Participatory Extension Strategies for the Implementation of Sustainable Agriculture

by

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Abstract

M.Sc. Jacques Nault Renewable resources

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Requirements for the development of sustainable farm systems include the generation of site-specific management practices, and heightened levels of awareness and empowerment within the farming community. The current model of technology development and transfer does not adequately facilitate the development of these characteristics. In this study, an alternative, participatory approach for agricultural extension is elaborated. The experiences of a support group, consisting of six farmers and a university co-research team, who employed this approach to develop more ecologically sustainable farm systems, are presented. Changes that took place at the farm and farmer level over the 17-month period of the study are described. The stages of a "process of development model" are elaborated. These comprise: General Systems Description, Convergence, Implementation, Exchange, and Monitoring and Evaluation. This model is proposed as a means to expand the potential of participatory extension strategies to facilitate the development of sustainable agricultural systems. The primary implications of the participatory extension approach for the future roles of agricultural extension workers are outlined.

Résumé

M.Sc. Jacques Nault Ressources renouvelables

Stratégies participatives de vulgarisation pour l'implantation de l'agriculture durable

Le développement de systèmes agricoles durables passe par une régie adaptée à chaque site, et par une communauté agricole à la fois connaissante et compétente, et possédant une faculté de faire élevée. Le modèle courant de développement et de transfert technologique ne favorise pas adéquatement ces caractéristiques. Dans cette étude, une approche de vulgarisation participative est élaborée comme alternative. L'expérience d'un groupe, constitué de six producteurs et d'une équipe de co-recherche de l'université, qui a employé cette approche pour développer des systèmes de fermes plus écologiques, est présentée. Les changements qui se sont produits, après 17 mois, au niveau de la ferme et du producteur sont décrits. Les étapes du "processus d'un modèle de développement" sont définies. Celles-ci sont: Description Générale des Systèmes, Convergence, Implantation, Echange, et Suivi et Evaluation. Ce modèle est proposé pour accroître le potentiel des stratégies de vulgarisation participatives, et pour faciliter le développement de systèmes agricoles durables. Les implications de l'approche participative pour les rôles futurs des vulgarisateurs sont soulignées.

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Table of contents

Table of contents (cont'd)

Table of contents (cont'd)

Appendices

List of Tables

List of Figures

PREFACE

This study is about extension for sustainable agriculture.

It is original in both content and methodology. In content, because it is, to my knowledge, the first comprehensive study, conducted in Quebec, addressing extension strategies for sustainable agriculture. And in methodology, because this project is an action-research that involved farmers throughout, and in which the strategies employed, and the model that developed, emerged directly from the field work.

The basic premise of the study is that the development of sustainable agriculture requires new approaches in agricultural extension. This realization originally arose during my experience as a cooperant in a rural area of West Africa. There, my own ignorance of local agriculture, and my isolation from other foreign "experts", placed me in a receptive learning mode with the local farmers. As I learned and experienced a totally new way of farming, I became increasingly aware of my own biases, and the assumptions that were built into the problems I saw, the solutions I suggested, and the ways I suggested them. I realized then that a change in perspective, and of the approaches used in extension, should be the first step in facilitating any changes in agricultural production.

This project has been one of the most rewarding and demanding experiences of my life. Most importantly, it has heightened my faith in people, and enhanced my hopes for a more humane future for all.

Introduction

The agricultural sector finds itself in the midst of a social, economical and environmental crisis. This has led the agricultural community to re-assess its current agricultural systems at the farm, extension, and research levels, and to search for viable alternatives. For instance, in Quebec, a province-wide consultation was organised by "l'Union des producteurs agricoles" (UPA) to analyse present trends and plan appropriate political and social actions (Cahier special, UPA, 1991). Some of the proposed solutions seem to be based on a set of values and thoughts that reflect the emergence of a new societal paradigm.

This paradigm has emerged from the work of many people, coming from a diversity of backgrounds including (among many others): a) in Agriculture: Koepf et al., 1976; Fukuoka, 1985; Hill, 1980, 1991; Altieri, 1987; b) in Economics: Schumaker, 1973; Dasman et al., 1973; Commoner, 1976; Daly & Cobb, 1989; c) in Education: Freire, 1970; Boulding, 1977; Richards, 1988; d) in sociology: Davis & Mouch, 1977; Roberston, 1978; Gowan et al., 1979; e) in Third World Development: Chambers, 1983; Dumont, 1988.

Roberston (1978), for instance, refers to his vision as a Sane, Humane, and Ecological (SHE) society. The salient features of the SHE society include:

1- People, rather than thing-oriented.

2- A decentralized and informal local economy and an equitable international economy.

3- The use of resources based on ecological principles.

4- The use of appropriate, humane technology.

Gowan et al. (1979) examine the U.S. society using a different set of criteria than those normally employed (i.e., economic growth, unemployement rates etc.). They diagnosed a seriously ill society, and suggested a model for a new political economic system along with strategies to achieve it. The criteria they used to evaluate the soundness of the current system were:

1- Physical security: for each and every human being.

2- Equality: of social benefits, services and costs.

3- Non-exploitation: income based on work and needs.

4- Work: enhance one's own skills, talents, thoughts, and creativity.

5- Democracy: people's participation in decisions that affect them.

6- Wholeness: spiritual, psychological, physical.

7- Community: cooperation and mutual well-being.

8- Freedom: to change.

9- Conflict: accepted as a natural part of life, experienced with openness and honesty.

10- Ecological harmony: concern for other human beings, including future generations, and for other species.

11- World community: equal world citizens.

Daly and Cobb (1989), in a convincing book, call for a move away from liberalism-oriented economic growth, and argue for a more humane and community-oriented perspective. Numerous arguments are put forward to show that current approaches to development and growth will likely lead to dire consequences.

Paehlke (1989) builds on the historical achievement of environmentalists and suggests that their actions can be translated into a new political ideology called "Environmentalism". He argues that environmentalism is not on the right to left political spectrum, but appears on a different axis and is based on a set of values that could appeal to people almost anywhere along it. These values are:

1. An appreciation of all life forms and a view that the complexities of the ecological web of life are politically salient.

2. A sense of humility regarding the human species in relation to other species and to the global

ecosystem.

3. A concern with the quality of human life and health, including an emphasis on the importance of preventive medicine, diet, and exercise to the maintenance and enhancement of human health.

4. A global rather than a nationalist or isolationist view.

5. Some preference for political and/or population decentralization.

6. An extended time horizon - a concern about the long-term future of the world and its life.

7. A sense of urgency regarding the survival of life on earth, both long-term and short-term.

8. A belief that human societies ought to be reestablished on a more sustainable and physical basis. An appreciation that many aspects of our present way of life are fundamentally transitory.

9. A revulsion toward waste in the face of human need (in more extreme forms, this may appear as asceticism).

10. A love of simplicity, although this does not include rejection of technology or "modernity."

11. An aesthetic appreciation for season, setting, climate, and natural materials.

12. A measurement of esteem, including self-esteem and social merit, in terms of such non-material

values as skills, artistry, effort, and integrity.

13. An attraction to autonomy and self-management in human endeavors and, generally, an inclination to more democratic and participatory political processes and administrative structures. (p.145)

All these authors have contributed to the emergence of a new paradigm that Milbrath (1989) called the "New Environmental Paradigm". Its characteristics can be grouped under three main categories, and are summarized in Table 1.

