A COMPARISON OF AGRICULTURAL RESOURCE MANAGEMENT ON SELECTED GROUP AND INDIVIDUAL FARMS IN SASKATCHEWAN

by

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ABSTRACT

M.Sc. M.E. GERTLER Renewable Resources

A COMPARISON OF AGRICULTURAL RESOURCE MANAGEMENT ON SELECTED GROUP AND INDIVIDUAL FARMS IN SASKATCHEWAN

Resource management practices were compared on 15 Saskatchewan group farms and 15 neighbouring individual farms. With a median of 5 operators, the group operations were much larger than average farm units in the province. The individual-type farms were also above average in size. Land use on the two sets of farms was typical of Saskatchewan farms generally. Larger group farms tended to grow a greater number of different crops. The groups kept, on average, 1.5 times as much livestock per hectare as the average farm in their municipalities. The groups managed with 26% less tractor power, 24% less seeding equipment, and 32% less combine capacity per unit land area than the individual-type farms with which they were matched. The groups showed equal or greater propensities to experiment with new farming methods while operating in the context of large and relatively diversified farm operations.

ABREGE

M.Sc. M.E. GERTLER Ressources Renouvelables

COMPARAISON DE L'AMENAGEMENT DES RESSOURCES AGRICOLES DANS DES FERMES D'EXPLOITATION EN COMMUN ET DES FERMES DE TYPE-INDIVIDUEL AU SASKATCHEWAN

Une comparaison de 15 fermes d'exploitation en commun avec 15 fermes avoisinnantes, de type-individuel au Saskatchewan, basée sur la pratique de l'aménagement des ressources, a été effectuée. Caracterisées par une médiane de cinq opérateurs, les entreprises de groupes étaient beaucoup plus extensives que la moyenne des fermes dans la province. Les fermes individuelles selectionées dépassaient aussi cette moyenne. L'utilisation des terres pratiquée par ces deux groupes de fermes s'est avérée typique des fermes au Saskatchewan. Les plus grandes fermes d'exploitation en commun avaient tendence à cultiver une plus grande variété de récoltes. Les entérprises de groupe gardaient 1,5 fois plus de bétail par hectare que la ferme moyenne de leurs municipalités. De plus, les fermes d'exploitation en commun opéraient avec 26% moins de traction mécanique, 24% moins de semeuses, et 32% moins de moissonneuses par hectare que les fermes de type-individuel avec lesquelles elles étaient comparées. Ainsi, les fermes d'exploitation en commun manifestaient une propension égale ou supérieure à celle des fermes individuelles pour l'expérimentation de nouvelles méthodes agricoles tout en fonctionnant dans un cadre d'entreprises extensives et relativement diversifiées.

TABLE OF CONTENTS

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LIST OF TABLES

LIST OF APPENDICES

1. INTRODUCTION

New farm technologies have increased yields, labour productivity, and economic returns from agriculture while making it more capital intensive and complex. Farmers, as much as ever, are faced with capital, labour, and management problems. They must also deal with uncertainties about the future cost and availability of farm inputs and the ecological appropriateness of their methods. Group farming is one innovation being tested by agricultural producers in response to changing technological, economic and social pressures.

Group farming is the joint ownership and/or operation of one or more farm units by several operators, each of whom provides a substantial proportion of the management and labour effort required. Multi-purpose machinery co-operatives (hereafter, machinery co-operatives), co-operative farms, and agri-pools--a type of production co-operative that falls between the former two in terms of extent of co-ownership and/or joint use of resources--are good examples of group farming. In 1977, Saskatchewan accounted for 25 out of 29 of the co-operative farms reporting to Agriculture Canada, and 18 out of 21 machinery co-operatives (Canada Department of Agriculture 1979).

The machinery co-ops referred to here involve joint ownership of farm machinery and joint operation of land, title to which usually remains in the hands of the individual members. Members are responsible for labour and operating inputs in proportion to the amount of crop land they have in the co-op, and receive a similar proportion of proceeds from sale of crops. Since all production is pooled, and all land farmed as a unit,

there is no need for argument over priority of access to machinery.

The typical agri-pool arrangement extends one step further to include collective ownership of livestock as well as machinery. Also in an agri-pool, members may rent their land to the organization which may also rent land from a third party. Member families retain personal control over their homes, gardens, and any elective farm activity carried out there on a small scale, for example, raising a small number of chickens or hogs. Members receive wages for labour and management time invested in the operation, cash rent for their land, and a share of any surplus or net income.

On co-operative farms, all land, buildings, machinery, equipment, livestock, as well as members' homes may be owned by the organization, and additional assets may be leased from a third party. Members receive income in the form of wages or salary for labour and management input, interest on loans to the co-operative, and a share of any cash surplus at the end of the fiscal year (Morris 1972, Saskatchewan Department of Co-operation and Co-operative Development 1976).

The vast majority of farms in Canada are private individual or family operations. According to census definitions, other organizational forms, including partnerships, corporate, and institutional farms, together accounted for 8% of farms, 19% of the total land area, and 18% of the capital value of farms in 1976. Comparable values derived for Saskatchewan were 8%, 17% and 13%. The corporate categories include farms in which shares are mostly owned by the principal operator and

immediate family, and a smaller number of farms in which a majority of shares are owned by some other person or business. A category "other type" includes farms operated privately for an estate or trust company, Hutterite colonies, and co-operative farms. Each of these catagories includes a number of group farms. Though they fit the definition, Hutterite farms were not included in this study. Their religiously-motivated colonies represent fairly unique circumstances and their agricultural operations have been documented elsewhere (Bennett 1969,Ryan 1977). Machinery co-operatives, agri-pools, co-operative farms, and corporate farms that involved several owner-operators who provide a substantial share of management and labour for the operation were included in this study as the substance of the working arrangement between the operators is of greater importance than its label.

Informal co-operation between farm families has always been an important social and economic phenomenon (Bennett 1969). Other kinds of organized co-operation in production-related activities have also been reasonably common. Examples include grazing co-operatives for the joint use of grazing land, feeder co-operatives for the joint operation of feedlots, and single-purpose machinery co-operatives involving the shared ownership and operation of specialized farm equipment. The Canadian Farm Credit Corporation makes loans available to groups or "syndicates" of three or more farmers for the acquisition of machinery or specialized buildings that might be used in common (Farm Credit Corporation 1979). In all these situations, the joint activity supplies

one input or service to established individual-type farms, supplementing but in no way supplanting this organizational form. None of these could be said to constitute group farming.

This study was designed as a preliminary exploration of the effects of group farming on the management of agricultural resources. The focus was on group farming as practised in Saskatchewan in 1978. The study thus compared resource management on group and individual-type farms operating in the context of multiple influences promoting or discouraging "beneficial management" of agricultural resources. Beneficial management, in contrast to exploitation, is defined as management to maintain or increase the productivity of agricultural ecosystems over the short and long term (Spurr 1969).

Specific research questions investigated included the following: does group farming as now practised in Saskatchewan lead to -

1) more diversifed cropping programs, longer rotations, and/or reductions in summer fallow area;

2) increased livestock holdings;

3) greater attention to soil conservation measures;

4) greater experimentation with improved farming methods;

5) more attention to soil testing, field trials and the keeping of agronomic records;

6) access to large and sophisticated equipment while achieving savings in total machinery inventory per unit land area and per operator;

7) greater attention to measures to deal with occupational hazards of farm work?

2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

2.1 Group Farming and Resource Management

Agricultural systems are quite specific to particular physical, economic, and political environments. Therefore, though valuable and of interest, related experiences on other continents were, for the most part, not included in the literature reviewed here. Attention is focused on those experiences most immediately relevant to the elaboration of systems appropriate to Saskatchewan and Canada.

An economic analysis of production co-operatives in Saskatchewan was provided by Morris (1972). Comparing 18 group farms to model farm units, Morris found that only the larger group operations, in terms of total area under cultivation, area cultivated per operator, and number of active operators, outperformed relevant "yardstick" farms. Net income per operator, the ratio of annual total costs to value of production, and other indicators of economic efficiency were used. Major advantages cited by participants in the group farms included: reduced machinery costs per operator and/or access to larger equipment; the benefits of member expertise in particular aspects of farming; the superiority of formalized group decision-making; improved procurement of credit; more free time; security in times of illness or in case of an accident; and reduction of isolation and other social benefits for participants and their families (Morris 1972). The finding that "most respondents believed that innovation and experimentation had been more widespread than it would have been on an individual basis" (Morris 1972: 131) is especially relevant to the present study.

The potential resource management advantages identified by Morris (1972) were reiterated by the Saskatchewan Federation of Production Co-operatives (1973). Additional sources of advantage cited by the Federation include better record-keeping, a greater ability to keep abreast of new developments, and greater capacity to diversify into livestock enterprises that may complement grain production economically and ecologically. In a series of studies on private company farms, partnership farming and production co-operatives, Elmgren *et al.* (1973), Elmgren (1974) and Elmgren and Brown (1978) suggested similar resource management advantages of multiple-ownership and co-operative effort: resource pooling and savings associated with economies of size; improved management; specialization and division of labour; and diversification into complementary and supplementary enterprises.

Economic modelling of hypothetical co-operative dairy farms suggests potentially significant cost advantages over individual-type operations, with greater cost economies resulting from fuller integration of the various aspects of the dairy operations into the co-operative (Santos and Oleson 1976). In Manitoba, surveyed participants in multi-member dairy farms organized as partnerships or family corporations, reported advantages including a greater ability to pay attention to quality and sanitation control and to look after maintenance and repair of equipment (Santos and Oleson 1976). In Prince Edward Island, Fobes (1975) has promoted the agro-service bank type of machinery and labour exchange organization as a capital and resource-conserving strategy. Similar claims have been put forward by the Quebec Department of Agriculture in its promotion of labour exchange and machinery sharing

(Bruneau and Ferron 1978), and by Wild (1972) who studied farm machinery syndicates in Quebec.

It seems possible that both the size and the organizational structure of group farming operations would contribute to their impact on resource management. The potential roles of these two closely related factors are explored further in the following sections.

2.2 Economies of Size

When a farm is enlarged and adjustments in the proportion of factors and products occurs, any resulting changes in unit costs would correctly be labelled as positive or negative economies of size. Economies of scale may be said to exist if a production unit is enlarged by increasing all resources and products proportionally, and a change in total cost per unit of production results. In farming the latter situation is uncommon (Madden 1967, Morris 1972). A theoretically possible exception would be the merger of two identical farm operations.

Potential cost economies resulting from size of production units are relevant to the present study inasmuch as they reflect efficient use of resources in the physical and technical sense (Miller 1969). The potential contribution of larger farm size to achieving savings in machinery inventory per unit of land farmed has been documented in the Saskatchewan context. Johnson (1977) surveyed small, medium and large farms with an average of 257, 518 and 929 ha of crop land respectively. All were located on the dark brown soils of west central Saskatchewan. Capital investment in machinery on the large farms was about twice that it was on the small farms in the sample. However, the larger farms also

had about four times the area of crop land. As a result, the cost of machine inventories per hectare, measured as depreciation and interest on investment, was reduced by almost one half. Johnson (1977: 7) characterized the lower machinery costs as being "of real significance in lowering expenses on larger farms".

Records of Saskatchewan grain farms using the Canfarm record-keeping system suggest similar cost economies with increasing size (Saskatchewan Department of Agriculture 1979b). This was true for all soil zones (Table 2.1), though the relationship between size and investment did not appear to have been perfectly linear. In two of the three soil zones, the smallest category of farms showed lower machinery investment per hectare than the next largest category of farm, and in two of the three zones, there was no further reduction in per hectare investment levels moving from the next-to-largest to the largest category of farms.

Table 2.1 Machinery and Equipment Investment at Original Cost, on Saskatchewan Grain Farms registered on the Canfarm Record-Keeping System, 1978.

	Total hectares			
	<259	259-388	389-648	>648
Soil zone	Average investment per grain hectare at original cost ($)			
Brown	29	24	16	17
Dark brown	25	26	19	16
Black	28	33	23	23

Source: Adapted from Saskatchewan Department of Agriculture, 1979. Farm Business Review for the Year 1978. Regina: Saskatchewan Department of Agriculture, Statistics Branch.

Slightly lower values on some of the smallest farms may reflect a tendency for these operators to use smaller, older, and second-hand equipment or, perhaps, to use more rented, shared, or borrowed machinery and/or more custom services. The lack of further economies as one moves from the second-largest to the largest class of farms sampled, may reflect the organization of these farms as much as it does the absence of further potential savings. If the largest farms were still essentially one-operator units, time constraints would impose the necessity of a very high level of mechanization and considerable reserve capacity. Despite the non-linearity of the observed relationship, there is a clear trend towards reduced machinery investment per land unit as farm size increases. Inasmuch as these lower machinery costs reflect actual reductions in the amount of machinery bought and used hectare-for-hectare on the larger operations, this suggests a possible material and energy savings as well.

Economies of size are a notably two-edged sword. As operations get larger, new problems enter and unit and dollar resource costs may actually climb. To be successful, larger units require expanded management effort and capacities. The complexity of the task is aggravated by the non-uniformity of agricultural resources, including soils and livestock. A key problem is co-ordination. According to Madden (1967: 9) "the essential feature of co-ordination is that every decision be made in the context of all other decisions already made or likely to be made". On larger farms there are more factors to co-ordinate and a greater possibility that the person or persons fulfilling the co-ordinating role are not well-informed about all the relevant variables. Whether or not the largeness leads to

reduced information flow to those co-ordinating operations is, of course, very sensitive to the organization of the work and management tasks and the relationship between the participants (Williams 1977).

While all farms large and small now use more energy, it is commonly argued that there is a positive correlation between larger size operations and both more rapid growth in the level of mechanization and greater reliance on energy-intensive inputs such as fertilizers and pesticides (Steinhart and Steinhart 1974). Buttel and Larson (1979) found a positive association between farm size and the energy intensity of crop production in the U.S.A. However, although they speculated that the energy invested in equipment inventories is possibly greater, measured per unit area, on large farms, their analysis considered operating inputs only. Since manufacturing energy costs for machinery and equipment were not considered, any savings in this area would not have been reflected in their results.

Studying the energy budgets of Saskatchewan farms emphasizing various agronomic practices, Thompson *et al.* (1978) found a moderate negative relationship between farm size and energy invested in machinery inventories calculated on a per cultivated hectare basis. It is important to note that in their study, the larger farms tended to be "conventional" matches for a sample of smaller "innovative" operators who had opted not to use synthetic pesticides or fertilizers on their farms. Therefore two fairly different production systems were involved. Also relevant is the fact that the research method employed made no distinction, where energy was concerned, between farm equipment purchased one year before and

equipment that had been purchased 10 years before, perhaps second-hand. In other words there was no provision for depreciation of the equipment inventory in energy terms as there would normally have been, in dollar terms. This would be a complex calculation to make, but in its absence there is a potential for under-rating the energy conserving effect of keeping equipment the full length of its useful life, and/or the effect of using it for fewer hours each year.

Stirling (1979: 24) found some strong interactions between farm size and energy inputs and energy output:input ratios (Table 2.2). Energy output:input ratios tended to increase with farm size, at least in the brown and dark brown soil zones, and this was attributed mainly to decreasing levels of input energy per hectare. There was no clearly discernable trend in the case of farms in the black soil zone. Different crop mixes and yields undoubtedly contributed to some of the observed differences between soil zones and may have been a contributing factor within zones as well.

According to Stirling, despite limitations in the data base used, it is possible to state that the most energy-"efficient farms tended to minimize their consumption of the two main energy inputs characteristic of grain farms - machinery energy and fuel energy" (Stirling 1979: 25). The observed differences in input energy levels are relevant to this study since they imply that size may contribute to resource economies under at least some Saskatchewan conditions. Overall energy input savings of 630 MJ and 1290 MJ per ha, or 12 and 25%, were realized as farm size increased from 486-606 ha to 607 ha and over, in the brown and dark brown soil zones respectively (Table 2.2). Increases in energy efficiency with size suggest a potential benefit of group farming.

Table 2.2 Energy Inputs, Energy Outputs and Energy Ratios by Farm Size and Soil Zone, Saskatchewan, 1971. (Energy values are in 10^1 Megajoules per crop hectare).

	Farm size (hectares)				
Soil Zone	<243	243-363	364-485	486-606	>606
Brown					
Energy Inputs	-	576	540	540	477
Energy Outputs	-	1996	1738	1983	2153
Energy Ratio (ER)[1]	-	3.47	3.22	3.67	4.51
Dark Brown					
Energy Inputs	-	-	555	522	393
Energy Outputs	-	-	2688	2657	2225
Energy Ratio (ER)[1]	-	-	4.84	5.09	5.66
Black					
Energy Inputs	647	575	587	599	
Energy Outputs	2782	2634	2429	2343	
Energy Ratio (ER)[1]	4.30	4.58	4.14	3.91	

[1] Energy Ratio (ER) measures the edible energy output divided by the input of non-renewable energy.

Source: Adapted from Stirling (1979: 24).

Distance internal to the farm, or intra-farm distance, increases the resource cost of management and machinery and material transport on large farm units with fragmented and far-flung holdings. Madden (1967) however, suggests that improvements in the areas of transportation and communication have increased the distance over which dispersed farm operations can be effectively managed. Studying farm operations surrounding Mennonite villages in Manitoba, De Lisle (1978) found compensating strategies being used to reduce the cost of operating more distant tracts. These included less frequent monitoring and less rigorous weed control practices, as well as field consolidation to make larger fields that would be more worthwhile to travel to in order to carry out specific operations. Slightly lower yields in outlying tracts and larger fields that might be more vulnerable to wind erosion were one result.

2.3 Farm Organizational Structure and Resource Management

Organizational structure as used here goes beyond size in terms of land area and number of operators, to include the relationship between ownership, management and labour functions in farm firms (Rodefield 1978). Interactions between aspects of organizational structure and resource management have been noted by a number of researchers. Buttel and Larson (1979) found modest to strong relationships between the prevalence of non-family type corporate farm holdings and the energy intensity of crop production. Pine *et al.* (1956) found that conservation practices were less in evidence on rented than on owner-occupied land in the U.S. Midwest. Reimund (1979) suggested that certain forms of group farming can augment the quantity and quality of human resources available through specialization

and pooling of skills.

Raup (1973) maintains that questions of farm size and structure must be considered in the light of effects on the entire economic and social system. Data collected by Jensen (1977) showed that a significant proportion of the energy budgets of prairie farms was accounted for by home and personal car use, and by farm trucks used to haul crops and for other farm business. In this connection, organizational innovations such as group farming would be of interest if they could reduce the number of farm business-related trips to town per unit of crop produced and the number of motor vehicles required per capita. Large farm units facilitated by pooling might also be able to make efficient use of the larger trucks that become more necessary with centralization of grain delivery points (Martin and Devine 1977). Archer *et al.* (1976) have proposed the concentration of farm settlement along more major roads to reduce the cost of maintaining transportation infrastructure and providing services in rural areas. Such a plan might facilitate both informal and formal joint-ventures. More importantly, the objectives of such a plan could perhaps be met as effectively through the central farmyards and grouped homesites of some types of production co-operatives and multi-family farming corporations.

Some of the ways in which group farming might affect resource use may be indirect, resulting from changes in human relations and in human personality. Williams (1977) has stressed the importance of organizational form where the motivation of participants to work efficiently and to exercise their initiative and creativity for resource management purposes

is concerned. Bennett (1978: 4) reminds us that "co-operation is a social as well as an economic strategy" and can involve "resocialization of the human group and personality". These observations take on increased significance when viewed in conjunction with research on the adoption of conservation methods in farming.

Pampel and van Es (van Es and Pampel 1976, Pampel and van Es 1977) found that farmers who were ready adopters of commercial innovations did not tend to be early adopters of environmental innovations, and vice versa. Testing three explanations for the adoption pattern they encountered in southern Illinois, they were able to discard theories of "psychological innovativeness" and "profitability orientation" in favor of a theory of "farming orientation". This theory suggests that propensity to adopt various types of innovations is best explained by a farmer's orientation toward farming and farm life. Farmers who viewed "farming as a way of life rather than as a business enterprise" turned out to be the fastest adopters of environmental innovations of all kinds (Pampel and van Es 1977: 59-60). Interestingly, the number of years a farmer had been exposed to formal education had a significant positive effect on adoption rate of commercial innovations, but had a negligable effect on propensity to adopt environmental innovations (Pampel and van Es 1977).

The research of Pampel and van Es (1977) is relevant in several ways to a consideration of the impact of group farming on resource management. Besides documenting the existance of various farming techniques in a single locale, with various likely impacts on the environment, their work suggests that choices in technology and technique are partially conditioned by a

farmer's outlook on farming. This suggests, in turn, that changes that can affect an operator's outlook on farming may have a strong influence on the environmental impact of agriculture.

2.4 Agricultural Resource Use in Saskatchewan

Before European settlement, Saskatchewan soils supported the buffalo economy of native Indian populations for many millenia. As recently as 1870, farming was almost non-existant in the area and though land alienation to settlers proceeded rapidly from the 1890's, much of the land now cropped was broken only in the second and third decades of the 1900's. The area in census farms increased from less than 2 million hectares in 1901, to 11 in 1911, 18 in 1921 and 23 million in 1931. Since World War II the area farmed has been between 24 and 26 million hectares.

Agriculture in Saskatchewan is labelled extensive, because of the relatively small amounts of crop inputs used per hectare and the relatively low yields expected. In terms of percentage of land surface that is under cultivation, however, Census Divisions 1 through 17, accounting for close to 100% of the occupied farm land and making up the southern half of the province, are now worked more than many intensively-managed agricultural landscapes in Europe (Coupland 1977a). In this large area, equal in size to all of the United Kingdom, the Netherlands, Belgium and Luxembourg combined, 83% of the land is classified as occupied farm land according to the 1976 Census of Canada. In turn 67% of this farm land, or 56% of the land surface is under cultivation, that is, under crops or in summer fallow. Since most of the crops are annuals, more than half the land surface is worked in any given year. In 1976, wheat and summer fallow

each accounted for 23% of the area, while tame hay, the only cultivated crop not requiring annual tillage, accounted for only 3%.

