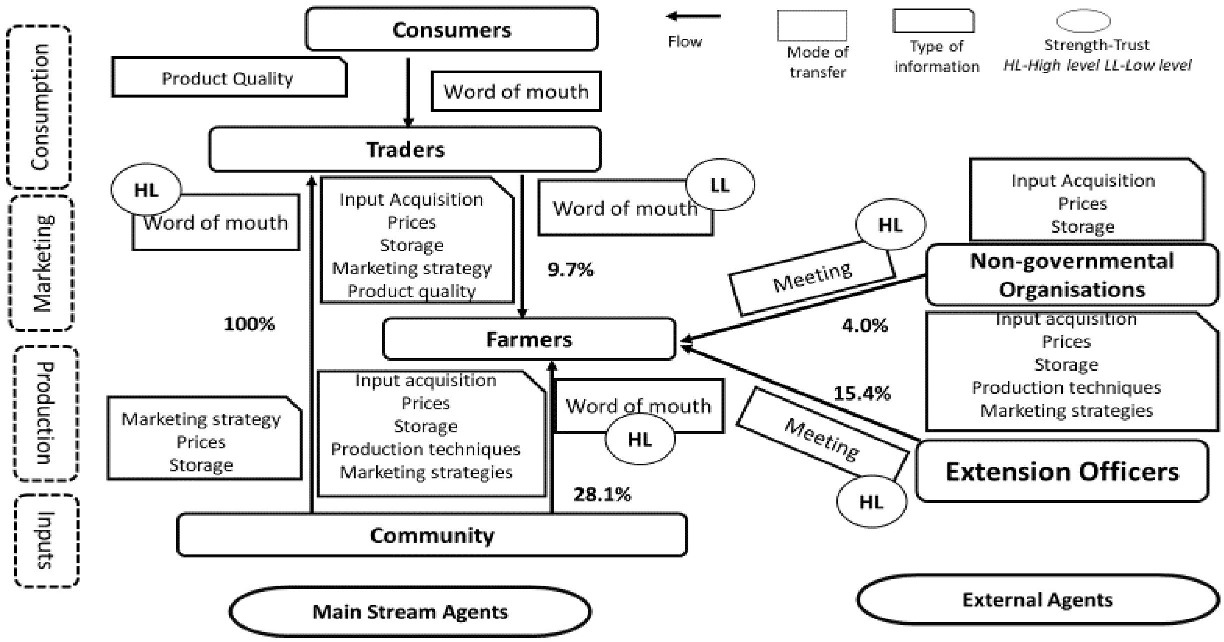


Figure 5. 10: Flow of knowledge along the common bean value chain

Knowledge process

Knowledge acquisition: About 60% of traders obtained information through observation, an intentional acquisition of knowledge. This is usually obtained through an inactive form of searching. Knowledge acquisition by producers varied based on the kind of information being acquired. The main mode of information transfer is by word of mouth, however, when the information is acquired from extension officers or NGOs, it is done through formalised meetings.

Knowledge innovation: Information received is mainly combined with already available knowledge. It was found that 83.5% of the farmers combined old and new information to suit their needs, 8.2% used the information as presented to them while 8.3% transformed new information. Both practices led to the creation of new knowledge which was integrated into the flow of information along the chain.

Knowledge protection: Approximately, 96.2% did not protect information when they received it which implied that producers trusted the source of information and were willing to share with others.

Knowledge integration: Common bean producers and traders indicated that it was easy to translate the knowledge obtained into practice whether it was received from friends, extension agents or NGOs. The timing within which the information is received is likely to impede its integration in activities when needed. Farmers indicated a change in practices to improve yield and quality of produce as a result of information received. Previous practice for planting was to plant directly in the soil, however, currently, ridges are made for planting. Beans were solely produced for consumption but presently being commercialised. Threshing of beans was performed directly on the bare soil but is presently being done by placing beans on sacs.

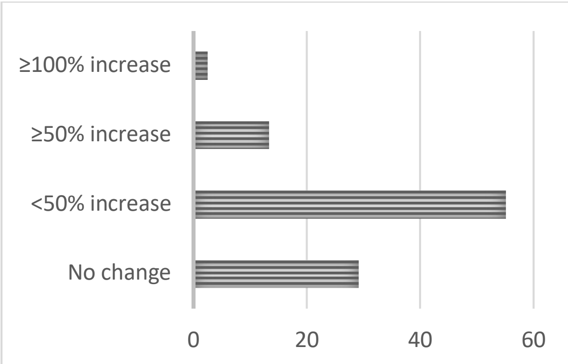
Knowledge dissemination: About 88% of the producers were willing to share knowledge acquired with others and 5.7% were not willing. Among traders, 90% were willing to share information while 10% were not willing. About 63.9% of the producers actively searched for information. The majority (80%) of the traders also search for information. The high percentage of producers and traders who are willing to share and search for information build the knowledge network and contribute to the knowledge base.

Knowledge performance: Based on the results, it can be concluded that the flow of adequate, timely, modern and innovative knowledge from trained personnel to producers is very limited. The overall performance is poor due to the low percentage of producers who acquire new knowledge and the frequency at which it takes place. Common bean traders did not receive any information from trained personnel on the storage and marketing of common beans.

Majority of the farmers indicated that information on prices of common beans are hardly communicated to them beforehand and thus they only attain this information during the sale of their produce. Based on these scenarios' producers were asked to indicate the price they would have sold their produce if they had obtained knowledge on the best price before sale. The results showed that 29.1% of the producers were satisfied with the price at which their produce was sold irrespective of when price information was received (Figure 5.11).

About 55.1% of the producers would have however sold their beans at a price 50% higher than the price at which it was sold. Also, 13.3% would have sold it at a price which was >50% higher than the sale price. The lack of timely knowledge on the best and profitable price to sell farm produce can result in a financial loss to producers. Bean traders sold beans at prices which were lower than the desired prices due to the lack of timely knowledge on the price to sell produce.

Thus, 50% of the traders indicated that they would have sold the beans at a price which was >50% higher than the actual sale price (Figure 5.12).



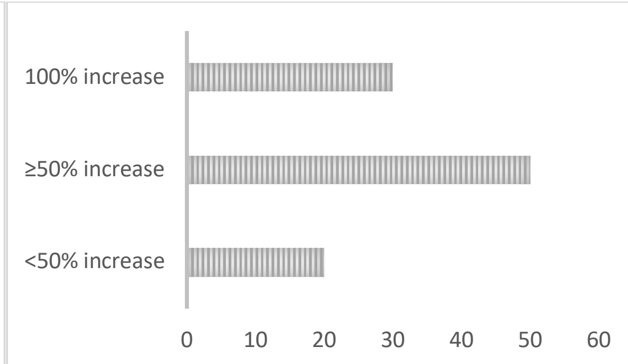


Figure 5. 11: Impact of knowledge on price (producers)

Figure 5. 12: Impact of knowledge on price (traders)

The study presents information on how the kinds of knowledge acquired complement or substitute each other. The logit model results are presented in Table 5.8. The effect of producer characteristics and knowledge activities on knowledge acquisition are also presented. Significant and positive associations were found between the acquisition of information on bean prices and input acquisition. Acquiring information on bean prices had a positive relationship and an increased probability to obtaining information on input acquisition and production technology. For every information received on bean prices, the probability of obtaining information on input acquisition and production techniques increased on average by 36.3% and 23% respectively. Also, for every information on input acquisition acquired, the probability of obtaining information on bean price and marketing techniques increases on average by 24.1% and 16.4% respectively. This relationship was found to be a two-way linkage. It implies that obtaining information on at least one of the three kinds of information resulted in an increased probability of obtaining information on the other two kinds of information.

Associations also existed between the acquisition of information on marketing techniques and production techniques. The arrows in Figure 5.13 and Figure 5.14 for farmers and traders respectively depicts the link between knowledge acquisition activities. Acquisition of information on storage techniques, however, did not have a strong association with any of the four kinds of information. A weak association between acquisition of information on bean prices and marketing techniques was also observed.

Table 5. 8: Factors influencing the types of knowledge obtained by producers

Variables	Input acquisition	Bean prices	Storage techniques	Production techniques	Marketing techniques
Knowledge sourcing					
Input acquisition	-	0.3629***(0.1141)	-0.0662 (0.1352)	0.4639**(0.2057)	0.0383 (0.0376)
Bean prices	0.2410***(0.0847)	-	-0.1176(0.1305)	0.3664**(0.1670)	0.0114 (0.0296)
Storage	--0.0742 (0.0540)	-0.0390 (0.0725)	-	0.0036 (0.1093)	-
Production techniques	0.1643**(0.0733)	0.2299**(0.0884)	0.1262(0.1065)	-	0.0578*(0.0370)
Marketing strategies	0.1403(0.1392)	0.0555 (0.1794)	-	0.6871**(0.2757)	-
KM process					
Knowledge acquisition	-0.0440 (0.0591)	-0.0161 (0.0832)	0.2032* (0.1097)	0.1462 (0.1348)	0.0057(0 .0195)
Knowledge innovation	0.0497 (0.0765)	0.1640 (0.1318)	-0.2293(0.1466)	-0.0041(0.2276)	-0.0827***(0.0512)
Knowledge integration	0.2158** (0.0955)	-0.1760 (0.1247)	-0.0025(0.1636)	0.4356 (0.2839)	-0.0710** (0.0466)
Knowledge dissemination	-0.0934 (0.0791)	0.2390**(0.1114)	-0.1599 (0.1668)	0.0861 (0.2055)	0.0160 (0 .0440)
Producer characteristics					
Sex	0.0019 (0.0489)	0.0136 (0.0705)	0.0264 (0.0914)	-0.1644 (0.1121)	0.0165 (0 .0172)
Age	0.0004 (0.0025)	0.0081* (0.0036)	0.0037(0.0043)	0.0099**(0.0049)	-0.0005 (0.0008)
Literacy	0.0251(0.0557)	0.1478** (0.0772)	0.1235 (0.0945)	0.1445 (0.1053)	0.0139 (0.0185)
KM infrastructure					
Knowledge holder	-0.0013 (0.0110)	0.0176 (0.0144)	-0.0224(0.0180)	0.0595**(0.0212)	-0.0004 (0.0032)
Agent-Agent relationship	0.0857 (0.0977)	-0.2423 (0.1715)	0.1319 (0.2119)	-0.5565* (0.3227)	0.0032 (0.0401)
Log likelihood	-44.701348	-47.981117	-95.096074	-64.395203	-24.407408

Note: Standard errors in parenthesis, ***p < 0.01, **p < 0.05, *p<0.1

However, there is an increased probability to obtain information on marketing techniques when information is received on production techniques. Due to the informal nature of information acquisition, there is the likelihood to obtain different kinds of information during communication among agents. Information on storage techniques was obtained mainly from external agents, non-governmental agencies through formal communication methods. Such agencies are likely to provide specific forms of information tailored to the present needs of the farmers and thus producers are less likely to receive other kinds of information when receiving information on storage techniques.

Producers who acquired information had a higher probability of obtaining information on storage techniques. For every information acquired, the probability of obtaining information on storage techniques increases significantly by 20.3%. A significant and positive relationship was also observed between the dissemination of knowledge and information on bean prices. Information on bean prices was more likely to be disseminated compared to other kinds of information.

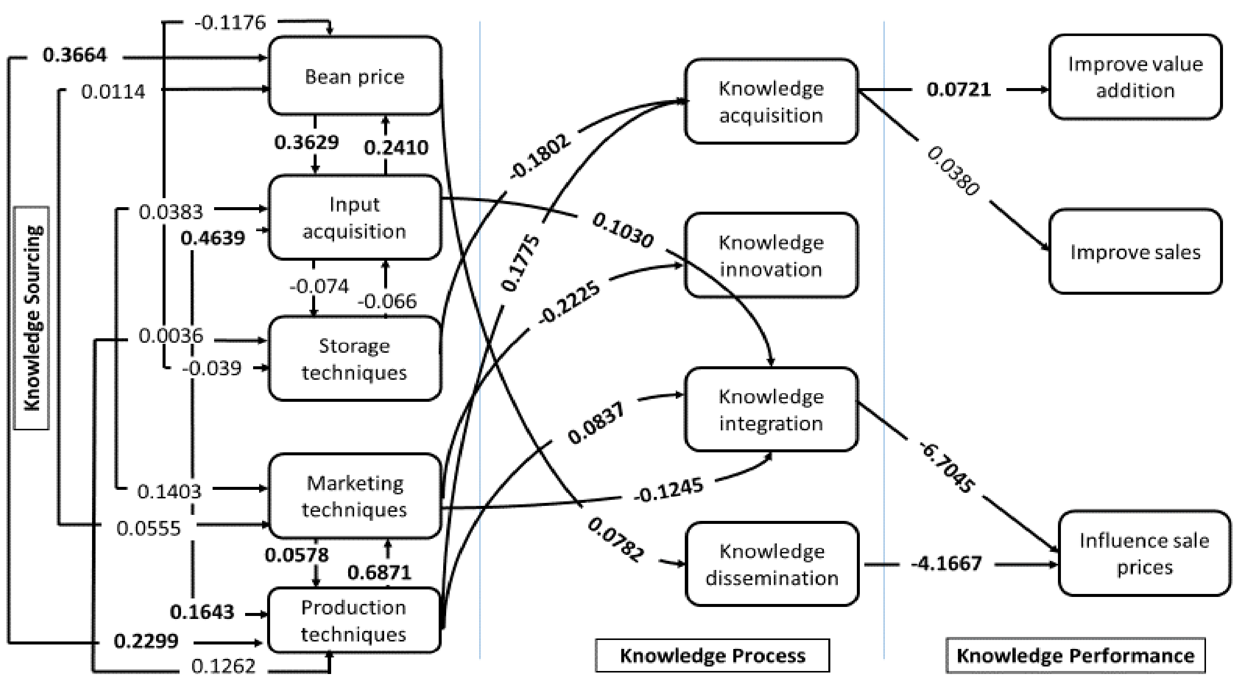


Figure 5. 13: Producer knowledge value chain (bold marginal effects represent significant relationships)

Producers were more likely to act on information obtained about input acquisition by 21.5% and less likely to act on information about marketing strategies by 7.1% (Table 8). This could be largely due to the group of people providing the information and the level of trust between traders and producers. Statistically significant correlations were not observed for traders.

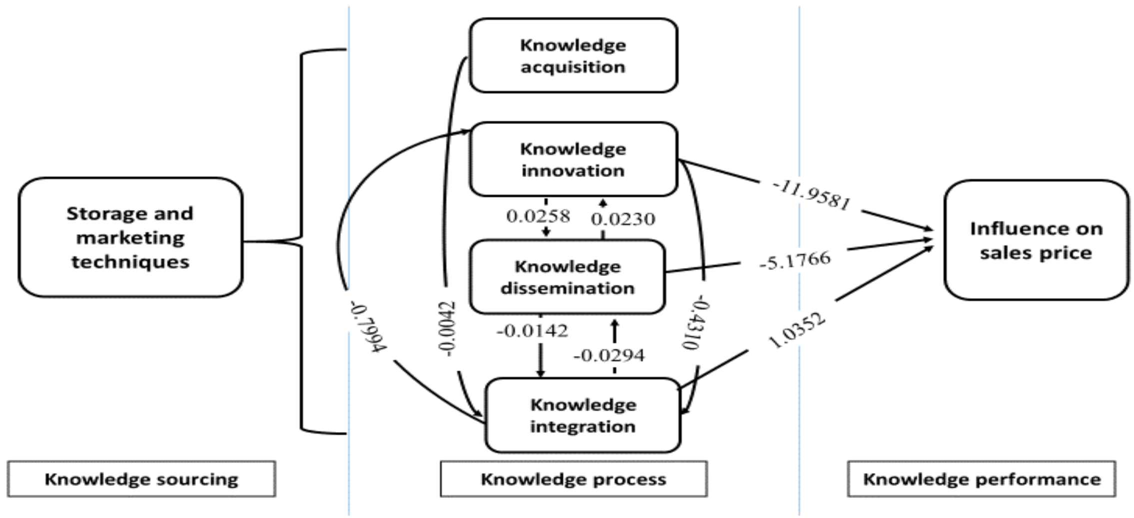


Figure 5. 14: Trader knowledge chain

5.4.2.4.2 Postharvest loss Assessment

Material flow analysis

Percentage loss after harvest was estimated based on the number of gallons (5kg/gallon) lost out of the total harvest after the quantity for seed and consumption were removed. Percentage of beans lost after storage was estimated based on the number of gallons lost during storage out of the total number of gallons stored. The distribution of beans along the chain is presented in Figure 5.15.

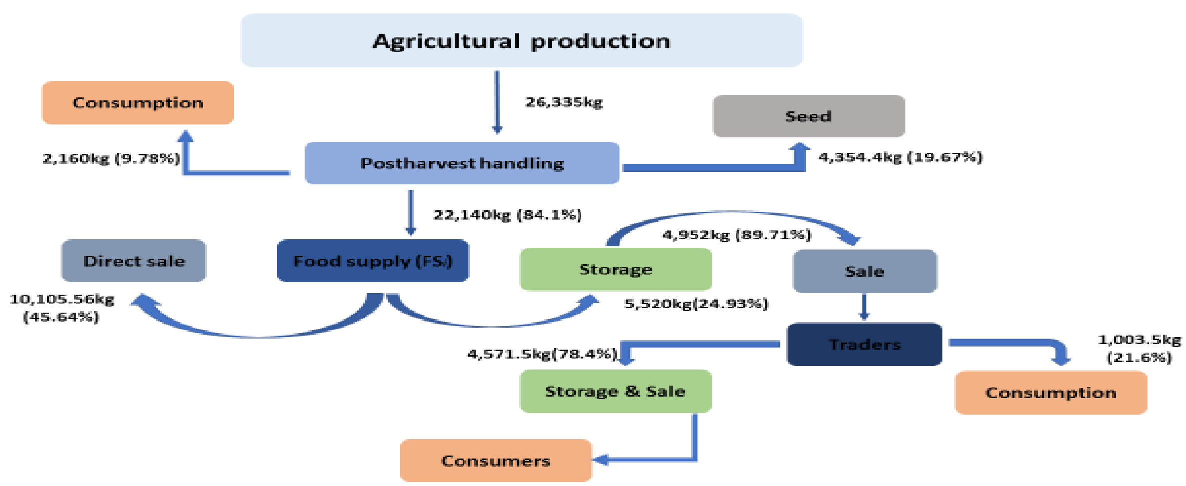


Figure 5. 15*:* Material flow of common beans along the chain

About 81.6% of farmers sold a portion of their beans immediately after harvest before storing the desired quantity to be sold at a higher price in the future. Thus, out of 88.6% who stored their beans 25.9% had losses between 11 to 30% of the overall beans stored. The majority (36.2%) of the farmers had losses between 1 -10% of the total produce harvested. The percentage lost by traders was minimal, with 56.7% of the traders having no losses and 36.4% having losses of 1 – 10% after storage. The results show that the percentage average loss after harvest was higher than during storage.

Economic estimation of losses

The price of beans immediately after harvesting, storage and at the market was different for a specified quantity. This was accounted for in the estimation. The description of the quantities lost at each stage of the chain and the economic losses are shown below in Table 5.9. Average losses at the production stage (post-harvest handling and storage) were estimated to be 4,763kg out of 26,335kg while at the marketing stage, losses were estimated to be 135kg out of 5,710kg. Table 5.9 shows the relative contribution of the two major stages to total food loss. Including market prices provides an in-depth understanding to the cost of food loss. The postharvest handling level at the production stage contributes 88.07% of the total weight loss while the storage level contributes to 11.93%. Post-harvest losses of legumes have been estimated to range from 1.3% to 7.3% at the storage stage (Abdoulaye et al. 2016) which is lower than observed in this study but higher than estimated by Tibagonzeka et al. (2018) in Uganda.

The marketing stage (2.8%) contributed less to the total weight loss along the common bean value chain. The postharvest handling level and the storage level at the production stage, however, contributed 85.65% and 11.60% to the total weight loss along the common bean chain. At the storage level where the market price was higher the associated cost of food loss was observed to be higher thus increasing the total cost of food loss. The average percentage of the beans stored after harvest was found to be 79% but contributed less to total food loss. However, due to the higher price at which it is sold, the cost of loss is significant though not comparable to the cost of loss at the post-harvest handling stage. The lower level of losses at the storage stage irrespective of the poor storage technology could be as a result of close monitoring since beans were stored at home. Thus, while early sale has the advantage of reducing the risk of loss due to poor storage facility, low levels of losses at the storage stage indicate that it is worth taking the risk.

Table 5. 9: Postharvest economic loss estimations (2017 season)

Production stage			
Total production(kg)	26,335kg		
Quantity harvested (kg)	26,335kg	Quantity stored (kg)	5,520kg

Total average weight loss during post harvest handling (kg)	4,195kg	Total average weight loss (kg)	568kg
Total loss after harvest (%)	15.9%	Total loss after storage (%)	10.3%
Market price after harvest	K25 per gallon (5kg)	Market price after storage	K50 per gallon
Economic loss (kwacha)	K20,975	Economic loss (kwacha)	K5,680
Economic loss (USD)	$2,114.4	Economic loss (USD)	$572.6
Total average weight loss at the production stage (kg)	4,763kg	% contribution of post harvest handling loss to total cost	88.07%
Total loss (%)	18.1%	% contribution of storage loss to total cost	11.93%
Economic loss (Kwacha)	K26,655		
Economic loss (USD)	$2,687		
Marketing stage			
Total purchase (kg)		5,710kg	
Total average weight loss (kg)		135kg	
Total loss (%)		2.4%	
Market price		K30 per gallon	
Economic loss (Kwacha)		K810	
Economic loss (USD)		$81.7	
Common bean chain			
Total weight loss along the chain		4898kg	
% contribution of post harvest loss to total cost		85.6%	
% contribution of storage loss to total cost		11.6%	
% contribution of marketing loss to total cost		2.8%	
Total economic loss along the chain (Kwacha)		K27,465	
Total economic loss along the chain (USD)		$2,768.6	
% contribution of post harvest loss to total cost		76.4%	
% contribution of storage loss to total cost		20.6%	
% contribution of marketing loss to total cost		2.9%	

Note 1USD = 9.92ZK

In terms of cost, the storage stage contributes 20.6% to the total cost of food loss while the post-harvest stage handling stage contributes 76.4%. The marketing stage contributes only 2.9% of the total economic costs (Table 5.9). The production stage, therefore, contributes more than 90% of the total loss in economic terms. Although the price of a gallon of beans at the post-harvest stage is lower, the quantity lost indicates that this stage of the value chain contributes significantly to losses as well and its relative cost especially from an economic perspective. This indicates that significant quantities of the food are lost before storage which could be due to limited processing capacity. The beans that are lost also constitute beans with defects developed largely on the farm and also during handling. This means that though inefficient handling and storage methods cause losses, farming techniques which produce quality seeds with a low defect should not be ignored.

Quality loss estimation

Good quality beans were expected to have a good size, right colour, gloss and whole. Bean seeds which did not have such characteristics were characterised as low quality. Food quality loss, therefore, occurred due to shrinkage, mould, pests and broken grains. These were therefore second graded contributing to economic loss. About 55.7% of the producers did not grade beans, however, for the 44.4% that did, 4.5% sold low-quality beans at a price 60% lower than the average price. About 60.8% sold it at a price 40% less than the average price. Such reduction in prices will result in significant economic losses. The impact could be quite significant since 44.4% of the producers sold low-grade beans at lower prices.

Nutritional loss estimations

Common beans are very nutritious containing proteins and minerals. The amount of each nutrient varies based on the variety of beans. The nutrient profile of beans based on the average of the popular varieties (*kabulangeti, Lusaka and mixed* beans) is presented in Table 5.10. Bean varieties in Zambia contains high amount of protein (26.9g), carbohydrates (59.13g), calcium (154.33mg), phosphorus (349.06mg), potassium (1744.77mg) and iron (8.22mg).

Table 5. 10: Nutrient profile of beans

Nutrient	*Amt in 100g*	*Nutrient*	*Amt in 100g*
Protein	26.90g	Phosphorus	349.06mg
Fat	1.26g	Potassium	1744.77mg
Carbohydrate	59.13g	Sodium	2.01mg
Energy	1484.20KJ	Iron	8.22mg
Calcium	154.33mg	Zinc	3.84mg
Magnesium	188.09mg		

Source: Author's own computation

Bean lost along the chain are not only in quantity, quality or economic terms but nutrient losses as well. For each bean lost, the nutrients in the grain are lost when they could have been consumed to provide the needed nutritional requirements for different groups of individuals. The study estimated the total amount of each nutrient lost at every stage of the common bean value chain based on the total weight lost. The estimated values are presented in Table 5.11. Findings revealed that 1128.46g of protein, 2468.50g of carbohydrate and 344.83mg of iron is lost at the post-harvest handling stage. This is based on the quantity of beans lost at that stage. At the storage stage, 152.79g of protein, 335.86g of carbohydrate and 46.65mg of iron are lost. Out of the total nutrients lost at the production stage, the post-harvest handling stage contributes to the majority of the losses compared to the storage stage. The nutrient losses at the marketing stage were minimal due to the low quantity of beans lost at that stage. The amount of protein, carbohydrate and iron lost at the marketing stage are 36.3kg, 79.83kg and 11.1kg respectively based on the quantity lost at that stage. Different groups of individuals could have had their Recommended Daily Allowance (RDA) met either fully or partially by consuming the beans lost along the chain.

Factors influencing losses

Losses at the production level were found to be caused by unfavourable weather, seed quality, weeds, late harvesting and insects, birds and rodents on the field and during storage. These factors have also been found by Abdoulaye et al. (2016), Tibagonzeka et al. (2018) and Alavi et al. (2012) to cause postharvest losses in Nigeria, Benin, Ethiopia and Uganda. Losses also occur due to the inefficient marketing system (lack of coordination) where producers find it difficult to sell their produce and thus a significant quantity is loss due to prolonged and inadequate storage. Producers unawareness of the best loss management practices and the absence of facilities to manage temperature and reduce pests' infestation also poses a significant challenge. The manual nature of the activities such as threshing and sorting performed by the producers increases losses. This has also been found by Sakaar et al. (2013). At the marketing stage, inadequate storage practices and spillage were found to lead to losses.

Measurement and awareness of factors affecting losses

Investment in postharvest loss reduction strategies will only be undertaken by actors if they are aware of the magnitude of losses and the causes. The percentage of producers and traders who measured losses were 65.8% and 70% respectively. Ideally, farmers and traders should be able to measure losses at different stages of the chain to determine points where there are a majority of losses. It was however observed that farmers mainly measured at the storage stage.

Studying behaviours of actors in relation to food loss is a necessary step to dealing with losses. Hence, the awareness of value chain actors on the types of losses and loss factors were solicited (Table 5.12). The awareness of losses being in terms of quantity, quality and monetary loss was rated highly by both producers (>71%) and traders (>75%). A strong level of agreement was not observed for the awareness of nutrient losses due to the lack of knowledge in that regard. Producers (65.2%) reported that there were higher losses at harvest than during postharvest handling activities.

Table 5. 11: Nutrient losses along the chain

V C stages	***Qty***	***Total amount of each nutrient per quantity lost***										
Postharvest handling		*Protein(g)*	*Fat(g)*	*Carbo(g)*	*Energy(KJ)*	*Ca.(mg)*	*Mg.(mg)*	*P(mg)*	*K(mg)*	*Na(mg)*	*Fe(mg)*	*Zn(mg)*
Qty harvested (kg)	*26,335kg*	*7,084.12*	*331.82*	*15,571.89*	*390,811.4*	*40,642.81*	*49,533.5*	*91,924.95*	*459,485.2*	*529.33*	*2,164.74*	*1,011.26*
Av. harvested weight loss (kg)	*4,195kg*	*1,128.46*	*52.86*	*2,480.50*	*62253.8*	*6,474.14*	*7,890.38*	*14,643.07*	*73,193.10*	*84.32*	*344.83*	*161.09*
Storage												
Qty stored (kg)	*5,520kg*	*1,484.88*	*69.55*	*3,263.98*	*81,927.84*	*8,519.02*	*1,0382.6*	*19,268.11*	*96,311.30*	*110.95*	*453.74*	*211.97*
Av. stored weight loss (kg)	*568kg*	*152.79*	*7.16*	*335.86*	*8,430.26*	*876.59*	*1,068.35*	*1,982.66*	*9,910.29*	*11.42*	*46.69*	*21.81*
Production												
Total av. weight loss (kg)	*4,763kg*	*1,281.25*	*60.01*	*2,816.36*	*70,692.45*	*7,350.74*	*8,958.73*	*1,6625.73*	*83,103.40*	*95.74*	*391.52*	*182.90*
Marketing												
Total purchase (kg)	*5,710kg*	*1,535.99*	*71.95*	*3,376.32*	*84,747.82*	*8,812.24*	*1,0739.9*	*1,9931.33*	*99,626.37*	*114.77*	*469.36*	*219.26*
Total average weight loss (kg)	*135kg*	*36.32*	*1.70*	*79.83*	*2,003.43*	*208.35*	*253.922*	*471.231*	*2,355.44*	*2.71*	*11.10*	*5.18*
Total loss along the chain												
Total loss	*4,898*	*1,317.57*	*61.72*	*2,896.19*	*72,687.43*	*7,559.08*	*9,212.65*	*17,096.96*	*85,458.83*	*98.45*	*402.62*	*188.08*

Losses on the farm were also reported to be higher than during storage (56.9%). Traders indicated that losses were higher during handling than on the farm but lower at the market than on the farm. The views of the actors corroborate with the findings obtained from the loss assessment since losses at the postharvest handling stage was higher compared to other stages. Producers strongly agreed that factors such as pests and diseases, bad climate and improper handling influenced losses. More than 50% of the actors mildly agreed that losses were impacted by harvesting time, packaging and transportation. This is problematic since harvesting time and packaging could cause significant losses. Mould formation (due to high moisture content) and physiological maturity (due to late harvesting) lead to losses. Inadequate packaging materials for storage also creates a conducive environment for insects to thrive.