Table 1

Characteristics of the New Environmental Paradigm

Categories	Characteristics
1- Environmental Harmony	- concern for other species - harmony with nature's cycles - synergy with biological processes - recognition of physical and biological limits - extended time horizons - aesthetics
2- Human Beings' Fulfillment	- concern and respect for other human beings, including future generations - community and people orientation - simple ways of living - appreciation of people based on human criteria (love, creativity, etc.), rather than material criteria and social status - informal economies - decentralized economic and social structure - participatory, highly democratic political structure - fair and equitable access to tools of development - education and opportunities that lead to freedom, awareness and empowerment
3- Production Sustainability	- use of local renewable resources - conservation of resources - use of appropriate, human-size technologies - thermodynamically-smart production systems and societal organizations

Within the agricultural milieu, this new paradigm has been the driving force behind the emergence of an alternative, farmer-driven way of farming (National Research Council, 1989). This has been termed "sustainable agriculture", and Hill (1991) defines it most appropriately:

Ecologically sustainable agriculture (ESA) is both a philosophy and a system of farming. It is based on a set of values and visions that reflect an awareness of both ecological and social realities and a level of empowerment that is sufficient to generate responsible action. Efforts to ensure short-term viability are tested against long-term environmental sustainability, and attention to the uniqueness of every operation is considered in relation to ecological and humanistic imperatives, with an awareness of local and global implications. It emphasizes benign designs and management procedures that work with natural processes and cycles to conserve all resources (including beneficial soil organisms and natural pest controls) and minimize waste and environmental damage, prevent problems and promote agroecosystem resilience, self-regulation, evolution, and sustained production for the nourishment and optimal development of all (including rural communities both here and abroad). Special attention is paid to the relationships between soil conditions, food quality and livestock health; and steps are taken to care for livestock in the most humane way

> possible. In practice such systems have tended to avoid the use of synthetically compounded fertilizers, pesticides, growth regulators, and livestock feed additives, and instead rely upon crop rotations, crop residues, animal manures, off-farm organic wastes, mechanical cultivation, and mineral-bearing rocks to maintain soil fertility and productivity, and on natural, cultural and biological controls to manage insects, weeds and other pests. The potential of this approach, however, goes far beyond its present expression, which has largely been limited to the substitution of environmentally benign products and practices. As this new vision of what is ecologically responsible becomes established, significant development can be expected in the science and art of agroecosystem design and management. (p. 216-7)

Ecologically sustainable agriculture has two fundamental characteristics. First it is an approach that views agriculture as a system, comprising three interrelated support systems:

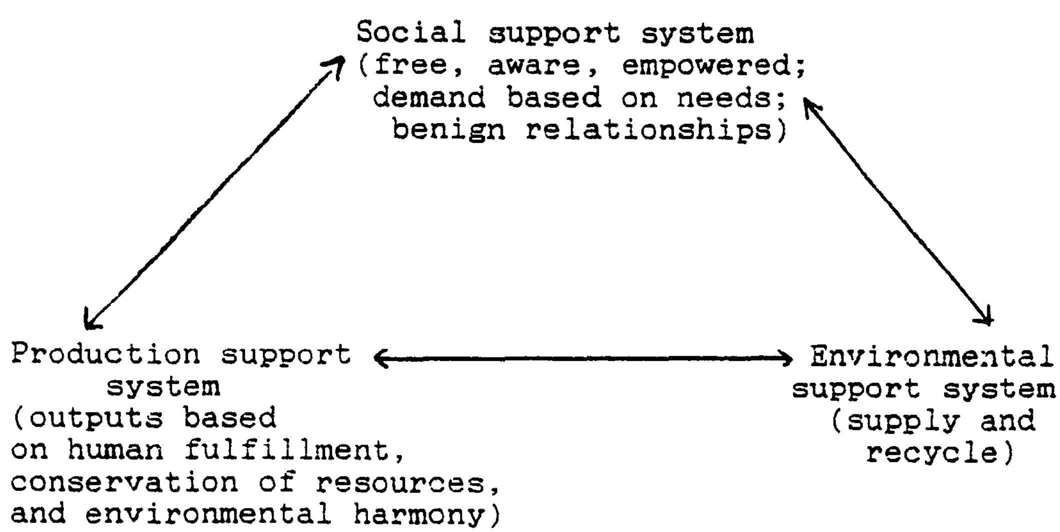
1- An environmental support system that supplies some of the resources and materials for the production and social support system.

2- A social support system in which humans are free, aware and empowered, and relationships are benign; and that is a source of materials and labour for, and a sink of needs for the outputs of, the production support system.

3- A production support system that transforms locally-available renewable resources and materials from the two other support systems into outputs that fulfill the needs of the social support system, and into by-products that the environmental support sytem can easily recycle.

Such a sustainable agricultural system is illustrated in Fig.1.

Figure 1. Sustainable agricultural system (adapted from Hill, 1980, 1985, 1991).



The second fundamental characteristic of sustainable systems is that they are resilient, self-regulating, and evolutionary. As such, they are process-dependent systems. For instance, they are designed to rely on biological processes to maintain soil health, fertility and productivity, to control pests and weeds, and to produce food. Natural processes are also involved to transform energy, and recycle nutrients and water.

It is these two fundamental characteristics (interrelating support systems and processes-dependency) that are at the roots of the sustainability of the food system. The reason for this is that natural and biological processes, and the connection between the support systems (for instance between production outputs and humans real food needs - as opposed to manipulated wants), have built-in limits (Hill, 1980) that provide checks on unlimited growth, resource depletion, and environmental intoxication.

The problem is how do large numbers of people acquire the qualities (free, aware, empowered) that would make them responsive to, and responsible for, the environmental and social well-being of the overall system, and how do they achieve levels of knowledge and competence sufficient to work with natural processes. The answer might be as simple as its implications for research and extension are deep: give them the opportunity to be involved in, and committed to, the transformation of their world.

Thesis organization

This research project is guided by the values and characteristics of the new environmental paradigm. It is an attempt to be consistent with it, and to enhance the implementation of a sustainable agriculture in Quebec.

The thesis is divided into 5 sections:

1. Chapter 1 is the literature review; it is divided in two parts. In the first, it will be argued that the way most knowledge in agriculture and agricultural extension has been generated and transfered is incompatible with sustainable agriculture.

2. In the second part of Chapter 1, an alternative participatory approach is suggested as more appropriate. Reasons for the compatibility of this approach with the development of sustainable agriculture are given.

3. In Chapter 2, the way in which this action research project. which involved both a university research team and a group of farmers, was designed, is explained. The research methods for data collection and analysis are presented, and the question of the validity of the results is addressed.

4. Through the use of participatory extension strategies the project was implemented, and its evolution over a 17-month period is recorded in Chapter 3.

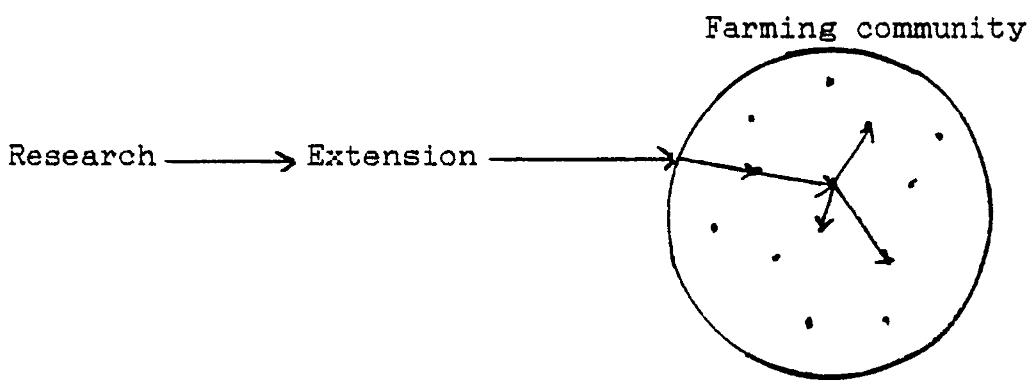
5. In Chapter 4, this evolution is interpreted and its implications for extension are discussed.