In Saskatchewan, a large proportion of the total land area is devoted to agriculture, and a large proportion of this agricultural surface, in turn, is under cultivation. Two other important factors from a resource management perspective are the preponderance of a few crops, in particular spring wheat, and the prevalence of the use of summer fallow (Table 2.3). In 1976, 38% of the "improved"[1] farm land in Saskatchewan was in summer fallow and 38% in wheat. In declining order of importance summer fallow, wheat, barley, improved pasture, tame hay, oats for grain, rapeseed, oats cut for fodder, rye, flaxseed, mixed grain, and mustard seed together accounted for 99% of improved farm land (Table 2.3).

On grain farms, wheat and barley are typically grown in a 2-year or 3-year rotation of summer fallow, followed by one or two grain crops. While some new crops have been introduced, for instance rapeseed and lentils, wheat is uncontested as the major crop. As of the 1976 Census, 66% of Saskatchewan farms with sales of $2,500 or more, were classified

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[1] The Census of Canada classifies farm land as improved or unimproved. Improved land includes crop land, improved pasture, summer fallow, and other improved land. Crop land designates land sown or to be sown for harvest in the census year. Improved pasture designates land being used for pasture or grazing and which has had some improvements such as cultivation, drainage, irrigation, fertilization, seeding down or spraying, made to it in recent years. Summer fallow refers to land from which no crop is harvested in the census year but which is worked for weed control and/or moisture conservation. Other improved land refers to barnyards, roadways, home gardens and cultivated land being neither summer-fallowed or cropped. Unimproved land includes native pasture or hay land, brush pasture, grazing or waste land, sloughs, marsh and rocky land etc.

Table 2.3 Land Use on Census-Farms, Percent of Improved Land and Percent of Farms Reporting, Saskatchewan, 1951-1976.

	Percent of improved land						Percent of farms reporting					
Land Use	1951	1956	1961	1966	1971	1976	1951	1956	1961	1966	1971	1976
Wheat	40.6	36.0	37.5	42.7	27.9	37.7	(1)	88.2	92.4	92.4	87.9	90.1
Barley	6.3	7.5	4.2	5.0	12.0	6.4	44.2	51.7	34.0	37.5	75.0	44.8
Oats for Grain	9.7	7.5	6.1	4.0	4.1	3.4	71.9	70.1	60.2	47.1	49.9	39.2
Rye	1.7	0.7	0.5	0.9	1.1	0.6	(1)	4.7	3.8	5.7	9.3	5.1
Mixed Grain	0.1	0.1	0.3	0.3	0.4	0.3	0.7	1.3	3.2	3.5	4.6	2.7
Tame Hay	1.4	1.6	2.4	2.7	3.5	4.6	(1)	21.1	27.5	30.6	33.0	36.1
Oats for Fodder	(1)	(1)	1.0	0.8	1.0	0.7	(1)	(1)	16.9	16.6	17.0	11.1
Flaxseed	0.8	4.2	2.2	0.9	2.0	0.4	5.6	21.6	15.3	7.3	16.0	4.1
Rapeseed	(1)	0.7	0.9	1.6	5.9	1.5	(1)	(1)	7.5	11.9	33.6	11.5
Mustard Seed	(1)	(1)	0.1	0.2	0.3	0.1	(1)	(1)	0.6	1.2	2.1	0.8
Improved Pasture	3.7	2.8	3.2	4.2	4.2	4.8	(1)	24.8	27.3	27.7	25.8	23.0
Summer Fallow	33.3	35.0	39.9	35.0	35.7	38.0	(1)	92.4	94.6	92.4	91.4	92.4

(1) Not available from census documents for this year.

Source: Statistics Canada, Census of Canada, various years. Percentages derived by author.

as wheat farms meaning that they derived more than half of total potential sales value of agricultural products from wheat. Various reasons have been suggested (Shannon and Richards 1969) for the dominance of wheat in the farming system. Among these are small local markets and long distances to other markets; the physical environment; the extensive nature of farming units and of farming operations; large investment, in machinery and equipment for grain production and grain handling and storage facilities; tradition; and the various advantages of specialization, such as simplification of management tasks.

Between 1951 and 1976 the number of cattle in Saskatchewan more than doubled despite a 71% drop in the number of milk cows (Table 2.4). While the numbers of horses and ponies, hens and chickens, turkeys, geese and ducks also decreased, the number of pigs and sheep showed no conclusive trend. Beef cattle dominate the livestock complement of the province and their increased number accounted for an intensification of livestock production in Saskatchewan as expressed in animal units (a.u.)[1] per ha. Cattle other than dairy cows accounted for 88% of the 2.2 million a.u. kept in the province in 1976 compared to 42% of the 1.1 million a.u. kept in 1951. Despite the large increase in beef cattle, however, livestock numbers expressed in a.u., came to only 0.08 per hectare of farm land in 1978. This is roughly equivalent to one cow for every 13 hectares.

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[1] Animal unit (a.u.) is a common denominator for expressing livestock numbers. One a.u. corresponds roughly to 1 mature cow in terms of feeding requirements and manure production. Census data on livestock numbers were converted to a.u. using values adapted from Ensminger (1970).

Table 2.4 Livestock and Poultry on Census-Farms, Saskatchewan, 1951-1976.

	Total number of animals (thousand)						Percent of farms reporting					
	1951	1956	1961	1966	1971	1976	1951	1956	1961	1966	1971	1976
Cattle (total)	1136	1869	2056	2398	2621	3128	74.6	72.6	72.2	63.8	61.4	60.1
Dairy Cows (1)	261	272	227	154	110	75	67.2	59.2	55.0	37.5	28.5	17.2
Pigs	470	592	620	488	1129	490	52.3	46.8	45.9	31.5	35.1	17.4
Sheep	118	143	178	128	140	83	3.8	3.9	3.4	2.3	2.2	1.6
Hens and Chickens	7428	8219	6584	5393	4966	4177	68.4	65.2	60.5	46.2	41.7	34.3
Turkeys	357	773	1221	777	524	309	12.5	16.1	17.9	10.4	7.9	7.6
Geese	28	52	41	38	42	42	5.1	7.9	6.7	4.6	5.1	5.4
Ducks	44	78	53	71	84	64	5.7	9.1	6.0	5.7	6.6	5.0
Horses and Ponies	304	171	110	75	65	(2)	70.8	55.5	42.4	32.9	29.2	(2)

(1) Cows and heifers, 2 years and over, milking or to be milked.

(2) Not available

Source: Statistics Canada, Census of Canada, various years.

Although there has been an overall growth in the livestock population of the province, the number of livestock herds has fallen and with them the number of diversified, mixed farming operations that relied on livestock for a substantial share of their income. The remaining livestock operations are larger and the locus of livestock husbandry is more concentrated, reducing the overall diversity and spatial heterogeneity of farm activities. In 1976, 41,785 farms, 60% of all census farms, reported some cattle. In 1951, 83,533 farms, 75% of census farms, reported cattle. The reduction in numbers of farms reporting was greater for other types of livestock. For example, in 1951, 52% of farms reported pigs in some number, while in 1976 only 17% of farms kept pigs. And whereas about 68% of farms kept chickens in 1951, only 34% of a smaller total population of farms kept them in 1976.

Although yields and production have increased in the 1940's, 50's, 60's and 70's, there are important problems with the production methods in use, in relation to environmental impact, energy use, and social costs. The eloquent words of the Dean of Agriculture at the University of Saskatchewan, describe some of these resource management problems (Brown, 1976):

> .... there is an urgent concern about more conservation orientated physical management of our land heritage. Thousands of acres are lost annually to increased salinity, and our soils have experienced a heavy loss of native fertility, tilth and humus materials. The resultant deterioration of soil structure and moisture-holding capacity has had a major impact on the productivity of some of our soils, and is an important factor in the reduced effectiveness in our use of water for plant production.

According to some estimates, soil organic matter content levels have been reduced by one half since cultivation began (Rennie 1978). The continuing loss of this storehouse of plant nutrients and basic constituent of soil structure has been blamed, in part, on present rotation practices and the prevalence of summer-fallowing which leaves ground bare for up to 21 months out of each 24-month period. One in 10 ha under cultivation in the province is adversely affected by salinity, and saline seep, which is adding to the area of salt-affected soils, has also been linked to current practices (Rennie 1979). Loss of soil organic matter and lack of cover when fields are fallowed has been blamed for greater surface movement of water (Rennie 1978). Additional run-off represents water lost to crop production and can cause erosion. In addition, water and soil particles removed from cropland contaminate surface and ground waters with nutrients and agricultural chemicals such as 2,4-D (Cullimore 1978).

Coupland (1977b) noted declining soil fertility and unfavourable rates of annual biological production, or amount of energy fixed, under current cropping systems, in comparison to natural grassland. Although farming in Saskatchewan shows a favourable output:input ratio of between 3 and 5 units of digestible food energy produced for every unit of cultural energy invested, De Jong (1977) has suggested that the ratio would be considerably diminished if the system were charged for the 47 kg of nitrogen per hectare he estimated to be lost annually from the soil organic matter under prevailing production practices. This heavy drawdown on nitrogen reserves is particularly troublesome given the projected price of synthetic nitrogen fertilizers, the production of

which typically involves large amounts of fossil fuels.

The problems of agricultural resource management observed in Saskatchewan are not fundamentally unique. Commoner (1971) has noted that farmers may be induced to exploit their biological capital in order to succeed economically. The "unprofitable" nature of conservation pratices has been documented in specific instances by Pimentel *et al.* (1976), Kasal (1976), Taylor and Frohberg (1977) and Wade and Heady (1977). The problem goes beyond technical solutions. Prevailing farming methods are reinforced by the structure and organization of agriculture at the macro and micro levels (Shannon and Richards 1969, Nygaard 1978, Harwood 1980). This points to the need for social innovations that provide the necessary economic and social context for adoption of fertility-maintaining and energy-conserving cropping systems.

3. METHODOLOGY

3.1 The Analytical Framework

In this study, a comparison of selected aspects of the management and resource efficiency of group farms and neighbouring individual-type farm units was made. Whole farming systems, in the guise of actual operating farms, were studied. This introduced considerable complexity, stemming from each farm's unique combination of social and physical components but this method appeared to be the one most suited to achieving the objectives of the study.

Traditional economic measures were not used in studying resource management since this approach had already been pursued by Morris (1972) in his economic analysis of production co-operatives in Saskatchewan. The intent was to complement rather than duplicate his work. In addition to between farm comparisons, where data were available the performance of study farms was compared to average values for all farms province-wide or in their particular rural municipalities. For some variables it was also possible to obtain qualitative data on management practices before and after formation of the group enterprise.

Choice of research method was greatly influenced by the small number and varied characteristics of group farming operations in Saskatchewan. Both the small population available for study and the lack of a comprehensive listing from which to draw a random sample limited the potential application of statistical tests. The need to include parameters that are difficult to quantify and the uniqueness of each farm operation to be studied, taken together with the other characteristics of the

population, suggested a version of the case study approach (Morris 1972). Variations on this approach have been used successfully by researchers studying farm systems in Saskatchewan and elsewhere in North America and Europe (Beauregard 1977, Jensen 1977, Thompson, Gimby and Coxworth 1978, Viel 1979). Morris (1972) used a modified case study technique and the author has had experience with the development and application of such an approach to a comparative study of conventional and organic farms in the U.S. Corn Belt (Lockeretz *et al.* 1975, Klepper *et al.* 1977, Lockeretz *et al.* 1977).

As for most of these studies, the approach used here represented a compromise. Each farm was studied intensively enough to ensure that all the salient features of the production program were considered and none of the potentially confounding major components omitted. On the other hand, some of the detail that would have been collected in a true case study was intentionally foregone in order that a relatively large number of units, representing a wide range of situations, could be surveyed.

3.2 Sample Selection

A sample of group farms was compared to a control sample of individual-type farm firms. The two samples were outwardly similar in most respects except that the group farms were larger and involved several operators. In all, 15 group farming operations were studied. Eight of the operations were multi-purpose machinery co-operatives, five were organized either as co-operative farms or under the closely related formula of the agri-pool, and two were multi-family, family corporations.

Six of the farms were located in the brown soil zone, six in the dark brown soil zone, and three in the black soil zone.

The identification of potential study farms was accomplished using several sources. A list of farms identified for census purposes as machinery co-operatives or co-operative farms was supplied by the Co-operatives Unit of Agriculture Canada. A list of all production co-operatives incorporated in Saskatchewan was obtained from the Saskatchewan Department of Co-operation and Co-operative Development (Saskatchewan Department of Co-operation and Co-operative Development 1978). Starting with these lists, farms were selected for possible inclusion if they met several criteria of organizational structure and duration of operation.

To be included in the sample, group farms had to have been operating as such for at least three seasons, i.e. since at least spring 1976. As well, the group, or at least a number of operators in the group, had to be planning to continue farming together for at least three more years. The former criterion was included to ensure that the parameters studied would reflect management by the group rather than possible spill-over effects from previous years when the operation might have been run as a number of individual-type farms. The stipulation of plans for future joint operations was included to ensure that the farms represented joint operations in full production rather than units that were being wound down for sale or partition.

Another basic criterion for selection was that the group include at least three owner-operators. Preference was given to groups with participants that were unrelated or that included at least one operator not a member of the same family. The size criterion was chosen to ensure that the group farms would be sufficiently different from the individual-type operations to make a comparison meaningful. The non-relative stipulation was included because the author felt that these were the more unique operations, differing from the common father and son or two-brother firms in the important respect that the participants had not necessarily grown up farming together. A final criterion for inclusion was that owner-operators be willing to participate in the study. It was important that the potential interviewees be willing to take the trouble to answer a lengthy schedule of questions, some of which would require consultation of farm records.

In 1977 there were 43 operating multi-purpose machinery co-operatives and co-operative farms in Saskatchewan, according to Agriculture Canada. Application of the above criteria to this population yielded a sample of 13 group farms for inclusion in the study. In order to expand the size of the sample, two group operations organized as multi-family, family corporations were included. These farms, as noted in Chapter 1, resembled the other group farms in almost all major respects other than the legal terms of incorporation. The population of multiple owner-operator, multiple family, family corporations in Saskatchewan is probably a small fraction of the total population of family-type farming corporations. Information on the size of the population and its membership, however,

is not available from published census material or any other source. The selection of these farms was based on advice from agricultural representatives and other knowledgeable informants.

The median year of formal incorporation for the group farms was 1971. By 1978 they had been operating as co-ordinated units for a median of six seasons. The number of owner-operators actively involved in farming operations on the group farms ranged from 3 to 10, the median being 5[1]. In most cases these owner-operators had been lifetime farmers. In the few cases in which they had held other full-time jobs, all had at least grown up on farms.

Each of the group farms chosen for inclusion in this study was paired with a neighbouring farm being operated as an individual-type enterprise. In addition to the criteria of length of time farming, plans to continue farming, and willingness to participate in the study that were also used in selecting group farms, the individual-type farms had to have no more than two owner-operators and preferably only one. Twelve of the farms chosen for the study were one-operator, family-type operations. In the remaining three instances, informal father and son arrangements were in effect, with the older operator gradually leaving

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[1] The terms owner-operator and operator are used interchangeably in this report to designate those with full-time labour and management roles in the farm as well as an equity position. On the group farms it excludes members or shareholders who are inactive or who hold full-time jobs off the farm. It also excludes spouses, children and hired help, unless they are involved full-time in farm work and management and hold membership or shares in the operation.

more of the decision-making and labour input to a grown son. In two of these cases the senior family lived off the farm for much of the year. As for the group farms, all of these owner-operators were lifetime farmers or had at least grown up on a farm.

To be included in the study the match farm had to be involved in basically the same type of production (e.g. grain farming or grain and beef farming) as the group farm to which it would be paired. It also had to have roughly similar soils. Matching on the basis of soils was done qualitatively by consulting soil maps and Canada Land Inventory soil capability maps. In some cases further qualitative information on the productivity of the land was obtained by consulting Saskatchewan Department of Muncipal Affairs maps indicating assessment for tax purposes.

In almost all cases the individual-type farms were selected with the assistance of local agricultural representatives of the Saskatchewan Department of Agriculture who were asked to suggest farmers who were "better than average" operators and managers. This management criterion was applied to match farms so as to avoid biasing the results towards the group farms. Since the management criterion was applied together with other criteria on soil, location, and mix of enterprises, the extent to which the management criterion was met is not clear. In the small number of cases in which the local agricultural representative was not available for consultation or not familiar enough with farms in the portion of his district concerned, match farms were identified with the help of officials of the local rural municipality and, in one case, with the help of the membership of a group farm under study.

To further reduce variability within the pairs, at least so far as soils and climate was concerned, preference was given to farms close to the group operation being studied. The average distance between the most proximate parcels of land operated by the respective units in each pair was 5 km. In five instances the two farms in the pair operated one or more abutting parcels of land.

3.3 Measures

The first step in studying the resource-management impact of group farming was to identify resource management objectives and to decide on what constituted good or better management practices in light of these objectives and the constraints under which all farms, to a greater or lesser extent, must operate. In the area of natural resources-management a generally espoused (though much neglected) goal is conservation of the resource base (Canada Department of Agriculture 1977). This includes protection of land resources against irreversible or costly-to-reverse changes so that they will be available in present or improved condition for future generations. It also implies avoiding pollution of soil, water or air as a result of agricultural activities and adopting energy-conserving production strategies. Ideally this goal is to be achieved without sacrificing other important social and economic goals for agricultural development.

Many recommendations for conserving resources and minimizing the negative environmental impact of agricultural production can be found in the literature. The list below includes common recommendations, most of which have been widely publicized in Saskatchewan. A questionnaire

(Appendix A) was used to determine the extent to which these practices were adopted and implemented on the surveyed farms.

1. Lengthen crop rotations, moving towards continuous crop cover and away from frequent and prolonged periods of summer fallow (Rennie 1978).

2. Diversify rotations to include stands of legume/grass forage crops and leguminous green manure crops (Thompson and Gimby 1979).

3. Include livestock to make use of nitrogen-fixing forage legumes and as a source of manure (Austenson 1979).

4. Maximize recovery of precipitation by maintaining continuous cover, managing stubble to catch snow, and using other snow-trapping and evaporation and erosion control techniques (Saskatchewan Agricultural Services Co-ordinating Committee 1978).

5. Control wind and water erosion by use of grass waterways, cover crops, strip cropping, stubble-mulching, windbreaks etc. (Holm 1975).

6. Stabilize and/or reclaim salt-affected areas by planting salt-tolerant forage or grain crops, drainage, and reducing summer fallow (Henry and Johnson 197?).

7. Control weeds through diversified rotations and increased use of cultural methods such as higher seeding rates, post-seeding tillage, early harvesting of oats as a green forage crop, etc. (Hay 1978).

8. Increase management effort in the form of soil testing, monitoring of soil and crop conditions, designing sustainable production systems, experimentation, etc.

9. Conserve energy by using state-of-the-art and well maintained machinery and reducing field operations where consistant with good soil management.

Data were collected on seven major aspects of each farm operation. These included land base and land tenure; cropping program; livestock program; specific soil and water conservation problems and practices; machinery inventories and management; business management and planning;

and human resources management and organization. Data on establishment and previous occupations of the operators was taken to learn more about the participants and their reasons for forming or joining a group operation. Data on land tenure and land use were taken to learn the legal arrangements in force and the relative size of the land base, per operator, available to the group and individual farms in the sample. The distance between the most far-flung parcels farmed as part of each study unit was used as a simple proxy for dispersal of land holdings.

As part of the investigation of cropping practices, an effort was made to gain a general picture of cultivation, fertilization, and weed control practices as well as of the rotation followed and the area of different crops harvested in 1978. As a qualitative indication of innovativeness and intensiveness of management effort, data were collected on the use of soil tests and test plots or check strips, and on new methods or products tried. Preliminary information was also collected on specific erosion and salinity control measures in use. Basic data on livestock numbers, livestock management, and manure management were taken to determine the extent of, and approach taken to, livestock production.

An inventory of major items of farm machinery and equipment used in 1978 was taken, size, capacity and market value being recorded for tractors, combines and some other larger items. The use of highly specialized or unusual equipment was noted as well.

The approach to near- and longer-term planning was the subject

of additional questions as was the use of records and the methods used in decision-making. The organization of labour and management tasks and the use of outside resources was noted as well as the use of safety equipment. Finally, an attempt was made to get the participants' own views on how group operations affected resource management in the case of the particular farms under study.

Many of the questions asked were open-ended. This was particularly true of a series of questions about uncommon practices which took the general form: are you using and/or have you used practices (equipment, materials etc.) not commonly in use? Year of first use and reasons for success or failure were recorded for each item, where feasible. The intent was to discover the range of practices in use, to reveal any uncommon practices that would not necessarily have been dealt with in the other questions and, at the same time, to gain an approximate measure of the extent and type of experimentation and innovation practiced.

3.4 Data Collection

All 30 farms in the study were visited in March or April 1979. Data on the 1978 season and general operating practices were collected using an interview schedule that required from 3 to 5 hours to complete, depending on the size and complexity of farm operations. On the group farms at least one executive member, typically the president or secretary of the organization, was included in the interview. In the majority of cases, however, several of the officers of the group farm and additional

family members were present. Others were consulted by phone or in person for specific information in the course of completing the interview schedule. For the interview conducted on the individual-type farms, the operator's spouse was usually present throughout, or, at least, available for consultation on specific questions.