Table 5. 12: Farmers awareness of factors affecting losses

Factors	Producers			Traders		
	1-4	5-7	Importance	1-4	5-8	Importance
Awareness						
Losses can be in quantity	22.9	77.2	Strongly agree	0	100	Strongly agree
Losses can be in quality	27.3	72.7	Strongly agree	41.7	58.3	Agree
Losses can be result in economic loss	28.5	71.5	Strongly agree	25	75	Strongly agree
Losses can be nutritional losses	43.7	56.3	Agree	50	50	Neutral
Higher losses during harvest than postharvest	34.8	65.2	Strongly agree	-	-	-
Higher losses during handling than on the farm	56.9	43.2	Disagree	58.3	41.7	Disagree
Higher losses during storage than on the farm	56.3	43.7	Disagree	33.3	66.7	Strongly agree
Higher losses on the market than on the farm	-	-	-	91.7	8.3	Strongly disagree
Factors						
Harvesting time	51.9	48.1	Moderately unimportant	50	50	Neutral
Skill of people handling beans	41.5	58.5	Moderately important	70	30	Unimportant
Pests and diseases	23.5	76.5	Important	0	100	Important
Bad climate	8.2	91.8	Important	83.3	16.7	Unimportant
Improper handling	47.4	52.6	Moderately important	25	75	Important
Packaging	57.6	42.4	Moderately unimportant	41.7	31.7	Moderately unimportant
Transportation	63.9	36.1	Unimportant	90	10	Unimportant
Poor management technique and communication	-	-	-	66.7	33.3	Unimportant
Storage vehicle	53.8	46.2	Moderately unimportant	50	50	Neutral

Results are based on the Likert scale where 1 is not important and 8 is very important

5.4.2.5 Agility Evaluation

The food and agriculture industry face numerous uncertainties. To be productive and profitable, value chain actors should be able to respond to changes adequately and quickly. Thus, a uniform understanding of the dynamic environment within which they operate is necessary to ensure that the changes are quickly addressed. Agility is the ability of the agents to respond to changes within the environment, consumer preferences and competitive forces quickly and at a reduced cost. An agile chain is one where the actors are able to obtain information about the changes within their environment, have the range of options to address the issues and posses the ability to adjust to the changes within a reasonable time.

Findings showed that there were differences with respect to the changes observed by producers and traders along the chain. A greater percentage of the producers had observed changes in the weather (83.6%), increase in the scarcity of materials for production (67%), increasing concern for nutritious foods (50%) and increase in the consumption of beans (64.7%) (Table 5.13). Only a few farmers agreed to change towards processed foods. The changes were however reported to be slow for each of the factors. The changes in the weather and the scarcity of materials which were in the negative directions were reported to be threats to the activities of farmers. Producers, however, viewed the increase in the consumption of nutritious food as an opportunity since they produce a crop that was labelled as a nutrient-dense products (Table 5.13). Producers felt threatened by the increase in the consumption of processed foods since the demand for their produce would decrease.

Table 5. 13: Changing factors along the common bean value chain

Factors	Change (%producers)		Rate of change (% producers)		Perception (% producers)	
	Agree	Disagree	Slow	Fast	Threat	Opportunity
Weather	83.6	9.5	50	32.9	90.5	9.5
Scarcity of materials	67	20.3	46.3	33.5	79.7	20.3
Concern for nutritious food	50	38.6	66.4	22.1	34.8	65.2
Consumption of beans	64.7	20.3	32.9	53.8	24.1	75.9
Consumption of processed foods	13.9	68.4	81.7	11.4	6.1	63.9
Competition	31.6	60.1	70.9	24.7	22.8	77.2

A high percentage of the traders agreed that there were changes in the weather and increasing scarcity of materials (Table 5.14). The change in the consumption of beans, demand for processed foods and competition were also indicated by the majority of the traders. These factors were all observed to be increasing over the years. The concern for nutritious foods was however observed not to have changed by 75% of traders. They indicated that people are still less concerned about nutritious foods. The changes were generally observed to be slow. The changes in weather and scarcity of materials were perceived as threats by 95% and 90% of the traders respectively. The concern for nutritious foods, demand for beans and processed foods were perceived to be an opportunity since traders implied that it would rub off positively on their business.

Table 5. 14: Changing factors along the common bean value chain

Factors	Change (%traders)		Rate of change (% traders)		Perception (% traders)	
	Agree	Disagree	Slow	Fast	Threat	Opportunity
Weather	60	25	55	45	95	5
Scarcity of materials	45	25	45	45	90	10
Concern for nutritious food	25	30	65	15	20	50
Consumption of beans	45	35	40	40	40	60
Consumption of processed foods	45	40	35	30	35	75
Competition	60	25	45	40	60	40

Although there were corroborating views between actors (Figure 5.16), there were also conflicting views with respect to the concern for nutritious foods, competition and consumption of processed foods. Producers observed an increase in the concern for nutritious foods while traders observed otherwise. Traders observed an increase in competition and consumption of processed products while producers observed otherwise. These conflicting views could be as a result of the fact that each group is observing competition internally. Producers have very little contact with consumers and thus observe the changes from their neighbourhood. Traders are often in contact with the consumers and thus their observation about the concern for nutritious foods and consumption of processed foods carries more weight. It will be necessary for traders to relay such observations to farmers to ensure that they perform activities to minimise the risk of these changes on their performance and sustainability.

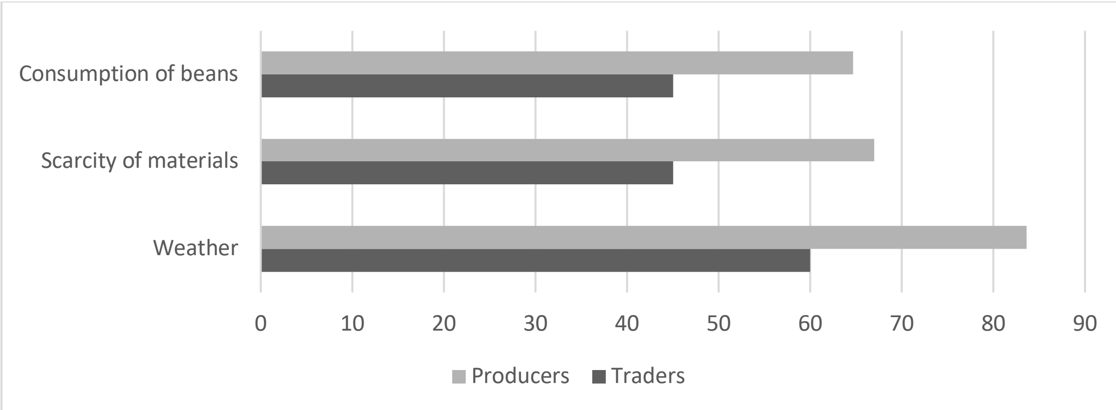


Figure 5. 16: Corroborating views about changing factors along the value chain

Generally, producers indicated that they were not able to respond to the changes which were occurring especially with respect to weather, increasing competition and scarcity of materials. Some farmers indicated that farming practices were adjusted when the weather condition prevented sprouting of the seeds by replanting. Only, 6.9% of the producers were able to mildly respond to changes by investing more funds into bean production to meet up with the competition. The majority (93%) were not able to respond to changes and indicated that the changes in weather was an act of God, and there was nothing they could do about it.

Producers had no contact with input suppliers, and thus they had no means of accessing the inputs needed for their farming activities. For producers who were able to make adjustments, there was a trade-off between using the funds available to cater for other households' expenses or invest in production. Due to this the decision process on whether to respond to changes and how to do so took a significant amount of time. With respect to the increasing concern for nutritious foods and consumption of beans, producers did nothing to take advantage of that market opportunity because they didn't have the technical capability to obtain higher yields and access markets. Since beans were not processed into other products, producers did not concern themselves with the demand for processed goods. Results revealed that agility along the chain is very low, value chain actors are not agile because they are not able to respond to changes adequately and quickly. A few, though an almost negligible percentage of the producers are responding to change compared to traders. The marketing stage of the common bean value can be classified as having higher agility compared to producers.

To better cope with challenges and make use of opportunities, value chain actors need to have access to different types of assets. Producers and traders had inadequate social, environmental, financial, physical and institutional assets to be able to respond to the dynamic environment within which they operate (Table 5.15). The lack of information and assets were the major contributions to the inability of the actors to adapt to changes and scale-up activities to meet consumer requirements and deal with uncontrollable natural occurrences.

Table 5. 15: Summary of assets

		Producers		Traders	
Assets	*Categories*	*Availability*	*Quality/Impact*	*Availability*	*Quality/Impact*
Environment	Climate	-	Negative	-	
Institutional	Extension services	Not Available	Negative	Not available	-
	Mobile network	Available	Low quality	Available	Low quality
	Roads	Available	Low quality	Available	Low quality
Physical	Land	Available	High quality	-	
	Building	-		Available	Moderate quality, Easy access thus Positive impact
	Equipment/inputs	Not available (72.8%)	-	-	-
	Transport vehicle	Not available	-	Available	Low quality and availability thus negative impact
	Sales outlet	Not available (67.1%)	-	Available	Easy access thus Positive impact
Financial	Credit	Not available (90%)	Low (10.8% had credit)	Not available	Low (20% had credit)
	Savings	Obtainable	Low (40% had savings)	Obtainable	Low (3.3% had savings)
	Profits	Obtainable	Moderate (96.8% had profits)	Obtainable	Moderate (70% had profits)
	Non-farm employment	Available	Moderate impact	Available	Moderate impact
Social	Education/knowledge	Available	Low impact	Not available	-
	Cooperatives	Not available	-	Not available	-
	Production/marketing skills	Obtainable	Indicated as low by 67.6%	Obtainable	Indicated as low by 75%
	Experience	Available	High (74.7% have more than 5 years of experience)	Available	High (73.3% have more than 5 years of experience)

5.4.2.6 Perception and Attitude Assessment

Knowledge, attitude and perception regarding the performance of activities to meet consumer preferences and to perform activities efficiency were assessed. Information was solicited with respect to storage practices, safety and quality. Value chain actors indicated that the best way to store beans to reduce waste was to use pesticides (89.6%) while 6.3% had no idea. About 53.9% indicated that it was more appropriate to store without chemicals with 66.7% strongly agreeing that beans stored with chemicals are safer to consume after three months. More than 90% of the actors agreed that storage facilities needed to be free from insects and rodents with controlled temperature. This was however not the practice. The majority (44.1%) indicated that beans were to be stored in warm temperatures while 26.2% indicated that cold temperatures were best. To reduce the production of low-quality beans, actors indicated that the most efficient method was to be careful (68.8%).

About 89.6% indicated that performing activities efficiently was necessary while 8.3% indicated otherwise. About 20.8% agreed to the fact that consumers will purchase any quality of product. Performing activities efficiently was perceived to be time-consuming by 56.3% of the actors, costly for 62.5% and not profitable for 60.4%. About 87.5% of the actors indicated that performing activities to reduce food loss and improving product quality was out of their control. More than 70% of the actors agreed that transport hygiene and appropriate packaging to ensure safety and preserve quality was important. However, 30% of the actors indicated that doing so increased their cost and job burden.

Value chain actors ensured that safety of products were provided for various reasons. About 20.4% strongly agreed that safety was ensured because of consumers, because it was the right thing (44.4%) and because it could lead to serious consequences (55.6%). About 57.4% indicated that it was generally difficult to ensure safety and also it was not a local concept in the community (79.6%). Overall actors had a positive attitude towards performing activities to improve quality and safety, however with the greater percentage of them indicating an increased job burden and cost implied that they were less likely to put into practice those positive attitudes. More than 50% indicated that the government had a role to play in ensuring that the activities are efficiently performed. This means they were relying on another entity as opposed to taking full responsibility for the performance of their activities.

5.4.2.7 Social Assessment

Employees working along the chain were either temporary or permanent workers who perform various activities on the farm. The workers varied based on age and sex; however the majority of the workers were not paid employees. Due to the nature of the activities on the farm, the paid workers were mainly males. Producers particularly hired more labour compared to traders. The average percentage of hired workers was 11% and family members made up 89% of the total labour. Out of this, seasonal workers constituted about 14% while permanent workers made up 86% of the total labour. Among traders, 55% employed labour between 2 to 6 persons, with 30% employing no labour.

Majority of the agents had a low level of education and training on how best to perform activities. As a result, these functions were not well performed as expected which has implications for consumer value, profits, income and sustainability of the chain. Producers did not have a lot of information available to them, they often obtain information from other farmers or community members (Figure 5.17). Thus, the information shared was mainly based on experience, perception and hearsay. All the traders indicated that information was received only from other traders or community members. Majority of farmers (60%) and traders (100%) indicated not having cooperatives to defend their interest.

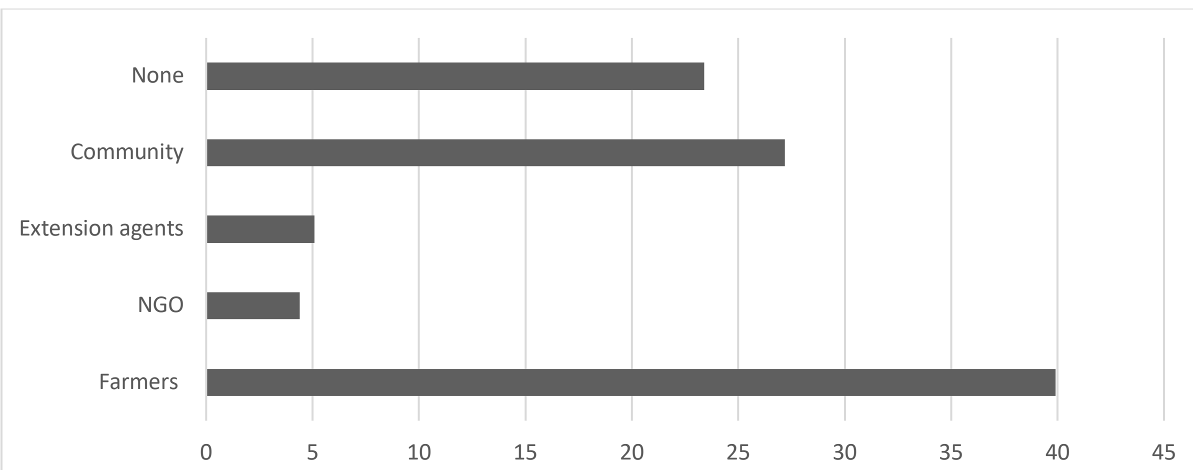


Figure 5. 17: Source of information for farmers

While farmers indicated that the activities along the chain have a negative influence on their health, traders indicated otherwise. Producers mentioned that the major injuries suffered were cuts and lacerations during land preparation and harvesting when the hoe and cutlass were being used. Some reported incidents of snake bites and insect bites. There were also cases of stepping on or handling dangerous substances on the farm during land preparation. Generally, the majority of the producers did not face severe injuries although, snake bites could be life-threatening. Farmers work in the same posture for many hours with repetitive movements which leads to musculoskeletal disorders. This combined with stress, fatigue and time pressure, altogether increases injuries and ill health. This is faced by many farmers worldwide and corroborates with studies that have found musculoskeletal injuries, fractures and bruises as the most predominant form of injuries (Levy et al. 2011; Fingerhut e al. 2005; Sprince et al. 2003; Kolstrup et al. 2013). Generally, hazards were at low risk. There was a high likelihood of injury on the farm however, the severity and frequency were averagely low. Farmers did not report cases where there had been injuries that led to permanent disabilities.

The majority (89.6%) of the producers did not receive information on farm safety and rarely from family and friends. Generally, less than 50% of the producers indicated having good knowledge on farm safety. A greater percentage (88.4%) of the producers did not apply any safety measures while performing their activities, 18.8% wore just boots and 2.1% had overall and boots. This is particularly troubling; however, it could be due to the fact that they do not have knowledge on which safety measures they could apply or the capacity to obtain them when they did. All the producers understood that injury could be prevented. About 64.6% indicated that it could be prevented by being extremely careful while 35.4% indicated that wearing protecting clothing was a way to prevent injury. Farmers mentioned boots, overalls, hats and gloves as the protective clothing that producers needed to have when working. The responses provided by producers indicated that they did not have adequate knowledge about hazards and how they can be adequately prevented.

Generally, there was limited opportunities for employment along the chain. Value chain actors had limited access to information and training and may often resort to outdated information. Worker safety could also be greatly improved through education and access to protective clothing.

5.4.2.8 Environmental Assessment

The study did not find excessive use of chemicals since producers did not apply any to their fields. Fertilizers were not also used by farmers since they could not afford them. Thus, the environment was not impacted negatively in this regard. Waste generated from activities included bean husk and damaged seeds which were applied as mulch on the farm or discarded. Deforestation and the burning of trees or plants after land clearing was the major activities having a negative influence on the environment. Environmental performance is not poor but below optimum. However, only

32.9% of the farmers indicated that the activity had a negative influence on the environment. None of the traders agreed to their activities having a negative impact on the environment because they did not understand the link between their activities and their environment.

5.4.2.9 Quality Assessment

Common beans should give value for the money paid by the consumer and possess all the attributes desirable to them. The consumers are particular about intrinsic (colour, size, shape) and extrinsic (safety, nutritional value and marketing parameters) attributes of the product. Other factors considered are retail point, convenience, availability of multiple varieties, packaging and price. Cleanliness was an important search attribute during the purchasing of beans because it reduced the sorting time which adds on to the long cooking time for beans. Unclean, broken or infested beans made the consumption of beans unpleasant. It also affected storability. Only 36.7% of the farmers and 60% of the traders indicated that they clearly understood the preferences and requirements of consumers. Value chain actors defined beans of high quality as one with a large size, bright colour and with a gloss. About 60% defined quality beans as one with a big size, 3.3% defined it as having a bright colour, 20% as having a big size and gloss. Consumer survey findings revealed that consumers have a preference for taste, packaging and beans with low cooking time. Value chain actors maybe not be fully meeting the preferences of consumers since they focus on only one or a couple of attributes and ignore others.

While the value chain actors can improve most attributes, others such as taste are dependent on the variety of the beans. The activities undertaken by the value chain actors have an indirect influence on quality attributes. Generally, value chain actors try to provide quality beans that meet the preferences of consumers though the manual and time-consuming nature of those activities limit them from efficiently performing those operations. Sorting, for instance, is a strenuous task and thus value chain actors can only spend some minutes performing the task. Consumers indicated the safety of beans as an important attribute, however, they had very little if any information about how beans stored with pesticide might affect their health. The lack of understanding in this regard by value chain actors creates a significant problem. The reduction of foreign and unsafe materials in beans is also key to ensuring that safe produce is available for consumption.

Common beans do not undergo any form of processing along the product value chain until it reaches the consumer. There is however the potential for common beans to be processed into other products to increase its appeal and utilization among different consumer groups. Processing can transform the beans into a form which makes it convenient to use yet maintains its nutritional value such as bean flour. Common bean flour can be a valuable protein supplement for infant foods. It can also be used in bakeries and other food products or as additives to cereal flour. Though the processing of beans is not popular in Zambia and in other developing countries, beans processing is undertaken in different countries. Beans are made into puree cake in Brazil, infant foods in Chile, pre-cooked flour in Guatemala, tempeh, tortilla and tacos in Mexico. In Peru, beans are toasted and cooked similar to popcorn (FAO, 1999). The demand for convenience foods is gradually increasing thereby transforming beans into diversified bean products will be a means of addressing the needs of consumers. This will transform the common bean value chain and expand the market for beans.

The attribute of beans such as the colour and size are influenced by different conditions (Aghkhanji et al. 2012). Other culinary (low cooking time, flavour, soft texture) and nutritional characteristics beyond the physical attributes also determine the quality of beans (Gathu and Njage, 2012). Quality impact of activities undertaken along the common bean value chain range from the means by which the beans are handled through to storage. The time of harvest has an effect on the quality of the beans when infestation and drying are considered. The threshing method reduces the quality of the beans since the beating of the beans with sticks is likely to lead to breakages. The manual nature of sorting does not lead to homogenous beans with similar sizes and free of infested beans and foreign materials.

Value chain actors (72.92%) indicated that they were not always able to adequately sort out beans to deliver good quality beans that meet consumer preferences. Value chain actors rated the percentage of quality beans offered on the market and it was found that 36.96% of the actors indicated providing beans of 60% quality, 26.09% indicated selling beans of 50% quality and36.96% indicated selling beans of <50% quality. About 31.48% of the value chain actors did not have knowledge of the best means of storing beans with respect to the method and temperature. However, beans storage has been found to influence the quality of beans. The study presents results on the effect of storage duration on seed size, grain damage, colour, appearance and cooking time for *kabulangeti* and *sugar* beans.

Seed size

The length and width of *kabulangeti* beans were measured to be 12.47mm and 7.41mm respectively while that of *sugar* beans was 14.67mm and 7.05mm respectively. The results show that *sugar* beans had a larger size compared to *kabulangeti* beans. The storage length and method did not have any effect on the size of the beans. Similar results were observed by Wacu et al. (2015) after storing beans for 6 months. Factors which influence the seed size include genotype, variety, planting period and others (Mkanda et al. 2007). Consumers generally prefer larger size beans and thus would prefer both varieties since they are larger than other varieties. Value chain actors have an influence on size based on the variety selected for production and trade. Threshing also affects size since it can break up seeds and affect wholeness.

Grain damage

There was no grain damage until the third month of storage for both varieties. However, after the third month of storage, 2 *kabulangeti* beans seeds were found to be infested per 100g of beans. Infestation may due to the presence of bruchid eggs or larvae on the surface of the beans before storage. Such beans when present in a lot cause damage to the whole batch and can lead to infestation of 90% of the grains in storage (FAO, 2014). Thus, it is recommended that to reduce losses, beans should be stored in batches as opposed to large lots. Packaging materials which allow for easy storage in batches need to be designed. Grain damage affects quantity, storability at the household level, appearance, safety and preparation time.

Storage insects have been found to thrive in temperatures above 25°C while mould occurs in temperatures between 15°C and 30°C. Therefore, warmer temperatures are not conducive for insect development. Moisture content is also an important factor for storage pests with the ideal situations being drying of grains to have less than 12% moisture content (FAO, 2014). Higher temperatures also have an effect on other attributes of beans which are desirable to consumers.

Color

There was visible discolouration (darkening) of the beans over the 5 months storage (Figure 5.18). Colour values are presented in Table 5.16 for Hunter L (lightness/whiteness), a (redness) and b (yellowness). Generally, consumers prefer lighter coloured beans (Rios et al. 2002). For the control samples which did not go through storage, comparison of lightness values indicates a darkening of beans for both varieties over the storage period. This is also attributed to hardening of beans (Wacu et al. 2015). The values for lightness decreased by the end of the storage period while a and b values increased. The decrease in lightness and overall increase in a and b values have been observed by Hellevang and Henson (2000), Almeida et al. (2017) and Wacu et al. (2015). *Sugar* beans had more redness and yellowness compared to *kabulangeti* beans and will be appealing to consumers who prefer beans with such characteristics.

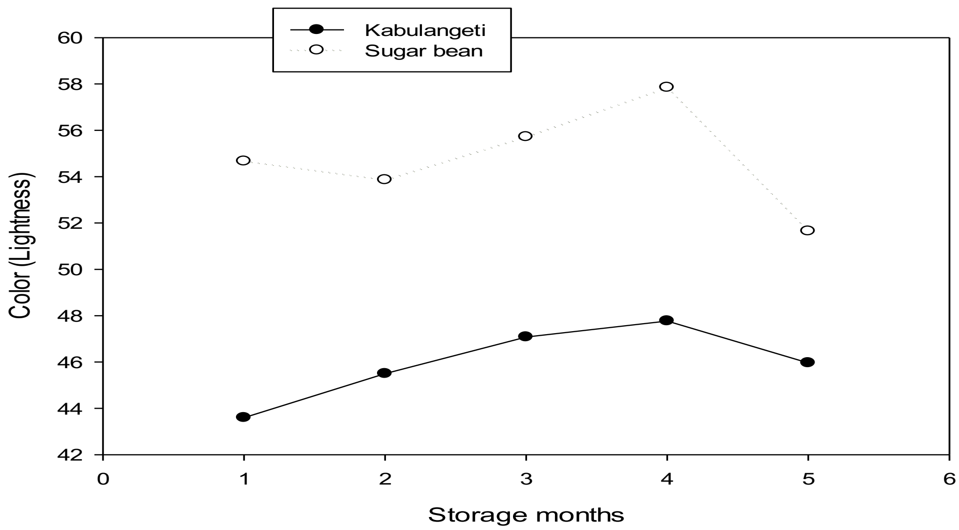


Figure 5. 18: Changes in color over 5 months of storage

Table 5. 16: Colour characteristics of kabulangeti and *Sugar* bean

Variety	Time	L	a	b
Control	0	50.09±0.014	5.64±0.01	5.62±0.01
Kabulangeti	1	43.60±0.01a	4.0±0.02a	2.75±0.007a
	2	45.50±0.01ab	4.03±0.06a	3.72±0.007b
	3	47.08±0.03b	7.76±0.04b	8.69±0.007c
	4	47.77±1.55bc	5.45±0.2c	5.2±0.4bd
	5	45.98±0.01bd	4.27±0.007a	3.91±0.02e
Control	0	61.02±0.007	6.78±0.007	12.43±0.00
Sugar bean	1	54.67±0.014a	7.41±0.00a	10.47±0.00a
	2	53.86±0.00b	7.37±0.04a	12.55±0.007b
	3	55.72±0.007c	8.82±0.03b	13.89±0.01c
	4	57.85±0.00d	9.06±0c	14.87±0.21d
	5	51.65±0.014e	8.99±0.03cd	12.56±0.00be

NB: abcd show significant differences between colour variables over storage months for each variety

One-way ANOVA tests revealed that there was a statistically significant difference between lightness values for *kabulangeti* beans stored in different months with a significance level of 0.0114 ($p<0.05$). Statistically significant differences were also observed between lightness values for *sugar* beans stored in different months ($p<0.05$). Turkey post hoc test revealed statistically significant differences between lightness values of beans stored in the first month and that in the

3^{rd}, 4^{th} and 5^{th} months of storage for *sugar* beans. There were statistically significant differences in lightness values between the fresh and aged beans for *kabulangeti* (Table 16). Colour is an important attribute and the first to be perceived by consumers and thus used as a characteristic for describing quality. It was also observed that as storage time increased, beans lost their shine which was also an important characteristic considered by consumers.

Cooking time

The cooking time for both varieties of beans was found to increase as storage months increased. Figure 5.19 shows the acceleration in cooking time over the 5 month storage period. Cooking times were 120 mins at time 0 for both varieties. For *Kabulangeti* beans, cooking times increased to 150 mins in the second month of storage and to 180 min in the 3 and 4 month and then 210min in the 5 month of storage. This resulted in a 75% increase in cooking time over 5 months of storage. For *sugar* beans, cooking time increased to 150 mins in the 2 month of storage to 180 in 4 month and 240mins in the 5 month. This resulted in a 100% increase in cooking time over 5 months of storage. The cooking time is an indication of the hardening of beans. Storage of beans under high temperature and high relative humidity even 60% have been found to result in the development of the hard to cook defect in beans (Ndung'u et al. 2012). Similar results of increasing cooking time when beans are for long have been observed by Almeida et al. (2017), Oliveira et al. (2011) and Coelho et al. (2009).

The development of the hard to cook defect is as a result of increased hardness of the cotyledon or a low ability for the bean to soften. This defect does not only affect the cooking quality of the bean but the texture and nutritional value (NasarAbbas et al. 2008). Consumers prefer beans that require short cooking time (Martinez- Manrique et al. 2011; Schoeninger et al. 2013). This makes the beans unacceptable to consumers, thereby reducing demand and consumption. This has implications for food security considering that beans are protein-rich foods recommended as a cheap source of protein especially in countries where animal protein consumption is low (Batista et al. 2010).

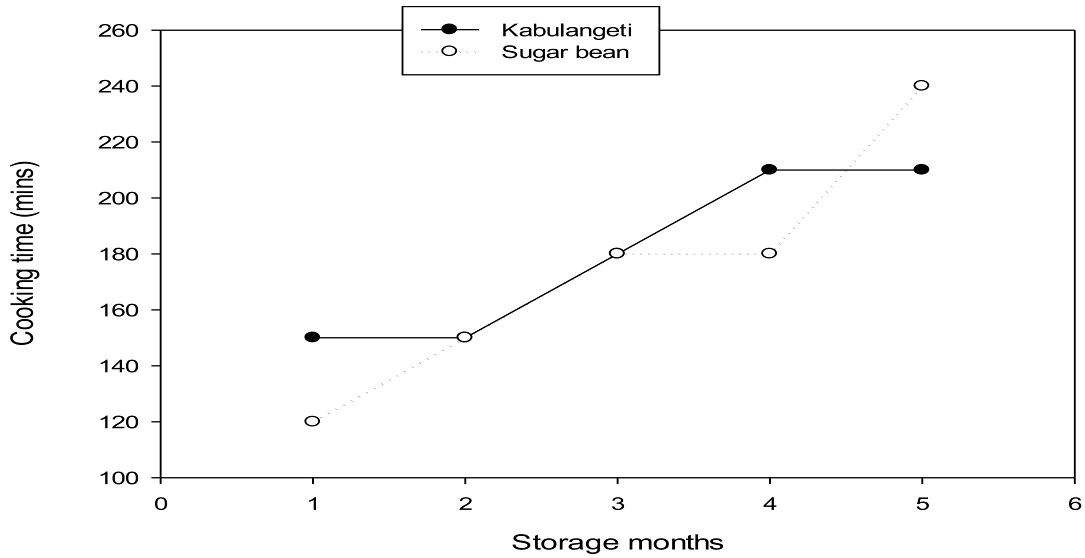


Figure 5. 19: Changes in cooking time over 5 months of storage

The results show that current storage of beans at high temperature (35 degrees) and relative humidity of 60-65% with jute sacs negatively affected attributes such as colour (darkening), appearance (less shiny), damage and cooking time (long cooking time) which consumers considered important. Based on interviews with value chain actors and lab testing, Table 5.17 presents results on how the various activities along the common bean value chain affect bean attributes. Inadequate postharvest and storage practices reduce the appeal and desirability of beans. It has implications for quantity, quality, safety, nutrition and price (high prices when losses are high). The results show that there is a need for improvements along the value chain to ensure the delivery of beans that meet consumer requirements.