CHAPTER 1: LITERATURE REVIEW

Part 1: Current Agricultural Knowledge System: Inadequacy For Sustainable Agriculture

In the current research and extension structure, most agricultural innovations are developed on a research station, passed to an extension department that transfers them down to farmers. This information flow, illustrated in Fig. 2, also represents the current agricultural knowledge system (AKS) (Blum, 1991; Roling, 1985).

Figure 2. Current agricultural knowledge system (adapted from Roling, 1985)



The system is divided into three stages: a) knowledge generation, b) knowledge transfer and c) knowledge use. It will be argued here that this system is incompatible with sustainable agriculture.

Research

Most agricultural research is conducted according to the positivist or quantitative research paradigm.

It is based on five assumptions: a) there is a reality out there that can be taken apart and studied; b) this reality is consistent across time and space; c) observations can be made that are independent, or neutral, to the theories and hypotheses that they will confirm or refute; d) observations can be made that are value-free, and consequently, research findings are objective statements of what is going on in reality, and do not represent the values of the researcher; and e) there is linear causality; everything is cause and effect (Lincoln & Guba, 1985).

Critics of positivism argue persuasively that none of these assumptions carry much weight when placed under scrutiny (Reason & Rowan, 1981; Bogdan & Biklen, 1982; Lincoln & Guba, 1985; Dalhberg, 1986). Reality is context dependent and has meaning only within that context. Reality is more than the sum of its parts. Data are not separable from theory because theory dictates what is data. Also, it is absurd to suggest that observations and findings can be value-free, since the research will inevitably reflect the goals and beliefs of the person or group undertaking the investigation. For instance, if a scientist's goal is to improve farming practices, the research will be biased towards his own definition of improvement (Sriskandarajah et al., 1989).

Thus, positivism is an extremely useful paradigm of inquiry to discover linear relationships, and most probable and generalizable causes of effects. It turns into a very poor approach to improve a system whose behaviour is determined by complex, and unique interactions of all the elements of that system (MacRae et al., 1989). Such is the case for sustainable agricultural systems. Also, sustainable systems rely on natural processes (nutrient, water and organic matter cycling and recycling, balanced insect populations etc.), which vary from one location (a region, a farm, or a field) to the next (Patriquin et al., 1986, 1989; Altieri, 1987; Lampkin, 1990; Madden, 1990). This ecosystem diversity should be reflected in the practices used and management strategies employed, if the integrity of each agro-ecosystem is to be maintained. Generalizable technologies and innovations are replaced, to a large extent, by knowledge of, and harmony with, the specific context in which each farm finds itself.

MacRae (1991) suggests some appropriate actions that political parties, agribusiness and research institutions should take to enhance the development of sustainable agriculture. For the research institutions, his suggestions include (among others): a) to perform new paradigm research and b) to use an agroecological agenda. His thesis is exhaustive. To arrive at his recommendations, he uses Hill's (1985, 1991) Efficiency-Substitution-Redesign framework. The framework is useful to understand the evolutionary process of the transition from conventional to sustainable agriculture, and to evaluate and select strategies for its implementation. MacRae et al. (1990) wrote: "Ideally, efficiency and substitution strategies should be selected for their ability to contribute towards a smooth evolution to the redesign stage." (p.78)

A second aspect of research that is incompatible with sustainable agriculture, is that agricultural innovations and knowledge are produced by too few people, at too few places. Since innovations are necessarily expressions of the whole context in which they were developed, they will be relevant only to farmers with resources, goals, and farm frames similar to those of the research station. Numerous examples from the literature on third world development examine or document the gap separating the research station and the farm (Chambers, 1983; Chambers & Ghildhyal 1985; Dahlberg, 1986; Chambers & Jiggins, 1986; Chambers et al., 1989; Francis & Atta-Krah, 1989; Sumberg & Okali, 1988; Ashby, 1986). Ashby (1982) gives a fascinating account of how the farm ecological make-up and resource compatibility with the technology, lead to its adoption or rejection. She writes " Farmers' adoption behavior appears more or less innovative depending on the suitability of the technology for different types of farm and has an ecological basis". (p.234)

The implementation on-farm of centrally-developed innovations forces the farms to change and adapt to these innovations (Leonard-Barton, 1988). The farms will thereby start to resemble the model for which the innovations were conceived, with its built-in objectives, biaises and consequences.

The problem is that research in agriculture has traditionnally overemphasized production and efficiency, and neglected the social and environmental side of agriculture (Allen, 1990). Heffernan (1986) divided agricultural research into: a) research that reduces the need for labor (e.g., mechanization, automation, etc.), and b) research that increases output by non-human inputs. In both cases, the result is a pressure to decrease the number of people involved in farming, and to increase the amount of capital needed to farm. Socially, this is a recipe for disaster. Since farming could not provide a decent living, people moved out of rural areas, depriving it of its most important resource. Also, the required capital was provided by the urban centers who consequently gained increasing control over agricultural production.

Agricultural research institutions have failed to address the social and political implications of their actions. Altieri (1989) recognized this major flaw when arguing for a new research and developmental paradigm: "Agroecology should deal with technological issues in such a way that these assume their corresponding roles within a political agenda that incorporates social and economic factions in its development strategy" p.38.

Powerful but skewed technologies also permitted the design of farm systems that proved extremely damaging to the environment. Soil erosion and compaction, pollution, destruction of habitats and losses of species, and pest outbreaks (National Research Council, 1989; Gips, 1987; Hill, 1980, 1991), were some of the results of linear farm systems that were designed for production only, and that use non-renewable energy sources, heavy machinery, few crop and animal species, chemicals to control pests and weeds, and inorganic fertilizers to feed plants.

Conventional farming that evolved through scientific research, succeeded mainly in producing cheap and large amounts of food and fiber. However, the list of negative effects is getting quite long

(Table 2) and well recognized.

Table 2

Negative effects of conventional farming practices

(adapted from Hill, 1981; Hodges & Scofield, 1983; Milbrath, 1989)

Degenerating ecosystems	Degenerating social systems
Resources: - soil erosion and degradation - increasing pest, disease, and stress problems in crops and livestocks - destruction of predators and other natural pest controls - massive expenditures on non renewable resources	Rural community: - decreasing numbers of small family farms - rural community stagnation and decline - rural unemployment - increasing rift between rural and urban dwellers - farmers' hopelessness and helplessness - devaluation of popular, contextual, indigenous knowledge - cultural erosion - regional and global inequities
Environmental quality: - resource-base uncertainty - loss of biodiversity/genetic erosion - diminishing wildlife habitats - climatic uncertainties - pollution of air, water, soil, landscapes (e.g., nitrates in drinking water)	Economics: - centralization of resources and markets, i.e., agribusiness taking control - debilitating financial debt - increasing dependence on subsidies and high levels of resource inputs - vulnerability to changes in world markets and natural events
	Health and nutrition: - food quality concerns - exposure to toxic chemicals or residues - poor diets

Changes in the research structure and methods of inquiry are necessary. As long as research in agriculture remains centralized geographically and politically, and as long as it is conducted almost solely according to a restrictive paradigm, it will be incompatible with sustainable agriculture. More participatory, broad-based, and open-minded approaches are required.

Extension

The next step in the model (Fig. 2) is to move innovations to the extension facilities, which then transfers them to the farming community.