3.5 Data Analysis

Each group operation was treated as a single unit even if, as in the case of machinery co-operatives, title to the various land parcels remained with individual members. A series of ratios was computed to facilitate comparisons between the group and individual-type farms. To compare their resource base, the ratios of total and cultivated area[1] to the number of active owner-operators were derived. The proportion of total area cultivated and the proportion of total area in crops and in summer fallow were included as measures of land use. Livestock present on the individual-type farms and all livestock owned collectively or individually by participants in the group farms, as of end of 1978, was recorded. The livestock complements of the farms were converted to the common animal unit (a.u.)[2] and ratios of animal units to total hectares, cultivated hectares, and active owner-operators were computed. These ratios were also compared to ratios derived from data on livestock

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[1] Cultivated land was defined as land summer-fallowed in 1978 as well as any land that was cropped in 1978, including tame hay and improved pasture in rotation.

[2] Animal unit values were adpated from Ensminger (1970): bulls, cows and heifers, 1 year and over, 1.0; steers, 1 year and over, 0.75; calves, under 1 year, 0.25; pigs, all ages, 0.25; sheep and lambs, 0.1; chickens and ducks, all ages, 1.0 per 200; geese and turkeys, all ages, 10 per 100; horses and ponies, all ages, 0.75.

populations and land area in the rural municipalities concerned. Overall averages for the group farms and for the individual-type enterprises were compared to averages for the 22 rural municipalities in which they were located. These averages were weighted in proportion to the number of farms in this study in each rural municipality.

The total power rating of agricultural tractors, excluding bulldozers, other construction equipment and any chore or garden tractors under 19 kW (25 hp), was computed[1]. This allowed the derivation of ratios of cultivated area to tractor kW, and of tractor kW to active owner-operators. The area seeded for 1978, including land sown in fall 1977 for 1978 harvest, was divided by the total width of seeding equipment to get a value for the amount of area planted per unit width of planting equipment. Similar measures were derived comparing the total width of swathers and total cylinder width of combines (a proxy for size and capacity) to total grain and oilseed hectares harvested (custom work considered). The market value of tractors and combines was compared to area under cultivation and area harvested.

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[1] Power ratings used in Saskatchewan include power take-off horsepower (pto hp), power measured at the pto shaft; engine or brake hp, power measured at the engine flywheel; and drawbar hp, power actually exerted on implements. In the initial computations, pto hp was used. Values quoted by farmers were checked against those provided by the Nebraska Tractor Tests. Where only engine or drawbar hp values were available, as was the case for some of the larger four-wheel drive tractors, an estimate of equivalent pto hp was made. Based on published data for larger tractors evaluated under the Nebraska program, a multiplier of 1.14 was used to convert reported drawbar hp to a pto equivalent and a multiplier of 0.84 was used for transforming engine hp to pto hp values. Power take-off hp was converted to the metric kilowatt (kW) using a multiplier of 0.75.

Values were computed for the average age, weighted by kW, of tractors, and the average age, weighted in proportion to cylinder width, of combine harvesters. To derive this weighted average age of tractors on each study farm, the pto kW rating of each tractor was multiplied by its model year, the products summed, and this sum divided by the total kW of tractors on the farm. The same process was repeated using the cylinder width in centimetres and the model year of each combine.

The Wilcoxon matched-pairs signed-ranks test was used to test the null hypotheses of no treatment effect against alternate hypotheses that the treatments were effective in raising or lowering these variables. The treatment was the grouping of owner-operators and their capital resources into a single, jointly-operated group farm. A non-parametric or distribution-free test was chosen because the computation of the Shapiro-Wilk w-statistic suggested that some of the input data did not come from a normally-distributed population (Helwig and Council 1979). Rather than attempting to reduce skewness and/or kurtosis through transformations or conducting further investigation into the normal or non-normal distribution of the differences between paired variables, the more generalized non-parametric test was adopted. Distribution-free Spearman rank co-efficients were also computed to measure association between farm size and number of operators, and the various other variables recorded for the two sets of farms in this study. In a few cases not all 15 pairs of farms were included in the calculation due to inapplicability of the questions or problems getting the necessary data. The actual numbers used can be found in Appendix C.

The respondents were asked to rank their farm's performance in the areas of "attention to soil conservation and environmental quality" and "effective use of records in planning production and financial strategy" in comparison to "other farms in the area". For both questions a continuous scale ranging from 1, "considerably below average", to 5, "considerably above average", was used to locate responses. Respondents unable to decide between two adjacent categories were assigned a number equivalent to the mid-point between them. Because membership in a particular matched pair was unlikely to have any effect on the answers, a non-parametric test suitable for comparing two treatments on two unrelated samples was chosen. The Wilcoxon rank-sum test (equivalent to the Mann Whitney U-test) was used (Lehmann 1975, Helwig and Council 1979).

4. RESULTS AND DISCUSSION

4.1 Land Base and Land Tenure

In 1978, the median total size of the group farms studied was 2040 ha (Table 4.1). Their median size per operator was 379 ha[1]. The median size of the individual-type farms with which they were paired was 588 ha in total, and 502 ha per operator. Area per operator was not found to be significantly different for the two sets of farms. The median number of operators on the group farms was 5, and the median number involved in the sample of individual-type farms was 1 (mean, 1.2).

Table 4.1 Size and Cultivated Area of Study Farms, 1978 (hectares)

		Group Farms	Individual-type Farms
Total area farmed	Mean	2196	602
	Median	2040	589
	Range	971-3796	324-971
Area farmed per operator	Mean	463	524
	Median	379	502
	Range	291-950	324-799
Total area under cultivation	Mean	1678	519
	Median	1217	516
	Range	937-3431	233-773
Area cultivated per operator	Mean	345	451
	Median	326	403
	Range	215-682	233-696

[1] For this and other statistics presented below, weighted measures of central tendency were used. Each farm received a weight of one, regardless of size or number of operators.

The mean size of census farms in Saskatchewan was 374 ha in 1976. If only farms with sales of at least $10,000 were included, the mean for the province was 453 ha. These statistics are not directly comparable to those presented for the study farms because of the elapse of two years between the census and this survey, because the census does not consider size per operator in the sense used here and because unweighted means would give different values than the weighted medians presented here[1]. Nevertheless, it appears that the individual-type farms studied were close to one third larger than the average commercial-scale farm unit in the province. The group farms, taken as single units, ranked among the top few percent of census farms in terms of size. They appeared to be close to average size, however, when the number of operators involved was considered.

On the group farms studied, median cultivated land area per operator was 326 ha. This was 19% less than the median 403 cultivated hectares per operator in use on the individual-type farms. This difference, which was statistically significant ($p<0.05$) arose partly from a trend to smaller overall farm area per operator on the group farms, and partly from differences in shares of total land under cultivation. The median for the groups was 76% of total land under cultivation, as opposed to 84% for the individual-type farms, shares

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[1] Unweighted mean size per operator was 433 ha for the group farms and 502 ha for the individual-type farms in the study.

that were significantly different ($p<0.05$). Possibly the percentage of non-arable land available on the group farms was greater than that found on the individual-type units studied. It is also possible that, given similar resources, the two sets of farms had different propensities to put land under cultivation.

In three of the machinery co-ops in the group farm sample, one or more members operated additional land outside of the formally constituted group enterprise. This land was rough pasture, and was used to pasture cattle being raised privately, except in one case in which a small amount of recently acquired crop land had not yet been formally included in the co-operative operation. For the 15 group farms taken together, the area of privately-operated land was 2% of the total land area operated. For the sake of more valid comparisons, this privately-operated land was included in the total land area figure for each group.

There was no significant difference overall between the group and individual-type farms in terms of proportion of land rented from outside parties. Though specific situations varied greatly, the median values for both sets of farms were similar. The groups for which data on this question were collected (n = 11) reported a median of 29% of their land rented from private or public leasors outside the firm under study (mean, 35%). The individual-type farms surveyed (n = 15) reported a median of 26% of their land rented (mean, 30%). These values were very close to the overall 1976 provincial average of 31%.

The similarity between the group and individual-type farms with respect to rental of land suggests that this aspect of land tenure would not have been a factor in any observed differences in resource management.

Land managed by the group operations was significantly ($p<0.01$) more spread out than that farmed by the individual-type operators. This was probably due, in part, to the fact that the group farms managed land that had formerly been organized into a number of smaller units. The median distance between the most far-flung fields on the group farms was 22 km, versus 13 km for their matches.

While historical accidents of ownership, survey patterns, and relationships are difficult to undo, there is ultimately no reason why even large operations need to be spread over a great area. A block of land 5 km on a side contains 2500 hectares. This is more than six times the average farm size in Saskatchewan in 1976 and somewhat larger than the average group farm under study here. Since it is potentially possible for large group farms to exist in a compact area, dispersal of land holdings should not be taken as a universal corollary of this form of joint operation.

Avoidable or not, the dispersal of holdings on the group farms studied probably had attendant resource costs such as extra energy and equipment needed for personnel, material, and machinery transport. It may also have contributed to reducing the risk of being totally hailed-out and have given them a greater range of soil conditions to work with.

Although it has also been suggested that monitoring of crop development and field conditions could be a problem on farms with far-flung holdings (Delisle 1978), this is perhaps not as severe a problem on a large group farm as it could be in a situation in which one or two operators managed a large property alone. The group operations typically involved several operators and the family groups involved generally lived on individual home lots dispersed among the land parcels used by the group.

4.2 Crop Production

The group farms in the study sample each grew between two and eight different crops in 1978 (tame hay included and all varieties of a single crop considered as one, except in the case of feed wheat). The individual-type farms raised between two and six different crops each. The median number of different crops grown on the group farms in 1978 was five, while the individual-type farms had a median of four crops. This difference was found to be only weakly significant with a one-sided test ($0.05<p<0.10$).

There was a high correlation ($r_s = 0.71$; $p<0.01$) between the number of active principal operators and the number of crops grown on the group farms but only a weakly significant correlation ($r_s = 0.47$; $0.05<p<0.10$) between area under cultivation and the number of different crops grown on the group farms and no significant correlation between these variables on the individual-type farms. This suggests that availability of management and labour was possibly more important than farm size in determining the number of different crops raised in any given season on group farms.

The proportions of land devoted to commonly raised crops were similar on the two sets of study farms and closely resembled, in turn, the crop mix on all census farms in the province, considered collectively (Table 4.2). Two- or three-year rotations of fallow and wheat, or of fallow followed by some sequence of cereal, oil seed and forage crops, were the norm on the study farms, with summer fallow and wheat dominating the cropping program to about the same degree that they do in the province as a whole. Some deviation was recorded for rape, which was grown more on the individual-type farms and for improved pasture, which was more evident on census farms generally than on the farms surveyed. The apparent dearth of improved pasture on the study farms may have been an artifact of definitional problems or it may have been a reflection of geographical bias in the process by which farms were selected for study.

Table 4.2 Land Use on Group and Individual-type Study Farms, 1978, and on Census Farms in Saskatchewan, 1976.

Land Use	Percent of Total Cultivated Land[1]		
	Group Farms	Individual-type farms	Census Farms
Summer Fallow	37.4	38.9	38.0
Wheat	42.8	39.6	37.9
Barley	6.7	5.1	6.4
Oats	2.5	3.0	3.4
Rye	1.9	1,2	0.6
Tame Hay	3.5	3.0	4.6
Rapeseed	2.8	4.7	1.4
Improved Pasture	1.0	0.6	4.8
(Above 8 combined)	98.6	96.1	97.2

[1] Unweighted values

In Saskatchewan, monocultures and rotations involving only two or three crops have been blamed for pest problems, for damage to soil structure and fertility, and for contributing to an inefficient use of labour and capital (Bentley 1978). Over-reliance on one or two crops has also been cited (Thair 1978) as a basic cause of boom-and-bust instability in the farm economy, itself a detriment to long-term planning and rational resource use. It was therefore of interest to determine whether group farmers, given greater human resources and larger land areas, might choose to grow a greater variety of crops. The actual difference observed was not great, suggesting that the common economic and informational context in which the two sets of farms operated was an important influence.

It should be remembered that although rotations involving different types of crops are generally held to contribute to the maintenance of a desirable soil structure, the significant factor is probably not so much the rotation itself but the residue levels and number of tillage operations associated with the particular crops used in the rotation (Blake 1980). These aspects and others need consideration before a conclusion can be reached that the inclusion of more different crops in a rotation is indicative of better soil management. Flax, mustard, and rape, for example, leave less residue than the common cereal crops, and a continuous stand of leguminous hay is more beneficial to soils than almost any rotation involving different cereals, oil seeds, pulses and hay crops.

There was no significant difference in the number of times that 1978 summer fallow was worked on the two sets of farms under study. The usual number of passes made on summer fallow fields ranged from three to seven on the group farms and from two to nine on the individual -type farms. The median number of passes was five on both sets of farms. The lack of overall differences in this respect suggested that on average tillage strategies for summer fallow were similar on the paired sets of farms. The number of tillage passes does not tell the whole story, however. Choice of implement, depth of cultivation and timing of operations as well as any complementary herbicide programs influence the degree to which summer-fallowing contributes to the break-down and erosion of soils and the degree to which it facilitates water conservation and weed control. It is interesting that the range of frequency of cultivation on fallow fields was considerable. This indicates latitude for adjustment, especially since in this survey, operators working under similar agronomic conditions sometimes showed considerable difference.

Sixty-seven percent of the group farms and an equal proportion of the individual-type farms used some commercial fertilizer for the 1978 crop. Among those using it, fertilizing strategies varied widely: from light use of a blended product only on certain stubble (second crop) fields, to use of blended fertilizers on all fields, with additional nitrogen being applied to stubble crops. Although a detailed field-by-field analysis was not completed, it appeared that there was no marked overall difference in the type, rate, and extent of fertilizer application on the two sets of farms.

Some soil testing had been done in the last ten years (or since the group had been formed, if that was less than ten years before), by 67% of the group farms. Only 27% of their matches had had any soil samples analyzed in the last ten years (or since they started farming, if that was less than ten years before). Even though the same proportion of group farms reported soil sampling as reported fertilizer use, 30% of the group farms reporting fertilizer application for the 1978 crop had never done any soil testing. Fully 80% of the individual-type farms reporting 1978 fertilizer use had likewise never had soil samples analyzed. This was not surprising in the light of the low percentage of individual-type farms doing soil testing in the first place. The greater incidence of testing on the group farms may reflect greater availability of labour and/or the need to justify fertilizer use or non-use in the more formal decision-making process employed by these farmers.

There did not appear to be any significant difference in propensity of the two sets of farms to conduct field trials. Forty-seven percent of the group farms reported having, at some time, set out tests plots or test strips to compare materials, varieties or practices. Forty percent of the farms they were paired with reported similar experiments. Such trials may take on a greater importance in the light of U.S. Corn Belt comparisons between experiment station results and on-farm results that show significant differences in the level of observed response to similar fertilizer treatments (Swanson 1957, Taylor and Swanson 1973).

A question designed to reveal qualitative differences in the amount of innovation, early adoption, and experimentation in cropping programs

on the two sets of farms gave mixed results. Eleven of the 15 groups cited experimentation with rotations, crops , or varieties not commonly used in their areas, a total of 23 instances in all. This was little different from the individual-type farms, 10 of which reported a total of 20 instances in which they were much ahead of their neighbours in trying some new crop or cropping method. Typical examples in both cases were the use of less common crops like peas, sweet clover, or sunflowers and experiments with continuous cropping or longer rotations. Similarly, little overall difference was revealed between the matched sets of farms in terms of experimentation with fertilizers, herbicides, or other crop inputs not at the time in common use in their areas. Seven of each of the group and individual-type farms reported a total of 10 and 11 instances respectively. Most commonly cited examples included early adoption of millet or wild oat herbicides and early use of aqua or anhydrous ammonia fertilizers. Two of the individual-type farms using fertilizers reported experimentation with commerical "organic" fertilizers.

There appeared to be a difference in the propensity of the two sets of farms to use the newer reduced or zero-tillage methods. Five of the group farms reported an uncommon tillage-minimizing practice, in most cases, the use of a no-till drill, while only one individual-type operator reported such a practice. This difference may have been partly the result of the group farms being able to share the cost and the risk of buying and using new types of equipment. However, since in some cases no-till machinery was rented, and in some cases no new machinery was involved at all, other effects may come into play. It is possible,

though difficult to verify, that the dynamics of group work and decision making encourages the introduction of some types of new techniques and technology.

4.3 Livestock Production

The paired farm research design used in this study did not facilitate direct testing for differences in livestock production. The criteria used in selecting the individual-type farms as matches for the study sample of group farms ensured that the farms making up each pair would be fairly similar with respect to presence or absence of livestock, type of livestock operation, and, to a lesser extent, with respect to size of livestock holdings per operator and per hectare. Given the pairing method employed it was not surprising that, overall, the group and individual-type farms showed no significant differences with respect to the number of animal units (a.u.) kept per unit of land farmed or per unit of land under cultivation (Table 4.3). There was also no significant difference in the amount of livestock kept per active operator.

Table 4.3 Selected Measures of Livestock Holdings on Study Farms and on All Farms in the Same Rural Municipalities ("All Farms" Statistics in Parenthesis).

		Group Farms	Individual-type Farms
Animal units per hectare of land farmed	Mean	0.077(0.050)	0.066(0.052)
	Median	0.062	0.062
	Range*	0.0067-0.099	0.019-0.099
Animal units per hectare of land under cultivation	Mean	0.10	0.076
	Median	0.086	0.062
	Range*	0.0068-0.15	0.019-0.12
Animal units per operator	Mean	33	30
	Median	28	29
	Range*	4-38	6-47

* Interquartile range

Twelve of the 15 group farms had commercial-sized livestock herds, as did an equal number of individual-type farms[1]. On eight of these group farms, herds were owned and managed collectively while on the four additional group farms which had livestock in commercial-sized herds, a total of 11 herds were managed separately and privately by members and/or their spouses and children. There was little evidence of greater diversification in terms of the type of livestock enterprises operated on the group farms. Cow/calf herds, with young stock being fed out to market weight in some cases, were the dominant type of operation on both sets of farms.

Of potentially greater interest, mean stocking rates on the study farms were also compared to stocking rates for all farms in the rural municipalities in which they were located. These comparisons showed the study farms to be above average for their areas in terms of amount of livestock kept (Table 4.3). At the end of 1978, the group farms had 54% more, and their matches had 27% more livestock per unit area than the average farm in their municipalities.

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[1] In all but two cases, the respective farming units in each matched pair situation either both included commercial-sized livestock enterprises or both had no commercial-sized livestock operations. In one of these two cases, the group farm included no livestock herds either as part of the group enterprise or under private management by one of the participants, but the individual-type farm with which it was paired had a very small (8 a.u.) herd. In the other case, one of the participants in the group farm operation had a small (14 a.u.) herd (managed privately as a separate operation), but the individual-type farm which had been chosen as a match to the group farm had no livestock.

It is safe to say that the group farms kept more livestock than one would expect given the general situation in their localities. Several factors may explain this tendency. On a group farm where livestock was held collectively, there would be opportunity for achieving physical economies of size in facilities. Specialization amongst the membership could also provide a high level of management effort on several different crop and livestock enterprises without penalizing any one. Theoretically, this could lead to a diversified mixed-farming operation in which each enterprise was efficiently run on a commercially viable scale. In group farming situations in which herds were managed separately by participants, economies in fodder and feedgrain production might nevertheless make livestock production more attractive. Probably more important, a reduction in labour and management commitment to grain production, realized through joint operations in that area, might allow a participating operator the additional time and concentration necessary to successfully manage a livestock enterprise.

To further explore this question, respondents for the group farms were asked if the overall amount of livestock kept by the participating operators had changed since the formation of the group enterprise. Seven of the 15 groups reported overall increases, while two reported decreases. Six groups reported little change. Reasons given for the increases included the need for alternative methods of marketing grain and the fact that the "cattlemen" in the group operations were able to manage the livestock operations. This made having a share in a livestock enter-

prise more attractive to those who had formerly been strictly grain farmers. Reasons given for the decreases in livestock holdings included lack of good quality water supplies and that the participants were making enough profit on crop production that they could afford to get out of livestock production. Those who had not kept and still kept no livestock gave reasons such as adequate income from grain production and the continuing need to specialize given the relatively small number of operators in the particular groups.

The keeping of stock might conceivably encourage the production of forage crops and feedgrains, thus increasing the diversity of the crop program. As a first look at this question, the possibility of a relationship between livestock holdings per hectare and the number of different crops grown was considered (Table 4.4). Only for the individual-type farms was this relationship found to be significant. It is possible that the group farms had a propensity to grow a greater number of crops, even without the inclusion of livestock as a factor, so that the presence of livestock changed matters relatively little. It is also possible that the relatively large area of uncultivated land present on the group farms was the main source of livestock feed. Although a positive relationship was seen between the number of operators and the number of crops grown on the group farms, there was no significant correlation between number of operators and stocking rate (Table 4.4).

Table 4.4 Spearman Product-Moment Correlation Coefficients for the Relationships between Stocking Rate and the Number of Crops Grown and the Number of Operators (Associated Probabilities of Greater Absolute Value of r_s Under the Hypothesis of Equality, in Parenthesis).

	Stocking Rate	
	Group Farms	Individual-type Farms
Number of Crops Grown	0.349 (0.202)	0.623 (0.013)
Number of Operators	0.317 (0.250)	-0.156 (0.580)

In response to questions about experimentation with livestock or approaches to livestock management not in common use, 8 of the 13 group farms with livestock, and 4 of the 13 individual-type farms keeping stock, reported a total of 11 and 8 innovations respectively. Typical examples were early adoption of artificial insemination or exotic breeding stock; use of labour-saving hay harvesting and feeding systems; and innovations in livestock buildings such as raised farrowing crates and nursery pens in confinement hog facilities. While this approach to comparing innovativeness on the two sets of farms is not refined enough to justify more technical tests, it is probably safe to say that there was no suppression of innovation on the group farms. Compared to the control farms there may even have been a slight tendency towards greater experimentation with innovations in livestock production.