Table 5. 17: Effect of value chain processes on bean attributes

Actor	Stage	Process/Factors	Effect
Farmer	Production	Use of recycled low yielding varieties	100% of the farmers used recycled seeds. This has implications for yields since low quantities of beans available to meet consumer demand.
	Harvesting	Late harvesting	Farmers took up to 30 days to complete harvesting. This increases the probability of infestation, leading to higher quantities of bored grains or grains infested with bruchid eggs. Due to the inability to adequately remove beans infested with bruchid eggs, storage at the farm, trader and household level is compromised.
	Drying	Drying in the sun, essential for moisture	Moisture content of less than 12% is required which was found to be the moisture content in the beans when tested in the lab (11%).

		reduction to ensure adequate storage.	This led to no development of moulds and is also necessary for lower pests infestation.
	Threshing	Manual and inefficient	Threshing method resulted in broken beans which had an effect on bean wholeness and size preferred by consumers. Also introduces stones and other foreign materials into beans.
Farmer and Trader	Sorting/ cleaning	Manual and inefficient	56.19% of value chain actors did not grade beans to make homogenous products available to consumers and 31.5% occasionally sorted beans. This reduced the overall quality of beans available in terms of size, color and wholeness. In efficient sorting indicated that beans offered to consumers are likely to have portions that are broken, bored infested and with foreign materials. This also affects storability at the household level.
Farmer and Trader	Storage	Storage temperature of 30 to 35 degrees Beans stored at home.	
		Beans not stored in constant temperature and relative humidity Storage length up to 7 months	Results in changes to colour of beans, shine and increased cooking time. This has implications for cooking quality, texture and nutritional value.
		Packaging material for storage (not hermetically sealed)	The material increased the introduction of pests into beans and provided a conducive environment for pests to thrive. With inadequate sorting, the quality and safety of beans for consumers is compromised.
		Storage method- use of ash or pesticides	Pesticides are not considered safe for consumers and thus though efficient in controlling infestation can be unsafe for consumers

5.4.3 Value Chain performance Assessment

The performance index presented in Chapter 3 was employed in evaluating the performance of the value chain in meeting consumer preferences and food security indicators. The main source of data was survey data from targeted groups specifically, producers, traders and consumers. To avoid weighting of variables, all values were normalised to fall within the range of 0 to 1 using the decile (quantile) method. Therefore, the minimum score is 0 and the maximum score is 1. Responses falling within a certain decile were automatically assigned the same value. When expressed in percentages, the maximum percentage will be 100% and the minimum, 0%. While some indicators were measured at the farm or trader level, others were measured across farms. A summary of the scoring method is presented in Table 5.18.

Table 5. 18: Summary units of measurement and scaling

Unit of measurement	Scaling
Binary questions (Yes/No)	The expected is scored 1 and otherwise 0.

	Expected values are based on recommended practices, methods or approaches in literature.
Likert scale questions	More positive responses or those leaning towards expected responses had higher scores e.g. strongly disagreeing to an expected response =0 while strongly agreeing to an expected response=5
Impact assessment questions	Responses that indicate a negative effect on the consumer or system are scored 0 and otherwise 1.
Rating of performances and experiences	These are Likert scale rankings, with a positive rating having a higher score compared to a negative rating. The target distance is divided into equal sections. When normalised, higher weights approach 1 while lower weights approach 0.
Responses which need to be compared to standardised scores	If the value is below the recommended it is given a score of 0 and if it is the recommended or above, it is scored 1.
Percentage estimations	Percentages were calculated as a percentage of the maximum attainable score, quantity or average (e.g. average yields). After which the values are normalised to fall between 0 and 1.
Proportions	For variables such as number of crops grown, proportion of legumes on farm, these are divided by the total farm size. The final output is transformed to fall into 0 to 1.
Scaling of performance scores	Performance scores are estimated as mean values after aggregation of the indicator and dimension scores. They are then categorised to determine the performance levels. Values between 0 to 24% are considered to have a high negative performance, 25-50%- Low negative, 51-74%- Low positive, 75-100% high positive.

All dimensions are attributed the same level of importance in contributing to the capacity of the value chain in achieving food security. For each food security indicator, a link is made between the indicator and the specific consumers' requirement(s) that needs to be met by value chain actors. This is further linked to the activities performed along the value chain to meet the specified requirement. To determine whether value chain actors are performing well in meeting consumer preferences and food security indicators, a number of indicators, criteria and dimensions were selected to assess their performance. A description of these indicators, dimensions and the method of assessment is presented in Chapter 3.

Since variables were transformed to ensure that they were all within 0 and 1 by using the quantiles (deciles) method, there was no weighting of the indicators and dimensions. Thus, all the scales of the indicators were standardised. The lack of weights resolved the problem of the attributing importance to different indicators. A correlation matrix was also employed to ensure that only indicators with a statistically significant correlation with the index were used in estimating performance scores. Those that did not have any correlation were removed.

This section presents results on the performance of the value chain in meeting consumer preferences and food security indicators. Performance scores in relation to each food security indicator is estimated and the contributing factors are discussed. In the index, dimensions are aggregated value chain indicators which describe a similar value chain function. The scores for the dimensions are used in estimating the performance scores for each food security indicator. Different indicators and thus dimensions are used in estimating each food security indicator. All scores were presented in percentages. Score approaching 100% indicate a higher performance of the value chain. Average scores for each dimension and the food security indicator is presented.

5.4.3.1 Availability

The performance scores of the common bean value chain for the food security indicators are presented in Table 5.19. These scores represent the performance of the value chain in contributing to achieving food security indicators by meeting consumer requirements. The common bean value chain scored low on bean availability (36.2%). The performance is a low negative performance. The score was measured based on 8 dimensions including operational, governance, agility, attitude and preference, social, environmental, economic and management. The assessment was centred on assessing yields, production capacity, loss management, access and utilization of productive assets and infrastructure, production practices, ability to adapt quickly to changing natural and market environment, perception towards the efficient performance of activities etc.

Table 5. 19: Performance scores of food security indicators

Food security Indicators	Minimum score (%)	Maximum score (%)	Average score (%)	Performance
Availability	21.65	52.32	36.22	Low negative
Accessibility	35.81	63.11	48.81	Low negative
Affordability	20.26	60.01	46.22	Low negative
Acceptability	30.93	53.20	41.52	Low negative
Utilization and consumption	27.68	52.35	39.48	Low positive

NB: Reference scale for performance: 0-24%- High negative performance; 25-50%-Low negative performance; 51-74%-Low positive; 75-100%-High positive score (performance)

The low score can be attributed to these factors among others since they limit increased production, reduction of losses and efficient performance of activities required to ensure that good quality beans is available in adequate amounts on the market. These factors are reflected in the performance scores of the different dimensions which in turn contribute to the low availability score. Operations at the farm level are inadequately performed due to their manual nature. Other factors include; lack of competence, financial and technical capacity, high uncertainty leading to wrong decisions and dependence on primitive methods of production. At the management level, value chain actors did not have the knowledge, infrastructure and capacity to manage losses adequately. They also had limited access to information and training, thus resorted to outdated information. The value chain actors did not have the ability to adjust quickly to changing environment and consumer preferences. This is evident in the low scores obtained for the operational (31.30%), management (35.79%) and agility (24.17%) dimensions (Figure 5.20). The value chain performed slightly better at environmental (51.39%), social (48.46%) and at the governance (45.86%) levels.

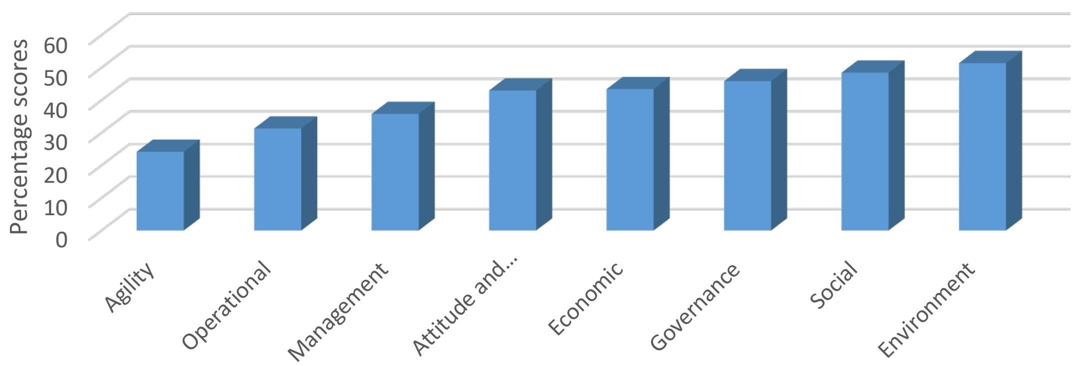


Figure 5. 20: Average performance scores across dimensions used in the estimation of the availability score

Correlation analysis was used in the study as a statistical measure of the relationship between the value chain indicators and the dimensions scores as well as the dimensions scores and the food security indicator scores. Correlation is a good indication of the strength and direction of the relationship between two variables. All correlations between dimensions scores and food security indicator scores were positive and statistically significant from zero. Table 5.20 presents information on the Spearman's correlation between dimensions scores and food security indicator scores. The variables (value chain indicators) used in creating them is also presented in the table. A range of correlation coefficients is reported since different indicators were used in estimating the dimension scores but all of them could not be presented in Table 5.20. Only those that were statistically significant were included in the table. The positive linear correlation indicate that as the score of one variable increases the score of the other also increases. Correlation coefficients above 0.5 indicate strong linear correlations between the scores.

Table 5. 20: Spearman's correlation between variables used in assessing the performance of the value chain in contributing to achieving food security indicators

Criteria	Indicator	Correlations: Indicator vs Dimension	Dimension	Correlations: Dimensions vs Availability	FSI

	Production capacity	0.24-0.45			
Production	Land productivity	0.23-0.48			
	Production/ value chain practices	0.20-0.45	Operational	0.34	Bean Availability
Technology	Technical capability	0.43-0.58			
Market	Delivery reliability	0.47			
Market	Product quality/ Market surplus	0.40			
Loss management	Loss management	0.25	Management	0.27	Bean Availability
Knowledge/ Communication	Information access	0.22-0.65			
Agro-technique	Agro-techniques	0.99	Environment	0.32	Bean Availability
Activity management	Governing activity	0.20-0.76			
	Relationship	0.60-0.62	Governance	0.33	Bean Availability
Institutions	Stakeholder involvement	0.23			
Profitability	Production value	0.54			
Financial capability	Production investments	0.67	Economic	0.40	Bean Availability
	Income stability	0.67			
Employment	Employment	0.44-0.75			
	Worker efficiency	0.18-0.40	Social	0.35	Bean Availability
Safety	Health/Safety	0.26			
Adaptability	Consumer adaptability	0.44-0.47	Agility	0.36	Bean Availability
	Environment Adaptability	0.31-0.44			
Attitude and perception	Actor attitude and perception	0.77-0.82	Attitude and Perception	0.33	Bean Availability

NB: Only statistically significant variables at p-value of 0.05) are reported. FSI=Food Security Indicator

Although there were some strong positive correlations between the indicators and the dimension scores, correlations were generally lesser than 0.5. This justifies the necessity of a comprehensive index which takes into consideration different variables. Also, correlations in social sciences are often weak (Sulewski and Kloczko-Gajeska, 2018). The positive correlation between dimension scores and availability score is expected. This is because as activities are better performed leading to higher scores, the value chain will score higher on its performance in contributing to food security by increasing the availability of nutrient-rich and quality beans for consumers. A strong and positive correlation was observed between the economic dimension score and the bean availability score because without the capacity to invest in new and improved technology and implement strategies to improve yields and reduce losses there will be little improvement even with knowledge. Thus, the value chain's performance in availability is expected to increase when their economic performance increases through access to capital resources. Financial analysis revealed that production and trading of beans was profitable for majority of the value chain actors. This implies that they are able to invest in farming and trading activities to make beans available.

5.4.3.2 Accessibility

The common bean value chain scored low on bean accessibility. A low negative performance score of 48.8% was estimated (Table 5.19). The score was measured based on 7 dimensions including operational, governance, agility, attitude and preference, social, economic and management. The assessment was centred on determining the varieties made available to consumers, the ability to meet seasonal demands, out of stock times, loss management, avenues for information, percentage of low-quality beans on the market, financial capability, policies, involvement of stakeholders, ability to adapt to changing consumer preferences etc. Majority of traders were able to offer consumers with different varieties however, they were not able to meet seasonal demands and were out of stock during sale periods. This made beans unavailable to consumers during those periods. Further, beans traders indicated some difficulties in accessing beans in a shorter period of time within shorter distances because farmers were far to reach. Storage of beans was not within a temperature and humidity controlled system which increased losses and low-quality products. Losses and low-quality products lead to low acceptable volumes of beans available to consumers.

The below average score can be attributed to these factors coupled with the lack of access to information on how to perform activities. This was reflected in the lower scores obtained for the management (43.34%), social (50.21%) and governance dimensions (50.53%). While producers rarely meet extension officers to receive information on the production of crops, traders are often completely left out such training. Traders play a significant role in making beans accessible to the consumer and thus influence the achievement of food security objectives.

It is essential that they are involved in training and knowledge transfer sessions. Increasing stakeholder involvement and access to financial services including policies and strategies to efficiently link traders and farmers can improve the accessibility of beans. This will improve the social and governance dimension scores. The economic dimension had the highest score of 60.7%

compared to others (Figure 5.21). This could be attributed to the fact that traders did not trade solely in beans but varied products, thus they were able to obtain funds from the sale of other products to purchase beans for sale. Majority of the actors made good profits from the sale of beans which fueled continuous engagement in the business. Nevertheless, this didn't translate overall to a high bean accessibility score due to inability access producers, meet consumers changing needs for quality products and efficiently package and store beans to preserve them for sale.

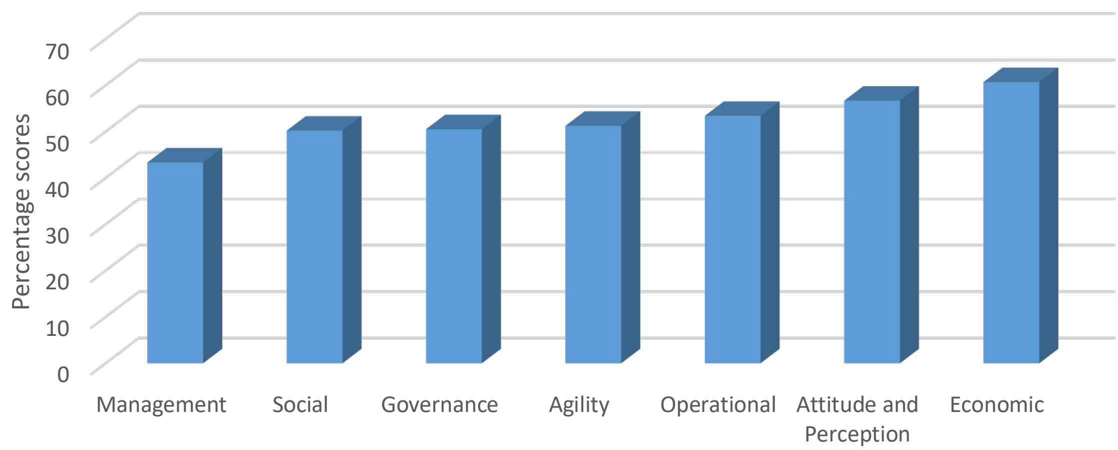


Figure 5. 21: Average performance scores across dimensions used in the estimation of the accessibility score

All dimensions had statistically significant correlations with the accessibility score except management and social dimensions (Table 5.21). When these were removed for further computation of the performance score for bean accessibility, it was found that the average score increased slightly to 49.1%. A positive correlation was obtained between the value chain indicators and the dimension scores as well as between the dimensions scores and the accessibility scores. An increase in the scores will, therefore, translate into an increase in the accessibility score. Actor attitude was observed to have a stronger positive correlation with the accessibility score. Value chain actors particularly, traders indicated making a conscious effort to keep food safe, provide consumers with different varieties of produce with few incorporating different marketing strategies to encourage the purchase of beans. When these attitudes are encouraged along with efficient loss management practices, beans will not only be made accessible to consumers but demanded.

Table 5. 21: Spearman's correlation between variables used in assessing the performance of the value chain in contributing to achieving food security indicators

Criteria	Indicator	Correlations: Indicator vs Dimension	Dimension	Correlations: Dimensions vs Availability	FSI
Market	Product delivery Delivery reliability	0.70 0.73-0.77	Operational	0.37	Bean accessibility
Market	Product quality Loss management	0.60 0.56	Management	0.017	Bean accessibility
Information access	Market/consumer knowledge	0.62			
Governance of activity	Trust/Relationship Entry restrictions	0.43 0.62	Governance	0.30	Bean accessibility
Profitability	Production value	0.72-0.83	Economic	0.34	Bean accessibility
Financial stability	Sources of funds for investment	0.63			
Employment	Employment Efficiency of worker	0.49-0.58 0.33-0.59	Social	0.18	Bean accessibility
Adaptability	Consumer adaptability	0.40-0.79	Agility	0.33	Bean accessibility
Attitude and perception	Actor attitude and perception	0.99	Attitude	0.50	Bean accessibility

NB: Only statistically significant variables at p-value of 0.05) are reported. FSI=Food Security Indicator

5.4.3.3 Affordability

The common bean value chain had a low negative performance with a score of 46.25% with respect to affordability (Table 5.19). The score was measured based on 3 dimensions including operational, governance and economic. The indicators used in the estimation of the score were grouped into different dimensions to determine how the value chain is performing across those dimensions and how they impact the consumer and food security indicators. The assessment was centred on evaluating cost efficiency in the performance of activities, gross margins, average purchasing price across different actors, assessment of the pricing scheme etc.

Generally, average prices for beans were not found to be widely varied among actors, traders had higher costs compared to producers which could translate to higher prices for consumers. The below average score can be attributed to the inefficient system of pricing which was found to be based on price formulation through hearsay as opposed to taking into consideration costs and revenues. Among the three dimensions, governance had a lower score of 34.2% which was as a result of the low level of trust among value chain actors. Farmers did not trust traders because they dictated prices and often paid lower prices than what farmers expected. Traders may want to purchase at a lower price to sell at a higher price which affects the affordability of the beans. Farmers may also quote prices above the actual price to ensure that they receive more or at least their desired price after bargaining. The poor level of trust has a negative influence on affordability (Figure 5.22). Prices were also settled on based on the amount of losses, that is, actors increased prices when losses are high.

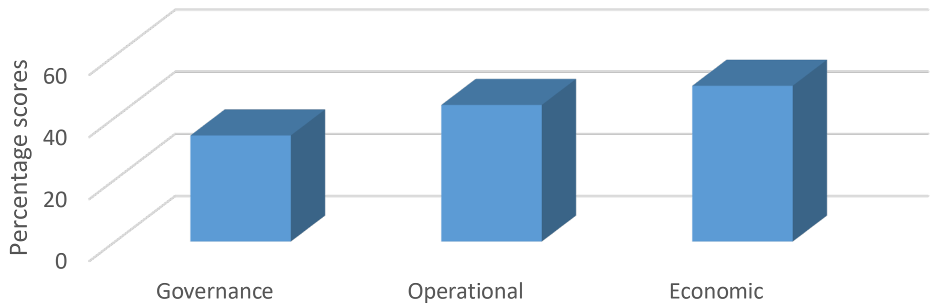


Figure 5. 22: Average performance scores across dimensions used in the estimation of the affordability score

The results show a positive correlation between indicators and dimension scores as well as dimension scores and affordability score (Table 5.22). A strong positive correlation is observed for operational dimension score and bean affordability score. This implies that a fair pricing scheme can ensure affordability of beans for consumers. Majority of value chain actors indicated that activities were not performed with the objective of reducing cost but rather the main drive was profits. Lower costs translate into lower prices which increases affordability for consumers. Even though beans are considered a cheap source of protein, the study found consumers who considered it expensive.

Table 5. 22: Spearman's correlation between variables used in assessing the performance of the value chain in contributing to achieving food security indicators

Criteria	Indicator	Correlations: Indicator vs Dimension	Dimension	Correlations: Dimensions vs Affordability	FSI
Cost efficiency	Cost efficiency/ Pricing scheme	0.97	Operational	0.87	Bean affordability
Trust	Trust	0.99	Governance	0.23	Bean affordability
Cost	Cost	0.35	Economic	0.30	Bean affordability
Price	Average price	0.57			
	Price fluctuation	0.53			
	Gross margin	0.52			

5.4.3.4 Acceptability

The common bean value chain had a low negative performance in relation to providing beans which consumers found acceptable, with a score of 41.5% (Table 5.19). The score was measured based on 5 dimensions including operational, attitude and perception, quality, agility and management. The assessment was centred on evaluating the impact of processes along the value chain on bean attributes, grading to obtain homogenous products, percentage of low-quality products on the market, perception regarding meeting consumer preferences, ability to adjust to market demands, packaging material used etc. Others include duration before completion of harvest, the method of threshing, storage for long periods in temperatures above 30℃ all together result in losses, infested or discoloured beans, broken beans, a loss of shine as well as beans with longer cooking time etc. They also affect the shelf life and the nutritional value of the beans. These attributes have been found to be important to consumers and thus the activities along the value chain negatively affect the acceptability of beans. These contributed to the low acceptability score. Agility dimension had a high negative score of 17.6% and contributed to the low acceptability score. This indicates the inability of value chain actors to adequately provide beans that meet the requirement of consumers because they do not have the full knowledge and capacity to do so. Performance in these areas are contributing factors to the inability of value chain actors to deliver and meet consumer preferences.

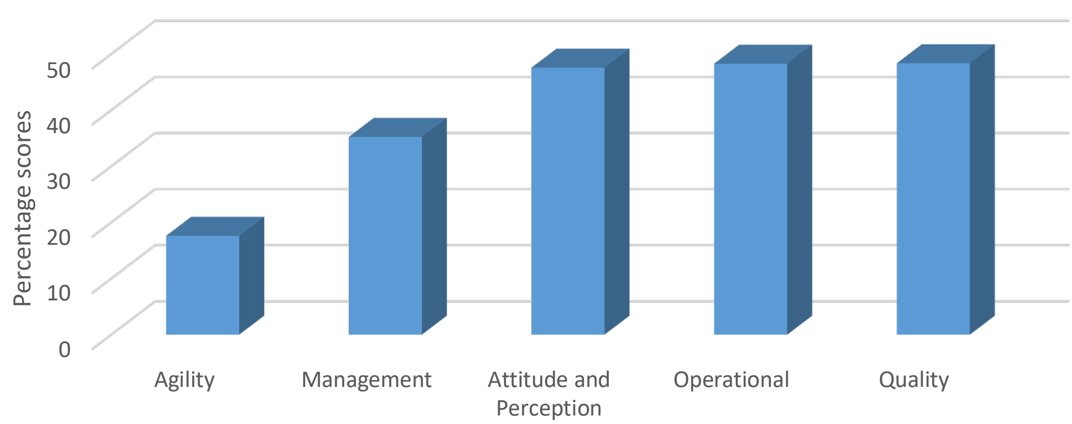


Figure 5. 23: Average performance scores across dimensions used in the estimation of the acceptability score

Value chain actors indicated providing consumers with products rated at a quality of 50% or less. This is evidence of their inability to provide products with low defects. Value chain actors who did not store their produce for long periods were more likely to provide products with less degrading quality. Quality dimension was observed to have a strong positive correlation with bean acceptability score which implies that the more quality is improved the higher the acceptability score (Table 5.23). This will require adequate storage practices to be put in place without neglecting grading, sorting and threshing methods since they all together affect the acceptability of beans.

Table 5. 23: Spearman’s correlation between variables used in assessing the performance of the value chain in contributing to achieving food security indicators

Criteria	Indicator	Correlations: Indicator vs Dimension	Dimension	Correlations: Dimensions vs Availability	FSI
Product reliability	Adherence to consumer quality preferences	0.22-0.86	Quality	0.72	Bean acceptability
Efficiency of system	Quality control Defect rate	0.70 0.87	Operational	0.22	Bean acceptability
Profitability Loss management	Loss management	0.92	Management	0.38	Bean acceptability
Knowledge acquisition	Market knowledge	0.40			Bean acceptability
Adaptability	Consumer adaptability	0.99	Agility	0.47	Bean acceptability
Attitude and perception	Actor attitude and perception	0.67-0.81	Attitude and Perception	0.35	Bean acceptability

NB: Only statistically significant variables at p-value of 0.05) are reported. FSI=Food Security Indicator

5.4.3.5 Utilization and consumption

The common bean value chain had a low positive performance with a score of 39.48% with regards to utilization and consumption of beans (Table 5.19). The score was measured based on 4 dimensions including operational, attitude and perception, quality, and management. The assessment was centred on evaluating value addition along the chain, knowledge on value creation opportunities, partnership with stakeholders to produce value-added products, perception towards diversification, ability to invest in the development of new products, application of safety tests, awareness of the implication of losses with regards to nutritional losses, quality checks before sale etc. The utilization indicator is measured based on the value chain’s ability to provide consumers with different product types which meet their diverse needs.

There were no value-added bean products on the market and the only diversity available was with regards to variety. There were no processors along the chain to transform the beans into other products. Though a few of the value chain actors indicated a shift in consumer demand towards more processed and convenient foods, the majority lacked the know-how and financial capacity to invest in the production of value-added products. Actors had a willingness to make value-added products and consumers demanded them, however, there is a need for external support, collaborations and financial investments. About 30% of the value chain actors had received training on the processing of beans into bean flours, however, due to the lack of market creation and financial support to invest in purchasing mills, the training has not led to any tangible output.

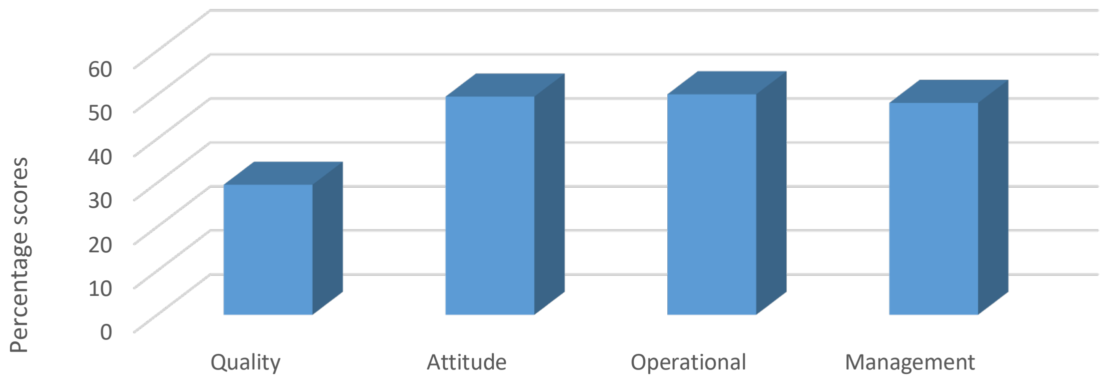


Figure 5. 24: Average performance scores across dimensions used in the estimation of the consumption and utilization score

Value chain actors did not undertake any standard safety tests except through sorting to ensure removal of infested seeds and foreign materials which was inefficiently performed. Value chain actors who stored beans with insecticides may be providing beans to consumers which are unsafe for consumption. The nutritional benefit to be derived from the product is reduced if the product is not entirely safe for consumption. Storage of beans at the household level for long periods of time without loss through infestation is important to consumers. Improper handling and storage along the value chain to provide consumers with products with long shelf life has a negative effect on utilization and consumption.

The score obtained can be attributed to low-value addition along the chain, inability to meet the demand for diversified bean products and the inadequacy of handling and storage methods. Performance along these dimensions were all below or at 50% (Figure 5.24). They are contributing factors to the inability of value chain actors to deliver and meet consumer preferences. Correlation results showed a strong positive correlation between attitude and management dimensions scores and bean utilization score (Table 5.24). Demand for safe, nutritious, convenient foods with improved taste, appeal, flavour and diversity of use is increasing among consumers. Building entrepreneurial capacity with regards to value addition among value chain actors to meet changing preferences is therefore required. Value chain actors indicated that conscious efforts to ensure safety can be time-consuming and costly. Changing the attitude regarding the need to ensure safety is important. This will improve the bean utilization score as management and attitude scores improve.

Table 5. 24: Spearman's correlation between variables used in assessing the performance of the value chain in contributing to achieving food security indicators

Criteria	Indicator	Correlations: Indicator vs category	Dimension	Correlations: Dimension vs Availability	FSI
Actor attitude and perception	Attitude towards processed products, safety and nutrition	0.50-0.72	Attitude	0.60	Bean utilization / consumption
Knowledge acquisition	Knowledge on market and value addition	0.99	Management	0.61	Bean utilization / consumption
Safety	Safety	0.64			
Product quality	Stored product quality	0.43	Quality	0.51	Bean utilization / consumption
Efficiency of system	Efficiency to detect and remove infested beans	0.38-0.46			Bean utilization / consumption
Product diversity	Level of product diversity	0.80	Operational	0.27	Bean utilization / consumption
Technology and Asset	Technical and financial capacity	0.33			

NB: Only statistically significant variables at p-value of 0.05) are reported. FSI=Food Security Indicator

Indicators such as grading of products, efficiency of drying method, subsidies to farm income, type of storage system, ability to sell quality seeds, presence of rules and restrictions to value addition, collaboration with public and private industries were not included in estimating the dimension and food security indicator scores because they were not statistically and significantly correlated with the index. The responses for these variables were very similar since value chain actors had the same experience or used the same equipment. Other indicators such as amount of fertilizer used per hectare, amount of pesticide used per hectare, access to credit by producers, were not included because the producers did not use any and thus, they did not correlate with the index.

5.4.3.6 Food security achievement

Table 5.25 shows the distribution of performance scores across value chain actors. Majority of the actors (>50%) had low negative scores with respect to each food security indicator except utilization and consumption. They are therefore having a least favourable effect on the majority of the value chain indicators and thus on food security achievement overall. The performance across the different dimensions are underlying factors to the low performance scores for the food security indicators. A summary of the performance of the value chain actors with respect to each food security indicator is presented in Figure 5.25.