Extension is dominated by the adoption-diffusion model of extension (Rogers, 1983; Thomsen, 1985). According to this model, farmers can be categorized into five groups: a) innovators, b) early adopters, c) late adopters, d) laggards, and e) non-adopters. They go through five stages in the adoption process: a) awareness, b) interest, c) evaluation, d) trial, and e) adoption (or non-adoption).

Despite its widespread acceptance and explanatory power, it has recently come under criticism (Duff et al., 1990; Nitsch, 1979). First, it gives a headstart to the farmers who are already ahead, which is unjust at best. Also, it has a pro-innovation bias, making the adoption the "good" behavior and the early adopters the "good" guys. It therefore discriminates against farmers who reject the innovations because their farm structure does not fit the right model (Bennett, 1986).

Research in extension has been concerned with identifying the factors that affect, explain, and predict adoption of new techniques by farmers. It suffers doubly from the characteristics of the quantitative paradigm. First, the researcher carries his/her conception of reality to determine what is important from the outset and goes on to measure it with as much control as possible. And second, the knowledge that it generates will be used, at best, to suggest policies and approaches to influence the behaviour of the very people it studied. Change is therefore seen as something that comes from without, rather than as a dynamic, contextual, and mutually shaping process between man and his world. Paradoxically then, research on behaviour change has prevented change, by replacing this internal process by external incentives, thereby perpetuating a model of outsider control, and insider helplessness (Bennett, 1986)

Erwin and Erwin (1982), for example, divided the adoption of soil conservation practices into three stages: a) perception of an erosion problem, b) decision to use soil conservation practices, and c) soil conservation effort. Their model points out that the adoption of an innovation is a difficult concept to maesure because it takes place over time. They also suggest that four categories (personal, institutional, physical, economical) of factors might influence one or more of the three stages of the decision-making process. Their research was very well done statistically speaking, and most of the factors correlated positively with the dependent variables, even though relatively few were significant at the 0.10 level. Their conclusions, however, are aimed at policy makers, and nothing in the knowledge they produce is very useful to guide the actions of farmers or extension workers in the field.

Hefferman and Green (1986) tried to correlate farm size with soil erosion. They found that soil loss potential was the key independent variable that predicted soil erosion on a farm. But, because land with low soil loss potential is better land to start with, it is owned by large-scale farmers, and consequently, farm size correlates negatively with soil erosion. The authors stated in their conclusion: " Soil erosion, then, is a problem of small-farm agriculture, not capital-intensive agriculture" (p.39). They go on to propose legislation to be applied to the small scale farmers to counterbalance this detrimental situation.

Nowak (1987) attempted to see whether informational or economical factors were more important in predicting the adoption of soil conservation practices. He found, among other things, that " larger operations also had lower quality land,... This is contrary to the findings of Hefferman and Green (1986)" (p.214). Nowak finally concluded that both economics and diffusion factors are important predictors. Also, he remarked that research in the area of adoption of soil conservation practices suffers from unreliable measurements and inability to differentiate between contexts. This is summarized by Duff et al. (1990) in a critical literature review: "Diffusion-based models have been criticized primarily for their lack of comprehensiveness in conceptual approach and inconsistency in research design" (p.20). They also identified four "key elements or steps in the decision-making process..." that are prerequesites to adopting "... a practice, group of practices, or a particular perspective or philosophy" (p.46).

They are: a) an awareness of both the problem and the existence of a potential solution, b) a need to see the problem solved, c) a commitment to find the solution, and d) a capacity to implement the solution.

The problem is that it is unlikely that any research on the factors affecting farmer's behaviour will ever help farmers and their advisors meet these four prerequesites.

In practice, extension's role has been to transfer scientifically-based knowledge to the farming community, via the farmers who were most likely to adopt first, and rapidly. Technology transfer involves linkages between research, extension, and producers, within an infrastructure comprising universities, agribusinesses, governments, and farm organizations (Webster, 1986).

Extension agents have traditionally been considered agricultural experts (Nitsch, 1985; Marchand, 1989), with a mission to enlighten the farming population about the most profitable management practices. These experts play an educational role to upgrade the technical competence of their clients, through the dissemination of relevant information.

There is some serious incompatibility between this transfer of information paradigm, and sustainable agriculture.

First, extension agents are the vehicle by which the dominant farm models (through the innovations) invade the farming community (White, 1978). Extension, then, is open to the same criticisms as research, that of having a much too narrow view of agriculture, and one that over-emphasizes the efficiency and production aspects. Recently, environmental concerns have triggered an interest in farming practices that can conserve resources, and minimize negative environmental impacts, while maintaining yields, and reducing costs. Some examples of this include ridge tilling in cash crops, and Integrated Pest Management (IPM) in vegetables and fruits. Even though it appears nonsensical to criticize practices that are environmentally more benign, and that reduce cost of production, the source of the problem - the design of the system - remains the same. The farm does not integrate harmoniously in its environment. Also, when enough farmers will have adopted these practices, it will drive prices down, and farmers out.

It could be argued that the farmers were the ones that demanded the efficiency model, and that extension and research only responded. Nitsch (1979, 1984), however, shows evidence, based on his own experience and empirical research, that most Swedish farmers see farming as stewarship and a way of life, and make decisions according to a rationality that is quite different from what is normally assumed by advisory service personel. Because it is unlikely that this is unique to Sweden, dividing farmers according to their approach to farming might put some of the so-called laggards and non-adopters into a shining new position.

Secondly, if education should lead to freedom, empowerment and awareness (Freire, 1970), then the transfer of knowledge paradigm is a dismal failure as an educational approach. Agricultural extension has confused development and adoption of innovations. It is unlikely that knowledge about a product, or a technology and its use, will stimulate the developmental process necessary to attain freedom, empowerment and awareness. In fact, the transfer of knowledge approach is more likely to lead to helplessness and dependency.

A parallel can certainly be drawn between extension and education. Referring to the latter, Torbert (1981) wrote: "The reason why neither current practice nor current research helps us to identify and move towards good educational practice is that both are based on a model of reality that emphasizes unilateral control for gaining information from, or having effects on, others." (p.142)

The design and implementation of sustainable farm systems will not be the work of experts, and the results of a transfer of knowledge. Rather, it will be the creation of countless people who have acquired the ability to think critically, and act responsibly, and who do not doubt the importance of the role they have to play in shaping the future. Extension activities and approaches must be such as to encourage responsibility, participation and development.

Summary and Conclusion

In this section, reasons for the incompatibility between the current model of research and extension, and sustainable agriculture, were given.

It was argued that the positivist paradigm that is used in most agricultural research, reduces complex phenomena to a relatively small number of measurable variables. It also generates innovations and technologies that are context-bound and skewed towards production. Therefore, positivism ignores the uniqueness and the complexities of each agro-ecosystem that must be globally accounted for if it is to be sustainable.

Also, the transfer of knowledge paradigm associated with current extension reflects an obsession with the adoption of innovations. Research in extension is concerned with the factors affecting the adoption of innovations. In practice, the technology-focus, whether it emphasizes production efficiency or resource conservation, is much too narrow to develop agriculture as a system. Furthermore, the transfer of knowledge approach is an inadequate educational method that fails to enhance human developmental processes and that, in fact, likely leads to dependency and helplessness.

For these reasons, the current structure of the agricultural knowledge system is compatible neither with the system-, nor the processes-based characteristics of sustainable agriculture. A more appropriate approach is suggested in the next section.

Part 2: An Alternative Model for the Agricultural Knowledge System

From the previous discussion it is evident that sustainable agriculture requires different approaches to research and extension.