4.4 Soil and Water Conservation

Eighty-seven percent of the group farm respondents and an equal proportion of their matches reported some salinity problems on land that

they farmed. There was no measurable difference in the propensity of the two sets of farms to respond to this resource management problem with appropriate measures. Nine of the 13 group farms and 8 of 13 of the individual-type farms reporting salinity problems also reported remedial actions taken in 1978. Typical measures reported were the planting of salt-tolerant grasses and legumes; growing barley instead of wheat; applying manure; and reducing the frequency and depth of cultivation in affected areas.

Few of the study farms were employing snow management techniques and there was no measurable difference between the two types of farm holdings with respect to snow management. Several of the respondents reported that their land had adequate bush cover to trap snow, making special practices unnecessary but the low incidence of snow-conserving initiatives more probably reflected a low opinion of the efficacy of the available methods.

Comparing their own operations to other farms in their areas in terms of attention to soil conservation and environmental quality, all the group and individual-type respondents rated themselves average or better than average. The median scores for the group and individual-type farms were 3.5 and 3.0 respectively on a scale that assigned the value of 3 to "average", 4 to "somewhat above average" and 5 to "considerably above average". The scores were not found to be significantly different overall. Among the 8 group farms and 6 individual-type farms rating themselves above average, reasons given for choosing the ratings included:

the use of sweet clover or other forage crops in rotations; shallow tillage and/or reduced number of cultivations; careful and moderate use of herbicides; keeping livestock and careful application of their manure; longer rotations; never burning stubble; avoiding fall tillage; and avoiding large fields.

4.5 Machinery Management

The group farms in this study appeared to achieve some important economies in machinery and equipment in comparison with the sample of individual-type farms (Table 4.5). In terms of area under cultivation per tractor kilowatt, the group farms worked a median of 4.0 ha with each tractor kilowatt. This was significantly ($p<0.01$) more than the median of 2.9 ha worked by their matches. The group farms also managed with significantly less ($p<0.01$) tractor power per operator, a median of 87 kW versus 156 kW per active operator in the case of the individual-type farms. The group farms operated with a median of 372 tractor kilowatts in total while the farms with which they were paired had a median of 174 kW of tractor power at their disposal.

The median number of field and chore tractors on the individual-type farms in this study was two while the groups shared a median of five tractors. This meant that the group farms maintained significantly fewer ($p<0.01$) tractors per active operator, a median of 1.2 versus 2 for the control sample. The median estimated 1978 market value of field and chore tractors on the group farms was $34 per hectare of cultivated land compared to $56 for the individual-type

Table 4.5 Selected Measures of Machinery Capacity, Age, and Market Value for Group and Individual-Type Study Farms[1].

		Group Farms	Individual-type Farms	p[2]
Cultivated area per unit tractor power (ha/kW)	Mean	4.0	2.8	
	Median	4.0	2.9	<.01
	Range[3]	3.3-4.5	2.1-3.3	
Tractor value per unit cultivated land ($/ha)	Mean	42	65	
	Median	34	56	<.01
	Range	24-52	42-81	
Largest tractor (kW)	Mean	140	104	
	Median	141	95	<.01
	Range	106-144	78-123	
Age of tractors weighted by unit tractor power (years)	Mean	7	8	
	Median	6	7	ns
	Range	4-8	6-8	
Area seeded per unit width of seeder (ha/m)	Mean	50	39	
	Median	50	38	<.05
	Range	42-54	27-41	
Area swathed per unit width of swather (ha/m)	Mean	58	40	
	Median	54	36	<.01
	Range	47-66	29-41	
Area harvested per unit combine cylinder width (ha/cm)	Mean	3.5	2.5	
	Median	3.4	2.3	<.01
	Range	2.6-4.2	1.7-3.0	
Combine value per unit area harvested ($/ha)	Mean	46	73	
	Median	35	57	ns
	Range	20-43	28-97	
Age of combines weighted by unit cylinder width (years)	Mean	5	5	
	Median	4	4	ns
	Range	2-7	1-7	

[1] See Appendix B for similar table in Imperial units.

[2] Significance level of difference between group and individual-type farms

[3] Interquartile range in all cases

operations. This difference was statistically significant ($p<0.01$), and even larger than the difference found in kilowatts of tractor power per cultivated hectare. Measured per unit of land under cultivation, the group farms reported a median of 26% less kilowatts of tractor power and 37% less investment in tractors than the matched individual-type farms.

The median size of the largest tractor found on the group farms was 141 kW. This was significantly larger ($p<0.01$) than the 95 kW median for the most powerful tractor on the match farms. In concert with this finding, while 3 of the individual-type farms in the sample had regular use of a four-wheel drive (4-WD) tractor, 11 of the groups had at least one 4-WD tractor and 5 groups reported more than one. Overall, 40% of the tractor power on the group farms came from 4-WD units compared to only 14% for the individual-type farms.

The average age of field and chore tractors found on the two sets of farms was not significantly different: 11 and 12 years for the group and individual-type farms respectively. The inclusion of smaller, older tractors increased the overall average age of tractor inventories considerably. Since older, smaller tractors tend to be used for relatively few hours annually, and rarely for field work, it was useful to calculate the average age of the larger field tractors. In 1978, the average age of the largest tractor on the individual-type farms was 3 years. On the group farms the average age of the largest tractor was 2 years; of the largest 2 tractors, 3 years and of the largest 3 tractors, 5 years. As an additional comparison, the median average age of tractor kilowatts in use on the two sets of farms was calculated. The median age of

tractors weighted by kilowatt was 6 years in the group farms and 7 years in the individual-type farms, a difference that was not statistically significant.

There were strong indications that economies achieved by the group farms in the area of tractor inventory and investment were repeated for other major items of farm machinery and equipment as well. In 1978, the group farms sowed a median of 50 ha for each metre width of seed drill or seeder/discer equipment they owned, significantly more ($p \leq 0.05$) than the 38 ha established per metre width of seeding equipment on the individual-type farms. The group operations also swathed a median of 54 grain ha per metre width of swathing equipment in use compared to a median of 36 ha on the neighbouring individual-type farms. The calculation was made assuming all grain and oil seed was swathed, but since a few farmers reported some direct combining, both figures would be slightly inflated. The observed difference was found to be statistically significant ($p<0.01$).

A parallel situation existed with respect to combine harvesters. In 1978 the group operations threshed 3.4 ha of grain and oil seed crops for each centimetre of combine cylinder width they were using (the cylinder is the primary threshing site and cylinder width is roughly proportional to overall machine capacity at least up until the late 1970's when a new generation of combines began to appear). Again, this was significantly more ($p<0.01$) than the median of 2.3 ha per centimetre harvested by their matches. There was no significant difference in the median age of combine units in use on the two sets of farms: 4 years in

both cases. As revealed in terms of cylinder width, the median size of combines found on the group farms was, however, significantly greater ($p<0.05$) than the median for their matches. This value was 119 and 107 cm for the group and control samples respectively. The unweighted median for the 36 combines found on the group farms was 121 cm (mean, 117 cm) and 107 cm (mean, 110 cm) for the 17 combines in use on the individual-type farms. As would be expected, the group farms tended to have more than one combine. While two of the group farms had only one combine apiece, eight of the groups shared two combines between themselves, three groups had three combines, one group had four, and one group had five. Only two of the individual-type farms had a second combine.

Combine harvesters were found to be as important as tractors in terms of investment per unit land area (Table 4.5). There was, however, a large farm-to-farm variation in grain combine investment, whether measured as market value per hectare under cultivation or as market value per hectare actually harvested with the equipment in 1978. Besides differences in capacity, differences in age and the presence of both self-propelled and pull-type combines in these inventories contributed to the great range of values recorded. The median market value of combines per hectare combined was $35 on the group and $57 on the individual-type farms, the overall range recorded being from $15 to $145 and from $13 to $187 on the two sets of farms respectively. This variation meant that observed differences in median values for the two samples were not statistically significant even though the existance of a significant difference

in capacity per unit of land suggested the trend was significant. A larger sample would be needed to demonstrate this trend conclusively.

Inventories of tillage equipment are not as amenable to comparison because of the greater variations in type of implements used. In terms of weight, draft, cost, or effect, field cultivators, for instance, are not readily comparable to rod-weeders though to some extent one can be substituted for the other. For this reason, no calculations of the capacity or width of cultivating equipment per unit of land under cultivation are presented.

The groups worked 19% less land per operator than the individual-type farms studied (Table 4.1). They operated, however, with a median of 44% less tractor power, 49% less seeding equipment, 44% less swathing equipment, and 44% less combine capacity per active operator (Table 4.6). Lower per operator values recorded on the group farms were generally the result of having fewer machines per farmer, not small equipment. The relative size of field tractors and harvesting equipment on the two sets of farms suggested that the group farmers could expect to accomplish as much or more, per man-hour, as their matches.

The relationship between various machinery variables and cultivated area or number of active operators showed some interesting tendencies (Table 4.7). The negative correlation between market value of tractors per unit of land area and total area under cultivation was statistically significant both for the group farms ($r = -0.51$, $0.05<p<0.10$) and for the individual-type operations ($r = -0.55$, $p<0.05$). Similarly, significant

Table 4.6 Selected Measures of Machinery Capacity and Market Value Per Operator for Group and Individual-Type Study Farms.

		Group Farms	Individual-type Farms	p[1]
Tractor power per operator (kW/op)	Mean	90	162	
	Median	87	156	<.01
	Range[2]	65-99	119-188	
Width of seeding equipment per operator (m/op)	Mean	4.0	7.6	
	Median	3.4	6.7	<.01
	Range	2.8-5.4	5.2-9.1	
Width of swathing equipment per operator (m/op)	Mean	3.8	6.6	
	Median	3.1	5.5	<.01
	Range	2.8-4.4	5.5-6.1	
Width of combine cylinder per operator (cm/op)	Mean	58	108	
	Median	58	103	<.01
	Range	40-71	94-112	
Tractor value per operator ($1000/op)	Mean	15.0	26.4	
	Median	14.0	27.0	<.01
	Range	7.3-17.0	21.4-31.1	
Combine value per operator ($1000/op)	Mean	9.0	17.9	
	Median	6.6	13.3	<0.05
	Range	3.8-8.9	6.0-22.7	

[1] Significance level of difference between group and individual-type farms

[2] Interquartile range in all cases

Table 4.7 Spearman Product-Moment Correlation Coefficients for the Relationships between Farm Size Indicators and Selected Measures of Machinery Management (Associated Probabilities of Greater Absolute Value of r_s under the Hypothesis of Equality, in Parenthesis).

Machinery Variables	Area Under Cultivation		Number of Operators	
	Group Farms	Individual -type Farms	Group Farms	Individual -type Farms
Cultivated area per unit tractor power	0.400 (0.140)	0.286 (0.302)	0.302 (0.274)	0.039 (0.891)
Unit tractor power per operator	-0.004 (0.990)	0.232 (0.405)	-0.478 (0.072)	-0.290 (0.295)
Tractor value per unit cultivated land area	-0.507 (0.054)	-0.550 (0.034)	-0.389 (0.153)	0.077 (0.785)
Size of largest tractor	0.477 (0.072)	0.452 (0.091)	0.351 (0.200)	0.174 (0.536)
Area seeded per unit width of seeder	0.439 (0.101)	0.556 (0.039)	0.431 (0.109)	0.151 (0.606)
Area swathed per unit width of swather	0.429 (0.111)	0.279 (0.314)	0.731 (0.002)	0.174 (0.536)
Area harvested per unit of combine cylinder width	0.589 (0.021)	0.854 (0.0001)	0.422 (0.118)	0.270 (0.330)
Combine value per unit area harvested	-0.082 (0.771)	0.099 (0.737)	0.104 (0.711)	0.151 (0.606)

positive correlations existed between area harvested per unit of combine capacity and total area under cultivation on the group ($r = 0.59$, $p<0.05$) and individual-type farms ($r = 0.85$, $p<0.01$). This trend was especially significant on the individual-type farms which, given only one or two operators, could probably make little use of a second or third combine even if their crop area was large.

In 1976 machinery manufacture and repair accounted for one quarter of non-renewable energy inputs to Saskatchewan farm production (Stirling 1979). This machinery category of energy inputs increased by 93% between 1961 and 1976, growing faster, in absolute terms, than all other categories, and faster, in relative terms, than all other catagories save fertilizer and electricity (see Table 4.8). Changes in machinery inventories per unit area farmed or per farmer could therefore affect the energy cost of production significantly.

In comparison with the individual-type farms with which they were paired, the group farms in this study managed with a median of 26% less tractor power per cultivated hectare, 24% less seeding equipment per hectare seeded, 33% less swather capacity per hectare swathed, and 32% less combine capacity per hectare harvested. Conservatively, 25% can be taken as representative of the overall reduction in machinery and equipment inventory achieved with group farming. Savings on repair and replacement parts would not be directly proportional since, regardless of inventory, some portion of repairs and maintenance remains a function of area worked.

Table 4.8 Non-Renewable Energy Inputs for Saskatchewan Farm Production 1961-1976 (Energy Inputs in Units of 10^{10} Megajoules).

Year	Machinery		Buildings		Fuel and Lubricants		Fertilizer		Herbicides and Pesticides		Electricity		Seeds and Feeds		Total Inputs
	MJx10^{10}	%		%		%		%		%		%		%	
1961	1.36	20.3	0.37	5.5	3.57	53.4	0.09	1.4	0.04	0.6	0.18	2.6	1.09	16.2	6.69
1966	1.81	22.4	0.39	4.8	3.93	48.7	0.45	5.5	0.05	0.6	0.26	3.2	1.19	14.7	8.08
1971	2.17	23.9	0.41	4.6	4.37	48.1	0.22	2.4	0.05	0.6	0.42	4.6	1.44	15.8	9.08
1976	2.63	24.4	0.41	3.8	4.81	44.7	0.75	7.0	0.06	0.6	0.54	5.0	1.57	14.6	10.77
Percent increase 1961-76[1]	93%		10%		35%		718%		67%		207%		45%		61%

Source: Adapted from Stirling 1979:14

[1]Percentages are taken from original source and may not correspond exactly with values in table due to rounding error in conversions.

In the mid-1970's, the wholesale value of farm implement and equipment repair parts accounted for between 10 and 15% of the total wholesale value of farm implement and equipment sales in Saskatchewan (Saskatchewan Bureau of Statistics 1978). If 15% is chosen and if, to be conservative, no savings in repairs and maintenance parts is postulated for the group farms, then actual overall savings in materials might be of the order of (.25 x 85%) 20% (materials being equated with dollar value for purposes of this calculation). Since machinery manufacture and maintenance accounted for approximately one quarter of total energy inputs for production in recent years (Stirling 1979), a 20% savings in this category would translate into 5% energy savings overall (all inputs considered). Although 5% savings in non-renewable energy use for farm production may appear small, it is equivalent to more than the share of farm input energy that goes into construction of buildings (3.8%) (Table 4.8), all on-farm electricity consumption (5%), herbicides and pesticides manufacture (0.6%), and close to the share represented by the manufacture of all commercial fertilizer used on Saskatchewan farms (7%) (Stirling 1979).

Pooling of machinery on the group farms was often combined with the sharing of a central servicing and equipment storage area. This allowed some of the groups to make economical use of tools and repair facilities that would have been available only in the better-equipped machinery dealerships. The individual-type farms often had

well-appointed workshops as well, but few could undertake the major overhaul and machinery building and rebuilding tasks that some of the groups attempted. Pooling also appeared not to inhibit experimentation with new types of equipment. Ten of the 15 groups reported having experimented with machines not in general use, making important modifications to equipment, and/or designing and building new equipment. Only 3 of their matches reported such activities. Examples of machinery innovation among the group farms included home-design and building of multiple-hitching arrangements, self-unloading grain and materials transport trailers, and a truck-mounted hydraulic soil-sampler.

4.6 Business Management and Planning

The group farms kept fairly detailed financial records as required by law. Many but not all of the individual-type farms kept similarly detailed accounts using systems developed by banks, farm organizations, or the Saskatchewan Department of Agriculture. One of the individual-type farms and two of the group farms were registered on the Canfarm record-keeping system. The preparation of annual budgets to forecast labour requirements and other costs and revenues was reported by ten group farms and three of their matches. Ten of the groups and two of the individual-type farms reported the use of cash-flow forecasts and statements. This was usually done to support credit applications. Both sets of farms reported extensive use of crop and hail insurance.

All of the individual-type and group farms rated themselves at least average when asked to compare their operations to other farms in the local area with respect to effective use of records in planning production and financial strategy. Eleven group farms and six of the matches rated themselves better than average. The median score for the groups was significantly higher ($p<0.01$), 4.75 versus 3, on a scale that assigned the value of three to "average", four to "somewhat above average", and five to "considerably above average". This spread probably reflected some real differences in the extent to which records were kept and used on the two types of farms. It might be argued, however, that records are less critical where only one operator is making decisions. Some of the record-keeping undertaken by groups may be done in response to legal requirements and more to facilitate equitable sharing of costs and revenues among participants than to improve other aspects of resource-management.

In response to questions about buying strategies, three of the group farms and five of their matches volunteered that they made an effort to shop locally. Eleven of the thirteen group farms which were organized under the Co-operative Production Associations Act reported that they tried to patronize other co-operatives and farmer-controlled organizations when buying supplies. None of their matches mentioned this bias specifically. In 1978 all of the group farms surveyed had made some major purchase from co-operative companies such as Canadian Co-operative Implements Ltd., the Federated Co-ops,

or the Saskatchewan Wheat Pool. Twelve of their matches had done likewise. Three of the group farms reported that they had asked for submission of tenders on farm machinery purchases at some time in the past.

The median distance from farm headquarters to dealers from which machinery, fertilizers, and herbicides were purchased in 1978 was not significantly different for the two samples of farms (Table 4.9). The distances reported were also similar to those recorded by Johnson (1978a). Surveying farms in west-central Saskatchewan he found that the average distance between farmsteads and dealers from which inputs were bought was 55 km for machinery, 19 km for fertilizers and 15 km for herbicides and pesticides.

Table 4.9 Distance (km) from Dealers Where Major Purchases Were Made in 1978.

Input		Group Farms	Individual-type Farms
Machinery	Mean	67	50
	Median	68	32
	Range*	31-92	14-72
Fertilizers	Mean	19	23
	Median	13	15
	Range*	8-27	12-19
Herbicides	Mean	20	12
	Median	16	11
	Range*	8-29	6-18

* Interquartile range

4.7 Human Resources Management and Organization

While the median number of active operator members on the group farms studied was 5, the groups were, in practice, not just associations of owner-operators but, to a considerable extent, of their families as well. The units studied included from 3 to 10 nuclear family groupings and involved from 5 to 21 adults and from 1 to 14 children living on the farm or still supported by their parents.

In sampling the group farms, preference was given to larger groups and those that included unrelated individuals. Despite this bias, all group operations studied were found to include at least two related operators and, in five instances, all participants were related. Family ties appeared to weigh heavily in the mutual selection process by which groups were formed. Though wives of member-operators acted as secretaries and/or book-keepers for at least 6 of the 15 groups and received payment for doing so, only in 2 of the production co-operatives were wives formally included in the group as full voting members. Not surprisingly, reduced involvement in farm decision-making and reduced contact with farm operations generally, were negative aspects of group farming reported by some women. Advantages reported included the following: reduced necessity for doing hard physical labour if one preferred not to, greater opportunity to develop outside interests and to hold outside jobs, and the possibility of being paid for any field work, truck-driving, record-keeping or other direct involvement with

farm operations. Wives also shared in benefits such as increased physical and financial security, and reduced isolation.

Formal group organization provided a framework for hiring the children of the participating families and for orderly transfer of assets to them. The dynamics of group decision-making and work allocation may, however, have reduced the opportunity for informal and part-time involvement of young people in some instances. The large equipment in use reduced labor hours and required experienced operators. This limited the opportunities for children and wives to participate in fieldwork on all farms, but particularly on the group farms. Though difficult to measure, the effect this had on the transfer of skills from one generation to the next and the effect it had on the potential for sustaining enthusiasm for farming, and particularly group farming, amongst family members not involved in day-to-day operations, were probably considerable.

All of the 15 group farms studied reported some specialization in labour and managment functions. Sometimes this was specialization of a fairly rudimentary sort, involving, for example, one operator doing all the welding or book-keeping or some other task requiring a particular skill. In most cases, however, areas of responsibility such as machinery maintenance and livestock management remained the charge of particular operators, or sub-groups of operators, for protracted periods. In about half the groups, one or two participants served as work co-ordinators, responsible for drawing up schedules

and allocating tasks. In some instances shifts were organized to allow 16-hour or even round-the-clock operation of machinery at critical junctures in the crop season. Scheduled meetings to plan operations and consider business transactions were held on anything from a weekly to a monthly or even a yearly basis. In the latter cases, more frequent informal gatherings served for all but the most major decisions.

In general, the existence of well-defined and democratic methods for reaching decisions and allocating work facilitated the participation of each operator as an independent and equal partner regardless of any family relationships that might or might not exist between individuals. From the point of view of new generations of operators this may be an especially important characteristic. Under the various co-operative formulae at least, new members gained full voting privileges immediately, or after a short probationary period, and therefore had an equal formal role in decision making.

Data gathered in this study indicated that some groups have successfully weathered the entry of children and the retirement of founding generations. The ages of owner-operators in the groups ranged from 19 to 70 years old and 7 of the 15 groups included operators from two generations of the same families. Two additional groups had membership whose age range was more than 25 years, but the younger and older operators concerned were not related. In at least three cases, the younger generation of members included operators

who had joined some years after the initial formation of the group.