Table 5. 25: Distribution of value chain actors within performance groups

FSI	High negative	Low negative	Low positive	High positive
Availability	0.63	98.10	1.27	-
Accessibility	-	56.67	43.33	-
Affordability	2.80	62.62	34.27	-
Acceptability	-	97.14	2.86	-
Utilization and consumption	-	98.15	1.85	-

The overall average food security score was estimated to be 42.4% with about 96% of the value chain actors scoring between 38 to 50%. The score was obtained by aggregation of the food security indicator scores. The low negative performance is attributed to the low performance across the different food security indicators (FSI). This implies that the common bean value chain is not performing satisfactorily in contributing to food security due to the inability to make beans available, accessible, affordable, acceptable with a high rate of utilization for consumers.

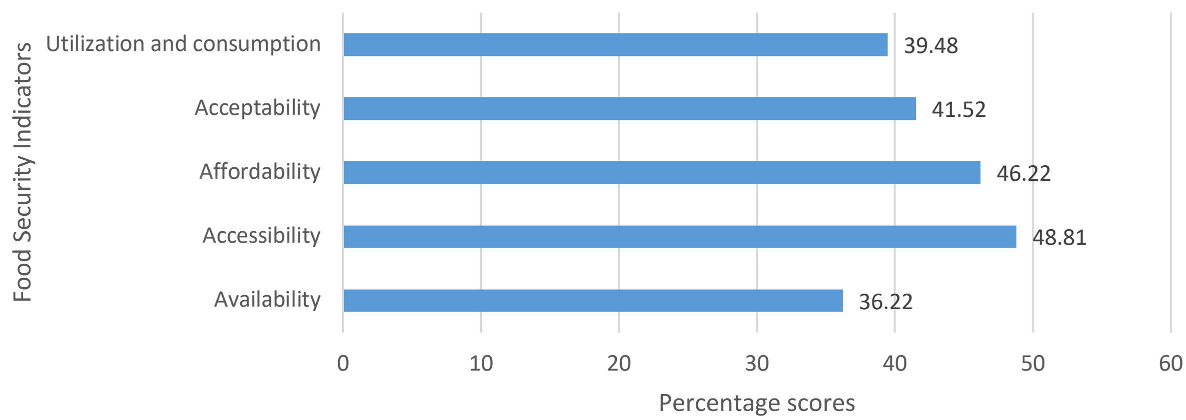


Figure 5. 25: Percentage scores for food security indicators

Among all the indicators, availability had the lowest score, followed by utilization and consumption and then acceptability. This could be due to the inability of the value chain actors to produce more, reduce losses and access the market. Different constraints at the governance, management and operational level are also contributing factors. Accessibility has a slightly higher score due to low exposure to factors which negatively impact health and higher capacity to invest in the trading of beans to make it available to consumers. Apart from low productivity, availability is hindered by the lack of promotion and strengthening of the knowledge of value chain actors at the management level. The lack of external and financial support, technology use, inadequate market and consumer preference information does not create an enabling environment for actors and restricts the capacity to make beans available. These factors limiting the availability of beans also limit accessibility at the market stage (trader level).

Utilization also had a lower score because value chain actors did not have the entrepreneurial skills to take advantage of new opportunities and fully participate in the market. This led to low diversification of products and untargeted distribution of products to meet the varied needs of consumers. Overall, the stability of all the dimensions over time is low because of inadequacies in the achievement of the different food security indicators. This is due to low performance scores for the dimensions which define the structure, function and dynamics of the value chain.

Table 5. 26: Correlation coefficients between food security indicators and food security score

	Availability	Accessibility	Affordability	Acceptability	Consumption	FSS
Availability	1					
Accessibility	-0.1552**	1				
Affordability	0.1196	0.1481*	1			
Acceptability	0.01	0.0506	0.0078	1		
Utilization	0.0269	0.0301	0.1766**	-0.2213**	1	
FSS	0.4062**	0.1851**	0.8798**	0.1959**	0.2990**	1

Sig levels: *10%, **5%

Table 5.26 presents a correlation between food security indicators and food security score (FSS). There were positive significant correlations between all the food security indicator scores and the overall food security score. There was however a strong correlation between affordability and the food security score followed by availability compared to the other indicators. Both indicators score were below 50% with the availability score being the lowest. This implies that increasing those scores will result in an overall improved performance of the value chain in contributing to food security and nutrition. There were also statistically significant associations between some of the food security indicators. A positive correlation was observed between affordability and accessibility as well as utilization. A negative correlation was observed between utilization and acceptability scores. This implies that increasing acceptability scores does not result in increasing utilization scores. Acceptability scores are based on providing raw beans which meet consumer bean attribute requirements. However, utilization is centred on value addition and diversification of bean products. Thus, a negative correlation is expected since consumer requirement for value-added products is not met with improved the quality of raw (no value-added) bean products.

5.4.3.7 Comparison of value chain-based performance assessment and consumer-based performance assessment

Assessment of the contribution of the common bean value chain in meeting food security indicators was not only undertaken from the value chain perspective but also from the consumer perspective. Achieving food security indicators is inherently linked to meeting consumer preferences. For instance, ensuring the affordability of food is necessary for demand and consumption because consumers desire cheap or affordable products. Ensuring accessibility is important because purchase and consumption are fueled by having easy access to products. Thus, consumer assessment of how the value chain is performing in meeting their preferences within the food security context sheds more light on the performance of the chain. It is also an indication of whether the requirements of consumers are being met. From Table 5.27 it can be observed that the consumer-based performance scores were slightly higher than the value chain based performance scores with the exception of utilization. All but one of the consumer-based performance scores were within the low positive performance level while that of the value chain assessment was within the low negative performance level.

Table 5. 27: Comparison of performance scores based on value chain evaluation and consumer assessment

Food security Indicators	Value chain performance scores (%)	Consumer based performance scores (%)
Availability	36.22	48.22
Accessibility	48.81	52.40
Affordability	46.22	56.64
Acceptability	41.52	51.39
Utilization and consumption	54.39	51.98
Food security score	45.26	52.12

The differences in the scores could be attributed to the fact that consumer-based indicators did not take into consideration process and management effects among others in estimating performance scores. The difference between the scores is not extremely wide which serves as an indication that the index was able to adequately assess the performance of the chain.

The consumer-based performance scores also revealed that the value chain is not performing poorly in meeting consumer preferences and food security indicators though it can be greatly improved. Consumers unmet requirement for diversified value-added products and high willingness to substitute beans for other products resulted in the lower utilization score by consumers. A presentation of the correlation between the food security indicator scores at the value chain level and consumer level with the overall food security score is presented in Figure 5.26. Significant correlation coefficients are bolded.

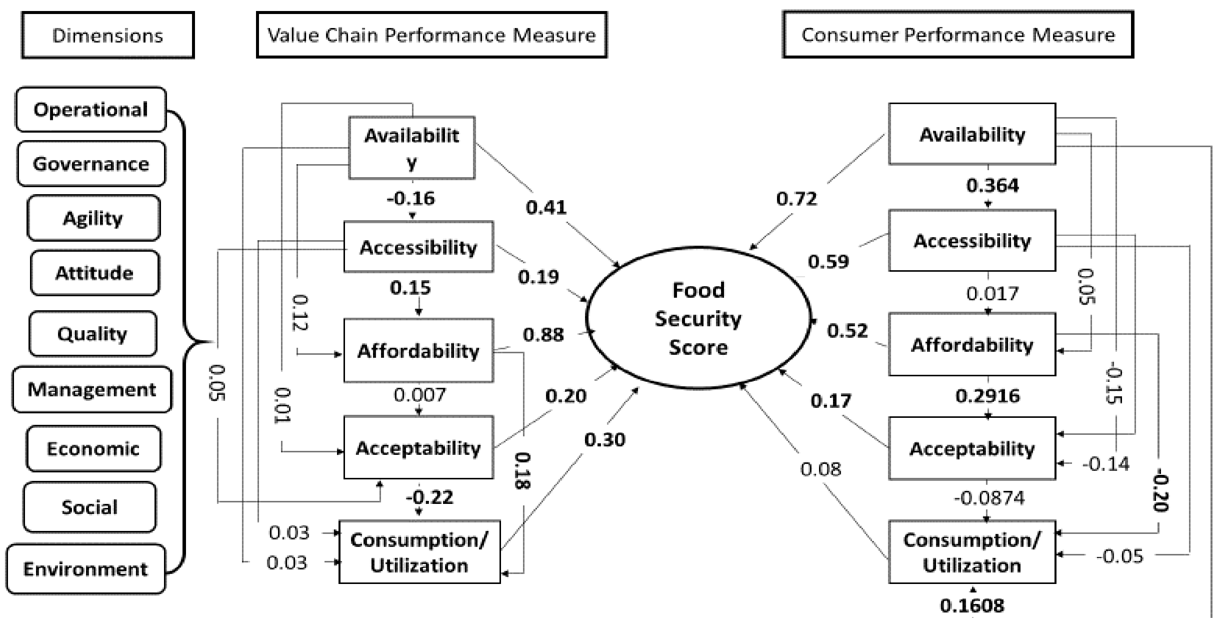


Figure 5. 26: Correlation between food security indicators and food security score (FSS)

5.4.3.8 Implications for consumer preference

The sub-optimal (low negative) performance of the value chain in contributing to meeting food security indicators has direct implication for consumers. Generally, consumers do not always have access to beans and their desired varieties at different times and across seasons. They also do not have beans at affordable prices and thus are not able to purchase frequently or purchase desired quantities. Consumers do not also have products with attributes that satisfy their preferences such as colour, shine, damage free, cooking time, packaging, long shelf life etc. as well as value-added products. It implies that consumer needs and preferences are not being met satisfactorily which could affect demand and consumption. This is reflected in consumers willingness to shift from the consumption of beans to other products which may not necessarily be nutritious even if cheaper. It could also result in a reduction in the frequency of bean consumption which has health and nutrition implications for vulnerable groups who are either unable to have access to beans all year round or have beans that meet their preferences.

5.4.3.9 Cluster analysis: Clustering value chain actors with respect to scores

Cluster analysis was used to create similarities among value chain actors based on food security indicator scores and dimension scores. The dendrogram is a representation of the similarity among clusters (Figure 5.27). Three clusters were obtained from the analysis. Cluster 1 comprised of 49.4% of the value chain actors, Cluster 2 comprised of 34.8% and Cluster 3 comprised of 15.8% of the actors. Negative or zero similarity indicates that the mean scores are not similar for food security indicators. Similarity is shown by horizontal lines. The results show a similarity among value chain actors taking food security indicator scores into consideration.

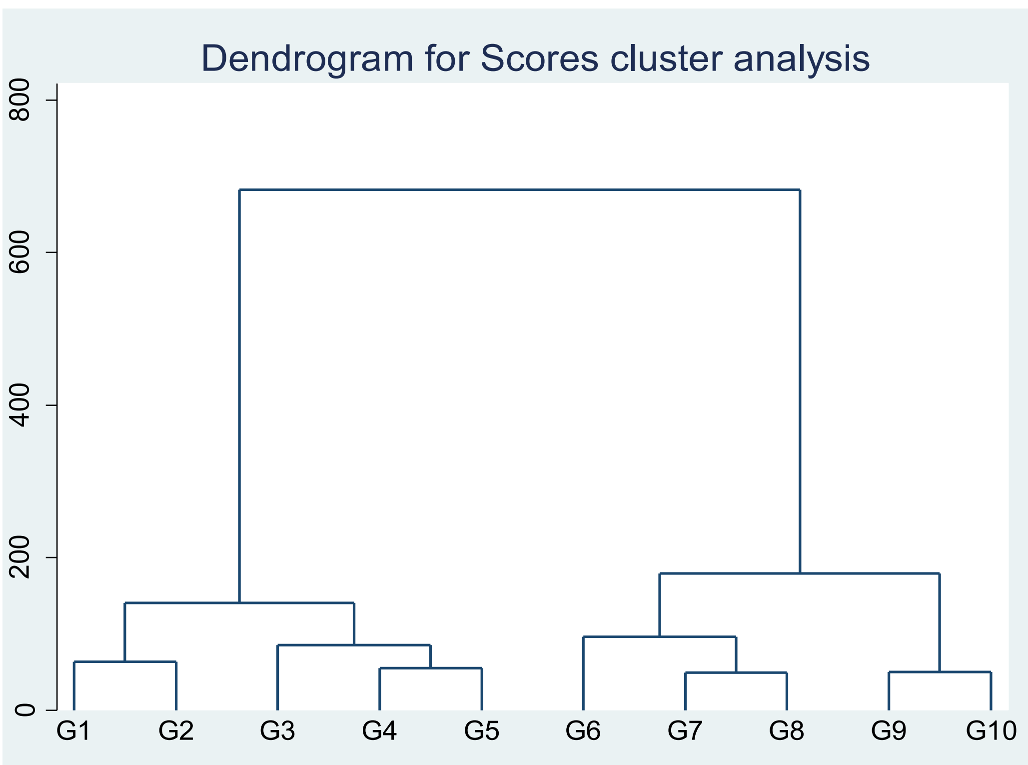


Figure 5. 27: Dendrogram for Cluster Analysis

The ANOVA and Turkey post hoc tests results show that there were statistically significant differences between clusters with respect to availability scores (Table 5.28). Availability score was significantly higher for value chain actors in cluster 3 compared to cluster 2 and in Cluster 2 compared with cluster 1 at p-value <0.05. There was no significant difference in accessibility and acceptability scores among clusters. A significant difference was observed between affordability scores and utilization scores. Overall food security scores were found to be significantly different between clusters 2 and 1 as well as clusters 3 and 1. Scores for cluster 1 members were higher compared to cluster 3 and also cluster 2.

Table 5. 28:Difference between clusters

Scores	Cluster 1	Cluster 2	Cluster 3
Availability	37.56a	33.27b	38.50a
Accessibility	49.20a	48.81a	48.56a
Affordability	55.04a	40.37b	30.40c
Acceptability	41.19a	41.42a	42.75a
Utilization	40.22a	38.98ab	38.24b
Operational	46.13a	37.03b	35.34bc
Governance	41.18a	39.30b	40.01ab
Agility	37.91	35.62	37.54
Attitude	45,82	43.77	43.66
Quality	44.10	45.09	46.86
Management	40.18a	38.25b	39.26ab
Economic	56.94a	53.96b	50.20c
Social	56.94a	53.96a	50.20b
Environmental	51.4	51.16	51.85
Food security score	44.65a	40.57bc	39.69c

Significant differences were also observed in the dimension scores among clusters. There were significant differences in dimension scores for operational, governance, management, economic and social dimensions. Economic dimension scores were significantly different in all clusters. Management and governance scores were higher in cluster 1 compared to cluster 2. Social dimension scores were higher in cluster 3 compared to clusters 2 and 1. Operational dimension scores were higher in cluster 1 compared to clusters 2 and 3.

Value chain actors in cluster 1 had higher scores in affordability and accessibility while those in cluster 2 and 3 had higher scores in accessibility and acceptability. Cluster 1 members had higher scores in operational compared to clusters 2 and 3. Clusters 2 and 3, however, had higher scores in quality compared to cluster 1 which explains the higher acceptability scores. This reveals that cluster 1 members contributed more to making beans affordable to consumers possibly through better pricing and lower gross margins. Cluster 2 and 3 members had more positive attitudes towards providing quality products and placed more effort into providing beans with consumer preferred attributes through grading, sorting and shorter storage periods. Although the performance was generally assessed, the clustering results revealed that value chain actors performed differently in contributing to meeting consumer preferences and food security indicators. This is due to the different levels of assets, information, capacity, working environment etc. available to value chain actors. Strategies should, therefore, be targeted to different groups of value chain actors since a weakness of particular group of value chain actors may not be the same for others. Targeting strategies may lead to higher performance levels compared to generalising them.

5.4.3.10 Implications for the common bean value chain

The low performance scores for FSI obtained by value chain actors is a reflection of the low performance with regards to the dimension scores. Value chain level indicators selected to measure the dimensions were specific to each FSI. This enables understanding of the accumulative effect of the indicators on the overall performance of the value chain. This is viewed as a better construct as opposed to using a single indicator to measure one dimension. Table 5.29 presents a summary of the dimension scores while Table 5.30 presents the correlation between the dimension scores. The results showed that economic and environment dimension had slightly above average scores compared to the other dimensions. This is because activities along the chain were not found to cause significant negative impacts to the environment. Also, activities for both traders and producers were found to be profitable and thus the majority of the actors were not operating at losses. Profits are important for the running of any business and ensuring that bean is made available and accessible to consumers.

Table 5. 29: Performance score across dimensions

Dimensions	Average scores (%)	Min (%)	Max (%)
Operational	41.25	30.85	61.85
Governance	40.34	32.75	51.95
Agility	37.06	14.67	64.78
Attitude	44.77	30.38	72
Quality	45.93	26.38	66.86
Management	39.37	23.98	48.21
Environment	51.39	44	60
Economic	54.83	36.36	72.77
Social	49.77	31.5	67.1

Statistically significant correlations were observed for the dimension scores, some of which were positive and others were negative. Significant negative correlations were observed between operational scores and quality scores. This can be explained based on the fact that activities undertaken along the chain did not have a positive effect on the quality of the produce. Value chain actors were focused on performing activities to increase yield or profits without consideration for quality. Significant negative correlations were also observed between management and quality as well as management and agility. Due to the low level of knowledge on the efficient performance of activities, there was low management of losses and lack of information to produce quality products. The general lack of information on product and process management techniques limited the ability of value chain actors to be agile.

Significant positive correlations were observed between economic and operational scores which is due to profitability in the production and trading of beans. Positive correlations between management scores with attitude scores were attributed to a positive attitude towards the efficient performance of activities and the willingness to undertake them. This was practically limited by financial/technical capacity and skills. Positive attitudes can be leveraged on by external agents to equip value chain actors to improve performance.

Table 5. 30: Correlations between performance scores for dimensions

	operational	governance	agility	attitude	quality	management	economic	social	environment
operational	1								
governance	0.05	1							
Agility	-0.02	-0.07	1						
Attitude	0.09	0.003	0.13*	1					
Quality	-0.2**	-0.12	0.11	-0.03	1				
management	0.03	0.26**	-0.18**	0.22**	-0.16**	1			
economic	0.32**	-0.07	-0.13	-0.09	-0.09	0.0003	1		
Social	-0.08	0.08	-0.03	-0.05	0.22**	-0.09	-0.14*	1	
environment	0.01	0.15*	-0.16**	0.043	0.11	0.23**	0.01	0.02	1

Improvement in the dimension scores requires an understanding of constraints along the chain. Tackling the identified issues will, therefore, lead to positive impacts on performance. Socially, occupational wellbeing, employment and training play a significant role in how activities are performed to the benefit of the value chain actor. The level of injury associated with the performance of activities is almost negligible for traders. The farmers were the most vulnerable to injuries coupled with the fact that they have limited training on safety. The negative impact of activities on welfare automatically leads to negative performance of activities which has rippled effects. The low employment opportunities, the lack of training to develop the capacity of actors to diversify and risk of injuries contribute to the low positive score for the social dimension. This has implications for food security because the competence level of actors is not improving to match the dynamic environment within which they operate.

Development of technical and behavioural skills enables actors to perform their job efficiently (Fedrova and Pongracz, 2019). Better wellbeing leads to prosperity and further investment of money and time into ensuring that products are available, accessible, affordable, acceptable and tailored to consumers changing consumption needs. The length, number of activities and the complexity of a value chain are promising for employment since it creates numerous avenues for entry. There is a potential for job creation along the common bean value chain, however, this has not been tapped into. The activities constitute mainly producing and selling which limits job creation. There is also a limited infrastructural investment and limited stakeholder involvement at the private or government level to upgrade value chain actors and weave them into modern food value chains.

With regards to attitudes and perception, the value chain actors attitudes were found to be positive. The low positive score was because they were not willing to invest the necessary time and money into translating their attitudes into practice. There were some perceptions that were not entirely positive. Some actors perceived that performing operations efficiently increases their job burden, efficiency is not profitable, consumers will be willing to buy products irrespective of how it is handled etc. The study weighted attitude based not only on a positive indication to change but a willingness to invest in its realisation. Adoption of new varieties and technology, successful implementation of projects and strategies cannot live their full potential except they are accepted by value chain actors. Thus, changing the perception of value chain actors regarding the importance of meeting consumer preferences and working efficiently is needed. However, this will amount to less without capacity building to ensure that information is put into action.

With regards to governance, there is minimal collaboration among actors, no contractual arrangements and mainly spot transactions. Effective knowledge sharing among producers, traders, extension agents and other external actors is necessary to ensure that food moves along the chain at the right time to the target consumers. Internal and external value chain actors passing on consumer preference information can help ensure that the quality of the beans is preserved at each stage of the chain. This has implications for improving the acceptability score. While there may be no formal barriers or stringent rules to entry into the chain, the lack of support and avenues to encourage entry can be a barrier and also limit product transformation. Creation of producer and trader cooperative, value addition and strong market linkages is recommended.

Management involves the management of losses and knowledge along the value chain. There was minimal contact with NGOs or extension agents. The ability to source and acquire reliable information should be created by providing actors with a strong knowledge base made up of extension agents, and other government and non-government organisations. Knowledge transfer was largely informal and unidirectional, internal and centred mainly on farming practices. There is a need to implement policy interventions which will strength information sharing and acquisition from varied sources. Generating and promoting the use of new knowledge in agriculture and breaking the barriers to communication has a place in improving food security and nutrition. They should be viewed as a resource (skillset) in addition to physical inputs. Knowledge management programs should not only be focused on the transfer of information but ensure that the knowledge is translated into value (Baker, 2006).

The results show that all the stages along the common bean value chain contribute to physical, economic and nutrient losses along the chain. Thus, in meeting SDG 12, specific interventions should be targeted at the different stages of the chain to effectively deal with food loss. Overall, agricultural policy and programmes should focus on the provision of product handling training, loss management techniques and effective coordination among agents. The results of the study show the need to strengthen research towards post-harvest handling technologies and policies since it has been tilted towards production and preharvest (Affognon et al. 2015). Improvement in management and handling systems along the chain is expected to result in lower levels of losses and high-quality products. These have implications for availability, accessibility, acceptability and affordability.

Operationally, farmers have lower yields and postharvest activities are manually and inefficiently performed. The crop is grown in conditions that make it entirely dependent on the natural environment and thus increases risk and vulnerability. Producers do not invest in the use of high yielding varieties or adopt practices to improve soil fertility and pests control. Inadequate storage facilities conditioned to have optimum humidity and temperature has a negative influence on quality specifications and prices. It leads to losses and high chances of product rejection. Poor storage facilities also limit the retention of high volumes of beans and deter traders from purchasing high volumes to meet seasonal demands. Long travel distances, poor roads, inefficient transportation system makes it difficult for traders to easily purchase beans to make them accessible to consumers. Inaccessibility to credit facilities limits investment towards expansion and upgrading of the business to reach more and diverse consumers. The marketing structure of the produce needs to be enhanced through cost/value based pricing, the formation of strong linkages between agents and access to financial assistance.

Value chain actors that meet the specific needs of consumers have a competitive edge because they are able to provide acceptable products. Profits as opposed to meeting the preferences of target consumers had a major influence on the activities of value chain actors. Acceptability characteristics have not received much attention in the design of programs to increase consumption. Beans not meeting factors such as colour, appearance, cooking characteristics, storability etc. may make it largely unacceptable and thus less consumed. Efforts to improve bean marketing should not overlook consumer value through the improvement of bean quality and diversification towards value-added products. Storage of beans through the use of appropriate methods that does not only lead to increase shelf life but contribute to safety and nutrition needs to be considered. There is also a need to conscientize value chain actors to undertake activities along the chain based on quality standards and consumer requirement.

Findings obtained showed that weather, input availability and consumption of beans had changed over the years. Agility along the chain is very low, value chain actors are not agile because they are not able to respond to changes adequately and quickly. The study finds that the lack of assets was the major contribution to the inability of the actors to adapt to change and scale-up activities to meet consumer requirements. Upgrading the food value chain and particularly the common bean value chain is necessary to have value chain actors participate in the changing yet growing market. Awareness of these changes is critical, however, the ability to respond to them is key. Governmental and non-governmental institutions can play an important role in enhancing farmers asset acquisition and growth.

5.5 Conclusion

Performance assessments of value chains have numerous advantages. They provide measurable outputs which can be used by value chain actors to assess their efficiency in performing activities and meeting specific goals. They can also serve as benchmarks for comparison and, basis for decision making and strategy development, especially for policy support. Performance evaluations with respect to meeting consumer preferences and largely contributing to achieving food security have not been undertaken in food value chains.

The study formulated a performance index with indicators that are not complex, easy to identify and survey and appropriate to best assess the performance of the agri-food value chain. The main goal of assessing the performance of the chain in meeting food security indicators was to be able to create a link between the indicators and operations along the chain. It is a way of translating food security indicators into operational terms at the individual value chain level. The results of the study are applicable at different levels for researchers and especially value chain actors and policymakers who require clear and concise indicators to measure performance and implement strategies.

The index was applied to evaluate the performance of the common bean value chain. Different variables were used in the index because a single variable cannot best provide all the needed information. Only variables that were correlated with the index were used in the assessment. Performance of the chain was assessed based on food security indicators (availability, accessibility, affordability, acceptability and utilization) and 8 dimensions within which the value chain operates. The performance of the common beans value chain in meeting consumer preferences and food security indicators was found to be below optimum. It is evident that activities were not performed with the consumer and their requirements in mind. Consumer requirements for easy access to desired quantities of quality, safe, nutritious and affordable beans and varieties at all times is not adequately provided by value chain actors.

The common beans value chain scored below average for all indicators, 36.2% for availability, 48.8% for accessibility, 46.2% for affordability, 41.5% for acceptability and 39.48% for utilization. Lower scores on availability (36.2%) and utilization (39.5%) indicators show that critical attention is required in those areas without neglecting others.

Performance scores were found to be influenced by value chain characteristics and agents. There were several challenges such as the inaccessibility to markets, power asymmetry, lack of information, inefficient production and marketing techniques which hinder the performance of the value chain. Other factors include low stakeholder involvement, lack of financial and technical capacity, low trust and lack of value creation opportunities. These factors are reflected in the low performance scores for the value chain dimensions used in measuring the efficiency of activities and their effect on food security indicators. The value chain obtained lower scores for agility

(37.1%) and management (39.4%) dimension and a higher score for the economic dimension (54.8%). Correlation analysis revealed correlations between dimensions and food security indicators. Cluster analysis revealed similarities among value chain actors based on performance scores. The majority of actors were found within the cluster characterized by higher scores in affordability and accessibility.

The performance of the value chain should be improved by reducing costs, increasing outputs, affordable pricing, improving the quality of the product and the marketing system. This will however, require the involvement of other private and public sector stakeholders who can influence value chain actors positively. The capability of the value chain actors to offer food and create value for consumers without compromising on the worker, the environment, consumer preference and safety is important for optimum performance of the chain.

Connecting text

In Chapter 5, the performance of the common bean value chain in meeting consumer preferences and food security indicators were assessed. The structure and dynamics of the common bean value chain were also discussed. The results reveal that the common bean value chain was performing at a low negative level in meeting consumer preferences and food security indicators. The low score was found to be attributed to the inefficient performance of the activities along the chain and constraining factors. Based on the findings, it is recommended that value chain actors adjust and align their activities to meeting consumer preferences.

Meeting consumer preferences however requires investment which can be costly. Value chain actors will be willing to invest only if it will be economically viable to do so. Based on this, Chapter 6 focuses on assessing the economic viability of meeting consumer preferences. This is accomplished by assessing the additional amounts consumers are willing to pay to have their preferences met and how current activities along the value chain (specifically storage practices) affect consumer value and profitability.

CHAPTER 6 Assessment of the economic viability of meeting consumer preferences and food security indicators

Abstract

Achieving food security indicators and meeting consumer needs is dependent on meeting two requirements. The food must be accessible, acceptable and affordable, and the consumer must choose to consume it. Consumers will choose food that meets their preferences and value chain actors have the responsibility of providing such foods. The focus of the study was to determine if investment in such changes by value chain actors will be worth it and how current storage practices affect consumer value and profitability. The results of the study showed that consumers were willing to pay additional amounts ranging from 13% to 25% of the average price to have their desired bean attribute levels. This was an indication that investment in the meeting consumer preferences will be worth it. A value selection index was developed as a tool to aid value chain actors maximise profits by meeting consumer requirements based on economic values for attributes and attribute levels. Based on the selection index, scenarios were created to estimate the economic benefits for meeting consumer preferences for different attributes. The estimates showed that improvement of different combinations of attribute levels is likely to result in between 11 % to 79% increase in profits. To determine the impact of current practices on bean attributes and potential profits, the impact of storage conditions on beans was studied. Storage in warm temperatures and over long periods was observed to have negative quantity and quality effects. Specifically, storage methods and conditions resulted in significant changes in colour (darkening of beans), shine (less shiny), cooking time (increased cooking time), quantity (losses due to infestation) and moisture content (lower moisture content). Due to this, profit margins decreased from 26% to 65%. It is recommended that beans should be stored in lower temperatures and with hermetically sealed packaging materials which creates an environment that reduces insect infestation and results in better quality products.

6.1 Introduction

Improving food security is dependent on meeting demand and supply side requirements along the food value chain. On the demand side, the food must be available, accessible and affordable to the consumer who must choose to eat the target food. Beyond the nutritional value of food, the product must be acceptable to consumers based on product attributes, social norms, tastes, preparation practice, ease of preparation etc. These factors, if not met, can reduce acceptability and overall intake (Maestre et al., 2017). On the supply side, there must be aligned interest to produce, process and distribute the food. This aligning of interest will involve an initial need for the value chain actors to be willing to adjust their activities to meet consumer requirements. A change in practices and the adoption of modern technology will then be necessary not only to improve productivity but also quality based on consumer preferences.

Improving productivity involves the availability and utilization of effective and efficient inputs to increase yield, expand farm size, access to credits, risk reduction, etc. (Duflo et al. 2011; Croppenstedt et al., 2003). There has been a significant focus on technology adoption and factors influencing adoption. Although important in agri-food development, information and knowledge are intangible inputs that can significantly affect the performance of value chain actors. It is also an essential condition for technology adoption. Thus, if value chain actors do not have adequate information about the benefits of using a particular technology or changing a practice, adoption is likely to be minimal. This could explain the reason for the low adoption of modern technology especially in Africa (Evenson and Gollin, 2003; Sheahan and Barrett, 2014). Value chain actors will, therefore, require knowledge on consumer preferred attributes, how individual activities along the value chain influences consumer attributes, what changes are necessary and the benefits of aligning their activities to meeting consumer preferences. Doing so requires investments in terms of time and money in gaining access to consumer preference information, new technologies and practices to produce high-quality products. Therefore, there should be a motivation for value chain actors to invest in new methods and technologies.