Clues as to what the alternative model(s) should look like are provided by various groups who are presently involved in developing sustainable agriculture. For instance, the "Practical Farmers of Iowa" [1] and the " Southwest Wisconsin Farmers Research Network"[2] have undertaken their own research and developed their own innovations. The latter group wrote (June 1988): "The Network has been spawned from a grassroots initiative and is growing across the state in the same manner. While staff can usefully advise and inform Network members about research and policy options, the leadership development of farmers themselves is important to the long-term effectiveness of the project." (p.8).

Closer to home, another group warrants attention. Resource Efficient Agricultural Production (REAP)[3] , is a Quebec-based organisation with, at its core, an

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[1] Practical farmers of Iowa; c/o Rick Exner, Agronomy Hall, Rm 2104; Iowa State University, Ames, IA 50011

[2] Wisconsin Rural Development Center; 1406 Highway 18-151 East; Mount Horeb, WI 53572.

[3] REAP, P.O. Box 125, Ste-Anne de Bellevue, Quebec H9X 1C0.

agricultural scientist, working in collaboration with a dozen farmers. They have accomplished an astonishing amount of research, on-farm, regularly published in their quaterly newsletters (Sustainable Farming).

The striking similarity between these three examples, is that the farmers are central to both research and extension. It is not done for them or on them, but with them and by them. Considering the systemic nature of sustainable agriculture, it is not surprising that its development would have to take place on farm, with farmers, in a collaborative manner. So far, the effort has largely been to adopt scientific methods to produce statistically valid data using farm scale experimental design and machinery (Rzewnicki et al., 1988; REAP, 1989). A good example of this is the side-by-side strip design made popular by the Rodale Research Institute (1990, 1991).

The real potential of this approach, however, goes far beyond producing scientific results, as the literature on participatory research demonstrates.

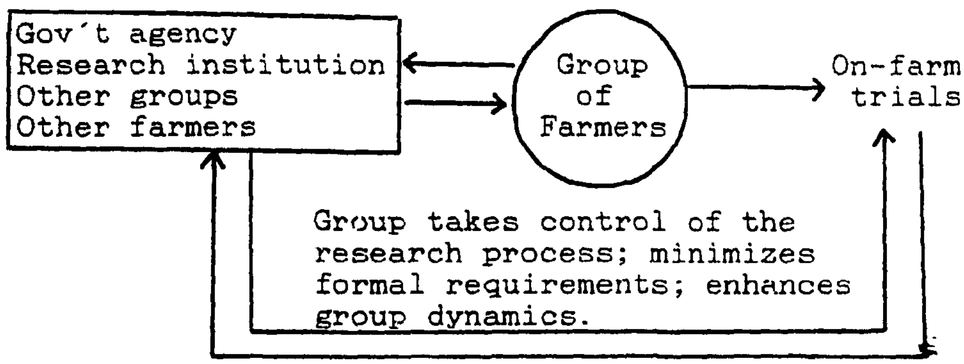
<u>Participatory research</u>

Participatory research is an approach that involves, in the research process, those persons who are to benefit from, or be affected by, the research findings (Hall, 1981). It has taken momentum in third world development efforts, and was triggered by the failure of conventional research and extension to solve the current development and food crisis (Chambers & Jiggins, 1986; Jiggins, 1989). This momentum was enhanced by the realization that local people possess a wealth of knowledge about their environment and an extraordinary ability to innovate in a dynamic and self-directed fashion (Richards, 1985, 1986; Altieri, 1983; Edwards, 1989). This last point is crucial: there is not only people´s knowledge, but also people´s process to generate knowledge. The recognition that indigenous people are veteran experimenters and that their "science" has often generated ecologically and financially sound innovations (Richards, 1985; Colorado, 1989), was a powerful enough argument to convince some "developers" to work collaboratively with local people, and to elaborate new models of development (Molnar, 1988).

The parallels between sustainable agriculture and third world development are too obvious to be ignored: a) diversity of settings, and b) incompatibility with the conventional model of research and extension (ILEIA, 1989). It is a small step to take, to assume that the approach that shows great potential to work for one, might also be tried for the other. Patriquin (1989) wrote: "..."Participatory"... research models arising out of third world research for Resource Poor

Farmers offer a way out of this dilemma, and are highly desirable from an ecological perspective because they deal explicitly with the problem of regional variation" (p.4). His model is shown in Fig. 3.

<u>Figure 3.</u> Participatory research model (adapted from Patriquin, 1989).



In Patriquin's model, the outside agent (scientist or extensionist) becomes a facilitator of the group's research process. The challenge for the agent is to truly encourage farmers to take the initiative and to trust their knowledge and self-interest as an adequate guide for the research process. The concept of learning from farmers (Ashby, 1986; Chambers & Jiggins, 1986; Chambers et al., 1989), requires much from a university-trained expert, and yet this is the basis of the techniques that can serve to enhance farmers' participation in technology development (ILEIA, 1989).

Hoare and Crouch (1988), for example, propose a methodology, centered around farmers-extensionists meetings. The methodology was designed to enhance farmers´ participation in project planning and implementation. It consists of: a) a first meeting with the concerned community to identify the main problems, b) a second meeting to select a series of possible solutions, c) a third meeting to identify the most financially-sound solutions, and d) the measurement of present resource use by different groups of farmers. Conway (1985), has developed a method for the analysis of agroecosystems. It consists of a series of workshops in which participants define their development objectives, analyse the systems in which they evolve, identify problems and solutions, implement the solutions and monitor the results. A focus group session format (Folch-Lyon & Trost, 1981) has also proven to be a powerful tool for in-depth information generation.

Baker et al. (1988), used field meetings at which scientists, extensionists and farmers meet to discuss on-going on-farm experiments. They showed that the meetings increased farmers´ motivation to manage on-farm trials, and lead to greater effectiveness of the technologies being tried.

Kean (1988) also favored discussion as the means to collect farmers´ feedback and input into the research agenda. He starts with surveys as the means of gathering background data, and later selects appropriate technologies to extend to farmers. Because this resulted in poor farmer participation, he expanded his strategy to include a problem identification discussion with the targeted group of farmers. This early direct involvement lead to a much more accurate diagnosis of the farm situation, but also to the identification of key testable questions, and to an increased farmer commitment to the research.

All these approaches are based on respect for the participants´ knowledge and skills, and are consistent in grounding the reflections and the analyses in the participants´ current environment and in gearing their learning towards eventual action. Also, in all cases, it was reported that farmer-scientist cooperation lead to at least one, and often to all, of the following outcomes: it improved understanding between the two groups (Norman et al., 1988), generated commitment, motivation and awareness, stimulated enormous creativity, and yielded farming practices with an important quality: immediate adoptability (Chambers & Ghildyal, 1985). Furthermore, the process of generating self-directed knowledge also brings empowerment and has been a way to confront and positively affect strong and oppressive power structures in North America (Gaventa, 1988).

These outcomes resemble the prerequesites to change identified by Duff et al. (see p. 23 of the present document). They could also be considered prerequesites to the development of sustainable agriculture. They are contrasted in Table 3 with what Hill (1991) suggests are the main factors that limit the adoption of sustainable practices.