Group farming may facilitate the smooth succession of generations (Elmgren and Brown 1978) and the avoidance of losses of information and resources occasioned by changes in personnel, production strategy, and enterprise that may occur when a farm changes hands. Data presented by Steeves (1979) suggested that the potential magnitude of this problem is large. The net reduction in the number of farm operators in Saskatchewan between the 1966 and 1976 censuses was a fairly modest 18%, but this does not reveal the gross flow of farmers in and out of farming. Although the province was well below the national average in this respect, fully 37% of those farming in 1976 had entered in the preceding 10-year period and, in gross exit terms, 49 % of census farm operators farming in 1966 had exited by 1976 (Steeves 1979).

In group enterprises involving a number of operators, the different economic strategies appropriate to different stages of the family cycle may be a source of friction. An older family may be content to maintain its economic position without taking on the risk and work involved in expansion or intensification of production. On the other hand, a younger family may find heavy borrowing and long hours of work quite appropriate in their effort to increase equity and income (Cooperstock 1968). Analysts of group enterprises have referred to these differences as problems of "institutional time" or "structural duration" (Abarbanel 1974).

On the group farms studied, conflict over economic strategies appeared, in general, to have been successfully handled by compromise. It is possible that improvements in economic position enjoyed by both younger and well-established families as a result of joint operations allowed significant adjustments in personal economic strategies without serious sacrifice. The problem was not, however, always as easily surmountable. Two of the groups studied reported losses of membership due, in part, to disputes over major investments and expansion.

While compromise was clearly necessary on questions of economic strategy, interviews with group farm participants suggested that their operations facilitated the resolution of several related and significant resource management issues. One of these problems is the changing mix of labour power and capital that a typical family has to reckon with when farming alone. Families starting out may have ample labour power but little capital with which to buy land, livestock, machinery etc. More established farmers may have capital and borrowing power but not enough physical stamina or economic incentive to make full use of this capital. As a member of a group operation, however, younger farmers could sell their labour power to older participants, while membership in the group would give access to larger equipment and to credit. Older farmers would continue to share in decision-making but could opt not to supply all of the labour that would otherwise be necessary to farm their share of the land.

Detailed data were not recorded on the frequency with which the two sets of farm operators made use of consultations with the Department of Agriculture's agricultural representatives or of field days, farm tours, short courses or other educational opportunities. The majority of group farms, however, reported an increased incidence of consultations and/or attendance at agricultural courses ranging from farm management to record-keeping, welding, mechanics, carpentry, electronics, and veterinary methods. No groups reported any decrease since group formation.

While the formal education experience of the two sets of farmers ranged from not having completed high school to graduation from university degree programs, all the group farms included at least some members with training in agricultural subjects beyond the high school level. This was not true for 20% of the individual-type farms. Although it cannot be categorically stated that the average level of formal training was higher for the group farmers, it may be that even if their individual backgrounds were, on average, no different from the farmers they were paired with, the group farms, as units, had access through their membership to a greater range of specialized training.

An important potential benefit of group operations is the opportunity it may afford participants to develop and share skills of a social as well as of a technical nature. The ability of other operators to continue operations in periods of absence from the farm may also enable some participants to become involved in community

activities and even to hold other jobs. A majority of the group farms studied included members that held elected positions in community or agricultural organizations off the farm. Farmers in the group operations studied appeared to serve on committees and boards, including those of supply and marketing co-operatives, credit unions, livestock associations, and local and provincial government agencies, in numbers disproportionate to their population. Ten of the 15 groups reported members with paid part-time work off the farm and in 4 groups at least one member was inactive on the farm because of a full-time job in industry or in educational or political organizations. In most cases, however, part-time work did not interfere with the ability of participants to contribute their share of labour to farm operations. In contrast with the group farms, only two of the individual-type farms in the study reported paid off-farm work.

An aspect of group farming often mentioned by participants was the security it could provide to operators and their families in the event of illness or accident. Of equal importance would be any contribution, direct or indirect, that group farming could make to reducing stress-related illness (Gogerty 1978) or work-related accidents (Dennis 1976). Participants in the group operations under study reported that shorter shifts and the presence of more than one operator in the field, or when handling livestock or equipment, helped to prevent accidents. Others suggested that shared decision-making alleviated some of the stress of farm management, unless, of course,

serious disagreement rendered the process more stressful.

More concretely, in the area of occupational health and safety, the incidence of use of recommended safety devices was recorded for the two sets of farms. In this connection, 13 of the group farms studied reported that their membership made regular use of noise-reducing earmuffs. The two farms that did not report use of such protective devices claimed that they were unnecessary since all machinery was adequately equipped with cabs that reduced noise levels. Only six of the individual-type operations claimed regular use of noise-abating earmuffs while an additional four individual-type operations reported that noisy machinery was outfitted with cabs obviating the necessity for other measures.

All 15 of the groups reported the use of protective masks at least for some grain-handling operations. Again, a smaller number, 11 in all, of the individual-type operations claimed at least some use of masks. Guards on auger intakes were not widely used on either set of farms. In both cases, only four of the 15 farms reported that guards were in place and even in those instances this was sometimes only true for the newer and/or larger augers in use.

Informal co-operation amongst neighbours, though less prevalent today than formerly, is still an important element in the economic success of farmers and in their ability to manage resources efficiently. The group farmers were asked if formation of the group had affected the

level of informal sharing and helping back-and-forth with neighbours not in the group. Responses ranged from avowals that nothing had changed, to suggestions that borrowing of equipment by other neighbors had increased, to observations that the group organization inhibited the spontaneous assistance with planting and harvesting that neighbours typically offered each other. No clear picture emerged. It seems likely that personalities and prior neighbourhood relations were important influences.

Overall, the data collected on the social organization of work and living on the group farms suggested that potential problems such as disagreements over economic strategy, cumbersome decision making, divided personal allegiances, disaffected family members, and unsympathetic neighbours, could generally be overcome. Where such problems were absent or were successfully dealt with, group farming contributed, on the balance, to greater self-development for the people involved and to the achievement of important physical resource management objectives. On the group farms, specialization as to task performed and areas of responsibility facilitated greater overall diversification of the farm operation. Shared responsibilities and a formal yet flexible system for reaching decisions seemed to foster and support innovative actions. And, close co-operation among member families appeared to encourage rather than to inhibit expanded or new forms of interaction with other organizations and individuals.

5. CONCLUSIONS

5.1 Major Findings and Their Implications

The results of this study provide further evidence that group farming, in the Saskatchewan context at least, can lead to important economies in farm machinery and equipment. In comparison with neighbouring individual-type farming operations, the surveyed groups owned less machinery per operator and per unit of land under cultivation. In terms of capacity per unit of land under cultivation, the groups operated with 26% less tractor power, 24% less seeding equipment, 33% less swather capacity, and 32% less combine harvesting machinery. These economies were reflected in capital investment savings, 37% in the case of tractors, and the reduced machinery inventory could have been expected to result in an overall saving of 5% in energy used per unit of land farmed. It is important that these savings were achieved without sacrificing labour productivity or increasing labour time. The groups had access to machinery that was new and as large or larger than the agricultural equipment used by the sample of individual-type operators with whom they were matched.

Joint ownership could be expected to facilitate economical access to a wide range of farm equipment. This may have contributed to somewhat greater experimentation on the part of the groups with respect to, still rare, tillage-minimizing crop establishment techniques. Economical access to a full line of equipment might also be expected to facilitate the inclusion of a greater variety of crops in a cropping program. In the Saskatchewan context, however,

it appears that agronomic limitations, market conditions and perhaps farmer preference for more free time, have combined to insure that the group operations do not make full use of this potential. While the group farms did grow a median of 5 different field crops in 1978, which compares favorably with a median of 4 different crops grown by their matches, overall crop mix was similar for the two sets of farms. Wheat and summer fallow dominated farm land use to the same extent that they did in the province generally. In the case of the group farms, a positive correlation between the number of operators and the number of crops grown, a relationship which was much stronger than that between area under cultivation and number of different crops grown, suggested that larger groups might be expected to be more diversified in their crop programs.

The cropping programs of the group farms studied were fairly similar to those of the individual-type farm matches. Greater livestock holdings, however, meant that both sets of farms were more intensive and diversified than was typical of farms in their neighbourhoods. On average, at the end of 1978 the group farms were keeping 54% more livestock per unit of land area farmed than was generally kept by farmers in their rural municipalities. This may reflect economic pressures on the groups, given their smaller land area per operator, and/or it may reflect the ability of groups to maintain or expand livestock operations. Several among the groups reporting

overall increases in livestock holdings since organization of the joint enterprise maintained that the ability to delegate livestock responsibilities to participants with special skills in that area made animal agriculture more attractive to those who had previously specialized in grain. Whatever the causes, the existence of relatively large livestock holdings on group farms is a significant finding. It has agronomic significance, given the beneficial soil effects of livestock manure and forage crops, and it has economic significance. The Saskatchewan government has encouraged the expansion of livestock production both to broaden the economic base of agriculture and to increase the economic value of agricultural activities in the province (Saskatchewan Department of Agriculture 197?).

Large group farms require a higher level of management effort than one operator units. Co-ordination and provision for continuity in decision making and record-keeping do not happen automatically when many persons are involved. The performance of the group farms in several different spheres suggests, however, that the management efforts they made were sufficient to compensate for increased complexity. More groups than individual-type farms reported soil sampling and the group farms reported at least as much attention to resource-management problems such as salinity control and water conservation, as their matches. This was true as well for the conduction of field trials and for the maintenance and use of financial and agronomic records.

Despite the fact that the individual-type farms studied were likely above average in this respect, the multi-operator units showed as much or more propensity to experiment with new techniques. The two samples of farms showed similar proclivities with respect to experiments with varieties, crops and rotations not commonly used, and with respect to trying new products or practices for fertility maintenance or weed control. Compared with matches who also kept livestock, group operations which had an animal enterprise showed a somewhat greater tendency to try different breeds and/or management techniques. As discussed, the group farms reported more experimentation with as-yet-uncommon no-till drills. They also reported more experimentation with new equipment and/or the designing and building of their own machinery. In their case a readiness to try social and organizational innovations did not appear to exist at the expense of experimentation in farming methods. This applied sometimes to "commercial" kinds of innovations, sometimes to "environmental" kinds of innovations (Pampel and van Es 1977), and often to both of these broad categories of change.

5.2 Limitations of the Study Methods

Before proceding further with a discussion of the implications of group farming for resource management and the contribution that this study can make to such a debate, it would be useful to review some of the problems that any study on this matter would encounter as well as some of the limitations peculiar to this particular inquiry.

To start with sampling procedure and data analysis, there are some serious limitations on the extent to which inferences can be made from data gathered in this investigation. In some ways, the two sets of farms studied more closely resembled judgement or authoritative samples than they did randomly drawn samples. For this reason it could be argued that the use of procedures more technical than the descriptive statistics presented in the tables, was not called for. Having a random sample is, after all, a basic condition that must be met before any confidence can be placed in probability statements obtained by the use of parametric or distribution-free tests.

While this observation must be borne in mind, there are some indications that the sample used resembled any randomly-selected samples that could have been drawn from the population of Saskatchewan farms meeting the minimum selection criteria. In the case of the group farms, almost 100% of the population of production co-operatives meeting criteria of size, years in operation, and number of operators was included in the sample. There is no reason to believe that the two additional group operations included, the multi-family, family-type corporate farms, were not fairly representative of the relatively small population of this type of farm in Saskatchewan. However, without further study, there is admittedly no way of knowing to what extent these two farms were representative of their class of operation. For individual-type farms in the study, geographic dispersal and their selection by a number of different agricultural representatives using

explicit objective and subjective criteria should have helped to ensure that they were fairly representative of "better than average" individual-type farm operations in Saskatchewan. Some of the characteristics of this sample, such as their size relative to the norm in the province, lend credence to this assertion.

Although it would have been preferable to have a sample selected through a more systematic procedure, the selection method used was probably the most appropriate one given the nature of the study populations and of the questions being put. In any case, it would be of interest even to know if some sample of group farms was performing relatively well in the area of resource management, provided that the sample had not been selected in such a biased fashion that similar results could not be expected from other group farm operations. Proof that the sampling procedure utilized here was reasonable, in the sense that the group farms studied were not too different from similar-sized group farms that were not studied, or from similar group farms that could conceivably be formed in the future must also, of course, await further study.

It should be emphasized that this study focused on Saskatchewan farms, farms that have a particular agronomic, economic, political and social context in which to operate. Saskatchewan's farmers still reflect some of the spirit and philosophy of the recent pioneering history of the area, and have a legacy of co-operative and other farmer initiatives to draw on. The large-scale, highly mechanized cereal

production they are involved in requires a different type of management input than, say, a dairying or horticultural enterprise. These factors may facilitate group operations but, on the other hand, they may conceal some of the potential of co-operative ventures in farming.

Besides sample construction, one of the more taxing challenges in a study such as this is the choice of appropriate measures by which to gauge resource management. The measures selected usually represented fairly minimal departures from present practices and involved steps widely held to be economically feasible, that is profitable or, at least, not too costly. Nevertheless their implementation is far from certain or complete and they are not all easily put into practice given the capital, labour and management constraints that farmers generally work under.

One important constraint on the data base for making resource management comparisons was the fact that farm records were kept primarily for tax and accounting purposes, though some farms kept records for planning crop programs etc., as well. Rarely were records kept to facilitate the testing of conservation methods or for the sake of having a complete history of practices used and results achieved on a field-by-field or farmwide basis. For this reason, much in the way of historical information that would have been helpful in assessing resource management practices was unavailable. Even in attempting to reconstruct recent history, i.e. the season just completed, the problem of collecting the

relevant information persisted. It was necessary to frame questions in terms that were familiar to the respondents, avoiding issues outside the day-to-day concern of most operators that would be likely to elicit responses of very uneven reliability.

Though the execution of a multi-year study might introduce biases in that respondents might have greater opportunities to figure out the "correct" response and might adjust their reports or even their practices accordingly, it would have been desirable to have data on agricultural practices spanning several seasons. A longitudinal study would probably have revealed some additional differences in programs as well as showing some apparent differences to be aberrations rather than real disimilarities. Some of the questions asked did cover a historical time frame and the use of one year's crop and livestock program was not so unreasonable, given that the matching of study farms would have helped to ensure that exogenous variables such as weather and markets would have been experienced in a similar manner by both sets of farms. This is not to say that it would not have been of interest to see how the farms studied would have reacted to a drought year like 1980 or to a year of particularly good or poor grain or cattle prices.

In evaluating the results, some other aspects should be considered. First, the farmers involved in the group operations probably joined with economic and social purposes in mind but were less likely to have had the goal of farming in a more ecologically sustainable manner as a

primary objective. While it could be argued that they included a disproportionate number of innovative individuals who might anyway have been likely to adopt more advanced methods, this could not be directly tested except by comparing their practices before and after the formation of the group. Equally plausible is the hypothesis that particular capital, labour, or management difficulties made group farming an attractive option for them and that the group's operations still reflected these (or new) pressures to some extent, perhaps to the detriment of long-term resource managment. Second, it is quite possible that the farms used as controls in this study were above average with respect to adoption of innovations, including environmental innovations. By their own reports, as reflected in their answers to a question about how they compared to other local farmers in terms of conservation practices, none of the individual-type farms was below average and 6 of the 15 claimed to be above average in this respect.

5.3 The Potential and Limitations of Group Farming

While considering the potential advantages of group management it is important to remain aware of some overriding limitations. While pooling of skills and resources may expand the range of strategies that can be implemented, the forces of the marketplace will remain an effective barrier to many types of innovation. Group farmers may enjoy some flexibility compared to single operators, but they remain dependent on markets over which they have little control. They are

not immune either, from the pressures of inflated land prices. In sum, they remain very much tied to the fate and direction of the larger system.

Apart from their potential impact on agricultural resource management, an essential question about these forms of multi-family group farming is how unique, or conversely, how reproducible are they. This can be further divided into two lines of inquiry: first, what are the characteristics of the people already opting for this approach to farming and second, what are the factors encouraging or discouraging such amalgamations. Neither of these subjects was dealt with in any detail in this study, but some preliminary observations can be discussed.

With very few exceptions, the principal operators surveyed in this study had been farming all their lives or had grown up on farms and come back to farming after relatively brief stints in other occupations. They were not ex-urbanites, part-time farmers, or gentlemen farmers. Farms being reorganized as corporations are probably, in general, above average in size and capital resources. This is to be expected given the costs of incorporation and that tax benefits do not accrue until a fairly large size operation is reached. Certainly, this observation appears to apply to the two multi-family corporate farms in the study sample. The operators involved in the various forms of production co-operative sampled, however, probably included a broader economic cross-section of farmers. Among those

who had farmed on their own prior to joining the group, were those who had been medium to small farmers, under considerable economic pressure, as well as larger, more affluent operators who were succeeding admirably by themselves. Some of the groups involved members who might otherwise have had to leave farming due to capital, health, or other problems. Likewise, some groups included members who would not otherwise have had an opportunity to enter farming.

The attractiveness of group operations does not seem to be limited to one size of farm operation. Widespread interest in multiple-ownership forms of farm organization and a growing number of multiple-ownership units were cited when the Department of Agricultural Economics at the University of Saskatchewan undertook a series of studies on farm tenure, capitalization, and organization in the early 1970's (Elmgren, Brown and Minogue 1973). The authors of these studies speculated that this approach was being "adopted to help cope with some of the problems being encountered in developing adequate units, assembling risk capital, transferring assets, achieving economics of size, and adapting to change" (Elmgren, Brown and Minogue 1973).

Group farming has been and continues to be a very popular approach to agricultural resource management. Versions implemented in Japan, Eastern Europe, Israel, and in countries of the European Economic Community demonstrate that the multi-family farm is a common alternative

even in countries with technologically advanced farming systems (Dorner 1977). Among the economic, social, cultural, and resource-management needs met by these approaches are some new ones that emerge as the farm family changes along with the rest of society (Raup 1969). Extended formal schooling and opportunities for off-farm employment, for example, have changed the labour picture for family farms. Where it once absorbed all family efforts, the farm may now be increasingly the responsibility of one or two family members. These operators will not necessarily have a family reserve of part-time labour power to call on in moments or seasons of peak demand. In this context, a two- or three-person operation not infrequently implies a two- or three-family farm.

The trend towards multi-family operations is reinforced by high prices for land and machinery which make it impractical for young families to start off farming on their own. The trend may also be reinforced by the continuing problems that farmers face with respect to employing hired labour, by the growing complexity of management tasks on large farms, and by the growing sentiment for free time and vacations on the part of operators and their families. The availability of bigger, more sophisticated, costly equipment raises the possibility that group operations may be seen as a useful approach to making full use of large-capacity, expensive, labour-saving machinery. For some types of new technology, the technology for production of fuels from crop residues and grain, for instance, some

form of sharing may prove to be the only economical approach (Buttel 1980). For the more management-intensive approaches to soil fertility maintenance and pest control that are implied in any move towards a more "organic", "biological", or "ecological" agriculture, group production with the specialization and sharing of skills it allows, may be attractive as well.

5.4 Further Work

As has been discussed, the study of resource-management implications of group farming would be strengthened by taking a multi-year longitudinal approach. With an expanded sample and a long-term study it would be possible to look at the performance of group and individual-type farms operating under various agronomic conditions and confronting various stages of family and firm development. It might also be possible to consider various sub-samples involving larger and smaller units and various types of organizational approach. There are large farm operations that have other combinations of labour and management inputs and different distributions of ownership and control. It would, for example, be of interest to compare the performance of this sample of group farms to the performance to large farms organized along the lines of a traditional industrial corporation with the greater separation of labour and management functions and the different financial structure this implies. At present such farms are relatively uncommon in Saskatchewan.

Comparative studies examining group farming and resource management in a number of North American and European contexts would provide background necessary to understand the role of government programs. In studying resource management on group and individual-type farms it would be desirable to have the capacity to establish long-term soil and water monitoring experiments. This would allow more direct measurement of the environmental impacts of various practices. It would also be desirable to study the decision-making processes of group and individual-type farmers with respect to choice of enterprise and crop rotations, use of agricultural chemicals, purchase of equipment, organization of work, etc. This, in conjunction with further work on values, attitudes and priorities, would contribute to understanding the potential impact of co-operation on "farmer consciousness".

Further research will very probably yield new and valuable insights. There is already adequate evidence of the potential benefits of group operations, however, that in addition to further research, several other recommendations seem justified. Evidence from this study supports a recommendation that group farming be considered as a potentially useful instrument where policy objectives include efficient use of agricultural machinery and maintaining or increasing livestock holdings, whether for economic or environmental reasons. Evidence from this study also lends qualitative support to assertions that group farming is deserving of further consideration as a component of

agricultural redevelopment strategies that would contribute to the simultaneous achievement of socioeconomic, production and conservation objectives.

6. SUMMARY

The objective of this investigation was to study impacts on agricultural resource management that result from the pooling of human, land, and capital resources in group farming arrangements. Does joint operation of farm units, as practised in Saskatchewan, contribute to the adoption of more or less ecologically sustainable farming practices, as far as that quality can be measured?

Fifteen group farms with a minimum of three active operators (smaller groups and the religiously-motivated Hutterite colonies were not considered) were paired with neighbouring individual-type farms. These latter farms were identified by local agricultural officials as being "above average" in terms of management and were roughly matched to the group farms in terms of soil type and kinds of agricultural production being undertaken. Data were collected for the 1978 crop year on the major aspects of their production systems: land base and land tenure; cropping program; livestock program; specific soil and water conservation problems and practices; machinery inventories and management; business management and planning; and human resources management and organization.

The group farms, considered as single units, ranked among the top few percent of census farms in terms of size. Their median size was 2040 hectares, compared to 589 hectares for the individual-type farms surveyed. These latter farms were also somewhat above average in size. Wheat and summer fallow dominated land use on both sets of farms, as they do on Saskatchewan farms generally. A positive association between

number of operators in a group and the number of crops grown, a relationship considerably stronger than that between area under cultivation and number of crops grown suggests, however, that larger groups would tend to grow a greater number of different crops in a given year.