In this section, the study determines if and how much consumers are willing to pay to have those desired preferences met. Further, the impact of value chain activities on premium attributes (those that consumers are willing to pay more to obtain) is assessed. Lastly, the impact of the value chain activities on economic benefits to be obtained from providing premium attributes is evaluated.

6.2 Methodology and data collection

6.2.1 Consumer survey

Data for this objective was collected from two sources, a field survey by interviewing consumers and from lab experiments. The consumer survey was undertaken to determine consumers' willingness to pay for additional units of their preferred attribute. The sample size for the consumer survey was 200 consumers in rural and urban Zambia. Consumers were randomly selected for interviews at their homes or the market centres. The questionnaire was made up of structured questions and was made up of 5 parts. The first part contained questions regarding the demographic characteristics of the respondents. The second part constitutes questions regarding the attributes (levels) of beans consumers usually find on the market. In the third section, consumers were requested to rank (relative weights or scores) their preference for bean attributes ranging from 0 (not important) to 5 (most important). They were first asked to choose from a list, the most important attributes and then rank the selected attributes. Table 6.1 provides details of the attributes considered and their levels. The attributes were selected based on literature review and pre-survey tests undertaken. The answers were averaged across consumers to determine the relative weight for each attribute. Data was collected from both rural and urban consumers.

Table 6. 1: Attributes considered in the sturdy and their levels

Attribute	Levels	References
Colour	1=Mixed,2= Red, 3=White, 4=Yellow, 5=Brown	DeYoung et al. (2017); Katungi et al. (2011); Sichilima et al. (2016); Mishili et al. (2009a); Medard (2017); Magreta and Jambo (2012); Hella et al. (2013); Quaye et al. (2011)
Size	1= small 2= medium 3=Large	
Taste	1=Not tasty 2= Slightly tasty 3 = Tasty	
State	1 = No hole, not broken, insects 2= No insects, not broken 3= No insect, bored, broken, bored, 4= No insect, bored or broken beans	
Appearance	1= Not shiny 2= Slightly shiny 3= Very shiny	
Cooking time	60 mins to 300 mins	
Aroma	1= Unpleasant 2= Normal 3= Nice	
Gas accumulation (flatulence)	1= More gas accumulation 2= Less gas accumulation 3= No gas accumulation	

Consumers were then requested to indicate their preferred level of each attribute and indicate the amount they were willing to pay for an additional unit of their preferred level of the attribute (comparison with the attribute levels found on the market). The amount was specified based on a kg of beans and the current market price. Different quantities were reported by consumers however, they were all standardized to 1kg.

The survey information was employed in estimating economic values for bean attributes and developing a Value Selection Index tool to aid value chain actors maximize profits by meeting consumer requirements.

6.2.1.1 Value Selection (Economic) Index

A selection index (I) is a linear function of attribute values (R) for *n* product attributes, each of which is weighted by their economic values (EV). Optimal changes can be made when selection is made on an index since each quality is weighted based on the relative weight (preference value) and the economic values. Selection is useful in making the necessary changes to attributes (Hazel, 1943). It is used as an activity objective where attributes with a higher economic value are placed in a single index (Hermesch et al. 2015). All factors that affect the price apart from bean attributes are assumed to remain the same, while changes are made to attributes and their economic values. The index is calculated as the sum of the attribute preference levels (weighted) and their economic values.

$$I = EV_x R_x + EV_y R_y + EV_y R_y \qquad \text{eqn (6.1)}$$

Economic weight derivation

The economic values for the product attributes were obtained by employing the production model (Gibson and Dekkers, 2003). The economic value of a trait is defined as the increase in price with a unit change in the attribute with all other traits kept constant. This is the value of a unit of improvement of an attribute (Hagan et al., 2016). Applying this to the food industry, economic value is the additional amount consumers are willing to pay for the product (attribute) with a unit change in the attribute with all other attributes kept constant. They reflect how the improvement in those attributes impact overall profitability and consumer satisfaction (Zhang et al. 2011). The average weights provided by consumers for each attribute was used in estimating a correction factor to obtain the true economic values. This was done to ensure that the economic values were a true representation of the rankings provided.

The economic value for each attribute is the product of the willingness to pay (WTP) amount stated and the weight (level of importance) assigned to the attribute.

$$EV_i = WTPammount_i * w_i$$

Where EV_i is the economic value of attribute i and w_i is the weight placed on attribute i.

6.2.1.2 Simulation (Prediction of attribute and monetary responses based on different selection criteria)

Following Hagan et al., (2016), multiple attribute selection approach and single attribute selection methods are applied to determine the economic response of the index when each of the selection methods is employed. It's a what-if analysis where the parameters in the index are varied while others are kept constant to determine how they influence the overall profitability. For the multiple attribute selection method, more than one attribute is selected and considered to contribute to profitability. For a single attribute selection method, only one attribute is considered, and the economic value of all other attributes are assumed to be the same. Thus, for each selection method, the total economic benefit which will be obtained from using the selection criteria is estimated as the sum of the economic value of each attribute and the weights placed on them.

The total economic benefit for each selection method (TR_{sm}) is

$$TR_{sm} = EV_x w_x + EV_y w_y + EV_z w_z \qquad \text{eqn (6.2)}$$

Where *x,y,z* are different product attributes.

Data is analysed using Excel and results are presented by employing descriptive statistics. Differences in index scores were tested across bean varieties using the ANOVA (F-test) based on Scheffe test by employing SAS version 9.4.

6.2.2 Lab experiments

Different forms of data were collected in the lab. The physical product, texture, and nutritional qualities of the beans were tested over varying storage lengths. Approximately 10kg of two bean varieties, *kabulangeti* beans and *sugar* beans, were collected after harvest from smallholder farmers in Luwingu in the Northern Province of Zambia in February 2019. The beans were placed in airtight bags and transported to the lab for the storage tests. The beans were stored over a period of 5 months under different temperatures (15°C, 25°C and 35°C) and a constant relative humidity of 60-65% RH for all three temperatures, the relative humidity was maintained by using concentrated sulphuric acid (O'Brien, 1948) and with different packaging materials (plastic bag, jute sacs and hermetic storage). The relative humidity was selected considering the average relative humidity in the Northern Province of Zambia. The temperatures and duration of storage were chosen to reflect the conditions in the Northern Province of Zambia. The samples were packed and stored in an incubator maintained at the selected temperatures.

The beans were placed in plastic bowls and properly sealed with the screw cap, in triple-layer bags (layers of low dense polypropylene bags and woven polypropylene bag on the outside). The triple-layer bags were designed to replicate Purdue Improved Crop Storage (PICS) which are made up of two inner bags of high-density polypropylene bags and outer woven polypropylene bags. These bags have been designed to reduce insect damage and are commonly used in Western and Central Africa for crops such as maize and groundnut (Murdock et al., 2012; Williams et al., 2014). The beans after being tightly sealed were placed in the woven propylene bag (jute). A third sample of the beans was stored in woven propylene bags (jute) and tightly sealed by winding a rope around it. 100g of beans were taken from each of the three packages for testing. This was done for the selected varieties. A completely randomized design was used where blocks represent the storage conditions (jute bag, plastic container, and triple-layer bag), and the sub-blocks comprise of the storage periods (0, 30, 60, 90, 120, 150 days). The following tests were undertaken;

Size

The dimensions of the beans were measured using Venier Caliper (Mastercraft, Vonore, Tennessee, USA). The length and width of each variety was determined using a representative of 50 seeds of each variety.

Colour

The colour was measured using a colorimeter. The measurement was done using CEILAB colour scale (L*a*b*) which is widely used (Yousif et al. 2007). L*is lightness, a* (chromaticness in the direction of green (−) to red (+)) and b* (chromaticness in the direction of blue (−) to yellow (+)), C ($[a^{*2} + b^{*2}]^{1/2}$) is chroma or colourfulness and h^0 is hue and $dE^* = \sqrt{dL^{*2} + da^{*2} + db^{*2}}$ is defined as the color distance (sphere around the actual target value). Color change for each of the samples was tested after storage in different temperatures (15°C, 25°C and35°C) and over time. The instrument was calibrated using standard white plates before measurements were taken.

Seed damage

The conditions of storage could lead to insect maturity and multiplication as well as mould formation. The presence of insects was, therefore, determining every month, the approximate number of live and dead insects as well as bored seed were noted. This was achieved primarily by observation and counting of both live and dead insects (Tripathy et al. 2001) manually.

Cooking time and texture analysis

One hundred dry unsoaked beans were selected for the cooking test. The beans were cooked in 200 ml of distilled water in a water bath at 96°C until beans were fully cooked. At 30 min intervals, ten seeds were randomly selected for texture analysis. Cooking time was determined as the overall time, required for more than 50% of the beans to get cooked. This was based on a subjective cookability practiced by consumers. The cooked beans were pressed between the thumb and the forefinger to determine its cookability. The beans were considered cooked if the cotyledons disintegrate upon pressing. This subjective criterion for bean hardness evaluation has also been used by other researchers (Kinyanjui et al., 2015; Vindiola et al., 1986.).

Water absorption

Water uptake was monitored after cooking. The cooked beans were transferred to a paper towel and blotted out to remove excess water after which it was weighed. Water absorption values were expressed as a percentage of water absorbed and grams of water absorbed per kilogram of beans. The weight of the cooked beans and the changes in weight were measured since it is important to consumers.

Chemical analysis

Proximate characteristics of the cultivars were determined. The Dumas combustion method in accordance with AOAC method 968.06 (AOAC, 2005) was used to determine the total nitrogen content of bean powders from which the crude protein content was estimated. The moisture content of pulverized samples was measured using the hot air oven method AOAC Method 925.09 (AOAC, 2005). Crude fat was determined by the petroleum ether extraction method (AOAC method 963.15) using solvent extractor (SER 148/6, VELP Scientifica, Usmate, Italy).

Protein digestibility

Protein digestibility was determined based on an in vitro digestibility assay method (3 enzyme method). The analysis was carried out by preparing a multi-enzyme solution including trypsin

(1.6mg), chymotrypsin (3.1 mg) and peptidase (1.3 mg) and added to the prepared sample at a pH of 8.0. The sample preparation includes 100g of the bean flour dissolved in 10ml of distilled water and rehydrated at 37 degrees for an hour after which 10ml of the aliquot of the enzyme solution is added to the sample with a pH of 8.0 (pH adjustment is made with NaCl and NaOH). After 10mins of reaction, the pH change is recorded and used in the calculation of the in vitro protein digestibility (Nosworthy et al. 2018).

$$Y = 210.46 - 18.10X$$

Where X is the pH change after 10 mins.

Statistical Analysis

Statistical analyses were made with the JMP Pro (version 13.0) software package for Windows (SAS Institute Inc., Cary, NC, 1989-2016). Significance differences among samples were separated using the Least Significant Difference (LSD) at a 5% probability level. A comparison of means was done using the Turkey-Kramer HSD model.

6.3 Results

6.3.1 Determination of price effects (consumer willingness to pay for additional units of attribute levels)

Consumers indicated their preferences for different bean attribute levels. With reference to size, 58.5% of consumers had a preference for larger size beans. As expected more than 80% of the consumers had a preference for very tasty beans. All consumers (100%) preferred beans that did not lead to flatulence after consumption. About 75% of the consumers preferred beans that were slightly shiny, as opposed to very shiny (Figure 6.1).

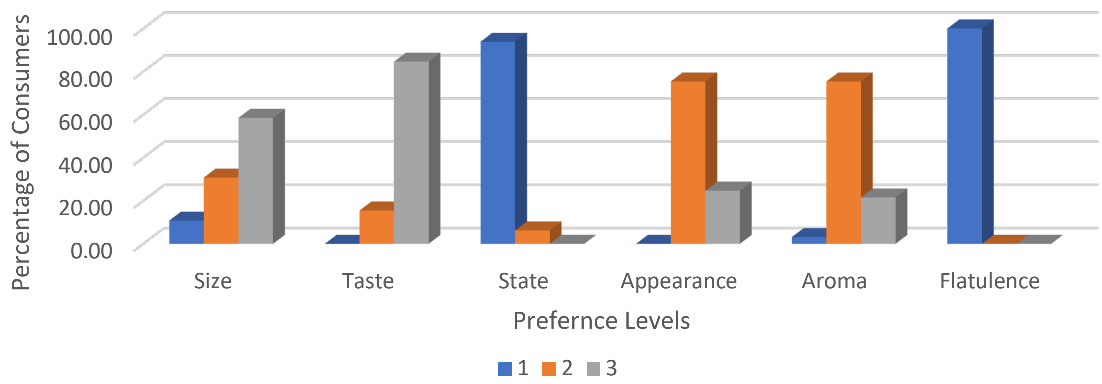


Figure 6. 1: Percentage of consumers who indicated preferences for different levels of attributes (A description of the attribute levels are provided in Table 6.1).

All consumers preferred beans that did not have holes and were not infested or broken, however in the situation that perfect beans could not be made available, 93.9% preferred beans that had no insect, not bored but broken. The presence of foreign materials in beans and variety have been found to influence consumer preference for beans (Munda, 2010). The majority (75%) of consumers also preferred beans that had a normal aroma as opposed to a stronger aroma even if pleasant (Figure 6.1).

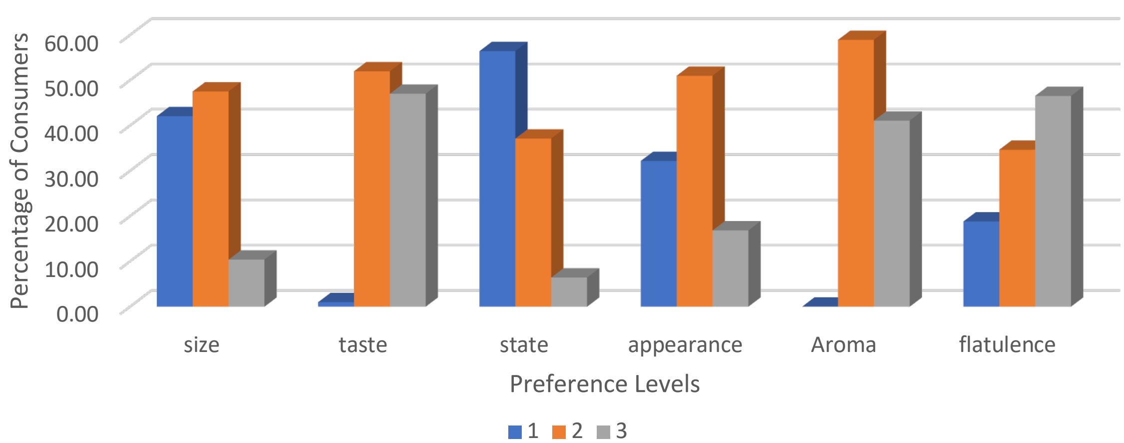


Figure 6. 2**:** A description of the attributes (levels) of beans found in the market. Percentage of consumers who indicated different levels of attributes of beans in the market (A description of the attribute levels are provided in Table 6.1).

Figure 6.2 shows the average levels of attributes of beans commonly found in the market and available to consumers. Averagely, beans on the market have smaller sizes, slightly tasty, good aroma (normal), slightly shiny, had no insects, not bored but broken and resulted in flatulence after consumption. Considering the preference levels of beans consumers desired, it appears that the preferences for taste and state are being met while that of size and flatulence are not. However, considering that consumers also agreed to pay an additional amount to have their preferences met, indicated that the level of satisfaction for these attributes can be improved. Also, the considerably high percentage of consumers who did not have their preferred levels of particular attributes shows that the market did not adequately meet consumers' preferences. For instance, only 6.2% of consumers preferred beans that had no insects, not broken but bored (Figure 6.1) but 37.13% mainly had beans with this state available to them even though they did not have a preference for it (Figure 6.2). Majority of the consumers preferred beans that were shiny; however, 32.2% of the consumers found mainly beans that were not shiny on the market. Although 21.5% of the consumers preferred beans that had a stronger but pleasant aroma, about 20% more consumers were offered beans with this attribute even though they did not have a preference for it.

About 42.5% of the consumers indicated that the beans available in the market required 240 mins to cook. However, >50% of the consumers preferred beans that required less than 90 mins to cook. Both groups of consumers preferred brown coloured beans to all other colours followed by yellow beans. However, there were more mixed coloured beans on the market. About 39.5% of rural consumers preferred *kabulangeti* and 33% preferred *lusaka* beans. However, *mixed* beans were the variety mainly found on the market. This negatively influenced the preference and satisfaction derived from consuming beans. With respect to varieties, consumers may prefer single varieties and may discount mixed varieties of beans (Mishili et al. 2011; Sambo, 2013). Among urban consumers, the preferred variety (46.5%) was *kabulangeti* which was also the major variety available on the market as indicated by consumers (30.2%). Therefore, in terms of bean colour and variety, the majority of the urban consumers had their preferences met. The results generally reveal that the market was not adequately meeting the preferences of consumers. This is largely influenced by the activities undertaken by producers and traders of common beans. A breakdown of the mean attribute levels of beans by consumers in rural and urban areas are presented in Table 6.2.

Table 6. 2: Mean attribute levels of beans

Attributes	Min	Max	Mean (Rural)	Mean (Urban)	Mean (Zambia)
Colour	1	6	1	5	5
Size	1	3	1	2	2

Taste	1	3	2	3	2
State	1	3	1	2	2
Appearance	1	3	2	2	2
Cooking time	60	300	7 (240)	6 (210)	6 (210)
Aroma	1	3	2	3	2
Gas accumulation (flatulence)	1	3	3	2	2

The average bean price for 1kg of beans in Luwingu among rural consumers is K10 and for urban consumers it was K20. Bean attributes on the market slightly deferred among rural and urban consumers. Rural consumers mainly had access to mixed coloured bean varieties while urban consumers have brown coloured beans. Grain color has been found to be important among consumer in Tanzania and Malawi (Mishili et al., 2009; Magreta and Jambo (2012). They were explained to give an attractive and appealing look (Samba, 2013). Consumers in Kenya were willing to pay a premium for color (Gigonta, 2013).

Generally, rural consumers mainly have access to small size beans, slightly tasty beans, beans that were bored, beans with normal aroma and high gas accumulation after consumption. Urban consumers mainly had access to beans that were medium-sized, very tasty, strong but pleasant aroma, and less flatulence after consumption.

Consumers were, therefore, requested to select the five most important attributes out of the 8 and rank them in the order of preference (Table 6.3). Taste was ranked as the most important attribute to both rural and urban consumers. Rural consumers ranked colour as the next important attribute followed by size, appearance and cooking time. Urban consumers ranked flatulence as the next important followed by cooking time, state, appearance, size, colour and aroma. Cooking time and flatulence were important to the majority of urban consumers probably because convenience is important to them and for rural consumers cooking time also implied high fuel consumption. Consumers are more likely not to consume beans because of the long cooking time which makes it inconvenient for consumption (Legato, 2014). In addition to the long cooking time are the high fuel requirements and the monotonous flavour which are not preferred by consumers (USAID, 2012; Vaino et al., 2016).

Table 6. 3: Ranking of attributes

Attributes	Ranks		
	Rural	Urban	Zambia
Colour	3.40	2.55	3.08
Size	2.94	2.56	2.81
Taste	4.24	3.67	3.97
State	-	2.95	-

Appearance	2.19	2.76	2.42
Cooking time	2.18	2.99	2.56
Aroma	-	2.53	-
Gas accumulation (flatulence)	-	3.51	-

Although consumers may indicate preferences for these attributes, they may not be willing to pay additional amounts to have them. To determine this, consumers were requested to indicate if and how much they are willing to pay for an additional increase or decrease (cooking time and flatulence) in their preferred attribute. The estimated economic values are given in Table 6.4. Rural consumers were willing to pay additional amounts ranging from 13% to 21.5% of the current price for a kg of beans. Urban consumers were, however, willing to pay a slightly higher price (3-4%) due to their higher income levels and thus had the ability to pay. The additional amounts urban consumers were willing to pay ranged from 16.8% to 25.7% of the current price for a kg of beans. Economic values for state, aroma and flatulence were not estimated for rural consumers because they were not indicated as a preferred variety by more than 50% of the rural consumers. Due to this they were also not included in the estimation when both groups of consumers were considered.

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Table 6. 4: Derived economic values for product attributes (in Zambian Kwacha)

Attributes	Economic values		
	Rural	Urban	Zambia
Colour	1.94	3.49	3.24
Size	1.34	3.35	2.55
Taste	2.15	3.92	4.55
State		3.67	
Appearance	1.30	3.60	2.81
Cooking time	1.32	3.58	3.18
Aroma		3.50	
Gas accumulation (flatulence)		5.13	

Urban consumers were willing to pay a higher additional amount (25.7%) to have beans with zero or lower flatulence. This is an indication of the level of importance attached to this attribute. Flatulence factor is associated negatively with the preference for beans (Ferris and Kaganzi 2008). While other factors may not have a strong influence on the preference for beans, flatulence was found to be key by Gigonta (2013) with consumers paying a discount for it. Although the taste was ranked highest, urban consumers were willing to pay a higher amount to have beans with lower flatulence compared to tastier beans (19.6% more of the current price). Rural consumers were, however, willing to pay a higher amount for an increase in taste (21.5% more of the current price) followed by colour (19.4% more of the current price) of which their preference is brown. This is expected since mixed-coloured beans are mainly available on the market instead of a pure colour. Consumer choice for the different bean types is influenced by the dish to be made and the taste (Gigonta, 2013).

The size was the third most important to rural consumers who preferred larger beans but mainly had access to small-sized beans and thus were willing to pay 13.4% more of the current price. Urban consumers were willing to pay 17.9% more to have beans that required at least a unit decrease (30 minutes less) in cooking time. However, they were willing to pay higher additional amounts for appearance (18% more of the current price) and state (18.4% more of the current price). Bean size contributes to volume, large grain size has been indicated to swell when cooking. (Chirwa, 2007). Consumers in Tanzania were willing to pay a premium for large bean sizes (Mishili et al., 2011). Gloss though not assessed in most studies was found to be an important factor among bean consumers (Mishili et al., 2011). In this study, it is defined as appearance.

Urban consumers had beans that were bored while rural consumers had access mainly to not bored but broken beans, this contributes to the higher additional amount they were willing to pay. The state of beans contributed to long preparation time due to sorting time and also food safety. Averagely, consumers in Zambia were willing to pay additional 30.3% of the current price for a unit increase in taste, 21.6% for their desired colour and 21.2% for beans with lesser (a unit decrease) cooking time. When considered together, rural and urban consumers attributed importance to these attributes and were willing to pay more to have them at the level that met their preferences. This implies that value chain actors are very likely to benefit financially from providing beans with these attributes. If consumers are willing to pay such premiums for 1kg of beans, the investment required in providing these attributes is likely to be worthwhile and also increase demand and consumption of the product. The economic values for the different attributes are inherently the monetary value consumers place on those varieties since they are amounts for additional units of an attribute.

The attributes which were considered as important to consumers and their economic values were imputed into an index to enable value chain actors not only visualize what consumers considered important but also determine how improvements in specific attributes is likely to improve or reduce the profitability

6.3.2 Value Selection Index

The results show that product attributes contribute to profitability. A single product attribute could be improved or multiple product attributes could be improved together. Different scenarios were therefore studied to determine their influence on the economic return to the value chain actor (producer or trader). The economic returns or changes in profitability as a result of a unit increase or decrease in the bean attributes were estimated based on average bean prices paid by rural and urban consumers. Rural consumers paid an average of K10 for 1kg of beans, while urban consumers paid K20. An average price of K15 was used in the estimation when both rural and urban consumers were considered. The estimated economic return is, therefore, the final price consumers are willing to pay when there is a unit increase in all the attributes.

The economic return estimated from the index takes into consideration only the attributes of the beans without other cost factors required for the production and sale of the beans. It is assumed that the price at which the beans are sold to consumers covers largely production and marketing cost. Consumers indicated additional amounts based on the current price of the product which means those costs have been indirectly considered. The economic returns estimated, therefore, provide an estimation of how profits can be increased for value chain actors when consumer preferences are taking into consideration and met.

Table 6.5 is the value selection index which can be used to estimate profitability or premiums value chain actors are likely to obtain when bean attributes indicated in the table are improved. This is estimated for rural, urban, and both consumers combined. The formula for the index is specified below, Eqns. (6.3-6.53) for rural consumers, urban consumers and both consumers combined, respectively. The attributes in brackets represent mean attribute levels or attribute levels averagely found in the market, which can be improved or reduced.

$Value\ Index\ (premium/profits) = 1.94 * (colour) + 1.34 * (size) + 2.15 * (taste) + 1.3 * (appearance) - 1.32 * (cooking\ time)$---eqn (6.3)

$Value\ Index\ (premium/profits) = 3.49 * (colour) + 3.35 * (size) + 3.92 * (taste) + 3.6 * (appearance) - 3.58 * (cooking\ time) + 3.67 * (state) + 3.5 * (aroma) - 5.13 * (flatulence\ reduction)$-----------eqn (6.4)

$Value\ Index\ (premium/profits) = 3.24 * (colour) + 2.55 * (size) + 4.55 * (taste) + 2.81 * (appearance) - 3.18 * (cooking\ time)$---eqn (6.5)

From the Index in Table 6.5, the mean value index considering rural consumers is K10.94. This is the amount consumers are willing to pay for average levels of the attributes considered in the index. The mean value index considering urban consumers is K29.21. Urban consumers are willing to pay K29.21 for mean levels of attributes in the urban market. Urban consumers considered more attributes important compared to rural consumers such as flatulence and state which were not considered by the majority of the rural consumers. This influenced the higher mean value selection index as well as the high economic value urban consumers attributed to a unit increase or decrease of each attribute. When both groups of consumers are assessed together, without consideration of the attributes which urban consumers did not consider important, the mean value index was found to be K16.9. The economic values (reported in Zambian Kwacha) from the index are also the amounts value chain actors are going to receive when the mean levels of the attributes are provided to consumers. Premiums or profits are additional amounts to the current bean prices.

Table 6. 5: Value selection index

Economic return	EVcol	Colour	EVsiz	Size	EVtas	Taste	EVapp	App	EVcok	CookT
					Rural consumers					
10.94	1.94	1	1.34	1	2.15	2	1.3	2	1.32	7
					Both rural and urban consumers (Zambia)					
16.94	3.24	5	2.55	2	4.55	2	2.81	2	3.18	6
					Urban consumers					
29.21	3.49	5	3.35	2	3.92	3	3.6	2	3.58	6
	EVstate	State	EVaroma	Aroma	EVgas	Gas Acc				
	3.67	2	3.5	3	5.13	2				

The economic values indicate the monetary value consumers place on each attribute. Based on this index, simulations were made where adjustments, specifically additional unit improvements were made to either single or multiple attributes to determine how they impact the value selection index (overall profitability). These simulations are presented in Table 6.6.

6.3.3 Value selection index simulations

The bean attribute levels and the economic values produced different outcomes for different strategies. Scenarios were created where single and multiple attributes were changed to determine their impact on the index. These scenarios were created based on assumptions. Some attributes can be more easily improved by value chain actors compared to others. For instance, storage method and duration have been found to impact the appearance (shine) and cooking time (Elias et al. 2016; Kinyanjui et al. 2016). Thus, value chain actors can improve these attributes by using adequate storage methods. The state of the beans is dependent on how beans are handled after harvesting and the storage method. Thus, the state of beans can be improved when activities are performed more efficiently. With regards to colour, storage is known to make beans darker (Kamau, 2016). Value actors can, therefore, improve on colour by using the appropriate storage methods. Colour is also intrinsic to the bean variety. Thus, consumer preferences for different colours of beans will require value chain actors to produce and offer the varieties that have the preferred colour.

Attributes such as flatulence, aroma, taste, and size can be difficult to improve by value chain actors and will involve the development of new varieties that possess the attribute levels consumers prefer. New varieties with shorter cooking times can also be developed. In any case, all the attributes can be improved through seed development. It is important to note that an improvement in one attribute may lead to a reduction in another attribute since the attributes are not independent of each other. For instance, while varieties with small sizes may have the desired colour consumers prefer, the size may be undesired. Thus, an index is useful in enabling value chain actors to determine which attribute can easily be improved and how different trade-offs influence the profits they are likely to make. This is important for decision making when there is a need to meet consumer preferences and still make a profit.

Table 6.6 presents simulations to the index with a focus on rural consumers. In scenario A, improvement is made with respect to appearance with all other attributes held constant since is it can be improved through storage. In scenario B, cooking time is improved with all others being held constant. In scenario C, multiple attributes are improved, namely cooking time and appearance since they can all be affected by storage. In scenario D, multiple attribute selection is made where taste and colour, the two most important attributes considered by consumers are improved. Colour is improved since value chain actors can choose to produce and trade beans with the colors consumers prefer. Taste though difficult to improve is an important attribute to consumers. In scenario E, size, taste and cooking time were improved. Each of these attributes are considered at different points of the consumption chain specifically, purchase, preparation and consumption. In scenario F, adjustments are made to the two most important physical attributes which are colour and size.

Single attribute improvements and multiple attribute improvements both led to improvements in the value selection index. All comparisons are made with respect to the mean value index (Table 6.5). Multiple attribute improvements, however, resulted in more substantial increases in the value index (Table 6.6), which implies higher value additions for value chain actors and also for consumers since their preferences are being addressed profitably. There was a 56.0% increase in the value index when the cooking time was reduced by 60 minutes, size increased by 1 unit (larger size) and taste increased by 1 unit (tastier). Comparing the value index for improvement in two attributes, there was a higher percentage increase of 72.9% when colour was improved to the brown colour which is the preference for rural consumers and the taste was improved by 1 unit.