Table 3

Contrast between the outcomes of participatory research and Hill's (1991) limiting factors for sustainability

(Adapted from: Baker et al., 1988; Chambers, 1983; Chambers & Ghildyal, 1985; Chambers & Jiggins, 1986; Chambers et al., 1989; Hill, 1991; Jiggins, 1989; Kean, 1988; Norman et al., 1988)

Outcomes of participatory research:	Hill's limiting factors:
Site-specific information	Information
Competence with new farming practices developed on site: ability to conduct own research	Skills; time and site-specific, and for the design of benign systems
Cooperation between farmers and scientists	Institutional support and removal of barriers; use of multifaceted approaches and removal of oppressive and unjust institutions and procedures
Commitment, motivation and creativity	Vision
Awareness	Awareness
Empowerment	Empowerment
	Values

As a research approach, a participatory structure can involve many more people, in many more places, than the conventional approach. This increased diversity has a two-fold advantage from an ecologically sustainable agriculture point of view. First, it can accomodate more diverse, numerous, and situation-specific objectives and biases, and, therefore, it can generate much different knowledge and innovations that respect the integrity of each particular agro-ecosystem. Of course, this is not a guarantee that short-term profit will not be the main driving motive behind the innovations, but it is more likely that different groups, immersed and tied to a specific environment and community, will realize the necessity of maintaining the health of both and act on that realization.

Second, it is also more likely, as the number of sources of knowledge increase, that different ways of inquiry and of discovery will be used. Some of these paradigms, grounded in the reality of the farms, will be more holistic, serving to create the processes and systems-based knowledge necessary for the design of sustainable farm systems.

As an extension approach, the participatory model can help define extension strategies that are truly educational, by recognizing current individual experience and situation, and by seeing learning as the process of transforming that experience and situation. In this case, knowledge is sought, generated, and used to fuel the process of transformation.

In the participatory model, then, the boundaries that define agricultural research, extension, and practice are blurred. Each group, and each participant, is involved at all stages. This is necessary to design site-specific management practices, but also to gain a sense of responsibility over the effects that these practices have on the local and global communities and environment, and to have the ability (freedom, awareness, empowerment, competence) to respond. Consequently, the participatory model is the precondition for, and paradoxically it is also the result of, the implementation of ecologically sustainable agriculture.

Summary and conclusion

Ecologically sustainable agriculture has begun its development in a grassroot fashion. Its viability as an alternative way of farming has attracted the interest of farmers, extension workers, and researchers, who have pursued their work on-farm, in a collaborative fashion.

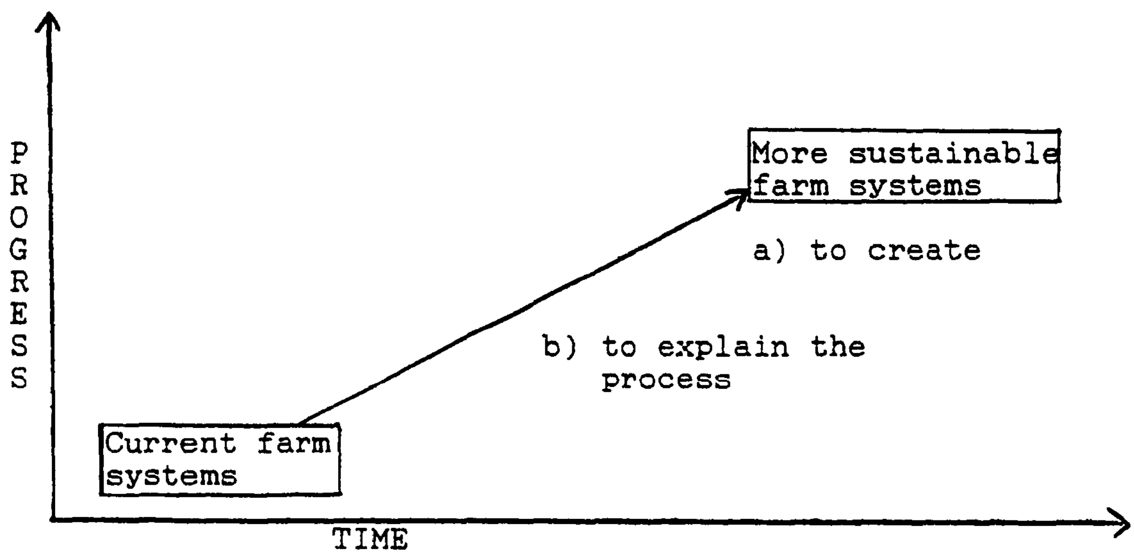
This participatory approach to research has produced an explosion of new knowledge, but more importantly, the process has generated empowerment, awareness, creativity,and commitment in the participants. These outcomes are necessary for consistent and responsible environmental and social actions. For these reasons, the participatory approach might provide a structure in which the new environmental paradigm can flourish.

CHAPTER 2: METHODS

In the previous discussion the necessity of working collaboratively with farmers to develop sustainable farming systems was demonstrated. The purpose of this collaboration is two-fold: a) to create more sustainable farm systems and b) to explain the process by which these systems evolve.

These two goals may be restated as: to improve the situations of the farms, and improve the way the situation is improved (Bawden, 1990). These goals are illustrated in Fig. 4.

Figure 4. Goals of farmers-researchers collaboration



Thus. this is an action-research project in which a research team and a group of farmers participated.

The creation of more sustainable farm systems. - goal a, was appreciated mainly by the field participants. For us (I was one of the participants), it resulted in some new behaviours, reflecting heightened levels of awareness and empowerment. These changes are discussed in Part 1 of the results section.

The explanation of the process - goal b, is presented in Part 2 of the results section. This explanation is the scientific outcome of this thesis. The process was discovered by examining and interpreting the data, which consisted of the chronological description of the activities that took place on-farm, during the course of the project, between January 1990 and May 1991. This description, which appears in Chapter 3, is useful for appreciating both the context of the project, and the activities that were undertaken to create more sustainable farm systems. The analysis of this description allowed patterns of activities to emerge that ultimately outlined the dynamics of the group's process of change. Therefore, the research methods employed consisted of careful observation of an evolving situation, followed by reflection regarding what was observed. The raw data are the activities that took place, and the analysis is their interpretation in terms of their meanings in a process of change.

Choice of a research paradigm

For every investigation, it is necessary to choose the appropriate research paradigm (Guba, 1981; Gage, 1989).

For this project, it was necessary to employ a qualitative research paradigm. According to Lincoln and Guba (1985) the five key assumptions of this paradigm are: "a) realities are multiple, constructed, and holistic; b) knower and known are interactive, inseparable; c) only time- and context-bound working hypotheses (idiographic statements) are possible; d) all entities are in a state of mutual simultaneous shaping, so that it is impossible to distinguish causes and effects, and e) inquiry is value-bound." (p.37)

Because this research was concerned with human behaviour, there were important ethical aspects that guided the choice of approach. These included: a) the participants cannot be studied as objects responding to treatments in an experimental design, and b) my own behaviour is not a dependent variable influenced by some independent variables. Rather, it is a complex reflection of my "background" and my current environment, and is self-directed to achieve desirable ends. It would be impossible to explain my behaviour in mechanistic terms. Since I have no reason to believe that I am different in that respect from anybody else, I chose a method of inquiry that is consistent with this way of thinking.

Validity of the results

Researchers generally are concerned with the external and internal validity of their results (Lecompte and Goetz, 1982). Externally valid results are generalizable to the broader population from which the research sample was drawn. In my case, however, the concern was slightly different. I assumed that the "truth" is context-bound and therefore ungeneralizable. However, by providing ample detail about the settings and interpretations, the results may be transferable to similar contexts, and be a source of questions relevant to different contexts. As Bogdan and Biklen (1982) state: " They therefore concern themselves not with the question of whether their findings are generalizable, but rather with the question of to which other settings and subjects they are generalizable" (p.41). Generalizability translates into transferability (Guba, 1981) in this paradigm.

Internal validity refers to the degree to which the research findings are distorted by variables not accounted for in the research design (Borg & Gall, 1989). For this inquiry, it is a question of whether the description and interpretation given actually represent and explain what happened or are the fruits of my imagination. There are three ways by which I guarded against this threat.