The group farms tended to have substantial livestock operations and the matched farms necessarily had similar characteristics. The groups managed on the order of one and a half times as much livestock per hectare farmed as was typically kept by farmers in their rural municipalities.

Compared to the individual-type farm operations, the surveyed groups managed with 26% less tractor power, 24% less seeding equipment, and 32% less combine capacity per unit of land under cultivation (measured in terms of, respectively, total kilowatts of power, width of seeding equipment, and width of combine cylinders). Their reduced machinery inventory could have been expected to result in savings of at least 5% in farm energy use. While principal field tractors were equally new on both sets of farms, the groups had the use of more powerful units and were more likely to have four-wheel drive tractors.

The groups could take advantage of opportunities for role specialization, with different operators serving as herdsmen, mechanics, record keepers, etc., but co-ordination and provision for continuity in decision making do not occur automatically when many persons are involved. Their accomplishments in several areas, however, indicate that the groups were

able to compensate for increased complexity without sacrificing innovation and experimentation or the performance of non-essential tasks.

The two samples of farms demonstrated a similar propensity to experiment with crops not in common use and to try new products or practices for fertility maintenance or weed control. One half of the individual-type farms and two-thirds of the group farms reported recent soil tests. Where livestock were part of the farming program, the groups showed a somewhat greater tendency to try different breeds and/or management techniques. In the area of machinery use, the groups reported more experimentation with no-till seeders, with other types of new equipment, and with modification or manufacture of implements. The use of face masks and devices to protect against hearing damage was also more widespread on the group farms.

This study dealt only with grain and mixed grain/livestock farms in Saskatchewan. Even for this population, however, the sample construction procedures introduce potential bias. These limitations must be borne in mind when attempting to generalize from the data. Nevertheless, the findings tend to support the contention that group farming can facilitate a relatively high level of resource management in the context of large and relatively diversified farm operations.

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Appendix A. Questionnaires for Group and Individual-Type Farms

RESOURCE USE SURVEY 1979

Introduction: 1)general nature of questions,2)clarification and comments, 3)confidential treatment of data

Road directions_____

Start time_____ End time_____ Date_____ Place_____

Name of farm_____

Farm type_____ R.M.(s)_____

Person responding_____ Position_____

Address_____ Phone_____

Person responding_____ Position_____

Address_____ Phone_____

Person responding_____ Position_____

Address_____ Phone_____

A. ESTABLISHMENT

1. Could you describe how the group came together, discussing any kinship, business or other relationships that existed between any of the members prior to joining the co-op_____

2. What were the previous occupations of the members, and in the case of those already farming at the time of incorporation, how long had they been farming?

3. What was the first summer of operation as a group?_____

4. Do any of the members belong to other production co-ops? Yes(__),No(__)
Comment:_____

B. LAND BASE

1. What was the total land area operated as part of the co-op in 1978?

2. Including summerfallow and rotation tame hay or pasture fields, how much is cropland?

3. Did individual members operate any additional acres outside the co-op in 1978? Yes(__),No(__). How much in all?(_____) How much cropland?(_____) What was grown?

4. What is the tenure arrangement under which the co-operatively farmed acreage is operated? Do members hold title individually or does the co-op have title; % rented, from whom, what terms?

5. Please give the legal description for all acreage farmed by the co-op.

portion-section-TWP-range-RM-acres	portion-section-TWP-range-RM-acres

6. Are the farm buildings Yes(__),No(__) or homes Yes(__),No(__) grouped in one central location? What is the arrangement?_____

7. What is the maximum distance between parcels?(_____miles) Comment:

8. In 1978, did any members live away from the farm for any significant amount of time?Yes(__),No(__)

Who	Where and Why	How Long

9. Did this pose any problems? Yes(__),No(__) What? Why?_____

C. CROP PRODUCTION

1. In the case of those who farmed the same land or comparable land in the region before incorporation, were there any changes in crop production practices associated with joining the group? Yes(__),No(__) Comment:_____

2. Does the co-op operate a grain pool? Yes(__), No(__) If yes, how does it operate?_____

3. Do members make any individual production decisions for their own land farmed by the co-op, regarding crops grown Yes(__),No(__); fertilizer Yes(__), No(__); other inputs? Yes(__),No(__). Comment:_____

4. Are adjustments made for differences in the quality of members' land in assessing expenses and dividing returns? Yes(__), No(__) Comment:_____

5. What is the basic rotation used today?_____

6. Has this rotation changed over the last 5 years? Yes(__),No(__) Why? How?

7. For each field,do you have records of:

	Yes	No	Years and Comments
a. crop grown	(__)	(__)	
b. specific variety grown	(__)	(__)	
c. crop yields	(__)	(__)	
d. type of fertilizer	(__)	(__)	
e. amount of fertilizer	(__)	(__)	
f. type of herbicide	(__)	(__)	
g. amount of herbicide	(__)	(__)	

8. Have soil tests been done on any of your acreage in the last ten years? Yes(__),No(__) Comment:(reasons, extent, years)_____

9. Does the co-op or any members have a rain guage? Yes(__), No(__) Keep rainfall records? Yes(__),No(__) Comment:_____

10. Is the co-op or its members experimenting with rotations, crops, or varieties not commonly used? Yes(__), No(__). Have you ever...? Yes(__), No(__) Please discuss the practice.

Rotation, crop or variety	Year first tried	Successful Yes/No	Reasons

11.

Abbr.	Crop	1978 Acres
SW	Spring sown wheat (excluding durum)	
DW	Durum wheat.....	
WW	Winter wheat (sown fall 1977).....	
OG	Oats for grain.....	
B	Barley.....	
MG	Mixed grains (2 or more together)..	
FR	Fall rye grain (sown fall 1977)....	
SR	Spring rye for grain.....	
FS	Flaxseed.....	
RS	Rapeseed.....	
TH	Tame hay.....	
OF	Oats cut for fodder.....	
OC	Other (_____).	
OC	Other (_____).	
OC	Other (_____).	
SF	Summerfallow.....	
IP	Improved pasture in rotation.....	
	TOTAL ACRES	

12. Crops grown in 1978, acreage 1st, 2nd, 3rd year, etc.

Portion of cropland in:
Fallow(____); First(____); Second(____); Third(____); Fourth(____); >Fourth(____)

13. Type and amount of fertilizer applied to 1978 crop (including fall 1977).

Crop, acres or 1/4's	Type	Amount/acre	Total amount

14. Are you experimenting with any fertilizers, herbicides, or other crop inputs not commonly used in your area? Yes(__),No(__). Have you ever...? Yes(__),No(__).

Fertilizer or other materials	Year first tried	Successful Yes/No	Reasons

15. In 1978, what percent of grain land was treated in the fall with a herbicide for winter annuals?(_____%)Comment:_____

16. On average, how many cultivations where used in summerfallow in 1978?(____)
Comment:_____

17. Are you experimenting with any reduced tillage or zero tillage methods Yes(__),No(__). Have you ever.... Yes(__),No(__). Comments:_____

Reduced tillage method	Year first tried	Successful Yes/No	Reasons

18. Have you ever, alone or in co-operation with university, company, or government personnel, set out test plots or test strips to compare materials, varieties, or practices? Yes(__).No(__) Please describe these tests and give the years that they were carried out._____

19. When seeding grain, to what extent did the group use pedigreed (certified, registered, etc.) seed in 1978. Percent of acres sown(____%) Comment:_____ If none sown in 1978, when was the last time that pedigreed seed was sown.(_____). Comment:_____

20. Where homegrown seed or non pedigreed seed was used, what percent of that sown in 1978 was cleaned.(____%) Where was it cleaned? At a primary elevator (__); on the farm (__); elsewhere (__) Specify:_____

D.LIVESTOCK

1. Is any livestock raised under the co-op arrangement? Yes(__),No(__) If Yes, describe the enterprises operated in 1978. _____

_____

_____

_____

_____

2. Do any of the members keep livestock as individuals or as part of anotner co-op operation? Yes(__),No(__) If Yes, describe the enterprises operated in 1978. If no, state major reasons. _____

_____

_____

_____

3. Were any cattle kept on community, co-op, or PFRA pasture in 1978? Yes(__), No(__) Distance, why, why not? _____

_____

_____

4. Please list livestock and poultry belonging to the group operation or its members, (including there immediate families living at home), as of December 31, 1978. Give the number of head managed under the co-op arrangement, by the members as individuals, or by the members under a seperate co-op arrangement.

	Number		
	Co-op	Individual	Animal Units
CATTLE:			
Cows & heifers, 1 yr. & over.....			
Steers, 1 yr. & over.....			
Bulls, 1 yr. & over.....			
Calves, under 1 yr.			
Total cattle all ages.....			
No. cows & heifers mainly for milk prod..			
PIGS: Total all ages.....			
SHEEP: Total sheep and lambs.....			
POULTRY:			
Total chickens all ages.....			
Turkeys, all ages.....			
Geese, all ages.....			
Ducks, all ages.....			
OTHER LIVESTOCK:			
Horses.....			
Goats.....			
Mink.....			
Rabbits.....			
Fish.....			
Other(_____).....			
Other(_____).....			

5. In the case of members already farming at the time of incorporation, has there been an overall change in the amount of livestock kept as a result of joining a group operation? Increase(__); Decrease(__); Same(__). Why?_____

6. Are you experimenting with any livestock or approaches to livestock management not commonly used? Yes(__),No(__). Have you ever...? Yes(__),No(__)

Livestock Type or Management Approach	Year First Tried	Successful Yes/No	Reasons

7. Please describe how manure was handled in 1978, including whether spread or piled in the field, how soon worked in, where spread, and when?_____

E. RESOURCE MANAGEMENT

1. Does any of the land farmed by the co-op have an apparent salinity problem? Yes(__), No(__) Comment:_____

2. Is this problem diminishing(__), more or less constant(__), or growing(__). Comment:_____

3. In 1978 were any sort of special measures so far as cultivation, drainage, choice of crop, etc. taken in fields effected by salt problems? Yes(__),No(__). Please describe these measures:_____

4. Were there any shelterbelts on co-op land at the time of incorporation? Yes(__), No(__) Describe briefly:_____

5. Have any shelterbelts been established or replanted on co-op acreage since incorporation? Yes(__),No(__) Describe briefly:_____

6. Besides any that were replanted, have any shelterbelts been removed? Yes(__), No(__) Reasons:_____

7. Have you ever found any snow management techniques to be suitable or practical? For instance, has any of the acreage been treated by:

ridging and plowing.....Yes(__),No(__),% cropland 1978(___%)
cutting stubble high.....Yes(__),No(__),% grain acres '78(___%)
cutting stubble stepwise at var. heights.Yes(__),No(__),% grain acres '78(___%)
other methods:_____,% ____ acres '78(___%)

Comment:_____

8. In 1978, was any stubble(__) or straw in windrows burned? Yes(__),No(__) Comment:_____

9. How are slough and/or pothole areas treated? For example, has any attempt been made to drain them, irrigate from them, work them, etc. ?_____

10. Are there any gullies, ditches or drainage ways on co-op lands that have been converted to grass waterways since the co-op was formed? Yes(__),No(__)

Comment:_____

11. Are there any gullies, ditches or drainage ways that might benefit from conversion to grass waterways? Yes(__),No(__) Comment:_____

12. Is any of your land strip-cropped? Yes(__),No(__) or contour strip-cropped? Yes(__),No(__) Comment:_____

13. Do you work any land that could benefit from either of these treatments? Yes(__),No(__) Comment:_____

14. What is the range of size and average size of fields being worked? Range (_____acres) to (_____acres). Average(_____acres) Comment:_____

_____

Have you made any changes in field size or shape since the co-op was incorporated? Yes(__), No(__) Comment:_____

_____

15. Have you ever found it practical to plant spring wheat, oats, barley, or rye as a cover crop on summerfallow fields? Yes(__),No(__) If Yes, what percent of summerfallow received this treatment in 1978?(_____%) Comment:_____

_____

16. Please discuss any measures taken to conserve energy or to improve energy use on the farm in the last 5 years._____

_____

17. Comparing your farm operation to other farms in the area, how would you rate it in terms of attention to soil conservation and environmental quality?

1	2	3	4	5
Considerably below average	Somewhat below average	Average	Somewhat above average	Considerably above average

18. Why did you choose this rating?_____

_____

_____

F. MACHINERY

1. Are you experimenting with any machinery not in general use, making important modifications to equipment, or designing or building any new equipment? Yes(__), No(__) Have you ever...? Yes(__),No(__) Comment:_____

Machinery	Year first tried	Successful Yes/No	Reasons

2. Please list all major items of machinery and equipment regularly used on the land farmed in 1978, giving type, capacity, make, model, year, year purchased, whether new or used, and estimated market value in 1978.

Make	Model	Year	Type	Capacity	Year Puchased	New/ Used	1978 Market
TRACTORS:							
FIELD IMPLEMENTS, INCLUDING PLANTING EQUIPMENT, SPRAYERS AND SPREADERS:							

Make	Model	Year	Type	Capacity	Year Purchased	New/ Used	1978 Market
HARVESTING EQUIPMENT INCLUDING HAYING EQUIPMENT:							
GRAIN TRUCKS:							
MISCELLANEOUS: (uncommon)							

Total H.P. of tractors	+	+	+	+	+	+	+	=
Total width of cultivators	+	+	+	+	+	+	+	=
Tot. width seeders/discers	+	+	+	+	+	+	+	=
Total width of swathers	+	+	+	+	+	+	+	=
Total cylinder width combines	+	+	+	+	+	+	+	=
Total capacity of grain trucks	+	+	+	+	+	+	+	=

3. Was any acreage outside the co-op farmed with this machinery in 1978 on a custom or any other basis? Yes(__),No(__) How much?_____

4. Was any custom work hired by the co-op in 1978? How much and what?_____

5. Do you have a grain loss monitor on any of your combines? Yes(__),No(__)

6. Do you have any other electrical monitoring equipment fitted to drills, sprayers, spreaders, etc.? Yes(__), No(__) What?_____

7. In 1978, did you have any herbicides applied by aerial applicator?Yes(__)No(__)

Comment:_____

8. Do you have records of total 1978 fuel consumption for farm operations? Yes(__), No(__) Please give any relevant data for 1978. _____

9. Do you subscribe to Prairie Agricultural Machinery Institute (PAMI) reports? Yes(__),No(__) Comment:_____

10. Is there any type of specialized equipment owned by the co-op that members would not be likely to own if farming as individuals? Yes(__),No(__). What?

G. FINANCIAL MANAGEMENT AND PLANNING

1. Do you use Canfarm, Yes(__),No(__); the Prairie Farm Account Book,Yes(__), No(__); or any other accounting system, Yes(__),No(__) Specify:_____

2. Do you use your records when planning next year's production (__), or are the records mainly of use for tax accounting and filing purposes (__). Comment:

3. Are annual budgets developed to forecast labour requirements, other production costs and revenues for any of the farms enterprises? Yes(__),No(__) Comment:____

4. Are cash-flow forecasts and statements used? Yes(__),No(__) Comment:_____

5. Did you carry crop insurance in 1978? Yes(__),No(__) On what percent of the crop? (_____%) Comment:_____

_____

6. Did you carry liability,Yes(__),No(__); theft,Yes(__),No(__); or workman's compensation insurance in 1978? Comment:_____

_____

_____

7. When acquiring credit (__), machinery (__), or material inputs (__), do you do comparison shopping, checking with 3 or 4 area sources before buying? What is your general approach to making major purchases?_____

_____

_____

_____

_____

_____

8. In 1978 where were major purchases made?(machinery, fertilizer, etc.)

Item	Source	Town	Distance

9. Comparing your farm operation to other farms in the area, how would you rate it in terms of effective use of records in planning production and financial strategy?

1	2	3	4	5
Considerably Below average	Somewhat below average	Average	Somewhat above average	Considerably above average

10. Why did you choose this rating?_____

_____

_____

_____

H. HUMAN RESOURCES AND FUTURE PLANS

1. How many members did the co-op have originally? (_____)

2. How many members are there today? (_____) Please discuss any changes in personnel that have occurred._____

3. What is the age range of the members?_____

4. Please briefly describe the families of each of the members (e.g. No. of children living at home and/or supported by the farm)_____

Total Adults:(_____), Total Children:(_____), Grand Total:(_____)

5. For 1978, please describe briefly for each principal operator, any agricultural or nonagricultural work off the farm, giving nature of work, number of days worked, and whether paid or unpaid.

Member	Nature of work	days worked	paid/unpaid

6. How is work allocated? Are jobs rotated or is there specialization and/or individual responsibility for specific functions and for the management of specific enterprises? Do you use shifts or any other methods for programming work hours?

7. How often are meetings held to plan work?_____

_____

8. Has group decision making and management proven adequate in practice? Yes(__), No(__) Please discuss advantages and drawbacks as you have experienced them, giving examples. _____

_____

_____

_____

9. Is a different wage paid to members for different kinds of work? Yes(__),No(__) At what rate were members paid or credited for labour in 1978? (_____/hr.) Others?(_____/hr.) Comment:_____

_____

_____

_____

10. In 1978, to what extent was members' labour used a) on members' own private acreage or livestock enterprises, and b) to do outside custom work._____

_____

_____

_____

11. Did the group hire any non-members as agricultural labour in 1978? Yes(__), No(__) Comment:_____

_____

12. Does the co-op provide life insurance, pension fund, paid vacation, or any other additional benefits?_____

_____

_____

_____

13. Please describe the roles that wives and older sons and daughters play in the operation of the farm, discussing decision making, labour contribution, payment, etc. and whether this is more or less participation than would be likely if the families involved were farming individually?_____

_____

_____

_____

_____

_____

_____

_____

_____

14.Please describe any formal training or education that any of the members have had, including years completed in school, any college or university courses, and any diploma, manpower, correspondence, or other courses taken.

Member	Course or program and level completed	Last calender year Attended

15. Has there been any change in the amount of use made of ag. reps., private consultants, field days, farm tours, short courses, etc. since members joined the co-op. Same(__), More(__), Less(__) Please comment, giving recent examples.

16. Has there been any change in the amount of involvement by members or their immediate families in community or farm related groups or activities since incorporation? Same(__). More(__), Less(__) Comment:

17. Have there been any health problems among members or their families that you suspect may be related to farming. Yes(__),No(__) What:

18. Have any changes been made to minimize the risks of health problems or accidents? Yes(__), What? No(__), Why not?

19. Do you use noise-feducing earmuffs when operating loud machinery without a cab? Yes(__), No(__)Comment:_____

20. Do you use a dust mask or filter masks for any farming operation? Yes(__), No(__) If Yes, specify operation, chemical, etc. _____

21. Are intake guards fitted to any of your augers?_Yes(__),No(__) Comment:_____

22. Does working in a group effect relations with neighbors, for example, the amount of informal sharing and help back-and-forth? _____

23. Has the experience of working in a co-op effected members attitudes towards trying new techniques and/or towards farming in general?_____

24. Does the co-op have a longer-term farm development plan for the coming 2 to 5 or more years? Yes(__),No(__) Are there any changes that you plan or hope to make in the future? _____

25. Are there plans for the future involvement of other family members or anybody else in the co-op as members? Yes(__), No(__). Do you anticipate any problem in transferring the operation to the next generation? Comment:_____

26.Are there any other points that you feel are important to note concerning group farming and resource management generally?_____

Could you suggest any individual operators in this area, farming similar soils and having similar enerprises on their farms, that might be willing to be interviewed as comparison farms for this study?

RESOURCE USE SURVEY 1979 : FAMILY OPERATIONS

Introduction: 1)general nature of questions, 2)clarification and comments, 3)confidential treatment of data

Road directions _____

Start time _____ End time _____ Date _____ Place _____

Name of farm _____

Farm type _____ R.M.(s) _____

Person responding _____

Address _____ Phone _____

Person responding _____

Address _____ Phone _____

A. ESTABLISHMENT

1. Could you describe how you got into farming, discussing previous occupations if applicable, how long you have been farming, and how long you have farmed at the present location. _____

2. How many are involved in the farm operation today? Please indicate how many operators are involved and the number of children living at home and/or supported by the farm. _____

3. Are there any informal or formal sharing arrangements between yourself and any neighbors or relatives(e.g. sharing of machinery, exchange of labour, or membership in a grazing co-op). Yes(__),No(__) What? _____

B. LAND BASE

1.What was the total land area you farmed in 1978? _____

2. Including summerfallow and rotation tame hay or pasture fields, how much is cropland? _____

3. What percent of your land is rented(____%)(_____acres) _____
from what source is it rented and what are the terms? (length, restictions,etc.)

4. Please give the legal description of all acreage you farmed in 1978.

portion-section-TWP-range-RM-acres	portion-section-TWP-range-RM-acres

5. Are farm buildings grouped in one central location? Yes(__), No(__) What is the arrangement?_____

6. What is the maximum distance between parcels?_____

7. In 1978, did you or members of your immediate family live away from the farm for any significant amount of time? Yes(__), No(__) Who, where, why, how long?

_____

_____

8. Did this pose any problems? Yes(__), No(__) What, why?_____

_____

C. CROP PRODUCTION

1. What is the basic rotation used today?_____

_____

_____

_____

2. Has this rotation changed over the last 5 years? Yes(__), No(__) Why, how?

_____

_____

_____

3. For each field, do you have records of:

	Yes	No	Years and Comments
a. crop grown	(__)	(__)	_____
b. specific variety grown	(__)	(__)	_____
c. crop yields	(__)	(__)	_____
d. type of fertilizer	(__)	(__)	_____
e. amount of fertilizer	(__)	(__)	_____
f. type of herbicide	(__)	(__)	_____
g. amount of herbicide	(__)	(__)	_____

4. Have soil tests been done on any of your acreage in the last ten years? Yes(__), No(__) Comment: (reasons, extent, years)_____

_____

_____

5. Do you use a rain guage? Yes(__),No(__) Keep rainfall records?Yes(__),No(__)

Comment:_____

6. Are you experimenting with any rotations, crops, or varieties not commonly used in the area? Yes( ),No( ) Have you ever? Yes( ),No( )

Rotation, Crop, or Variety	Year first tried	Successful Yes/No	Reasons

7.