Improvement in cooking time and appearance (36.0% increase), as well as color and size (64.4% increase), resulted in a high percentage increase. This increase was however lower compared to the profits obtained from improving taste and colour. Improvement in cooking time resulted in a 24.1% increase in the value index. These increases are indications of profitability for value chain actors if these improvements are made either through the varieties grown, the means by which the beans are handled and stored or through the development of new bean varieties. It is important to note that the attribute level of colour considered in the estimation of the value index for the different simulations is the one most preferred by consumers.

Table 6. 6: Scenario based value selection index based on rural consumer preferences

Scenarios	Attributes						% change
	Color	Size	Taste	App.	Cook time	Index (K)	
A	No change	No change	No change	+1 unit	No change	12.24	11.88
B	No change	No change	No change	No change	-2 unit (60 mins)	13.58	24.13
C	No change	No change	No change	+1 unit	-2 unit	14.88	36.01
D	+3 units	No change	+1 unit	No change	No change	18.91	72.85
E	No change	+1 unit	+1 unit	No change	-2 unit	17.07	56.03
F	+3 units	+1 unit	No change	No change	No change	18.1	64.44

Index reported in Zambian Kwacha

Table 6.7 presents simulations to the index with a focus on urban consumers. Percent change estimations are made with respect to the mean value index (Table 6.5). In scenario A, improvement is made with respect to size and appearance since they are important physical characteristics although size may be difficult to change. In scenario B, state is improved since value chain actors can undertake practices to produce quality beans. In scenario C, multiple attributes are improved, namely cooking time and appearance since they can all be affected and improved upon by storage. In scenario D, flatulence is improved since its an important attribute to consumers. In scenario E, multiple attribute selection is made. Here, flatulence, cooking time and state are considered since they influence the preparation and consumption of beans. Colour and taste are not considered because the majority of consumers in this group already have the colour and taste of bean they prefer in the market.

Improvement in the state of beans (reduction in insect infestation, broken or bored beans) resulted in a 25.5% increase in the value index. Providing beans with low flatulence factors resulted in a 31.0% increase in the value index. Reduction in flatulence leads to an improvement in economic returns for value chain actors because consumers consider it as highly important.

The highest percentage increase of the value index was realized when improvements were made in cooking time (beans that cooks 60 minutes less), state and flatulence resulting in a 72.3% change (Table 6.7). This is a three-attribute improvement. Among the two-attribute improvement, there was a higher increase in the value index when improvements were made with respect to appearance and cooking time (52.5% increase) compared to size and appearance (38% increase). Cooking time is considered more important to urban consumers compared to size leading to the higher economic returns for value chain actors when improved.

Table 6. 7: Scenario based value selection index based on urban consumer preferences

Scenarios	Attributes									% change
	Color	Size	Taste	App.	Cook time	state	Aroma	Flatulence	Index(K)	
A	No change	+1 unit	No change	+1 unit	No change	No change	No change	No change	36.16	37.96
B	No change	No change	No change	No change	No change	+1 unit	No change	No change	32.88	25.45
C	No change	No change	No change	+1 unit	-2 unit	No change	No change	No change	39.97	52.50
D	No change	No change	No change	No change	No change	No change	No change	-1 unit	34.34	31.02
E	No change	No change	No change	No change	-2 unit	+1 unit	No change	-1 unit	45.17	72.34

Index reported in Zambian Kwacha

Table 6.8 presents simulations to the index with a focus on both rural and urban consumers. In scenario A, improvement is made with respect to appearance with all other attributes held constant. In scenario B, cooking time is improved with all others being held constant. In scenario C, multiple attributes are improved, namely cooking time and appearance since they can all be affected by storage. In scenario D, multiple attribute selection is made where taste and size are improved. In scenario E, size, taste, and cooking time are improved. In scenario F, adjustments are made to the two most important physical attributes which are size and appearance. Colour is not considered because the majority of consumers in this group already have the colour of bean they prefer in the market.

As expected, an improvement in cooking time (a reduction) resulted in a higher percentage increase in the value index compared to an improvement in appearance when single attribute improvements are considered. There was a 37.5% increase in the value index when the cooking time was improved while there was a 16.6% increase in the value index when appearance is improved. Among the two attribute improvements, there was a 54.1% increase when appearance and cooking time was improved by 1 and 2 units (beans that cooks 60 minutes less), respectively. This was higher compared to improvements in taste and size (41.9% increase) as well as size and appearance (31.6% increase). Value chain actors who would want to increase their economic returns can improve on cooking time and appearance through storage techniques and storage length to obtain higher economic value. Value chain actors can meet consumer preferences when they produce and trade beans with larger sizes. Although this may have implications for other attributes either negatively or positively. The index is therefore useful in enabling value chain actors to assess trade-offs within their capabilities and time frame alongside obtainable economic returns. Higher economic returns are however realised when three attributes are improved, specifically, size, taste, and cooking time which resulted in a 79.5% increase in the value index.

Table 6. 8: Scenario based value selection index based on preferences of both consumer groups combined

Scenarios	Attributes						% change
	Color	Size	Taste	App.	Cook time	Index(K)	
A	No change	No change	No change	+1 unit	No change	19.75	16.59
B	No change	No change	No change	No change	-2 unit (60 mins)	23.3	37.54
C	No change	No change	No change	+1 unit	-2 unit	26.11	54.13
D	No change	+1 unit	+1 unit	No change	No change	24.04	41.91
E	No change	+1 unit	+1 unit	No change	-2 unit	30.4	79.46
F	No change	+1 unit	No change	+1 unit	No change	22.3	31.64

Index reported in Zambian Kwacha

In the ideal situation where value chain actors are able to improve by one unit the attribute levels of all the attributes important to consumers, it is estimated that value chain actors are likely to make K10.34 if all the identified attributes are improved by one unit for rural consumers. The new and higher value index implies more than a 100% increase in the index which is a significant value addition for value chain actors who tailor their activities and products specifically towards rural consumers.

Value chain actors are, however, likely to make K38.28 if all the attributes considered important to urban consumers are improved by one unit resulting in a 46.01% increase in the value index. Value chain actors who tailor their activities and products specifically towards fully meeting the preferences of urban consumers will have a significant improvement in profitability. For the combined index, value chain actors are likely to make K30.0 which is a 77.8% increase in the value index when all the attributes considered important to both consumers are improved by one unit. The increase in the value index represents increased economic returns for value chain actors. This ideal situation will, however, be constrained by the fact that it will require a long period of time for all the attributes to be improved in a bean and also huge capital investment.

6.3.3.1 Statistical Results

Table 6.9 presents the differences in index improvements across bean varieties for both rural and urban consumers. Consumers indicated their preferences for different attributes and attribute levels mainly based on their preferred bean variety. Index scores were therefore estimated for the different varieties and the difference in their means statistically tested.

Table 6. 9: Differences in value selection index improvements

Variety	Luwingu		Lusaka	
	Mean	Std err	Mean	Std err
Kabulangeti	20.25a	0.478	11.09	1.744
Lusaka	19.10ab	0.517	9.05	2.078
Mixed	15.77b	1.390	14.91	2.905
White	20.04ab	0.677	11.06	2.487
Solowezi			5.54	2.530
	F- value	3.61	F-value	1.68
	No of obs.	188	No of obs.	185

The same letter in a row indicates no significant difference at 95%

The results show that the index scores were not statistically different with respect to bean variety among urban consumers. For rural consumers, however, there was a statistically significant difference between varieties. Specifically, the value index improvements for consumers who preferred *kabulangeti* to other varieties were statistically different from consumers who preferred *mixed* beans at 0.0280 ($p < 0.05$). This could be because the majority of rural consumers do not prefer mixed variety compared to other varieties and also want pure varieties without any mixtures. This implies that value chain actors are more likely to have higher profits when they focus on producing and selling *kabulangeti* beans which are likely to have the most consumer preferred attributes compared to *mixed* beans. This should be targeted at rural consumers. This has implications for the varieties producers and traders produce and sell respectively. In this case, all other varieties except for *mixed* beans has a higher likelihood of obtaining premiums from consumers.

6.3.4 Determination of Quantity and Quality Effects (Influence of storage factors on product attributes)

Consumers evaluate beans for size, colour, taste, appearance (shine), state (bean damage), aroma, flatulence factors, texture and cooking time. These attributes are affected by postharvest activities and contribute to the acceptability of the beans and utilization by consumers. Thus, storage studies were conducted to determine the impact of storage which is a dominant post-harvest activity undertaken by both producers and traders on selected bean attributes. The bean attributes studied include size, colour, state (grain damage), cooking time and protein digestibility. Common beans are stored for different periods before domestic consumption and up to 7 months or more by farmers in Northern Zambia. Based on this, beans were stored for up to 5 months. The beans are not generally easy to preserve due to the effect of temperature and relative humidity on the quality properties of the beans (Kamau, 2016).

6.3.4.1 Seed size

The length and width of *kabulangeti* beans were measured to be 12.47mm and 7.41mm, respectively while that of *sugar* beans was 14.67mm and 7.05mm, respectively. The results show that *sugar* beans had a larger size compared to *kabulangeti* beans. The storage length and method did not have any effect on the size of the beans. Similar results were observed by Wacu et al. (2015) after storing beans for 6 months. Factors which influence the seed size include genotype, variety, planting period and others (Mkanda et al. 2007). Consumers generally prefer larger size beans and thus would prefer both varieties since they have larger sizes. Medium to larger seeds is preferred because they hydrate and cook well (Mkanda, 2007).

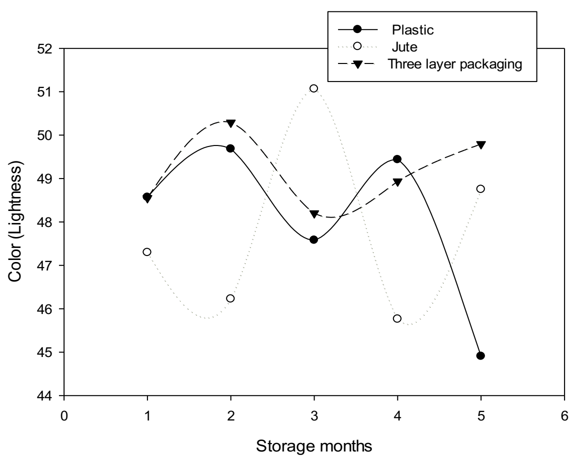
6.3.4.2 Grain damage

There was no grain damage until the third month of storage for both varieties stored in all the three different temperatures and in different packaging materials. However, after the third month of storage, 2 infested *kabulangeti* bean seeds were found in the 35℃ storage. In the 25℃ storage, 5 infested *sugar* bean seeds and 1 infested *kabulangeti* bean seed were found in a 100g of beans. All infested beans were found in the polypropylene (jute) sacs. There were no infested beans found in the 15-degree storage throughout the 5-month storage period. In the fourth and fifth month of storage, *kabulangeti* beans stored in the triple-layer bags at 25 degrees were found to be infested. Although beans were thoroughly sorted out to remove infested and bored beans before storage, the infestation was severe with the whole bag of beans almost infested. There were more than 50 insects in the bag with 40% of them still alive. Beans were stored in batches and infestation was found to be present in a particular batch. Infestation may be due to the presence of bruchid eggs on the surface of the beans before storage. Such beans when present in a lot cause damage to the whole batch. Thus, it is recommended that to reduce losses, beans should be stored in batches as opposed to large lots. Packaging materials which allow for easy storage in batches need to be designed. Thorough cleaning such as washing beyond simply sorting is required to ensure that good quality seeds are made ready for storage. Storage did not result in fungus development on the surface of the beans.

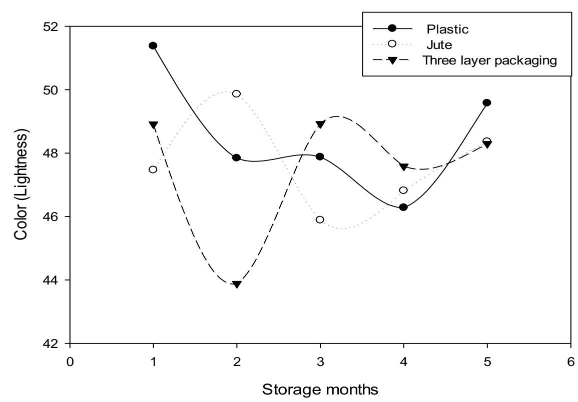
Insects which infested the beans are the bruchids known as *Acanthoscelides obtectus*. They are the most common insect pests affecting common beans (Mutungi et al., 2015). Insect infestation reduces the volume as well as the mass of the beans and also makes beans unacceptable because they affect the physiological qualities. Mutungi et al (2014) and Baoua et al. (2013) found PICS bags effective in reducing insect infestation by stopping the multiplication of insects. These authors used maize, groundnut, pigeon bean and mung bean in their studies. This study found contradicting results for beans stored at room temperature using triple-layer bags. The frequency of opening of the hermetic bags could contribute to reducing the efficiency of the seal in reducing insect infestation (Baoua et al. 2013; Mutambuki et al. 2019). This could be the influencing factor in the results observed.

6.3.4.3 Color

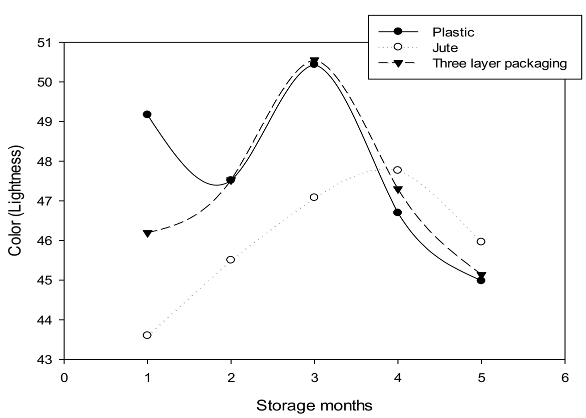
There was visible discolouration of the beans after the 5 months storage. The colour of the beans was observed to darkened after the third month of storage. Studies undertaken by Shaiga et al. (2011) and (Kamau, 2016) also observed a darkening of beans stored for more than 5 months. The darkening is evidence of phenolic compounds polymerization resulting in bean hardening (Srisuma et al. 1989; Reyes-Moreno et al., 2000). Gloss is a property which makes the product shiny. This is an attribute which is considered important by consumers and described as "'appearance" in the study. Although it was not measured, it was observed to decrease after the third month of storage especially when beans were stored at high temperatures (35°C).



(6.3a)



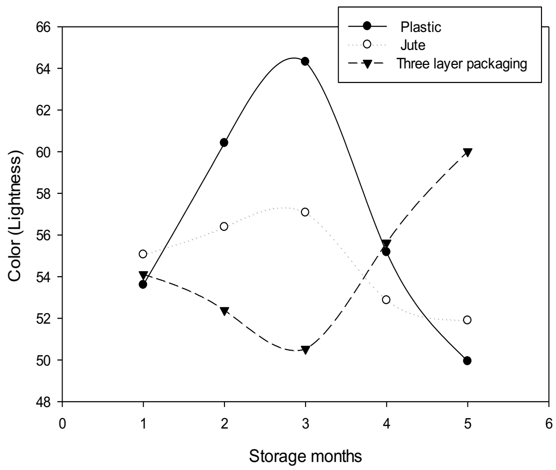
(6.3b)



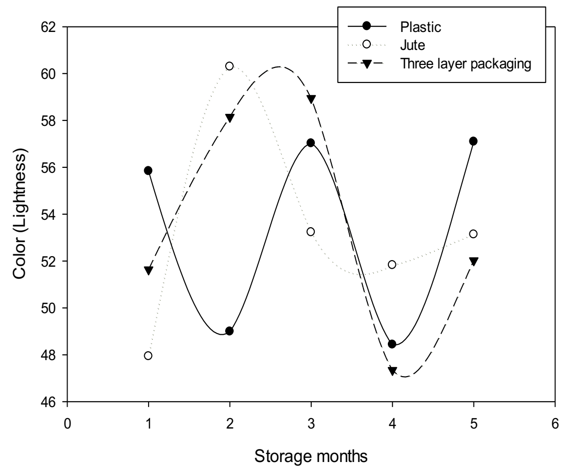
(6.3c)

Figure 6. 3: Changes in color (lightness) for Kabulangeti beans; at 15°C (6.3a); 25°C (6.3b) and 35°C (6.3c)

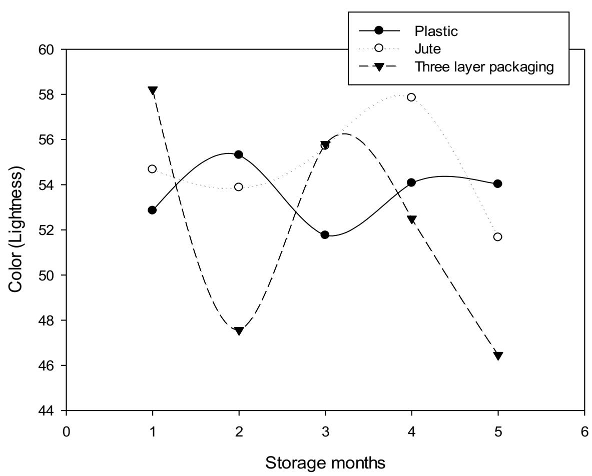
There was a slight variation in the lightness values over the storage months. However, there was generally a reduction in the lightness values at the end of the storage period irrespective of the packaging material or storage temperature. Darkening of beans was found to be more significant over the storage period when *kabulangeti* beans were stored at 35°C irrespective of the packing material (Figure 6.3c). There was also, larger reduction in lightness values for beans stored at 25°C (Figure 6.3b) compared to those stored at 15°C (Figure 6.3a).



(6.4a)



(6.4b)



(6.4c)

Figure 6. 4: Changes in color (lightness) for Sugar beans; at 15°C (6.4a); 25°C (6.44b) and 35°C (6.4c)

Lightness values for *sugar* beans decreased as storage time increased when stored at 35°C irrespective of the packaging material (Figure 6.4c). A decrease in lightness of *sugar* beans was observed with beans stored at 25°C with jute and triple-layer bags (Figure 6.4b). Similar trends were observed with beans stored at 15℃ with plastic containers and jute bags however, lightness increased after the third month when stored with the triple-layer bags (Figure 6.4a).

6.3.4.4 Moisture

The storage conditions did not lead to the development of fungus on the surface of the seeds. The moisture content of beans ranges between 8 to 11% (Nkunda, 2018) and corroborates with the moisture content of the local varieties studied. (Table 6.10). The control in this study is the fresh beans that were not stored. There was no statistically significant difference in the moisture content of *kabulangeti* beans stored with the triple layer packaging at 15℃ over the storage period. However, there was a significant difference (decrease) between the moisture content of the control and beans stored over time with jute bags. For *kabulangeti* beans stored with plastic containers, there was a significant increase in moisture after the first month of storage.

At 25℃, there was no significant difference in moisture content with increasing storage time for beans stored with triple-layer bags and jute bags. There was however a significant difference in the moisture content of beans stored with the plastic container after the third month of storage. At 35℃, there was no significant difference in the moisture content of beans stored with triple-layer bags over time. There was a significant decrease in the moisture content of beans stored with jute bags over time compared to the control, but there was no significant change across the months. The moisture content of beans stored with plastic containers decreased significantly with storage time compared to the control.

Table 6. 10: Moisture content of Kabulangeti beans under different storage conditions with different packaging materials

Storage month	15 degrees			25 degrees			35 degrees		
	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack
1	10.57± 0.00a	9.98± 0.01	9.46± 0.00a	9.87± 0.00	8.63± 0.00	10.44± 0.00	9.71± 0.01	7.48± 0.01	10.63± 0.00
2	10.54± 0.00ac	9.19± 0.00	10.19± 0.00a	9.40± 0.01	9.68± 0.01	10.07± 0.01	9.06± 0.00	7.31± 0.01	10.41± 0.00
3	9.22± 0.01b	8.73± 0.06a	11.95± 0.01b	8.64± 0.02	9.89± 0.02	9.32± 0.01a	9.89± 0.01a	6.96± 0.01	10.30± 0.06
4	8.60± 0.00b	8.18± 0.00	9.34± 0.00c	8.58± 0.00	10.16± 0.01	9.75± 0.01ac	8.12± 0.01b′	8.04± 0.02	10.07± 0.01
5	12.06± 0.01b	10.45± 0.01b	12.06± 0.00d	10.89± 0.00	8.96± 0.00	10.22± 0.00b	9.22± 0.01	8.88± 0.00	10.24± 0.01

The same letter in a row indicates no significant difference at 95% (Turkey test at 5%). Replicates are used for the estimation of means. Values ± are standard deviations.

There was a significant decrease between the moisture content of sugar beans stored in 15°C and the control irrespective of the packaging material used with increasing storage time. The moisture content of beans stored with jute sacs significantly decreased after the first month of storage. (Table 6.11). There was no significant difference in moisture content over the storage period for beans stored with jute bags and triple-layer bags at 25°C. However, there was a significant decrease in moisture content between the control and beans stored with plastic containers over the storage period. With the same packaging material, the beans stored for 5 months had significantly higher moisture content compared to those in the third and fourth month. The moisture content of *sugar* beans stored at 35°C reduced considerably with increasing storage time compared to the control irrespective of the packaging material. There was however a significant increase in the moisture content over the storage period for beans stored with jute bags and plastic containers. The increase in moisture content was however lower than the moisture content of the fresh beans (control).

Table 6. 11: Moisture content of sugar beans under different storage conditions with different packaging materials

Storage month	15 degrees			25 degrees			35 degrees		
	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack
1	10.12± 0.90	9.09± 0.69a	9.73± 0.02	9.53± 0.48	8.83± 0.18	9.53± 0.74	9.66± 0.14a	6.73± 0.28a	10.16± 0.46
2	10.39± 0.31	8.77± 0.02b	10.92± 0.02a	9.24± 0.08	9.20± 0.19	10.25± 0.12	9.22± 0.06b	6.98± 0.12b	9.77± 1.96
3	9.45± 0.01	9.32± 0.29c	9.57± 1.00bc	9.08± 0.67a	8.35± 0.04	9.00± 0.71	8.40± 0.20c	8.85± 0.05c	9.56± 0.36
4	9.78± 0.56	7.50± 0.86d	9.51± 0.01c	8.58± 0.89b	9.51± 0.16	10.26± 1.85	8.29± 0.13d	8.26± 0.05d	8.40± 0.33
5	10.26± 1.68	9.07± 0.70	9.92± 1.48	10.46± 1.03c	10.71± 0.37	9.96± 0.64	9.04± 0.38	9.28± 0.60e	9.91± 1.78

The same letter in a row indicates no significant difference at 95% (Turkey test at 5%). Replicates are used for the estimation of means. Values ± are standard deviations.

Studies have reported both an increase in moisture content with increasing storage time (Gipinath et al. 2011; Elias et al. 2016) as well as a decrease in moisture content with increasing storage time (Freitas et al. 2011; Kamau, 2016). Khalequzzaman et al. (2012) observed an increase in moisture content irrespective of the packaging material (Tin, polythene bag or gunny bag). There was no significant change in moisture content as observed by Shiga et al. (2011) and Nkunda, (2018). The study observed all three trends with beans stored at different temperatures and with different packaging materials. There were no significant changes in the moisture content of *kabulangeti* beans irrespective of the temperature with increasing storage time when triple-layer bags were used. There was, however an increase in moisture with beans stored with plastic materials and a decrease in moisture when were stored with jute bags. *Sugar* beans stored with triple-layer bags were not observed to have significant differences in moisture content compared to beans stored with other materials. This was also observed for higher temperatures compared to lower temperatures.

High moisture contents were observed for triple-layer and plastic materials compared to jute bags. High moisture content can lead to high infestation and fungi development (Resende et al. 2008; Alencar et al. 2009). This could also explain the high infestation of the beans stored in the triple-layer bags at 25°C with increasing storage time. Although Freitas et al. (2011) found lower moisture levels for hermetic storage, this study found otherwise. Moisture increase or decrease is due to the exchange between the grain and the air where water from the air is transferred to the grain when the relative humidity of the storage environment is higher than the equilibrium humidity (Elias et al. 2016).

6.3.4.5 Protein content

The protein content of legumes is within a range of 17% to 40% and are located in the cotyledon, the embryonic axis of the bean and the seed coat although there is a higher percentage in the embryonic axis of the seed (Bressani et al. 1978). The protein content is particularly important for protein and energy malnutrition in developing countries (Van Heerden & Schönfeldt, 2004).

There was no significant difference in protein content of *kabulangeti* beans stored at 15°C and 25°C over the storage period irrespective of the packaging material. There was a significant difference (decrease) in the protein content of *kabulangeti* beans stored at 35°C when stored with jute bags and triple-layer bags but not there was no change when plastic containers were used (Table 6.12).

Table 6. 12: Protein content of kabulangeti beans under different storage conditions with different packaging materials

Storage month	15 degrees			25 degrees			35 degrees		
	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack
1	19.71± 0.78	20.48± 0.49	20.70± 0.18	20.36± 0.18	19.59± 0.05	19.43± 0.78	19.32± 0.32	20.43± 0.07	19.65± 1.07
2	20.50± 0.15	20.02± 0.08	19.96± 1.79	19.12± 0.01	20.23± 1.11	21.23± 0.01	22.17± 2.23	21.68± 0.74a	18.15± 0.14a
3	20.54± 0.73	20.05± 0.51	19.60± 0.12	20.76± 0.99	21.03± 0.71	21.10± 0.98	20.43± 1.05	21.95± 0.28b	19.86± 0.21bc

4	20.64± 0.65	19.81± 0.08	20.64± 0.20	20.19± 0.02	20.58± 0.41	19.92± 0.71	19.95± 1.27	19.32± 0.23c	19.61± 0.55c
5	20.75± 0.28	19.70± 1.49	18.87± 1.11	19.72± 0.22	20.30± 0.21	20.38± 0.01	19.98± 0.49	19.36± 0.01d	18.66± 0.28

The same letter in a row indicates no significant difference at 95% (Turkey test at 5%). Replicates are used for the estimation of means. Values ± are standard deviations.

There was no significant difference in the protein content of *sugar* beans stored at 15°C over the storage period when stored with jute bags and triple-layer bags. There was however a significant difference (increase) in the protein content of *sugar* beans stored at the same temperature with plastic containers. The protein content of beans stored at 25°C did not change significantly over the storage period when stored with plastic containers and jute bags. There was however a significant increase in the protein content of beans stored with the triple-layer bags over the storage period compared to the fresh beans (control). The protein content of beans stored at 35°C with plastic containers increased significantly in the second and third month of storage compared to the control. At the same temperature, the protein content of beans significantly increased over time for beans stored with the triple-layer bags. There was no significant change for beans stored with the jute bag (Table 6.13).

Table 6. 13: Protein content of sugar beans under different storage conditions with different packaging materials

Storage month	15 degrees			25 degrees			35 degrees		
	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack
1	19.68± 0.00a	20.81± 0.01	19.95± 0.00	19.78± 0.00	19.21± 0.00	20.36± 0.00	19.64± 0.00	19.42± 0.00	18.28± 0.00a
2	20.7± 0.00ab	20.83± 0.00	20.71± 0.00	20.42± 0.01	20.12± 0.00	20.25± 0.00	20.44± 0.00	18.22± 0.01	20.20± 0.00b
3	20.9± 0.00c	20.68± 0.01	20.23± 0.00	20.61± 0.01	19.99± 0.00	19.71± 0.00	20.65± 0.00	19.50± 0.01	20.24± 0.01c
4	20.12± 0.02d	19.73± 0.02	20.70± 0.02	20.84± 0.02	20.84± 0.04	20.44± 0.04	20.04± 0.24	18.75± 0.04	20.38± 0.00d
5	20.76± 0.01e	20.66± 0.01	20.66± 0.00	19.91± 0.00	20.62± 0.00	19.85± 0.08	19.86± 0.01	19.48± 0.00	19.53± 0.00

The same letter in a row indicates no significant difference at 95% (Turkey test at 5%). Replicates are used for the estimation of means. Values ± are standard deviations.

There were no significant changes in the protein content of the beans as observed by Rani et al. (2013), Kamau (2016) and Elias et al (2016) although a slight decrease was observed. The study observed similar results however there were slight increases in protein content mainly for *sugar* beans stored with plastic containers (at 15°C and 35°C) and triple-layer bags (at 25°C and 35°C). Decreases were also observed for *kabulangeti* beans stored with triple-layer and jute bags at 35°C.

6.3.4.6 Lipids

The lipid content of beans ranges from 0.4% to 2.1% (Yousif et al. 2007) which corroborates with the lipid content ranging from 1 to 2.6 observed in the study. The lipid content in the *kabulangeti* beans was not observed to change significantly with increasing storage length for beans stored with jute bag at 15°C as well as with triple-layer bags at 25°C and 35°C. In all other cases, there were significant differences over the storage period. The differences were observed to be increases in the lipid content (Table 6.14).

Table 6. 14: Lipid content of kabulangeti beans under different storage conditions with different packaging materials

Storage month	15 degrees			25 degrees			35 degrees		
	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack
1	1.18± 0.00a	1.37± 0.00	1.49± 0.00a	1.12± 0.00a	1.04± 0.00	1.26± 0.00a	1.13± 0.00a	1.04± 0.00a	1.35± 0.00
2	1.20± 0.00ab	1.33± 0.00	1.11± 0.00b	1.21± 0.00	1.16± 0.00	1.29± 0.00a	1.30± 0.00b	1.27± 0.00b	1.23± 0.00
3	1.23± 0.00ab	1.17± 0.00	1.23± 0.00c	1.22± 0.00	1.16± 0.00	1.24± 0.01a	1.35± 0.00c	1.34± 0.00c	1.32± 0.00
4	1.45± 0.01ac	1.19± 0.00	1.40± 0.00a	1.47± 0.00b	1.43± 0.00	1.35± 0.00b	1.21± 0.01	1.29± 0.00d	1.60± 0.00
5	2.60± 0.65ad	1.16± 0.00	1.43± 0.00d	1.16± 0.00	1.13± 0.00	1.32± 0.02c	1.19± 0.00d	1.23± 0.00e	1.64± 0.65

The same letter in a row indicates no significant difference at 95% (Turkey test at 5%). Replicates are used for the estimation of means. Values ± are standard deviations.

The lipid content in the *sugar* beans was not observed to change significantly with increasing storage length for beans stored in triple-layer bags at 15°C and 25°C as well as with plastic containers and jute bags at 35°C. In all other cases, there were significant differences over the storage period. The differences were observed to be increases in the lipid content (Table 6.15).