First, a relatively long period of time (17 months) was spent working with the participating group of farmers as an involved participant. This enabled me to acquire a good, if not profound, tacit knowledge of the setting. It also discouraged me from drawing quick, but possibly flawed, conclusions about what I experienced.

Second, I worked as part of a team. Dr. Stuart Hill and Prof. Henri Garino provided ideas and reference materials. Dr. Hill also provided advice on methodology, and suggested a variety of perspectives and frameworks to facilitate my understanding of my interactions with the farmers. Also, Susan Green, a master's student working on the transition to sustainable farm systems (Green, 1991, unpublished thesis) with the same group of farmers, provided constant checks on my observations and interpretations.

Third, by not harbouring any preconceived ideas as to what I might discover regarding the process of farm development, and by acknowledging my own biases and assumptions at the outset of the project, I aimed to not impose a particular agenda on the participants. My role was that of an extension worker employing a participatory approach to work with his "clients", and guided in his actions by the characteristics of the new environmental paradigm. Thus, as an explorer discovering a new country as he travels through it, this project's design and activities emerged as we progressed.

CHAPTER 3: DATA

A chronological description of activities

Introduction

The description that follows covers the period from January 1990 to May 1991. It comprises and summarizes materials from three journals that I kept during the course of the project. These journals were: a) a personal journal, in which I recorded my comments, ideas, and feelings, b) a journal of activities, in which I recorded everything that was done on-farm, such as "farm visits to discuss the seeding rate of green manure", and c) a journal of my notes from the group's workshops and meetings.

The group that was ultimately formed consisted of six farmers and two masters students. In the following description, the term "we" refers to the two students, the term "the group" refers to the farmers and the students, and the term "the research team" refers to the students and our thesis supervisors.

In the description. I have attempted to present, chronologically, the group's activities, and how we performed our role as facilitators of change. I have tried to keep this description clear and accurate. However, it is difficult to convey the intensity of our relationship with the farmers and the honest friendships that developed. Although the description is correct, it does not portray the richness of the reality we encountered.

Also, this project took place within a specific political and social environment, at a specific historical time, and involved people with unique backgrounds. I did not cover these aspects, nor their possible influence within the project. I have briefly described each farm, but I have not tried to quantify any aspect of the farms and farmers.

The following description takes for granted the broader environment in which we find ourselves, and the richness of the relationships that have developed between the farmers and ourselves.

Winter 1990

Our involvement with a group of farmers started in January 1990. Prior to this, however, we had prepared ourselves by reading, meeting resource people, and attending relevant conferences and demonstrations.

In early January, we met with the advisor of the "syndicat de gestion LACONA" to explain the project. A "syndicat de gestion" is a group of farmers who hire a financial advisor. There are a number of these groups in Quebec who are arranged in a "Fédération" within the farmers' Union infrastructure. The syndicat is located in Napierville, South of Montreal, in the agricultural region number 07 of Quebec. We drafted an invitation to farmers to participate in our project for her (the advisor) to send to her members. The study was presented as an on-farm research project focusing on ecologically-sound practices.

On January 30, we held the first meeting in a community center, with the six farmers who responded to our invitation. The meeting proceeded as follows:

1. Introduction to participatory research; Patriquin's

(1989) model was explained.

2. Taking the work of the organisation "REAP" (Resource Efficient Agricultural Production) as an example, and using some of their slides, a small presentation was given on a particular rotation with built-in cover crops and green manures. This elicited much discussion and more questions than we had anticipated.

3. Explanation of our preliminary ideas concerning this project. The project was explained as best we could. At that time, we were not sure ourselves what we were looking for. We were simply driven by the overall goals of the action research. We put, however, three "conditions" to being involved in the project: a) each farmer was to select and carry out some sort of on-farm trial, b) this should involve a technique or a crop that is environmentally sound (or sounder than their present practices), and c) the farmers were to assume the cost and calculated risks associated with the trials. In exchange they would receive specific information, and our cooperation in carrying out experiments and in monitoring certain aspects of their farms.

In early February, we met individually with each of the farmers that attended the meeting, as well as with one more who was interested in participating. The purpose of these meetings was to get to know the farmers a little better, gain an overview of their farm systems, and determine their priorities. We conducted an exploratory farm survey

(Appendix 1).

On February 15, we held our first workshop. It had two parts. First, we gave a presentation on soil organic matter, its importance and behaviour. We also talked about weed management. We prepared a hand-out, and gave each farmer a booklet entitled "La gestion des matières organiques" prepared by the "Centre de Développement d'Agrobiologie du Québec (CDAQ, 224, rue Principale, Ste-Elizabeh-de-Warwick, Qué., JOA 1MO)". These materials were provided in a folder, individually identified with the name of each respective farmer. We also included several articles relevant to their particular farms. Our assumption, which we stated repeatedly, was that each farm was different and required different interventions.

In the second part of the workshop, we put the previous theoretical knowledge into perspective by showing how different management practices and rotations can contribute to organic matter cycling and weed prevention. This generated an animated discussion. I wrote in my notes: "After the presentation, the discussion warmed-up. The group seems to like looking at rotations, analysing them and relating them to what they have tried." At the end of the meeting, the farmers asked us to invite Pierre Jobin from the CDAQ, to talk about ecological agricultural practices in general, at a workshop to be held two weeks later.

Between February 16 and 21, we visited four farmers, including one new one who had asked to join the project, to discuss rotations. We wanted to examine the possibilities of incorporating practices such as green manures, mixed cropping (two crops grown together), cover crops, and mechanical weed control. We met with Roger Samson of REAP and reviewed the rotations of some successful organic farmers from Ontario. We spent a considerable amount of time documenting the farmers present crop mixtures and levels of production, and estimating what they could achieve with an alternative rotation. We began drawing transition matrices (an example is given in Appendix 2). These showed, on paper, what each field would grow over the 3 to 5 year period required to evolve from the current rotation to the preferred one.

On February 23, Pierre Jobin gave a workshop for our group on soil, soil fertility, microbial activity, organic matter management, and alternative farm management strategies. He used many slides and real-farm examples. The discussion became very lively as the presentation proceeded.

We were very pleased with the afternoon, as much because of the information given as for the fact that we had been able to deliver something useful. The farmers commented that we should have planned a whole day rather than just an afternoon.

By March, the emphasis was on action. In collaboration with each farmer, we drew up a possible rotation and transition matrix. We incorporated the use of green manures, mixed cropping, and the amount and place of the manure applications when appropriate. We consulted with a variety of resource people and read a lot, especially the specific files at the resource center of Ecological Agricultural Projects (EAP) at Macdonald Campus of McGill University.

From March 9 to 31, we met once with each farmer. We concentrated on which practices should be tried and in which field. We noted their questions and searched for answers. We also talked with each of them about the design of the experiments. Although we loved these meetings, we were nervous as to the outcomes of the trials. What if the trials did not work; what if their yield dropped? As an answer, I wrote in my personnal journal: " The farmers would not do it if they didn't think it was feasible." We were relying on their knowledge and practical experience to avoid costly errors.

On April 3, we held a workshop on the trials. Six farmers attended. By this time we were all supposed to know the "W5" (who, what when, where, why, and how) of the trials. During the workshop, each farmer explained what he was going to do. A summary of the workshop was later given to each participant (Appendix 3). The main treatments of the trials that were ultimately set-up are listed in Table 4. In most cases the treatments are compared to the regular practice.

As well as providing this summary, we prepared an information factsheet that gave the practical details of the new practices, such as seeding rates and dates, cost of seeds, etc.