Abbr.	Crop	1978 Acres
SW	Spring sown wheat (excluding durum)	
DW	Durum wheat.....	
WW	Winter wheat (sown fall 1977).....	
OG	Oats for grain.....	
B	Barley.....	
MG	Mixed grains (2 or more together)..	
FR	Fall rye grain (sown fall 1977)....	
SR	Spring rye for grain.....	
FS	Flaxseed.....	
RS	Rapeseed.....	
TH	Tame hay.....	
OF	Oats cut for fodder.....	
OC	Other (_____).	
OC	Other (_____).	
OC	Other (_____).	
SF	Summerfallow.....	
IP	Improved pasture in rotation.....	
	TOTAL ACRES	

8. Crops grown in 1978, acres 1st, 2nd, 3rd year etc.

_____

_____

Portion of cropland in:
Fallow(____); First(____); Second(____); Third(____); Fourth(____); >Fourth(____)

9. Type and amount of fertilizer applied to 1978 crop (including fall 1977).

Crop, acres, etc.	Type	Amount/acre	Total amount

10. Are you experimenting with any fertilizers, herbicides, or other crop inputs not commonly used in your area? Yes( ), No( ) Have you ever? Yes( ), No( )

Fertilizer, etc.	Year first tried	Successful Yes/No	Reasons

11. In 1978, what percent of grain land was treated in the fall with a herbicide for winter annuals?(_____%) Comment:

12. On average, how many cultivations were used in summerfallowing in 1978? (_____) Comment:

13. Are you experimenting with any reduced tillage or zero tillage methods Yes(__),No(__). Have you ever....

Yes(__),No(__). Comments:

Reduced tillage method	Year first tried	Successful Yes/No	Reasons

14. Have you ever, alone or in co-operation with university, company, or government personnel, set out test plots or test strips to compare materials, varieties, or practices? Yes(__).No(__) Please describe these tests and give the years that they were carried out._____

_____

_____

_____

15. When seeding grain, to what extent did you use pedigreed (certified, registered, etc.) seed in 1978. Percent of acres sown(____%) Comment:_____ _____If none sown in 1978, when was the last time that pedigreed seed was sown.(_____) Comment:_____

_____

_____

_____

16. Where homegrown seed or non pedigreed seed was used, what percent of that sown in 1978 was cleaned.(____%) Where was it cleaned? At a primary elevator (__); on the farm (__); elsewhere (__) Specify:_____

_____

_____

_____

D. LIVESTOCK

1. Did you raise any livestock in 1978? Yes(__),No(__) If Yes, describe the enterprise(s).

2. Do you keep any livestock under any sort of joint arrangement(e.g. feeder co-op) Yes(__),No(__) Comment:

3. Were any cattle kept on community, co-op, or PFRA pasture in 1978? Yes(__), No(__) Distance, why, why not?

4. Please list livestock and poultry belonging to you or members of your immediate family living at home, as of December 31, 1978.

	Number	Comment	Animal units
CATTLE:			
Cows & heifers,1 yr. & over.....			
Steers,1 yr. & over.....			
Bulls, 1 yr. & over.....			
Calves, under 1 yr.			
Total cattle all ages.....			
No. cows & heifers mainly for milk prod..			
PIGS: Total all ages.....			
SHEEP: Total sheep and lambs.....			
POULTRY:			
Total chickens all ages.....			
Turkeys, all ages.....			
Geese, all ages.....			
Ducks,all ages.....			
OTHER LIVESTOCK:			
Horses.....			
Goats.....			
Mink.....			
Rabbits.....			
Fish.....			
Other(_____).....			
Other(_____).....			

5 Has there been an overall change in the amount of livestock you kept in the last five years? Increase(__); Decrease(__); Same(__). Why? What?

6. Are you experimenting with any livestock or approaches to livestock management not commonly used? Yes(__),No(__). Have you ever...? Yes(__),No(__)

Livestock Type or Management Approach	Year First Tried	Successful Yes/No	Reasons

7. Please describe how manure was handled in 1978, including whether spread or piled in the field, how soon worked in, where spread, and when?_____

E. RESOURCE MANAGEMENT

1. Does any of the land farmed by you now, have an apparent salinity problem? Yes(__), No(__)

2. Is this problem diminishing(__), more or less constant(__), or growing(__). Comment:_____

3. In 1978 were any sort of special measures so far as cultivation, drainage, choice of crop, etc. taken in fields effected by salt problems? Yes(__),No(__). Please describe these measures:_____

_____

4. Were there any shelterbelts on your land at the time you aquired it? Yes(__), No(__) Describe briefly:_____

_____

5. Have any shelterbelts been established or replanted on your acreage since incorporation? Yes(__),No(__) Describe briefly:_____

_____

6. Besides any that were replanted, have any shelterbelts been removed? Yes(__), No(__) Reasons:_____

7. Have you ever found any snow management techniques to be suitable or practical? For instance, has any of the acreage been treated by:

ridging and plowing.....Yes(__),No(__),% cropland 1978(____%)
cutting stubble high.....Yes(__),No(__),% grain acres '78(____%)
cutting stubble stepwise at var. heights.Yes(__),No(__),% grain acres '78(____%)
other methods:_____,% _____ acres '78(____%)

Comment:_____

8. In 1978, was any stubble(__) or straw in windrows burned? Yes(__),No(__) Comment:

_____

9. How are slough and/or pothole areas treated? For example, has any attempt been made to drain them, irrigate from them, work them, etc. ?_____

_____

_____

_____

10. Are there any gullies, ditches or drainage ways on your lands that have been converted to grass waterways since you aquired the farm? Yes(__),No(__)

Comment:_____

11. Are there any gullies, ditches or drainage ways that might benefit from conversion to grass waterways? Yes(__),No(__) Comment:_____

_____

12. Is any of your land strip-cropped? Yes(__),No(__) or contour strip-cropped? Yes(__),No(__) Comment:_____

13. Do you work any land that could benefit from either of these treatments? Yes(__),No(__) Comment:_____

_____

14. What is the range of size and average size of fields being worked? Range (_____acres) to (_____acres). Average(_____acres) Comment:_____

_____

Have you made any changes in field size or shape
Yes(__), No(__) Comment:_____

_____

15. Have you ever found it practical to plant spring wheat, oats, barley, or rye as a cover crop on summerfallow fields? Yes(__),No(__) If Yes, what percent of summerfallow received this treatment in 1978?(_____%) Comment:_____

_____

16. Please discuss any measures taken to conserve energy or to improve energy use on the farm in the last 5 years._____

_____

17. Comparing your farm operation to other farms in the area, how would you rate it in terms of attention to soil conservation and environmental quality?

1	2	3	4	5
Considerably below average	Somewhat below average	Average	Somewhat above average	Considerably above average

18. Why did you choose this rating?_____

_____

_____

F. MACHINERY

1. Are you experimenting with any machinery not in general use, making important modifications to equipment, or designing or building any new equipment? Yes(__), No(__) Have you ever...? Yes(__),No(__) Comment:_____

Machinery	Year first tried	Successful Yes/No	Reasons

2. Please list all major items of machinery and equipment regularly used on the land farmed in 1978, giving type, capacity, make, model, year, year purchased, whether new or used, and estimated market value in 1978.

Make	Model	Year	Type	Capacity	Year Puchased	New/ Used	1978 Market
TRACTORS:							
FIELD IMPLEMENTS, INCLUDING PLANTING EQUIPMENT, SPRAYERS AND SPREADERS:							

Make	Model	Year	Type	Capacity	Year Purchased	New/ Used	1978 Market
HARVESTING EQUIPMENT INCLUDING HAYING EQUIPMENT:							
GRAIN TRUCKS:							
MISCELLANEOUS: (uncommon)							

Total H.P. of tractors	+	+	+	+	+	+	+	=
Total width of cultivators	+	+	+	+	+	+	+	=
Tot. width seeders/discers	+	+	+	+	+	+	+	=
Total width of swathers	+	+	+	+	+	+	+	=
Total cylinder width combines		+	+	+	+	+	+	=
Total capacity of grain trucks		+	+	+	+	+	+	=

3. In 1978 was an acreage in addition to your own farmed with this machinery on a custom or any other basis? Yes(__), No(__) How much?_____

4. Did you hire any kind of custom work in 1978? Yes(__), No(__) What?_____

_____

_____

5. Do you have a grain loss monitor on any of your combines? Yes(__),No(__)

6. Do you have any other electrical monitoring equipment fitted to drills, sprayers, spreaders, etc.? Yes(__), No(__) What?_____

_____

_____

7. In 1978, did you have any herbicides applied by aerial applicator?Yes(__)No(__)

Comment:_____

8. Do you have records of total 1978 fuel consumption for farm operations? Yes(__), No(__) Please give any relevant data for 1978: _____

_____

_____

9. Do you subscribe to Prairie Agricultural Machinery Institute (PAMI) reports? Yes(__),No(__) Comment:_____

G. FINANCIAL MANAGEMENT AND PLANNING

1. Do you use Canfarm, Yes(__),No(__); the Prairie Farm Account Book,Yes(__), No(__); or any other accounting system, Yes(__),No(__) Specify:_____

_____

2. Do you use your records when planning next year's production (__), or are the records mainly of use for tax accounting and filing purposes (__). Comment:

_____

3. Are annual budgets developed to forecast labour requirements, other production costs and revenues for any of the farms enterprises? Yes(__),No(__) Comment:_____

_____

_____

4. Are cash-flow forecasts and statements used? Yes(__),No(__) Comment:_____

_____

5. Did you carry crop insurance in 1978? Yes(__),No(__) On what percent of the crop? (_____%) Comment:_____

6. Did you carry liability,Yes(__),No(__); theft,Yes(__),No(__); or workman's compensation insurance in 1978? Comment:_____

7. When aquiring credit(__), machinery(__), or material inputs(__), do you do comparison shopping, checking with 3 or 4 area sources before buying? What is your general approach to making major purchases?_____

8. In 1978 where were major purchases made?(machinery, fertilizer, etc.)

Item	Source	Town	Distance

9. Comparing your farm operation to other farms in the area, how would you rate it in terms of effective use of records in planning production and financial strategy?

1	2	3	4	5
Considerably Below average	Somewhat below average	Average	Somewhat above average	Considerably above average

10. Why did you choose this rating?_____

H. HUMAN RESOURCES AND FUTURE PLANS

1. Have there been any major changes in personnel operating this farm in the last ten years? Yes(__),No(__) If Yes, how did this effect the operation?_____

2. How old are the principal operators?_____

3. Please describe any off-farm work in 1978.

Person	Nature of work	Days worked	paid/unpaid

4.(In case of more than one operator) How is work allocated? Are jobs rotated or is there specialization and/or individual responsibility for specific functions or enterprises?_____

5. (In case of more than one operator) How often are meetings held to plan work?

6. (In case of more than one operator) Has group decision making and management proven adequate in practice? Yes(__),No(__) Please discuss advantages and drawbacks as you have experienced them, giving examples._____

7. Did you hire any agricultural labour in 1978? Yes(__), No(__)(If No, skip to Q.9) Comment:_____

8. How many weeks in total?(_____) (Consider 6 days or 48 hours as equivalent to 1 week, 1 month equivalent to 4 weeks, 1 year equivalent to 52 weeks) Comment:

9. Please describe the roles that spouses and older sons and daughter play in the operation of the farm, discussing decision-making, labour contribution, payment, etc. _____

10. Please describe any formal training or education that any of the operators have had, including years completed in school, any college or university courses, and any diploma, manpower, correspondence, or other courses taken.

Person	Course or program and level completed	Last calendar year attended

11. Have there been any health problems among operators or their families that you suspect may be related to farming. Yes(__),No(__) What:_____

_____

_____

_____

12. Have any changes been made to minimize the risks of health problems or accidents? Yes(__), What? No(__), Why not?_____

_____

_____

13. Do you use noise-reducing earmuffs when operating loud machinery without a cab? Yes(__), No(__)Comment:_____

14. Do you use a dust mask or filter masks for any farming operation? Yes(__), No(__) If Yes, specify operation, chemical, etc. _____

_____

_____

15. Are intake guards fitted to any of your augers?_Yes(__),No(__) Comment:_____

_____

16. Do you have a longer-term farm development plan for the coming 2 to 5 or more years? Yes(__),No(__) Are there any changes that you plan or hope to make in the future? _____

_____

_____

_____

17. Are there plans for future involvement of other family members or anybody else in the operation? Yes(__),No(__) Do you anticipate any problem in transferring your farm operation to the next generation? Yes(__),No(__), Don't know(__) Why? How will this be accomplished?_____

_____

_____

_____

_____

18.Have you ever considered forming or joining any sort of multiple-operator farming arrangement(e.g. partnership, family corporation, machinery co-op)? Yes(__),No(__) What? Why? What are your feelings about these kinds of operations?

19. Are there any other points that you feel are important to note concerning farming and resource management generally?

Appendix B. Selected Measures of Machinery Capacity, Age and Market Value for Group and Individual-type Study Farms.

		Group Farms	Individual-type Farms	p[1]
Cultivated area per unit tractor power (ac/hp)	Mean	7.4	5.2	
	Median	7.3	5.3	.01
	Range[2]	6.1-8.3	3.9-6.1	
Tractor value per unit cultivated land ($/ac)	Mean	120	218	
	Median	117	209	.01
	Range	88-133	160-253	
Largest tractor (hp)	Mean	17	26	
	Median	14	23	.01
	Range	10-21	17-33	
Age of tractors weighted by unit tractor power (years)	Mean	7	8	
	Median	6	7	ns
	Range	4-8	6-8	
Area seeded per unit width seeder (ac/ft)	Mean	38	29	
	Median	38	28	.05
	Range	32-41	20-31	
Area swathed per unit width of swather (ac/ft)	Mean	44	30	
	Median	41	27	.01
	Range	35-49	22-35	
Area harvested per unit combine cylinder width (ac/in)	Mean	22	16	
	Median	21	15	.01
	Range	16-26	11-19	
Combine value per unit area harvested ($/ac)	Mean	19	29	
	Median	14	23	ns
	Range	8-18	11-39	
Age of combines weighted by unit cylinder width (years)	Mean	5	5	
	Median	4	4	ns
	Range	2-7	1-7	

[1] Significance level of differences between group and individual-type farms

[2] Interquartile range in all cases

Appendix C. Data for Group and Individual-Type Farms

Key to Data Label Abbreviations (in order of listing)

FARMTYPE G	group farms
FARMTYPE I	individual-type farms
HP	total horsepower of tractors (excluding construction machinery and any tractors under 25 hp)
TRACTVAL	1978 market value of tractors ($000)
CULACPHP	cultivated acres/tractor hp
TVPCUAC	1978 market value of tractors/cultivated acre ($)
HPPOP	tractor hp/active operator
SEEDWDT	total width of seeders and discers (ft)
ASEEDPFT	acres seeded for the 1978 harvest/SEEDWDT
CYLWDT	total cylinder width of combines (in)
GACPCYL	grain acres harvested, including custom work/CYLWDT
COMVALPG	1978 market value of combines/grain acres harvested, including custom work ($)
CAPTRK	total grain truck capacity (bu)
LARGETRAC	largest tractor (pto hp)
AGEHPWT	average age of tractors weighted by hp (yr)
AGECYLWT	average age of combines weighted by inches cylinder width (yr)
TRACPOP	number of tractors
GAHPTBU	grain acres harvested/CAPTRK
SWATHWDT	total width of swathers (ft)
GASWAPFT	grain acres harvested/SWATHWDT
CASWAPFT	crop acres harvested/SWATHWDT
TRACPAOP	TRACPOP/active operator
TOTACRE	total acres
CULTACRE	1978 cultivated acres including summer fallow
CROPACRE	1978 crop acres including tame hay and improved pasture in rotation
CUACPO	CULTACRE/active operator
PERCENT	percent of land rented from outside parties
PERCCUCR	CROPACRE as a percent of CULTACRE
SFWRKX	number of cultivations performed on 1978 summer fallow
CROPNO	number of different crops grown in 1978 (including tame hay and feed wheat, but not improved pasture)

PERCTOCU	CULTACRE as a percent of TOTACRE
PERCCUSF	summer fallow area as a percent of CULTACRE
DISTLAND	distance by road between most far-flung 1/4 sections (miles)
GRAINACH	grain acres harvested
AUTOTAC	animal units/TOTACRE
AUPCULAC	animal units/CULTACRE
COMAUPOP	animal units in commercial scale herds ($\geq$ 5 a.u.)/ active operator
CNSVRATE	conservation rating
DISTFERT	average distance to place(s) where fertilizer was purchased in 1978 (miles)
DISTHERB	average distance to place(s) where herbicides were purchased in 1978 (miles)
DISTMACH	average distance to place(s) where machinery was purchased in 1978 (miles)
RECORATE	record-keeping rating
NOPOPA	number of active operators
SET	number assigned to this farm and its match (group farm and a matched individual-type farm)
TOTAPO	total acres per active operator
TOTHAPO	total hectares per active operator
CULHAPKW	cultivated hectares/tractor kW
TVPCUHA	1978 market value of tractors/cultivated hectare ($000)
KWPOP	tractor kW/active operator
SEEDWDTM	total width of seeders and discers (m)
HASEEDPM	hectares seeded for the 1978 harvest/SEEDWDTM
CYLWDTC	total cylinder width of combines (cm)
GHAPCYLC	grain hectares harvested, including custom work/CYLWDTC
COMVALPH	1978 market value of combines/grain hectare harvested including custom work
CAPTRKM	total grain truck capacity (tonne)
LARGETRAM	largest tractor (pto kW)
GHHPTT	grain hectares harvested/CAPTRKM
SWATHWDM	total width of swathers (m)
GHSWADM	grain hectares harvested/SWATHWDM

CHSWAPM	crop hectares harvested/SWATHWDM
TOTHA	total hectares
CULTHA	1978 cultivated hectares including summer fallow
CROPHA	1978 crop hectares including tame hay and improved pasture in rotation
CUHAPO	cultivated hectares per active operator
DISTLANM	distance by road between most far-flung 1/4 sections (km)
GRAINHAH	grain hectares harvested
AUTOHA	animal units/TOTHA
AUPCULHA	animal units/CULTHA
DISTHERM	average distance to place(s) where herbicides were purchased in 1978 (km)
DISTFERM	average distance to place(s) where fertilizers were purchased in 1978 (km)
DISTMACH	average distance to place(s) where machinery was purchased in 1978 (km)
SEWDMPOP	SEEDWDTM per active operator
SWAWDPO	SWATHWDM per active operator
CYWDCPOP	CYLWDTC per active operator
TRAVLPOP	TRACTVAL per active operator
COMVAL	1978 market value of combines ($)
COMVLPOP	COMVAL per active operator

FARMTYPE I

OBS	HP	TRACTVAL	CULACPHP	TVPCUAC	HPPOP	SEEDWDT	ASEEDPFT	CYLWDT	GACPCYL	CONVALPG	CAPTRK
1	520	69.5	4.62	36.97	260	38	46.05	103.0	16.99	25.14	650
2	231	34.5	5.59	32.55	231	28	22.51	79.0	10.51	43.41	310
3	250	28.5	6.88	16.57	250	30	30.83	50.0	18.50	45.41	525
4	320	39.0	5.41	22.54	160	44	19.55	45.0	19.11	23.26	400
5	160	22.0	6.56	20.95	160	16	30.75	40.0	11.05	13.57	300
6	145	12.7	9.31	9.41	145	15	42.33	39.0	16.28	9.44	240
7	282	22.5	2.30	34.62	282	.	.	37.5	7.73	75.86	450
8	197	31.0	2.92	53.91	197	21	20.00	42.0	10.00	13.09	175
9	246	26.0	5.98	17.69	123	24	31.25	50.0	15.00	35.47	600
10	312	28.5	3.21	14.92	312	36	53.06	42.0	26.67	20.94	600
11	235	26.5	6.53	17.26	235	33	28.33	41.0	22.89	6.42	140
12	196	27.4	4.18	33.41	196	39	12.05	36.0	13.06	5.32	180
13	319	31.5	4.31	22.91	319	30	24.17	50.0	14.50	68.97	550
14	175	24.0	5.23	26.23	175	18	29.72	42.0	12.74	.	680
15	220	39.0	5.45	32.50	220	29	20.69	38.0	18.95	25.00	320

OBS	LRGETRAC	AGEHPWT	AGECYLWT	TRACPOP	GAHPTBU	SWATHWDT	GASWAPFT	CASWAPFT	TRACPADP	TOTACRE	CULTACRE	CROPACRE
1	178	7	4	5	2.69	36	48.6	50.4	2.5	2400	1880	1815
2	121	6	5	3	2.03	18	35.0	36.9	3.0	1280	1060	665
3	130	8	1	3	1.76	42	22.0	41.0	3.0	1975	1720	925
4	121	8	4	4	2.15	39	22.1	43.0	2.0	1760	1730	860
5	100	6	8	2	1.47	20	22.1	24.6	2.0	1470	1050	492
6	101	11	12	2	2.65	18	35.3	40.8	2.0	1440	1350	735
7	96	14	4	4	0.64	18	16.1	19.4	4.0	800	650	350
8	126	7	10	2	2.40	15	28.0	32.0	2.0	800	575	480
9	156	6	0	2	1.25	24	31.3	31.3	1.0	1600	1470	750
10	174	13	.	4	1.87	42	26.7	26.7	4.0	1920	1910	1120
11	150	5	13	2	6.68	20	46.8	46.8	2.0	1920	1535	935
12	162	5	1	2	2.61	20	23.5	24.0	2.0	940	820	480
13	189	8	1	4	1.32	18	40.3	47.2	4.0	1600	1375	975
14	105	8	4	2	0.79	18	29.7	33.1	2.0	1120	915	595
15	180	5	4	2	.	24	25.0	25.0	2.0	1280	1200	600

OBS	CNACPO	PERCENT	PERCCUCR	SFWRKX	CROPND	PERCTOCU	PERCCUSF	DISTLAND	GRAINACH	AUTOTAC	AUPCULAC	COMAUPOP	CNSVRATE	DISTFERT
1	940	33	96.54	2.0	6	78.53	3.46	8	1750	0.04	0.05	48.5	5.0	60
2	1060	0	62.74	9.0	5	82.81	37.26	3	630	0.03	0.03	32.0	3.0	.
3	1720	24	53.78	6.0	3	87.09	46.22	17	925	0.00	0.00	0.0	3.0	10
4	865	27	49.71	5.0	2	98.29	50.28	10	860	0.00	0.00	0.0	3.0	.
5	1050	2	46.86	3.0	5	71.43	53.14	4	442	0.05	0.06	68.0	3.0	8
6	1350	78	54.44	6.0	4	93.75	45.56	7	635	0.01	0.01	16.0	3.0	.
7	650	40	53.85	.	4	81.25	46.15	3	290	0.06	0.07	45.0	4.5	10
8	575	0	83.48	6.5	4	71.88	16.52	9	420	0.03	0.04	25.0	3.0	12
9	735	40	51.02	4.0	3	91.88	48.98	14	750	0.02	0.02	17.0	3.0	.
10	1910	21	58.64	3.8	5	99.48	41.36	10	1120	0.00	0.00	0.0	3.5	1
11	1535	100	60.91	5.0	3	79.95	39.09	11	935	0.02	0.02	33.0	3.0	.
12	820	17	58.54	5.0	6	87.23	41.46	5	470	0.06	0.07	54.0	3.0	13
13	1375	0	70.91	7.5	5	85.94	29.09	4	725	0.03	0.03	47.0	4.0	7
14	915	29	65.03	5.5	5	81.70	34.97	4	535	0.04	0.05	49.0	5.0	9
15	1200	38	50.00	7.0	2	93.75	50.00	10	600	0.01	0.01	8.0	5.0	.