Table 6. 15: Lipid content of sugar beans under different storage conditions with different packaging materials

Storage month	15 degrees			25 degrees			35 degrees		
	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack
1	1.19± 0.00a	1.35± 0.02a	1.32± 0.00	1.35± 0.00	1.38± 0.02a	1.24± 0.00	1.20± 0.00	1.22± 0.00	1.34± 0.03a
2	1.35± 0.01b	1.27± 0.00	1.31± 0.00	1.28± 0.00	1.28± 0.00b	1.38± 0.00	1.23± 0.01	1.20± 0.00	1.29± 0.00ab
3	1.34± 0.11bc	1.14± 0.00b	1.22± 0.00	1.20± 0.00	1.25± 0.00ac	1.37± 0.00	1.30± 0.01	1.50± 0.00	1.21± 0.00abc
4	1.26± 0.00bd	1.12± 0.00c	1.20± 0.00	1.22± 0.00	1.33± 0.01bd	1.34± 0.00	1.32± 3.01	1.40± 0.00	1.37± 0.01ad
5	1.22±	1.13±	1.18±	1.04±	1.25±	1.19±	1.23±	1.32±	1.30±

0.00be	0.00d	0.01	0.01	0.00ae	0.00	0.00	0.00	0.00abe

The same letter in a row indicates no significant difference at 95% (Turkey test at 5%). Replicates are used for the estimation of means. Values ± are standard deviations.

Ash content of *kabulangeti* beans ranged from 3.1% to 3.6% of the bean. Ash content was observed to increase slightly with increasing storage time for all *kabulangeti* beans stored at 15°C irrespective of the packaging. A similar observation was also made for beans stored at 35°C. Beans stored at 25°C were observed to have a slight decrease in the ash content when stored in woven polypropylene (jute) bags and triple layer plastic bags. But there was a slight increase in the ash content with increasing storage period for beans stored in plastic containers. Percentage increases ranged from 0.28 to 13.3% while the percentage decreases ranged from 0.3% to 17.5%.

Ash content for *sugar* beans ranged from 3.3% to 3.8% of the beans. For *sugar* beans, a slight increase in ash content was observed with increasing storage months irrespective of the temperature or packaging. However, ash content for *sugar* beans stored in polypropylene bags at 15°C was observed to decrease with increasing storage time. A similar observation was made with *sugar* beans stored at 35°C in the triple-layer bags. Carbohydrate content in *kabulangeti* beans (69.98±0.75) was not significantly higher compared to *sugar* beans (64.60±0.42) and are a major constituent of the beans. There were no significant changes in the carbohydrate content for both varieties irrespective of the packing material and temperature.

6.3.4.7 Moisture uptake

Preparation of beans requires an initial stage of hydration and cooking. With respect to cooking, there is cell separation and starch gelatinisation. Structural changes occur in the bean during cooking. The way by which the beans are handled affects the cooking quality of the bean. When beans are stored at high temperature, hydration of the beans is uneven based on this the bean doesn't soften adequately and it is hard to cook the beans. This affects the nutritional value and sensory quality of the beans (Gracia et al. 1994) as well as the textural quality and energy consumption. Hardshell leads to the impermeability of the seed coat and the inability of the cotyledons to soften during cooking. Cooking time necessary to have beans reach the acceptable texture is an important characteristic that influences consumer preference. Thus, the hard to cook (HTC) factor is critical to consumers.

The weight of *kabulangeti* beans was observed to increase after cooking; however, the percentage increase which is an indication of water uptake (swelling) was found to decrease compared to the first month of storage when beans were stored at 15°C and 35°C using plastic. The swelling was higher for beans stored with the jute bag at 15°C with increasing months but decreased with time when stored at 15°C and 35°C. The weight of *kabulangeti* beans stored with the three-layer packaging materials increased irrespective of the temperature (Table 6.16).

Table 6. 16: Swelling of kabulangeti beans over 5 storage months

Storage month	15 degrees			25 degrees			35 degrees		
	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack
1	156.85	121.08	160.18	112.04	153.71	145.08	134.44	150	134.8
2	132.1	136.58	128.64	123.48	88.12	132.7	165.24	132.13	94.72
3	127.73	130.34	118.46	140.06	69.53	130.47	128.09	124.78	129.45
4	145.44	124.87	131.14	122.81	128.48	125.07	134.05	129.39	128.38
5	116.39	156.31	109.78	129.73	133.59	119.07	124.62	132.74	118.15

The weight of *sugar* beans stored with plastic containers increased for the first two to three months when stored at 25°C and 35°C but decreased after the third month. At 15°C storage with the same material, the weight was observed to decrease. The weight of *sugar* beans stored at 15°C and 35°C decreased with increasing time when stored with the jute bags. The weight of *sugar* beans stored with the three-layer bag was observed to decrease irrespective of the storage temperature (Table 6.17).

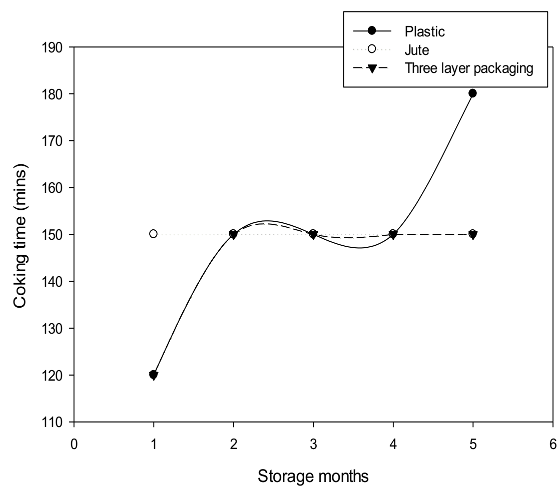
Table 6. 17: Swelling of sugar beans over 5 storage months

Storage month	15 degrees			25 degrees			35 degrees		
	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack
1	145.44	162.69	133.4	136.07	137.36	141.72	130.47	142.27	133.21
2	110.24	139.71	127.37	172.23	140.59	136.86	133.88	136.86	80.05
3	132.15	129.97	127.07	76.7	145.36	120.95	132.52	130.82	125.63
4	144.76	119.69	103.59	125.25	128.88	122.62	120.48	132.44	168.37
5	121.98	132.39	126.96	122.17	142.91	130.01	120.29	134.95	131.86

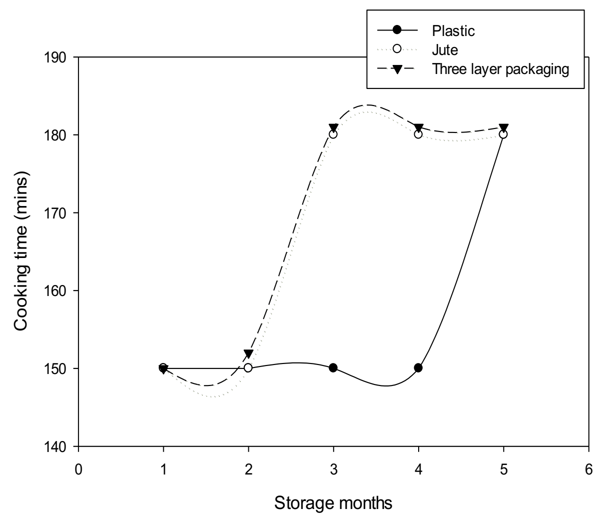
The general reduction in moisture uptake over long storage periods corroborates with findings by Kamau (2016) who observed reduction in moisture uptake after 6 months of storage. There were initial increases in moisture uptake for some beans stored at different temperatures with specific packaging materials. This observation was also made by Kamau (2016).

6.3.4.8 Cooking time

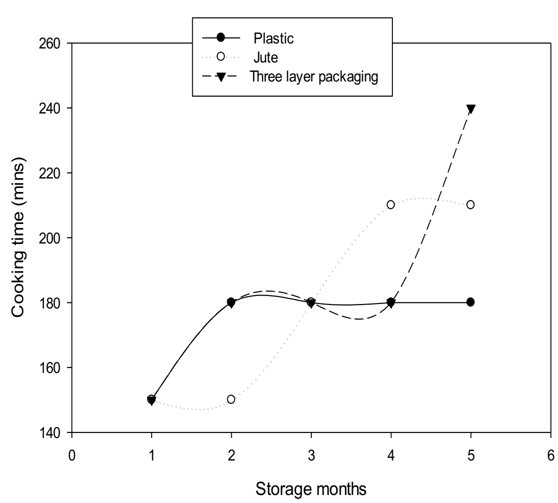
There was not a change in the cooking time for *sugar* beans stored at 15°C with jute bags and triple-layer bags over the storage period. The cooking time required was 150 mins over the entire storage period. However, the cooking time for beans stored with the plastic container increased progressively with increasing storage time. The cooking time required for beans stored at 35°C increased with storage time irrespective of the packaging material; however, cooking time remained constant after the third month of storage (150 mins) when stored with plastic containers. Cooking time for beans stored with jute and triple-layer bags increased to 220 mins and 240 mins respectively. The cooking time of beans stored at 25°C increased to 180 mins from 150 mins over the storage month irrespective of the packaging material (Figure 6.5).



(6.5a)



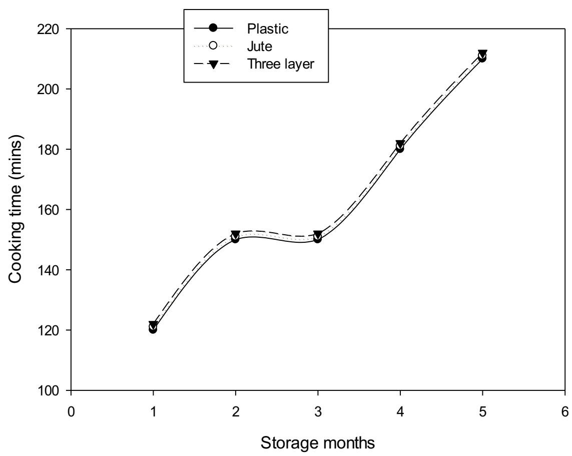
(6.5b)



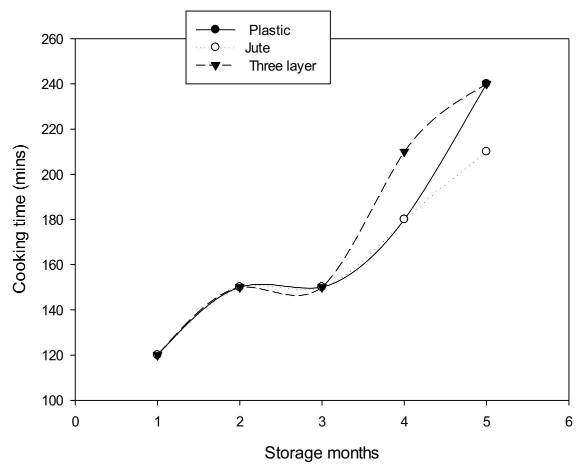
(6.5c)

Figure 6. 5: Changes in cooking time with increasing storage time for sugar beans; (6.5a) 15°C (6.5b) 25°C (6.5c) 35°C

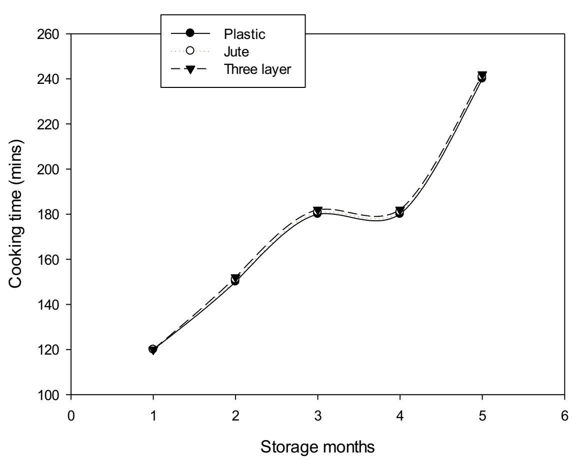
For *kabulangeti* beans, cooking time increased with increasing storage time irrespective of the storage temperature or the packaging material. Cooking time increased from 120 mins to 240 mins at the end of the storage experiment. *Kabulangeti* beans stored at 25°C using plastic containers and triple-layer bags required more time for cooking in the fifth month of storage compared to beans stored with jute bags which required 30 mins less time (Figure 6.6).



(6.6a)



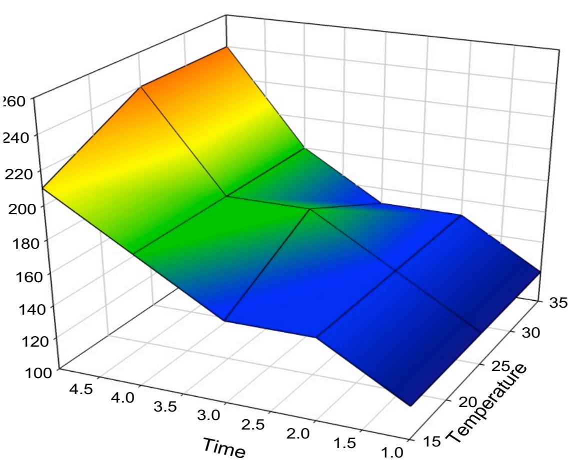
(6.6b)



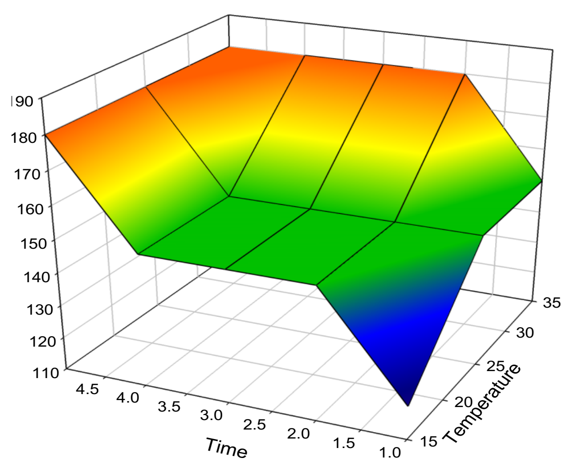
(6.6c)

Figure 6. 6: Changes in cooking time with increasing storage time for sugar beans; (6.6a) 15°C (6.6b) 25°C (6.6c) 35°C

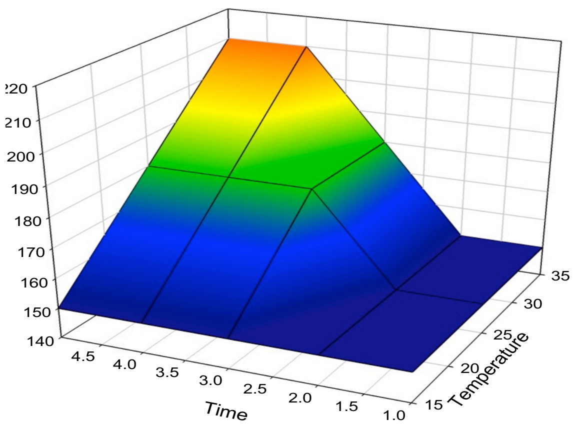
Increase in cooking time have also been recorded by Celho et al. (2007), Freitas et al. (2011), Kamau (2016), Elias et al. (2016) and Kinyanjui et al. (2016) for beans stored for 2 to 6 months. The increasing cooking time can be attributed partly to the competition for water between protein coagulation and swelling of starch. Starch gelatinization during cooking is prevented when there is protein coagulation which increases the cooking time (Ribeiro et al. 2008; Coelho et al. 2009). The increasing cooking time can be attributed to a textural defect known as the hard-to-cook defect which develops when beans are stored at high temperatures for long periods (Shiga et al. 2011). The defect also affects dietary fibre composition (Shiga, Lajolo and Filisetti, 2004). The defect affects other characteristics such as ease of preparation and chewability which have been identified to influence consumer preference for beans (Ndjeunga and Nelson 2005; Fafchamps et al., 2008). The difference in cooking time for *kabulangeti* and *sugar* beans shows that variety influences cooking time.



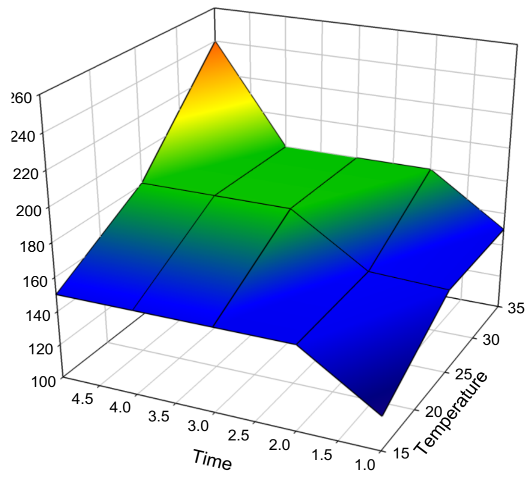
(6.7a) Kabulangeti beans



(6.7b) Sugar beans (Plastic)



(6.7c) Sugar bean (Jute)



(6.7d) Sugar bean (Triple layer)

Figure 6. 7: Changes in cooking time considering storage time and temperature are considered

Figure 6.7 shows changes in cooking time for different varieties and packaging materials when storage time and temperature are considered. For *kabulangeti* beans, there was an increase in cooking time after 3 months of storage irrespective of the temperature in which the beans were stored. This was found to be similar for *kabulangeti* beans stored with different packaging materials, thus only one graph was presented. Storage temperature and packaging material did not have a significant effect on the cooking time. For *sugar* beans, the cooking time is observed to increase from 180 mins after the third month of storage for beans irrespective of the packaging material. Cooking time increased after the third month of storage for *sugar* beans stored at lower temperatures (15°C) but at 25°C and 35°C cooking time increased after the fourth month of storage. *Sugar* beans stored with plastic containers had lower cooking time at the end of the storage period compared with other packaging materials. The increased cooking time is an indication of HTC which is developed at higher temperatures (Kamau, 2016).

Poor cooking quality develops when the seed coat of beans are made impermeable to water (hardshell defects) and when the cotyledons are unable to hydrate during cooking (hard to cook defects) (Yousif et al. 2007). Hard to cook defects lead to high fuel consumption due to increased cooking times. The defect is caused by biochemical changes such as the formation of protein - tannin complexes that increase seed coat hardness and biophysical changes. It is also as a result of changes in the cotyledon due to phytic acid hydrolysis and changes in the cellular protein and starch structure (Yousif et al. 2007). The hardness measured in cooked beans was found to be influenced by variety. *Kabulangeti* beans were found to be harder than *sugar* beans.

6.3.4.9 Protein digestibility

The increasing cooking time as a result of the hardness of the beans also serves as an indication of the presence of specific antinutrients which are responsible for the hardening of beans over time. Hardening of beans after storage is an indication of high levels of tannins in the cotyledon. The presence of antinutrients such as tannins and phytic acid which interact with proteins to form complexes decreases protein solubility and makes the protein complex less susceptible to proteolytic attack in the GI tract (Drulyte and Orlein, 2019). The tannins and phytates associated with the hardening of beans makes proteins and minerals in beans unavailable to consumers (Coelho et al. 2007). The pH change during the digestibility analysis is caused by the free amino acid carboxyl groups from the protein chain released by the proteolytic enzyme during digestion (Drulyte and Orlein, 2019). Processing increases protein digestibility as a result of protein denaturation which enhances accessibility.

Table 6. 18: Protein digestibility of kabulangeti beans over 5 storage months

Storage month	15 degrees			25 degrees			35 degrees		
	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack
1	64.27± 0.88a	63.64± 0.12a	64.70± 0.49a	64.49± 0.78a	63.59± 1.23a	65.00± 0.23a	64.38± 0.86a	63.47± 1.74a	62.73± 0.22a
2	72.41± 0.64ab	74.14± 0.17ab	74.13± 0.67ab	72.94± 0.90ab	73.75± 0.59ab	72.67± 0.40ab	73.64± 0.38ab	73.71± 0.06ab	72.75± 0.35ab
3	73.71± 0.59ac	73.22± 1.45ac	73.22± 0.83ac	73.62± 0.69ac	72.64± 0.01ac	71.42± 0.32ac	73.49± 0.32ac	73.04± 0.32ac	73.06± 0.35ac
4	72.74± 0.54ad	72.19± 1.42ad	73.33± 1.27ad	72.57± 0.33ad	73.08± 0.97ad	71.62± 0.19ad	72.78± 0.19ad	72.00± 0.73ad	72.28± 0.49ad
5	73.00± 1.41ae	72.15± 0.18ae	72.12± 017ae	72.83± 1.48ae	73.41± 0.48ae	74.22± 0.13ae	72.99± 0.05ae	74.55± 0.04ae	74.13± 0.25ae

The same letter in a row indicates no significant difference at 95% (Turkey test at 5%). Replicates are used for the estimation of means. Values ± are standard deviations.

There were no significant changes in protein digestibility with increasing storage time irrespective of the temperature and packaging material. Digestibility significantly increased over the storage period compared to the first month of storage. Compared to the control (fresh beans), protein digestibility in the first month of storage decreased. It later increased after the first month; however the increase was not significant from the control. This was observed for *kabulangeti* (Table 6.18) and sugar beans (Table 6.19). Digestibility was tested on cooked beans, cooking generally increases the digestibility of beans due to a decrease in antinutrient content during processing (Patil et al. 2016). Heat destroys protein inhibitors and denatures proteins (Khattab et al. 2009).

Table 6. 19: Protein digestibility of sugar beans over 5 storage months

Storage month	15 degrees			25 degrees			35 degrees		
	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack	Plastic	Jute	3layer pack
1	64.30± 3.1a	66.60± 0.77a	64.60± 1.01a	64.57± 0.00a	64.83± 2.09a	65.27± 0.52a	64.32± 0.54a	63.38± 0.19a	62.48± 0.09a
2	73.63± 0.12ab	72.79± 1.43ab	73.46± 0.95b	73.31± 0.83ab	74.02± 1.66ab	73.28± 0.18ab	73.59± 0.79b	72.86± 0.05ab	73.14± 1.28ab
3	72.49± 0.17ac	72.66± 0.10ac	72.95± 1.31ac	73.81± 0.04ac	74.07± 0.24ac	73.53± 1.25ac	71.80± 0.20ac	73.33± 0.51ac	72.95± 0.10ac
4	71.52± 2.25ad	72.48± 0.72ad	70.92± 0.32ad	73.04± 0.82ad	71.62± 0.73ad	72.55± 0.50ad	72.81± 0.54ad	72.62± 0.14ad	72.30± 1.13ad
5	71.41± 2.19ae	71.26± 0.34ae	74.54± 0.92ae	73.57± 0.84aae	73.70± 0.76aae	74.69± 0.66ae	73.73± 0.13ae	73.02± 0.27aae	72.51± 0.46ae

The same letter in a row indicates no significant difference at 95% (Turkey test at 5%). Replicates are used for the estimation of means. Values ± are standard deviations.

6.3.5 Influence of storage factors on economic gains: Implication for value chain actors

The storage conditions were found to influence bean attributes which consumers considered important. The effect of storage conditions on bean attributes was found to be different for the two varieties studied. There was largely no change in the nutritional factors (protein and protein digestibility), state and size for both varieties. Decreases in moisture content affect the cooking time of beans while an increase can lead to fungus development or insect infestation. Thus, the best situation is when there is no change in moisture content.

Table 6. 20: Effect of storage conditions on bean attributes for kabulangeti beans

Temp	Packaging	Size	Color	Shine	State	Cooking time	Moisture	Nutritional factors	% Loss Rural	% Loss Urban
15	Plastic	No change	Darken	Minimal change	No change	Increase	Increase	No change	26.8	37.2
	Jute	No change	Darken	Minimal change	No change	Increase	Decrease	No change	26.8	37.2
	Triple layer	No change	No change	Minimal change	No change	Increase	No change	No change	26.8	37.2
25	Plastic	No change	Darken	Minimal change	No change	Increase	Decrease	No change	33.5	46.5
	Jute	No change	Darken	Minimal change	Infestation	Increase	No change	No change	47.1	56.2

	Triple layer	No change	Darken	Minimal change	Infestation	Increase	No change	No change	53.8	65.5
35	Plastic	No change	Darken	Large change	No change	Increase	Decrease	No change	40.1	55.8
	Jute	No change	Darken	Large change	Infestation	Increase	Decrease	Decrease	60.4	74.8
	Triple layer	No change	Darken	Large change	No change	Increase	No change	Decrease	40.1	55.8

NB: % Loss is the loss in economic value obtained by value chain actors due to the impact of storage on attributes consumers value. This was estimated based on this formula; Value Index (Rural) $= 1.94 * (colour) + 1.34 * (size) + 2.15 * (state) + 1.3 * (appearance) - 1.32 * (cooking\ time)$. Estimates reported in Zambian Kwacha.

The storage conditions influenced the colour, shine and cooking time for both varieties. A summary of the changes are presented in Table 6.20 for *kabulangeti* beans and in Table 6.21 for *sugar* beans. These changes affect the acceptability of beans by consumers and also affect the price value chain actors can obtain for the beans. It also affects the quantity available to consumers due to insect infestation. Based on the temperature at which the beans are stored, and the packaging material used, the economic losses may differ. Economic responses of the value selection index created using size, colour, state, cooking time and appearance revealed different economic benefits for farmers.

Based on information regarding the economic values for the preferred levels of each bean attributed, it was estimated that value chain actors would have obtained a price of K19.66 per kg of beans if all the attributes were offered at satisfactory levels. This is the price rural consumers will be willing to pay for the beans. For urban consumers it was however estimated that they would be willing to pay K38.57 per kg if all the attributes were offered at satisfactory levels. However, storage conditions had negative impacts on certain attributes which led to losses in the economic value to be obtained by the actors. For *kabulangeti* beans, percentage losses ranged from 26.8% to 60.4% when the additional amounts rural consumers are willing to pay for a unit increase or decrease in attribute levels is taking into consideration. Percentage losses ranged from 37.2% to 74.8% when urban consumers are considered (Table 20). With regards to *sugar* beans, percentage losses ranged from 29.9% to 50.0% and 37.0% to 64.8% considering economic values of attributes obtained from rural and urban consumers respectively (Table 6.21). Lower economic losses were as a result of the minimal changes in cooking time. The value index for jute bags resulted in higher economic losses compared to plastic containers and triple-layer bags.

Currently, value chain actors store beans using jute sacs in temperatures above 30℃. Storing beans at lower temperatures with triple-layer bags did not result in significant darkening of *sugar* and *kabulangeti* beans. It also did not result in significant increases in cooking time for *sugar* beans. Plastic containers did not result in any losses while there was infestation in *kabulangeti* beans stored with jute bags and triple-layer bags. Storage of beans at lower temperatures is also expected to lead to minimal effect on gloss (shine). There was no change in moisture content of *kabulangeti* beans stored with triple-layer bags although there were some changes for sugar beans.

Table 6. 21: Effect of storage conditions on bean attributes for sugar beans

Temp	Packaging	Size	Color	Shine	State	Cooking time	Moisture	Nutritional factors	% Loss Rural	% Loss Urban
15	Plastic	No change	Darken	Minimal change	No change	Increase	Decrease	Increase	29.9	37.0
	Jute	No change	Darken	Minimal change	No change	No change	Decrease	No change	23.2	37.0
	Triple layer	No change	Increase	Minimal change	No change	No change	Decrease	No change	23.2	37.0
25	Plastic	No change	Darken	Minimal change	No change	Increase	Decrease	No change	29.9	37.0
	Jute	No change	Darken	Minimal change	No change	Increase	No change	No change	29.9	37.0
	Triple layer	No change	Darken	Minimal change	No change	Increase	No change	Increase	29.9	37.0
35	Plastic	No change	Darken	Large change	No change	Increase	Decrease	Increase	36.5	46.3
	Jute	No change	Darken	Large change	No change	Increase	Decrease	No change	43.2	55.6
	Triple layer	No change	Darken	Large change	No change	Increase	Decrease	Increase	50.0	64.8

NB: % Loss is the loss in economic value obtained by value chain actors due to the impact of storage on attributes consumers value. This was estimated based on this formula; Value Index (Urban) $= 3.49 * (colour) + 3.35 * (size) + 3.67 * (state) + 3.6 * (appearance) - 3.58 * (cooking\ time)$. Estimates reported in Zambian Kwacha.

Overall, the common beans are not meeting consumer requirements at the optimum and need to be improved upon. Based on the results of the study, it is recommended that value chain actors should store beans with hermetically sealed containers either plastic containers or triple layer bags due to their minimal effect on moisture content and insect infestation. Using triple-layer bags at lower temperatures can also aid in reducing the darkening of beans. The study does not make conclusions about the efficiency of triple-layer bags in reducing insect infestation since the infestation occurred only in a particular batch and could be influenced by frequent opening which changed the storage conditions. Storage in lower temperatures and with plastic containers have a positive effect on quality since the infestation was also found in jute bags though minimal. Due to the majority of studies which have found a positive impact of triple-layer bags on reducing insect infestation, the study recommends the use of triple-layer bags. However, conditions should be maintained by reducing frequent opening and also not storing close to beans which are not adequately stored to prevent the introduction of insects (Mutambuki et al. 2019).

Hermetic storage conditions modify the atmosphere in the material by converting oxygen into carbon dioxide which makes it unconducive for insects (Faroni et al. 2009). The use of hermetic storage materials has been proven to be efficient for the storage of grains such as those used in Australia and Brazil where bag type silos which are waterproof, white on the outside to reflect light and a black inner wall to slowdown darkening of the grain (Cadick, 2007). Hermetic storage specifically Purdue Improved cowpea storage (PICS) bags have become popular in recent times especially in sub-Saharan Africa (Zeigler et al. 2014). Effective control of insects with adequate storage materials reduces the use of insecticides which poses a safety risk for consumers (Freitas et al. 2016).

Value chain actors are recommended to store beans at lower temperatures due to their minimal effect on appearance (shine). It is recommended that value chain actors do not store beans over long periods of time before sale to consumers. Long storage time has a significant effect on various attributes of beans especially in high temperatures and relative humidity.

6.4 Conclusion

Value chain actors are likely to improve on their activities and obtain financial benefits by having access to information on consumer requirements and meeting those requirements by implementing adequate storage practices. This has implications for food security and poverty reduction since improved quantity and quality increases the availability, accessibility, acceptability and nutritional quality of the products.