FARMTYPE I

OBS	DISTHERB	DISTMACH	RECORATE	NOPOPA	SET	TOTAPO	TOTHAPO	CULHAPKW	TVPCUHA
1	5.0	60.0	4.0	2	1	1200	485.633	2.50635	91.353
2	9.5	10.0	3.0	1	2	1280	518.009	3.03257	80.431
3	16.0	3.0	3.0	1	3	1975	799.272	3.73240	40.944
4	4.0	44.7	3.0	2	4	880	356.131	2.93492	55.696
5	8.0	45.0	3.0	1	5	1470	594.901	3.55880	51.767
6	3.0	40.0	5.0	1	6	1440	582.760	5.05067	23.252
7	10.0	19.0	4.5	1	7	800	323.756	1.24775	85.546
8	12.0	20.0	3.0	1	8	800	323.756	1.58410	133.212
9	1.0	.	3.0	2	9	800	323.756	3.24415	43.712
10	1.0	1.0	3.0	1	10	1920	777.013	1.74142	36.867
11	14.0	63.0	3.0	1	11	1920	777.013	3.54252	42.849
12	13.0	80.0	4.0	1	12	940	380.413	2.26765	82.556
13	7.0	30.0	3.5	1	13	1600	647.511	2.33817	56.611
14	5.0	8.0	3.0	1	14	1120	453.258	2.83727	64.814
15	.	12.0	4.0	1	15	1280	518.009	2.95662	80.307

OBS	KWPOP	SEEDWDTM	HASEEDPM	CYLWDTC	GHAPCYLC	COMVALPH	CAPTRKM
1	193.970	11.5824	61.1544	261.62	2.70141	62.121	17.6919
2	172.335	8.5344	29.8933	200.66	1.67109	107.266	8.4377
3	186.510	9.1440	40.9422	127.00	2.94150	112.208	14.2896
4	119.366	13.4112	25.9624	114.30	3.03849	57.475	10.8873
5	119.366	4.8768	40.8360	101.60	1.75695	33.531	8.1655
6	108.176	4.5720	56.2142	99.06	2.58852	23.326	6.5324
7	210.383	.	.	95.25	1.22907	187.450	12.2482
8	146.970	6.4008	26.5600	106.68	1.59000	32.345	4.7632
9	91.763	7.3152	41.5000	127.00	2.38500	87.646	16.3310
10	232.764	10.9728	70.4637	106.68	4.24053	51.743	16.3310
11	175.319	10.0584	37.6222	104.14	3.63951	15.864	3.8106
12	146.224	11.8872	16.0024	91.44	2.07654	13.146	4.8993
13	237.987	9.1440	32.0978	127.00	2.30550	170.425	14.9701
14	130.557	5.4864	39.4682	106.68	2.02566	.	18.5084
15	164.129	8.8392	27.4763	96.52	3.01305	61.775	8.7099

OBS	LRGFTRAM	GHHPTT	SWATHWDM	GHSWAPM	CHSWAPM	TOTHA	CULTHA
1	132.765	39.9949	10.9728	64.5408	66.9312	971.267	760.826
2	90.271	30.1820	5.4864	46.4800	49.0032	518.009	428.976
3	96.985	26.1677	12.8016	29.2160	54.4480	799.272	696.074
4	90.271	31.9662	11.8872	29.3488	57.1040	712.262	700.121
5	74.604	21.8560	6.0960	29.3488	32.6688	594.901	424.929
6	75.350	39.4002	5.4864	46.8784	54.1824	582.760	546.338
7	71.620	9.5155	5.4864	21.3808	25.7632	323.756	263.051
8	94.001	35.6832	4.5720	37.1840	42.4960	323.756	232.699
9	116.382	18.5850	7.3152	41.5664	41.5664	647.511	594.901
10	129.811	27.8032	12.8016	35.4576	35.4576	777.013	772.966
11	111.906	99.3182	6.0960	62.1504	62.1504	777.013	621.206
12	120.858	38.8055	6.0960	31.2080	31.8720	380.413	331.849
13	141.002	19.6258	5.4864	53.5184	62.6816	647.511	556.455
14	78.334	11.7457	5.4864	39.4416	43.9568	453.258	370.295
15	134.287	.	7.3152	33.2000	33.2000	518.009	485.633

FARMTYPE I

OBS	CROPHA	CUHAPO	DISTLANM	GRANHAH	AUTOTHA	AUPCULHA	DISTHERM	DISTFERM
1	734.520	380.413	12.8747	708.215	0.09884	0.12355	8.0467	96.5604
2	269.122	428.976	4.8280	254.958	0.07413	0.07413	15.2887	.
3	374.342	696.074	27.3588	374.342	0.00000	0.00000	25.7494	16.0934
4	348.037	350.061	16.0934	348.037	0.00000	0.00000	6.4374	.
5	199.110	424.929	6.4374	178.875	0.12355	0.14826	12.8747	12.8747
6	297.450	546.338	11.2654	256.981	0.02471	0.02471	4.8280	.
7	141.643	263.051	4.8280	117.361	0.14826	0.17297	16.0934	16.0934
8	194.253	232.699	14.4841	169.972	0.07413	0.09884	19.3121	19.3121
9	303.521	297.450	22.5308	303.521	0.04942	0.04942	1.6093	.
10	453.258	772.966	16.0934	453.258	0.00000	0.00000	1.6093	1.6093
11	378.389	621.206	17.7027	378.389	0.04942	0.04942	22.5308	.
12	194.253	331.849	8.0467	190.206	0.14826	0.17297	20.9214	20.9214
13	394.577	556.455	6.4374	293.403	0.07413	0.07413	11.2654	11.2654
14	240.793	370.295	6.4374	216.512	0.09884	0.12355	8.0467	14.4841
15	242.817	485.633	16.0934	242.817	0.02471	0.02471	.	.

OBS	DISTMACM	SEWDMPOP	SWAWDMPO	CYWDCPOP	TRAVLPOP	COMVAL	CUMVLPOP
1	96.560	5.7912	5.4864	130.81	34.75	43995.0	21997.5
2	16.093	8.5344	5.4864	200.66	34.50	27348.3	27348.3
3	4.828	9.1440	12.8016	127.00	28.50	42004.2	42004.2
4	71.937	6.7056	5.9436	57.15	19.50	20003.6	10001.8
5	72.420	4.8768	6.0960	101.60	22.00	5997.9	5997.9
6	64.374	4.5720	5.4864	99.06	12.70	5994.4	5994.4
7	30.577	.	5.4864	95.25	22.50	21999.4	21999.4
8	32.187	6.4008	4.5720	106.68	31.00	5497.8	5497.8
9	.	3.6576	3.6576	63.50	13.00	26602.5	13301.2
10	1.609	10.9728	12.8016	106.68	28.50	23452.8	23452.8
11	101.388	10.0584	6.0960	104.14	26.50	6002.7	6002.7
12	128.747	11.8872	6.0960	91.44	27.40	2500.4	2500.4
13	48.280	9.1440	5.4864	127.00	31.50	50003.2	50003.2
14	12.875	5.4864	5.4864	106.68	24.00	.	.
15	19.312	8.8392	7.3152	96.52	39.00	15000.0	15000.0

FARMTYPE G

OBS	HP	TRACTVAL	CULACPHP	TVPCUAC	HPPOP	SFEDWDT	ASFEDPFT	CYLWDT	GACPCYL	COMVALPG	CAPTRK
1	656	32.0	7.26	6.72	109	60	38.33	104	22.12	27.82	1450
2	514	51.7	7.69	13.26	86	48	47.29	87	26.09	7.27	760
3	265	47.0	8.74	20.30	88	30	40.50	84	14.46	17.28	600
4	371	27.6	6.90	10.78	124	54	22.78	48	25.63	9.76	650
5	337	51.0	8.07	18.75	112	36	36.67	84	15.71	18.18	900
6	375	46.0	7.10	17.27	125	28	39.32	42	26.21	8.17	475
7	649	50.0	10.76	7.16	65	88	45.08	136	29.17	16.64	1100
8	656	95.8	4.03	36.15	139	58	33.62	96	20.31	49.23	525
9	985	75.2	8.61	8.88	99	105	59.98	245	39.27	12.78	.
10	621	51.0	8.13	10.10	207	63	41.27	84	26.19	5.91	1125
11	668	69.5	7.38	14.10	131	88	35.63	140	22.39	10.53	600
12	473	69.0	5.92	24.64	158	60	24.75	94	15.05	16.84	1000
13	350	39.0	9.19	12.13	58	54	39.81	126	17.06	6.98	.
14	482	56.0	5.08	22.86	121	52	33.65	100	16.50	15.43	600
15	1108	231.0	6.21	33.58	185	132	25.76	192	17.71	58.82	1400

OBS	LRGETRAC	AGEHPWT	AGECYLWT	TRACPOP	GAHPTRU	SWATHWDT	GASWAPFT	CASWAPFT	TRACPADP	TOTACRE	CULTACRE	CROPACRF
1	193	14	1	11	1.59	48.0	47.9	61.3	1.83	6560	4760	2940
2	146	11	8	6	2.99	42.0	54.1	66.0	1.00	5600	3900	2770
3	105	4	5	3	2.03	30.0	40.5	40.5	1.00	2400	2315	1215
4	150	7	5	4	1.89	42.0	29.3	29.3	1.33	2560	2460	1230
5	189	2	6	3	1.47	60.0	22.0	22.0	1.00	3790	2720	1320
6	130	3	7	4	2.32	54.0	40.8	30.2	1.33	7040	2664	1629
7	189	6	3	6	3.61	102.0	38.9	39.9	0.60	8616	6987	4508
8	221	6	1	6	.	47.0	41.5	43.5	1.20	4320	2650	2045
9	205	9	3	12	5.50	96.0	64.8	65.6	1.20	9380	8479	6298
10	189	6	8	7	2.31	72.0	36.1	36.1	2.33	5700	5052	2600
11	193	11	11	5	5.23	66.0	47.5	47.5	1.00	7560	4930	3235
12	193	6	.	4	1.49	46.0	32.3	32.3	1.33	3520	2800	1485
13	125	5	.	3	.	36.0	59.7	68.8	0.50	4480	3216	2478
14	189	8	3	5	2.75	42.0	39.3	41.7	1.25	2880	2450	1750
15	401	2	0	7	2.43	58.5	58.1	58.1	1.17	7000	6800	3400

OBS	CHACPO	PERCENT	PERCUCR	SFWRKX	CROPNO	PERCTCU	PERCUSE	DISTLAND	GRAINACH	AUTOTAC	AUPCULAC	COMAUPOP	CNSVRATE	DISTFERT
1	793	24	61.76	5.0	7	72.56	38.23	20	2300	0.070	0.100	77.50	5.0	14
2	650	.	71.03	5.5	8	69.64	28.97	27	2270	0.040	0.060	35.83	4.5	5
3	772	33	52.48	5.0	3	96.46	47.52	10	1215	0.002	0.002	1.67	3.5	.
4	820	44	50.00	5.0	3	96.09	50.00	15	1230	0.000	0.000	0.00	3.0	32
5	907	34	48.53	3.0	3	71.77	51.47	14	1320	0.010	0.010	10.33	.	.
6	888	57	61.15	4.0	3	37.84	38.85	25	1101	0.020	0.050	44.66	4.0	.
7	699	.	64.52	6.0	7	81.09	35.48	16	3967	0.030	0.030	22.70	3.0	21
8	530	11	77.17	6.5	5	61.34	22.80	9	1950	0.030	0.060	29.40	3.5	20
9	848	100	74.25	4.0	6	90.39	25.72	12	9621	0.050	0.060	50.00	3.5	.
10	1684	16	51.46	4.0	6	88.63	48.54	13	2200	0.003	0.003	4.67	3.0	5
11	986	.	65.62	5.0	5	65.21	34.38	8	3135	0.020	0.030	30.60	5.0	.
12	933	34	53.04	5.5	2	79.55	46.96	13	1485	0.110	0.130	123.00	3.5	1
13	536	10	77.05	5.8	7	71.79	22.95	17	2150	0.040	0.060	33.50	5.0	18
14	613	17	71.43	4.5	5	85.07	28.57	6	1650	0.040	0.040	26.25	3.0	10
15	1133	.	50.00	5.0	3	97.14	50.00	.	3400	0.000	0.000	0.67	4.0	5

FARMTYPE G

DRS	DISTHERB	DISTMACH	RECORATE	NOPOPA	SET	TOTAPO	TOTHAPO	CULHAPKW	TVPCUHA
1	14.0	68.0	5.0	6	1	1093.33	442.466	3.93855	16.6051
2	.	62.5	5.0	6	2	933.33	377.715	4.17182	32.7655
3	12.5	25.0	3.5	3	3	800.00	323.756	4.74145	50.1613
4	32.0	30.0	4.5	3	4	853.33	345.339	3.74325	26.6374
5	3.0	40.0	4.0	3	5	1263.33	511.264	4.37797	46.3312
6	.	20.0	3.0	3	6	2346.67	949.683	3.85175	42.6742
7	21.0	55.0	3.0	10	7	861.60	348.685	5.83730	17.6924
8	20.0	45.0	5.0	5	8	864.00	349.656	2.18627	89.3266
9	.	50.0	5.0	10	9	938.00	379.603	4.67092	21.9425
10	5.0	5.0	5.0	3	10	1900.00	768.919	4.41052	24.9571
11	3.0	50.0	3.0	5	11	1512.00	611.898	4.00365	34.8411
12	18.0	18.0	5.0	3	12	1173.33	474.841	3.21160	60.8854
13	8.0	70.0	5.0	6	13	746.67	302.172	4.98557	29.9732
14	10.0	85.0	3.0	4	14	720.00	291.380	2.75590	56.4871
15	5.0	5.0	5.0	6	15	1166.67	472.144	3.36892	82.9762

DRS	KWPOP	SEEDTM	HASEDPM	CYLWDTC	CHAPCYLC	COMVALPH	CAPTRKM	LRGETRAM
1	81.318	18.2880	50.9022	264.16	3.51708	68.743	39.4665	143.986
2	64.159	14.6304	62.8011	220.98	4.14831	17.964	20.6859	108.922
3	65.652	9.1440	53.7840	213.36	2.29914	42.699	16.3310	78.334
4	92.509	16.4592	30.2518	121.92	4.07517	24.117	17.6919	111.906
5	83.556	10.9728	48.6978	213.36	2.49789	44.923	24.4965	141.002
6	93.255	8.5344	52.2170	106.68	4.16739	20.188	12.9287	96.985
7	48.493	26.8224	59.8662	345.44	4.63803	41.117	29.9401	141.002
8	103.700	17.6784	44.6474	243.84	3.22929	121.647	14.2896	164.875
9	73.858	32.0040	79.6534	622.30	6.24393	31.579	.	152.938
10	154.430	19.2024	54.8066	213.36	4.16421	14.604	30.6206	141.002
11	97.731	26.8224	47.3166	355.60	3.56001	26.020	16.3310	143.986
12	117.874	18.2880	32.8680	238.76	2.39295	41.612	27.2183	143.986
13	43.270	16.4592	52.8677	320.04	2.71254	17.248	.	93.255
14	90.271	15.8496	44.6872	254.00	2.62350	38.128	16.3310	141.002
15	138.017	40.2336	34.2093	487.68	2.81580	145.344	38.1056	209.162

DRS	GHHPTT	SWATHWDM	GHSWAPM	CHSWAPM	TOTHA	CULTHA	CROPHA
1	23.6401	14.6304	63.6112	81.4064	2654.80	1926.35	1189.80
2	44.4553	12.8016	71.8448	87.6480	2266.29	1578.31	1121.00
3	30.1820	9.1440	53.7840	53.7840	971.27	936.87	491.70
4	28.1005	12.8016	38.9104	38.9104	1036.02	995.55	497.77
5	21.8560	18.2880	29.2160	29.2160	1533.79	1100.77	534.20
6	34.4938	16.4592	54.1824	40.1056	2849.05	1078.11	659.25
7	53.6735	31.0896	51.6592	52.9872	3486.85	2827.60	1824.36
8	.	14.3256	55.1120	57.7680	1748.28	1072.44	827.60
9	81.7740	29.2608	86.0544	87.1168	3796.03	3431.40	2548.77
10	34.3451	21.9456	47.9408	47.9408	2306.76	2044.52	1052.21
11	77.7596	20.1168	63.0800	63.0800	3059.49	1995.14	1309.19
12	22.1533	14.0208	42.8944	42.8944	1424.52	1133.14	600.97
13	.	10.9728	79.2816	91.3664	1813.03	1301.50	1002.83
14	40.8870	12.8016	52.1904	55.3776	1165.52	991.50	708.22
15	36.1292	17.8308	77.1568	77.1568	2832.86	2751.92	1375.96

FARMTYPE G

OBS	CUHADO	DISTLANM	GRANHAH	AUTOTHA	AUPCULHA	DISTHERM	DISTFERM
1	320.923	32.1868	930.80	0.172970	0.247100	22.5308	22.5308
2	263.051	43.4522	918.66	0.098840	0.148260	.	8.0467
3	312.424	16.0934	491.70	0.004942	0.004942	20.1167	.
4	331.849	24.1401	497.77	0.000000	0.000000	51.4989	51.4989
5	367.058	22.5308	534.20	0.024710	0.024710	4.8280	.
6	359.369	40.2335	445.57	0.049420	0.123550	.	.
7	282.881	25.7494	1605.42	0.074130	0.074130	33.7961	33.7961
8	214.488	14.4841	789.15	0.074130	0.148260	32.1868	32.1868
9	343.181	19.3121	3893.57	0.123550	0.148260	.	.
10	681.505	20.9214	890.33	0.007413	0.007413	8.0467	8.0467
11	399.029	12.8747	1268.72	0.049420	0.074130	4.8280	.
12	377.580	20.9214	600.97	0.271810	0.321230	28.9681	1.6093
13	216.916	27.3588	870.09	0.098840	0.148260	12.8747	12.8747
14	248.078	9.6560	667.75	0.098840	0.098840	16.0934	16.0934
15	459.519	.	1375.96	0.000000	0.000000	8.0467	8.0467

OBS	DISTMACM	SEWDMPOP	SWAWDMPO	CYWDCPOP	TRAVLPOP	COMVAL	COMVLPOP
1	109.435	3.04800	2.43840	44.0267	5.3333	63986	10664.3
2	100.584	2.43840	2.13360	36.8300	8.6167	16503	2750.5
3	40.233	3.04800	3.04800	71.1200	15.6667	20995	6998.4
4	48.280	5.48640	4.26720	40.6400	9.2000	12005	4001.6
5	64.374	3.65760	6.09600	71.1200	17.0000	23998	7999.2
6	32.187	2.84480	5.48640	35.5600	15.3333	8995	2998.4
7	88.514	2.68224	3.10896	34.5440	5.0000	66011	6601.1
8	72.420	3.53568	2.86512	48.7680	19.1600	95998	19199.7
9	80.467	3.20040	2.92608	62.2300	7.5200	122956	12295.6
10	8.047	6.40080	7.31520	71.1200	17.0000	13002	4334.0
11	80.467	5.36448	4.02336	71.1200	13.9000	33012	6602.3
12	28.968	6.09600	4.67360	79.5867	23.0000	25007	8335.8
13	112.654	2.74320	1.82880	53.3400	6.5000	15007	2501.2
14	136.794	3.96240	3.20040	63.5000	14.0000	25459	6364.9
15	8.047	6.70560	2.97180	81.2800	38.5000	199988	33331.3