Consumer survey results showed that consumers are willing to pay additional amounts to have their preferred levels of attributes. This was an indication that investment in the meeting consumer preferences will be worth it. A value selection index was developed as a tool to aid value chain actors maximise profits by meting consumer requirements based on economic values for attributes and attribute levels. Based on the selection index, scenarios were created to estimate the economic benefits for meeting consumer preferences for different attributes. The estimates showed that improvement of different combinations of attribute levels is likely to result in between 11% to 79% increase in profits. To determine the impact of current practices on bean attributes and potential profits, the impact of storage conditions on beans was studied. Storage in warm temperatures and over long periods was observed to have negative quantity and quality effects.

Specifically, storage methods and conditions resulted in significant changes in colour (darkening of beans), shine (less shiny), cooking time (increased cooking time), quantity (losses due to infestation) and moisture content (lower moisture content). Due to this, profit margins decreased from 26% to 65%. The value index for jute bags was mainly lower compared to plastic containers and triple-layer bags. Overall, the common beans value chain was not meeting consumer requirements at the optimum level. This has implications for consumer satisfaction, food security and profitability.

The study did not undertake a cost and benefit analysis to determine whether the value created from meeting consumer requirements is larger than the cost and the opportunity cost of not meeting those requirements. However, the storage methods studied except for cold storage are not very expensive but more likely to be effective and thus it is expected that considering the already low investment in the production and trade of common beans, value of adoption of the technology will exceed the cost. Value chain actors in developing countries have challenges accessing technology and credit to be able to adequately implement changes (Morris, 2007). However, the initial knowledge of the financial benefit is a good incentive to enable them to take steps towards improving on the methods they can control. To solve liquidity constraints, there can be formal and informal contracts systems where huge product buyers are able to transfer technology to ensure that value chain actors provide them with high-quality products. Transfers could range from finance, inputs, seeds, credit programs, loan programs, training, insurance etc. by processors and traders as has been done in some value chains (Gulati et al. 2007; Bellemare, 2012; World Bank, 2005, Casaburi and Willis, 2015; Minten et al. 2009). The overall goal is to enable value chain actors to improve attributes that have an economic benefit based on consumers willingness to pay for them. Including price correlations with the impact of the activities on the bean attributes are useful to value chain actors to motivate them to invest in materials and practices are that expected to improve quality and profits.

Connecting text

In Chapter 6, the common bean value chain was evaluated to determine if investment in meeting consumer preferences will be economically viable for value chain actors. The chapter also presented results on how current storage practices affect consumer value and profitability. The results of the study showed that consumers are willing to pay additional amounts ranging from 13% to 25% to have their desired bean attribute levels. This was an indication that investment in the meeting consumer preferences will be worth it. However, due to the negative impact of storage methods on quantity and quality of beans, the potential economic benefits to be received by value chain actors was lowered.

To meet consumer preferences and reap additional economic benefits, value chain actors will have to align their activities to meeting consumer requirements. This is expected to have an overall positive effect on food security and nutrition. Chapter 7 provides recommendations on the measures that are required to improve performance of the value chain.

CHAPTER 7 Recommendation for improvement of value chain performance

Performance assessment helps to understand how food systems need to change to achieve defined objectives. Dealing with the recurrence of food and nutrition insecurity is not to produce more food to make it available. It's about responsible food production systems and consumption and understanding underlying factors along the agri-food value chain that affect other factors beyond availability. This requires the design of frameworks that make strong connections between food value chains, consumer preferences, and food security indicators. Such frameworks will redirect the focus of value chains towards consumers and be more indicative of the food security situation in a given location.

This has been accomplished in previous chapters and applied to assess the common beans value chain. The performance of the value chain in meeting consumer preferences and food security indicators were found to be below optimum. To improve the performance, measures have to be implemented to enhance the activities performed by the agents and improve the environment within which the common value chain operates. These measures have been presented in Table 7.1. The measures have been presented in such a way that they meet both consumer preferences and food security indicators. The recommendations for upgrading the value chain to align its activities to meeting consumer preferences include product, process, volume, and coordination upgrade (Hawkes and Ruel, 2011).

The recommendations apply to different stages of the common bean value chain including farming, harvest, postharvest (transportation, threshing, drying, sorting and grading), storage and marketing. Both producers and traders, therefore, have a role to play in adjusting their activities to meet consumer preferences. However, the involvement and support of external government and non-government agents are recommended. Consumers had a preference for value-added products such as bean flour, therefore there is a need to expand the common bean value chain to include processing. At the consumption stage of the household value chain, it was found that beans were sometimes consumed with a corn-based meal. The meal is often consumed with vegetables, and for rural households, protein sources may not be included in the meal. Thus, when beans are processed into flour, it can be blended with the corn flour to improve its nutritional value.

Table 7. 1: Measures required to align value chain activities in meeting consumer preferences

Food security indicators	Consumer requirement	Alignment measures	
		Value chain requirements	**Product value chain measures**
Availability	Good quantities of products Good quantities of preferred varieties	Increase yields Reduce losses Produce more than two varieties of beans (with more focus on preferred consumer varieties) Have access to markets Collaborate with traders	Policies, subsidies, and incentives to increase productivity and increase youth involvement in bean production Strengthen understanding of agricultural techniques Improvement in handling skills and knowledge of value chain actors through training. Access to technology to like phones to obtain process, market and input information Access to credit, automated, and semi-automated technology. Formation of cooperatives for knowledge transfer and collaborations Access to irrigation systems and input suppliers Improve collaborations with government, non-government, and private organizations. Early harvesting to reduce insect infestation and the introduction of a less damaging threshing technique. Increased use of fertilizer, pesticides on-farm, high yielding varieties, soil conservation practices, and labor-saving technologies. Storage of beans at lower temperatures with hermetically sealed packaging to reduce losses and negative storage impacts as well as preserve beans for long periods to meet seasonal demands.
Accessibility	The product should always be accessible at the market	Purchase considerable amounts of beans based on demand in the community Reduce losses	Removal of distant markets between producers and traders to increase access to beans on the market. Improved organization between traders and producers for an efficient flow of product to consumers
	The desired variety of beans should be accessible at the market	Purchase more than two varieties for sale (with more focus on consumer preferred varieties) Improve marketing techniques to attract consumers	Access to credit facilities and the formation of cooperatives. Improvement in skills and knowledge of value chain actors through training. Storage of beans at lower temperatures with hermetically sealed packaging to provide quality beans all year round to consumers.
Affordability	The product should have affordable prices	Use cost-efficient materials and practices Avoid overpricing beans (especially or preferred varieties)	Enabling environment where prices are transparent and reflect the investment of value chain actors. Price incentive for value chain actors to improve the affordability of beans. Cost-efficient performance of activities.
	The desired variety should be at an affordable price	Grading to beans to make low-cost beans available to consumers	Access to storage facility or methods which provide a conducive environment to reduce losses

Acceptability (To improve desirability)	Product with desired gloss, size, taste, flavor, freshness, packaging, color, low cooking time and texture	Store beans using efficient materials, within adequate conditions and for a reasonable period of time. Avoid artificially improving the gloss of beans. Produce and sell beans varieties with color, size, and taste that consumers prefer.	Access to storage facility or methods which provide a conducive environment to reduce infestation and minimize the impact on gloss, cooking time, color, textural and nutritional qualities. Efficient grading and sorting of beans to provide homogenous products to consumers through the introduction of semi-automated machines Storage of beans for short periods before the sale and at lower temperatures Storage of beans in batches to minimize losses The introduction of a less damaging threshing technique.
		Invest in the packaging of beans to improve appeal.	Investment in the provision of clean and already packaged beans.
		Employ more appropriate methods of threshing, sorting, and grading	
			Adequate drying to obtain the required moisture content that creates conditions that do not favor deterioration.
Utilization	Value-added products	Seek out for training opportunities on value addition Undertake activities that preserve food safety Check the quality of beans before sale	Build entrepreneurial skills of actors to take advantage of new opportunities and full market participation Build processing centers with equipment and resources for the processing of common beans into products such as flour Improve collaborations with government, non-government, and private organizations to develop bean-based products. Policies, subsidies, and incentives to increase value addition and increase youth involvement in the bean value chain
	Safe and nutritious products		Effective sorting of beans to remove infested beans Avoid the use of pesticides to provide safe products for consumers
	Products with a long shelf life		Access to storage facility or methods which provide a conducive environment to infested beans. Frequent quality checks to remove visibly infested beans

Connecting text

Chapter 3 provides information about a methodological framework for consumer-based value chain assessment and a performance index for assessing the contribution of value chains in meeting consumer preferences and food security indicators. In Chapter 4 to 6, the framework and index were applied to understanding consumer preferences, the performance of the common beans value chain in meeting those preferences and the economic viability of improving activities to meet those preferences within the context of food security. In Chapter 7, recommendations of measures required to align activities along the common value chain to meet consumer preferences are presented.

In the final chapter of the thesis, a summary of all the results presented in the previous chapters are presented. The contribution of the thesis to scientific knowledge and food value chain development is presented in Chapter 8. The chapter concludes with further research work required to improve assessment and performance of food value chains, specifically common beans.

CHAPTER 8 General summary and conclusion

8.1 General summary

The value chain approach has been applied to improve the performance of firms over the years and recently in agri-food value chains. It has been used mainly to identify the flow of the product, the relationship among actors, constraints and areas where interventions can be targeted to improve the profitability of the chain. The literature suggests the need to pay more attention to the consumer in agri-food value chains and better link agri-food chains to food security. However, in agri-food value chains, they have not been applied with a consumer focus to improve its performance in meeting consumer needs and preferences in a food security context. There are no frameworks developed that adequately captures the link between food value chains, consumer preferences and food security.

Based on this, the study sought to answer an important question, "how can agri-food value chain assessments be made more consumer-focused and produce results from which inferences can be made for food security?" The study answers this question by addressing five specific objectives. The first objective was to formulate a methodological framework for agri-food value chain analysis based on a consumer-food security nexus. The framework is an integrated value chain analysis (VCA) approach that introduces different dimensions into the analysis and determines how they influence consumer preferences. Additionally, this approach is designed to provide important inferences for food security. The framework effectively captures consumers' preferences and translate those preferences into measurable value chain features. Consumer preferences are categorized and linked to food security indicators. Following these indicators, criteria and dimensions are identified as output parameters to evaluate the performance of the chain in meeting consumer requirements and food security indicators. Measures required to align value chain activities to meet consumer preferences and food security indicators after performance evaluation are identified. The developed framework was applied to the common bean value chain to assess its performance.

The second objective was to assess consumer preferences and the factors influencing demand, preparation, and consumption of common beans. This objective addresses the first stage of the consumer-based conceptual and assessment framework. Consumer needs and preferences were revealed by employing a household value chain analysis developed in the study. The household value chain enables value chain actors to comprehensively understand the users of the product and the processes the product undergoes along the consumption chain. The findings show that the activities along the bean consumption chain include product acquisition, preparation, storage and consumption. Consumers' had a preference for different bean varieties. Purchase frequency and quantity were influenced by price, income and availability. About 38% and 70% of rural and urban consumers spent >50% and <10% of their food expenditure on beans respectively. Consumers had different definitions for bean quality and considered attributes such as safety, taste, price, quality etc. when purchasing beans. Conjoint based choice analysis revealed that consumers were likely to trade off different levels of bean attributes when making purchasing and consumption decisions. Urban consumers placed more importance on tasty, low priced, and medium-sized beans while rural consumers placed more importance on beans with lesser cooking time and larger sized beans.

Cluster analysis revealed three consumer clusters based on similarities with their preferences. The findings show that 44.7% of the consumers fell within the cluster, characterized by taste, price, and level of bean damage. To determine how much value consumers placed on the bean attributes, hedonic price analysis was undertaken. The results revealed that consumers were willing to pay premiums for larger size beans (0.3% of the average price), bright-colored beans (17.5%), and packaging (10.6%). Discounts were paid for beans with a higher level of damage (11.3%), shiny beans (7.7%), and beans, which causes flatulence (10.4%). At the preparation stage, bean preparation was found to require lengthy preparation time and high consumption of energy. These factors were influenced by the preparation method, the bean variety and cooking stove used. At this stage, consumers undertook different practices to improve the flavor, taste and cooking time of beans. Regarding beans consumption, 45% of the consumers were willing to substitute beans with other food products due to limiting factors that reduced overall satisfaction for the beans.

Overall, the findings show that affordability (price), accessibility (desired varieties) and acceptability were important factors to consumers. With regards to acceptability, factors such as convenience (cooking time), appearance (colourful and larger size), taste, quality beans (not broken or infested) and low flatulence were considered important. Factors such as packaging and marketing strategy at the point of the purchase were also found to influence the purchase of beans. Consumers expressed concerns with bean attributes such as price, long preparation time, and resource (water and fuel use) and indicated the need for their improvement, among other factors such as packaging and marketing strategy.

Based on the knowledge of consumer preferences and needs, the next step was to evaluate the performance of the value chain in meeting consumer preferences and food security indicators. This constitutes the third objective of the study. The multidimensional performance index developed in the consumer-based framework was applied in evaluating the performance of the chain. The assessment of the value chain showed that producers and traders make up the primary actors along the common bean value chain. Bean production is characterised by the use of primitive tools and recycled seeds, manual and time-consuming activities, inefficient storage, threshing, and loss management techniques. These, therefore, led to low yields (average yields of 150kg/ha), low quality of products, and losses (28.6% of beans harvested and stored). The flow of produce and payment is simple and based on spot market transactions. The market structure is a perfectly competitive market where there are many buyers and sellers. Negotiation power from both ends usually determines how high or low the price of a product was. Benefit-cost ratio estimations revealed that involvement in the common bean value chain was profitable for 88% of producers and 70% of traders. The common bean value chain possess strong buyer power, minimal supplier power, considerable threat to entry, intense rivalry among actors and a minimal presence of substitutes. Knowledge transfer was largely informal and unidirectional (from traders to producers when communicating quality attributes), internal (among producers or traders) and centred mainly on farming practices. Results revealed that agility along the chain is very low because value chain actors do not have the necessary assets to respond adequately and quickly to the dynamic environment within which they operate. Quality assessment revealed that threshing, sorting and storage conditions led to a lack of homogenous and clean beans, broken beans, darkening of beans, increased cooking time, reduced shine and damaged beans.

Consumer preferences and needs were not found to be adequately met because the performance assessment revealed low scores for food security indicators. The common beans value chain scored below average for all indicators, 36% for availability, 48% for accessibility, 46% for affordability, 41% for acceptability and 39% for utilization. The low-performance scores can be attributed to inefficient performance and management of activities along the value chain, low stakeholder involvement, lack of financial and technical capacity, low trust and lack of value creation opportunities. These factors are reflected in the low performance scores for the value chain dimensions used in measuring the efficiency of activities and their effect on food security indicators. The value chain obtained lower scores for agility (37.08%) and management (39.37%) dimensions and a higher score for the economic dimension (54.83%). Correlation analysis revealed correlations between dimensions and food security indicators. Cluster analysis revealed similarities among value chain actors based on performance scores. The majority of actors were found within the cluster characterized by higher scores in affordability and accessibility.

Having established the performance of the chain in meeting consumer preferences and food security indicators, it is recommended that activities along the value chain should be improved to meet consumer preferences and increase performance scores. The next step was then to determine if there would be economic benefits from adjusting value chain activities to meeting consumer preferences. The results of the study showed that consumers were willing to pay additional amounts ranging from 13% to 25% of the average price to have their desired bean attribute levels. This was an indication that investment in meeting consumer preferences will be worth it. A value selection index was developed as a tool to aid value chain actors maximise profits by meting consumer requirements based on economic values for attributes and attribute levels. Based on the selection index, scenarios were created to estimate the economic benefits for meeting consumer preferences for different attributes. The estimates showed that improvement of different combinations of attribute levels is likely to result in between 11 % to 79% increase in profits. To determine the impact of current practices on bean attributes and potential profits, the impact of storage conditions on beans was studied. Storage in warm temperatures and over long periods were observed to have negative quantity and quality effects. Specifically, storage methods and conditions resulted in significant changes in colour (darkening of beans), shine (less shiny), cooking time (increased cooking time), quantity (losses due to infestation) and moisture content (lower moisture content). Due to this, profit margins decreased from 27% to 65%. This has implications for consumer satisfaction, food security and profitability.

This led to recommendations of measures necessary to align value chain activities to consumer preferences to ensure increased consumer satisfaction and profitability. This is the fifth and final objective of the study. The study recommends the design and implementation of interventions to strengthen the capacity of value chain actors to scale up production and marketing and also produce quality, affordable and value-added bean products. These interventions will largely depend on access to inputs, high yielding and marketable varieties, safe and effective storage facilities and materials, semi-automated and automated technology for efficiency, infrastructure, policies, subsides, training and skill development, access to funds for investments etc. The involvement of public and private enterprises to support training, research and market development is recommended.

8.2 Contribution to knowledge

The outcome of the study contributes to scientific knowledge and food value chain development. A few of the contributions include;

1) The study is among the few to develop a methodological framework for consumer-based value chain analysis tailored towards food value chains. The framework presented in this study moves away from the traditional value chain model which is centered on supply chain actors to the end consumers of food. The model can be applied by researchers and policymakers in determining how to maximise and provide more value for consumers towards the achievement of food security and nutrition goals.
2) Beyond the development of the consumer-based framework for food value chain analysis, the study developed an index for the assessment of the performance of food value chains in meeting consumer preferences as well as its contribution in meeting food security indicators. This is the first study to develop an index to assess the performance of food value chains in meeting consumer preferences within a food security context. This contribution is critical in developing strategies for improving the contribution of food value chains to meeting food security goals.
3) The study is the first to present a household food value chain analysis model to understand consumer needs and preferences by studying the food consumption chain from purchase to disposal. This model expands the knowledge base on consumer preference assessment methods, and it is also useful for in-depth consumer analysis.
4) This is the only empirical study the evaluates the performance of a selected food value chain in meeting consumer preferences and food security indicators. The results serve as background information for the development of strategies to improve the performance of the common bean value chain towards consumer and food security goals.

5) The study is the first to develop a value selection index based on estimated economic values for product attributes and attribute levels. This is a practical tool that can aid value chain actors maximise their profits by meeting consumer requirements. It will offer value chain actors with a clear understanding of consumer preferences, how much consumers will pay for the added value, and the profits accrued to them by providing more value to consumers.
6) The model proposed and applied in the study brings different dimensions (economics, food quality, food security and nutrition) together to ensure that the food value chain analysis is undertaken in a more holistic manner. Integrative models can help provide adequate insights into a specific problem by assessing it from different perspectives.

8.3 General recommendation

The study focused on the development of a consumer-based value chain assessment framework and its application to the common bean value chain. Some recommendation for future work is as follows;

1) The performance index has been applied to the common bean value chain; however, the sample size was less than 300 value chain actors. It was also focused on value chain actors within a particular district and province. It is recommended that the index should be applied to larger data set and consider value chain actors across different communities and provinces.
2) The performance assessment was based on current year data on practices and value chain dynamics. However, it will be interesting to apply the index to compare performance across different years based on a panel data and asses how it has changed over time. Such comparisons can be useful in the development of strategies, programs and policies.
3) The study did not undertake a cost and benefit analysis to determine whether the economic benefits obtained from meeting consumer requirements offsets the cost of implementing the required strategies. It is recommended that a cost assessment dimension should be included to determine the most cost efficient yet profitable technology to improve product quality.
4) Cluster analysis was used to create similarities among value chain actors based on food security indicator scores and dimension scores. It will be interesting to determine how demographic and socioeconomic characteristics of value chain actors influences the performance scores obtained.

Appendix

Table A 1: Summary Statistics for the Performance Index

Measure	Mean	Std	Range
Operational			
Level of product diversity	0.00	0.00	0.00 -2.00
Technical and financial capacity	0.13	0.34	0.00-1.00
Quality control	1.00	0.00	1.00-3.00
Defect rate	46.25	18.41	10-80
Pricing scheme	0.07	0.26	0.00-1.00
BCR	0.80	0.26	-0.38-1.00
Average quantities purchased for sale	10.04	10.91	1.00-44.00
Ratio of product varieties in bulk	3.47	1.04	1.00-4.00
Ability to meet delivery schedule	0.47	0.63	0.00-2.00
Time and difficulty to get to the market	1.4	0.77	0.00-2.00
Out of stock	0.267	0.45	0.00-1.00
Method of product storage	1.13	0.51	0.00-3.00
Adequacy of storage facility	1.44	0.94	0.00-3.00
Rating of assets available to traders	1.73	1.31	0.00-3,00
Easy access to bean producers	0.63	0.49	0.00-1.00
Adequacy of storage facility	0.27	0.45	0.00-2.00
Average yields per season (gallons)	39.29	34.29	2-200
Varieties grown (number)	2.16	0.86	1.00-4.00
Share of seeds recycled during planting (%)	100	0.00	0.00-100
Farm size allocated to bean cropping (ha)	0.42	0.34	0.048-1.6
Rate status of soil	3.20	1.08	0.00-4.00
Rate level of efficiency of tools/equipment for production	1.64	0.94	1.00-4.00
Assessment of productive resources	1.64	0.94	1.00-4.00
Time between production and sale (hrs)	794.25	598.67	72-2880
Ability to meet delivery schedule	1.5	0.86	1.00-4.00
Market availability	0.55	1.04	0.00-4.00
Access to inputs	0.46	0.82	0.00-2.00
Application of climate change mitigation strategy	0.07	0.26	0.00-1.00
Level of efficiency with harvesting	1.37	0.67	0.00-2.00
Level of efficiency with grading (%)	22.86	11.14	0.00-33.33
Level of efficiency with transportation (%)	61.67	12.53	50.00-75.00
Management			
Knowledge on value addition	0.28	0.45	0.00-2.00
Loss management	0.39	0.54	0.00-200
Market knowledge	0.04	0.20	0.00-1.00
Percentage quantity sold after losses at marketing stage	76.88	20.66	11.11-100
Percentage quantity sold after losses at production stage	72.26	25.86	9.09-100
Percentage of low-quality products at marketing stage	4.20	6.67	0.00-30.00
Percentage of low-quality products at production stage	46.25	18.41	10.00-80.00
Application of loss management techniques at marketing level	1.53	0.82	0.00-3.00
Easy access to information	0.6	0.50	0.00-1.00
Rate knowledge of markets	0.5	0.51	0.00-2.00
Level of knowledge sharing	1.97	0.18	0.00-2.00
Knowledge on plant and process needs	0.58	0.49	0.00-1.00
Rate usefulness of training	1.81	0.76	0.00-3.00
Frequency of training	0.33	0.56	0.00-2.00
Presence of avenues for information	0.78	0.46	0.00-2.00
Application of loss management techniques at production level	0.40	0.54	0.00-2.00
Economic			
Cost	23.02	59.36	0-320

Price fluctuation	0.97	0.97	0.00-2.00
Average gross margins	13.04	16.94	0-105
Transportation and storage cost	39.47	32.99	0.00-112
Income sufficiency	2.2	0.92	1.00-3.00
Subsidy to farm income	0.00	0.00	0.00-1.00
Off farm income (trader)	139.65	103.36	13.33-405
Off farm income (producer)	16.13	16.94	0.00-83.88
Access to credit	0.14	0.35	0.00-1.00
Trader profits	440.1	800.7	-450-3388
Producer profits	859.90	1130.5	-15-6374
Environment			
Practice of crop rotation	0.00	0.00	0.00-1.00
Amount of fertilizer used per hectare	0.00	0.00	0.00
Amount of pesticide used per hectare	0.00	0.00	0.00
Proportion of legumes grown to other crops	0.51	0.27	0.02-1.00
Assessment of the impact of activities on the environment	1.33	0.47	1.00-3.00
Attitude and perception			
Attitude towards the production of safety and nutrition	0.64	0.48	0.00-3.00
Willingness to adjust to changing demand	0.15	0.36	0.00-1.00
Actor attitude and perception with respect to marketing techniques, losses, safety and product delivery (% score)	87.14	7.48	75.00-100.0
Attitude and perception towards production efficiency (% score)	31.25	18.07	16.7-83.33
Attitude towards commitment to production efficiency (level of commitment)	28.30	29.26	0.00-100
Agility			
Ability to adapt to changing demand for products	0.08	0.28	0.00-1.00
Speed of adaptation to changing demand for products	0.09	0.33	0.00-2.00
Awareness of changing climate and its impact	4.12	1.10	1.00-5.00
Rate willingness to adapt to changing environment	0.07	0.26	0.00-1.00
Rate speed of adaptation to changing environment	0.09	0.35	0.00-2.00
Rate willingness to adapt to changing market	0.08	0.28	0.00-1.00
Rate speed of adaptation to changing market	0.10	0.33	0.00-2.00
Social			
Entry of new actors in 5 years	0.27	0.45	0.00-1.00
Rate of ease of entry	1.57	0.73	0.00-2.00
Easy access for young people and women	3.1	1.45	1.00-5.00
Income per worker (% income from beans)	55.15	20.02	20-100
Exposure to injury	00.81	0.90	0.00-1.00
Rate level of competence	2.63	0.91	1.00-5.00
Seriousness of injury	0.92	0.28	0.00-1.00
Adequate protection	0.23	0.47	0.00-3.00
Governance			
Trust	1.8	0.55	0.00-2.00
Entry restrictions	1.00	0.00	0.00-1.00
Presence of trader cooperatives	0.00	0.00	0.00-1.00
Competence of cooperative to defend interest	2.81	1.56	1.00-5.00
Involvement of stakeholders in marketing	0.00	0.00	0.00-2.00
Involvement of stakeholders in production	1.02	0.14	0.00-2.00
Policies to increase accessibility	0.00	0.00	0.00-1.00
Cooperation within the community	1.8	0.41	0.00-2.00
Policies on price	0.00	0.00	0.00-1.00
Strategy to increase yield	1.00	0.00	0.00-1.00
Consumer interest	0.35	0.48	0.00-1.00
Quality			
Safety	0.56	0.45	0.00-1.00
Stored product quality	0.53	0.71	0.00-2.00

Efficiency to detect and remove infested seeds	0.27	0.45	0.00-2.00
Harvest duration	503.77	429.56	24-2160
Efficiency of threshing method	0.43	0.50	0.00-2.00
Storage duration	2989.49	1418.298	336-5040
Impact of storage on cooking time	0.47	0.50	0.00-1.00
Impact of storage on gloss	0.47	0.50	0.00-1.00

NB: Amounts are reported in Zambian Kwacha

Table A 2: Sperman's correlation between dimensions used in assessing the performance of the chain in relation to availability

	Operat~l	Manage~t	Enviro~t	Govern~e	Economic	Social	Agility	Attitude	Availa~y
Operational	1								
Management	-0.2171	1							
	0.0061								
Environment	-0.1263	0.316	1						
	0.1138	0.0001							
Governance	0.2283	0.2493	0.1993	1					
	0.0039	0.0016	0.012						
Economic	0.2466	-0.1089	-0.0882	-0.12	1				
	0.0018	0.173	0.2707	0.133					
Social	0.0285	0.0062	0.0335	0.1199	-0.0557	1			
	0.7224	0.9382	0.6764	0.1333	0.4874				
Agility	0.0897	-0.1212	-0.0767	-0.1461	-0.1141	-0.0706	1		
	0.2625	0.1291	0.338	0.0671	0.1533	0.3779			
Attitude	0.0197	0.209	0.1024	-0.0439	-0.0569	0.0699	0.0392	1	
	0.8064	0.0084	0.2006	0.5839	0.4774	0.3829	0.6247		
Availability	0.3379	0.2668	0.3227	0.3316	0.4007	0.3495	0.3567	0.3285	1
	0	0.0007	0	0	0	0	0	0	

Table A 3: Sperman's correlation between dimensions used in assessing the performance of the chain in relation to accessibility

	Attitude	Agility	Social	Economic	Governance	Managem't	Operational	Accessibility
Attitude	1							
Agility	0.0546	1						
	0.7746							
Social	-0.02	0.1164	1					
	0.9165	0.5402						
Economic	-0.056	-0.0129	0.0277	1				
	0.7689	0.9461	0.8845					
Governance	-0.0782	0.0211	-0.1074	0.1687	1			
	0.6811	0.9118	0.572	0.3728				
Management	-0.0701	-0.051	-0.3649	-0.391	0.274	1		
	0.7126	0.7889	0.0474	0.0326	0.1429			
Operational	-0.3357	-0.2119	-0.0678	0.1385	0.2881	0.2087	1	

	0.0698	0.261	0.7217	0.4656	0.1227	0.2684		
Accessibility	0.5012	0.3134	0.182	0.3355	0.297	0.0172	0.3694	1
	0.0048	0.0917	0.3359	0.0699	0.111	0.9281	0.0445	

Table A 4: Sperman's correlation between dimensions used in assessing the performance of the chain in relation to affordability

	Operational	Economic	Governance	Affordability
Operational	1			
Economic	-0.0884	1		
	0.2408			
Governance	-0.0283	-0.0825	1	
	0.7077	0.2737		
Affordability	0.8689	0.2797	0.2394	1
	0	0.0002	0.0013	

Table A 5: Sperman's correlation between dimensions used in assessing the performance of the chain in relation to acceptability

	Agility	Management	Operational	Perception	Quality	Acceptability
Agility	1					
Management	0.2228	1				
	0.023					
Operational	-0.1635	-0.1392	1			
	0.0972	0.1589				
Perception	0.6015	0.1927	-0.2261	1		
	0	0.0501	0.021			
Quality	0.1818	0.2042	-0.0671	0.0798	1	
	0.0648	0.0376	0.4988	0.4207		
Acceptability	0.4658	0.3815	0.2221	0.3527	0.7198	1
	0	0.0001	0.0234	0.0002	0	

Table A 6: Sperman's correlation between dimensions used in assessing the performance of the chain in relation to consumption and utilization

	Quality	Attitude	Operational	Management	Utilization
Quality	1				
Attitude	0.1862	1			
	0.1776				
Operational	0.0829	-0.0645	1		
	0.5514	0.6433			
Management	0.0733	0.0321	-0.0878	1	
	0.5982	0.818	0.5278		

Consumption & Utilization	0.5123	0.5956	0.2725	0.6128	1
	0.0001	0	0.0462	0	

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