Table 4

Summary of the 1990 trials

Trial categories:	Number of farms:
1. Green Manures	
- Oil Radish	5
- White Mustard	3
- Red Clover	1
- Alsike Clover	1
- Buckwheat	1
2. Corn mixed-intercropping	
- Polebeans	2
- Soyabeans	1
- Grass/legumes/grass-legumes mixes	2
3. Fertilization rate	
- Reduced fertilization rate in corn after a hay/clover stand	2
4. Winter cereal survival	
- testing a mix of winter cereals	1
-Testing a spring cereal as a snowcatch	1
5. Mechanical weed control	
- Testing the rotary hoe as a method of weed control in soya	1

This workshop was very lively, with continuous interactions and questions. I noted that some of the ideas presented previously were being reconsidered, and their implications for the other operations of the farm in terms of workload and compatibility, evaluated. For example, one farmer remarked that because he contracts the spreading of his manure, he does not have the flexibility required to use it with the August sown green manures. Also, another participant suggested that polebeans be mixed in corn silage rather than soyabeans, as described by Marting et al. (1987). The original intention was to improve the quality of the silage. This was immediately recognized by the other farmers growing corn silage as a better practice.

Even though eight farmers had been involved up to this point, the group ended up with six committed participants. One of the farmers left because he was in the process of losing his farm, and another had started to show less and less interest as the growing season approached. Among the six who continued, three were dairy farmers, one had a feedlot and two grew cash crops. The farms were very different from one another. A brief description of each is given in Table 5.

Table 5

Farm descriptions 1990 (Note: H= Hay; C= Corn; CS= Corn Silage; S= Sorghum; W= Wheat; WW= Winter Wheat; B= Barley;)

FARM A

Background Information	Prior to 1990
Main production	Cash crops
Cultivated land base	122 ha (39 ha is owned by brother & is needed for hay)
Rotation	Unclear but roughly: H-H-H-C-C-C-W-B-WW
Fertilization	Chemical fertilizer & manure (from brother)
Manure management -storage -application	 Solid manure, no liquid catch 50 to 70 Tons/ha every 5 to 6 years: spread in the fall, usually on the hay and plowed under
Weed management	Chemical (broadcast herbicide) & mechanical (cultivation in corn)

FARM B

Background Information	Prior to 1990
Main production	Cash crops
Cultivated land base	150 ha (10 ha owned, 140 ha rented)
Rotation	Almost monoculture grain corn (130 ha of corn)
Fertilization	Chemical fertilizer (same rate everywhere)
Manure	-----
Weed management	Chemical (broadcast herbicide) & mechanical (cultivation)

cont'd

Table 5 cont'd

FARM C

Background Information	**Prior to 1990**
Main Production	Beef finishing feedlot
Cultivated land base	65.3 ha arable & 28 ha pasture
Rotation	H-H-H-H-C-C-C-C-B
Fertilization	Chemical fertilizer and liquid manure
Manure management -storage -application	 Liquid, under ground reservoir spreading is contracted, 50000 to 70000 l/ha, in the fall, every 4 to 5 years, plowed under
Weed management	Chemical (broadcast herbicide) & mechanical (cultivation in corn)

FARM D

Background Information	**Prior to 1990**
Main production	Dairy
Cultivated land base	86 ha
Rotation	H-H-H-H-C-CS-C-CS-B
Fertilization	Chemical fertilizer & solid manure
Manure management -storage -application	 Piston system, solid manure no liquid catch 50 to 60 Tons/ ha, in the fall, on the hay, every 3 to 4 years, plowed under
Weed management	Chemical (broadcast herbicide)

cont'd

Table 5 cont'd

FARM E

Background Information	Prior to 1990
Main production	Dairy
Cultivated land base	83 ha
Rotation	H-H-H-H-C-C-C-C
Fertilization	Chemical (broadcast herbicide) & solid and liquid manure
Manure management -storage -application	 Chain & elevator, solid manure, earthen catch for liquids Spread in the fall, where possible, quantities undetermined
Weed management	Chemical (broadcast herbicide)

FARM F

Background Information	Prior to 1990
Main Production	Dairy
Cultivated land base	122 ha
Rotation	H-H-H-C-C-C-(S1/2 +C1/2)
Fertilization	Chemical fertilizer & liquid manure
Manure Management -storage -application	 Liquid, outdoor reservoir On sorghum in the spring, on corn in the fall, 50000 to 80000 l/ha
Weed management	Chemical (broadcast herbicide) & mechanical (cultivation in corn)

Summer 1990

In May, the trials were set-up by the farmers. They essentially took control of the research process, the choice of treatments and the "experimental" design. The designs were informal, and can be grouped into three broad categories: a) Two side-by-side unreplicated treatments of various sizes, b) two treatments and a control, set-up in side-by-side strips and replicated twice, and c) the outright adoption of the "treatment", i.e., tried in one whole field. Also, we superimposed, where appropriate, three more formal (replicated three times) trials. The first tested hairy vetch as a green manure in barley. It was a simple experiment, in which the vetch was broadcast into growing barley at 25 kg/ha, and compared to a control. The plots were two by three meters, and the results (effects on weeds and barley yields, and biomass of vetch present in the fall) were evaluated "by eye" with the farmer, i.e., no precise measurements were taken.

The second trial tested winter rye as a weed control strategy in soya. In this experiment, winter rye was seeded at 26 kg/ha on two different dates (26th of May, and sixth of June),and compared to a control. The plots were three by five meters. This trial was abandoned because some of the plots were mistakenly sprayed with herbicide.

The third trial tested the effects of different seeding rates of polebeans on the yield and protein content of corn silage. Five polebeans rates were used. The plots were ten meters long by ten rows wide. The results are shown in

Appendix 6.

From May until early winter, we spent a significant amount of time on-farm discussing and observing the plots. In May, we worked on the design of worksheets to calculate nutrient budgets. We wanted to prepare something that the farmers could use easily. We consulted with the expertise available through the CDAQ, REAP and EAP. I started to participate in the meetings of the "conseillers de club d'encadrement technique" in Warwick. In June, I attended a course on on-farm soil evaluation with Claude Bourguignon (a French microbiologist; Laboratoire Analyse Microbiologique des Sols, Marey-Sur-Tille, 21120 Is-Sur-Tille, France). In August, using Bourguignon's approach (Bourguignon, 1990), we evaluated the soil of one field on each farm. We also took one soil sample from every field in which a trial was conducted, and interpreted the results of the analyses with and for the farmers. The samples were sent to the "Ministère de l'Agriculture, des Pecheries, et de l'alimentation du Québec" (MAPAQ). Each analysis revealed: a) the pH, b) the organic matter content, c) the levels of P and K, d) the CEC, and e) the ratio of base saturation and the total saturation. I remarked in my personnal journal that I had never learned so much and so fast.

On-farm, we observed the evolution of the trials. By the end of the summer we had started sampling and collecting data, and had results of the tissue, soil and manure analyses. We discussed the results with the farmers, and exchanged our respective interpretations. The journal of activities contains many entries such as:

Beef farm

"07-07-90
Farm visit. Farmer C was seeding a strip of hairy vetch and raygrass into corn in field 2B. Would have done bigger if had more seeds. The corn is perhaps too high already to be interseeded - above knee level. Cultivated once. Polebeans in large part of the field are yellow and suffering from last year's atrazine residues. Few weeds except on top of the hill by the road...

18-07-90
Field visit. Soya in corn, no nodules. Corn looks a bit lower in this field, but no difference between the control and the treatment. He said there were nodules in the polebeans. Some that were touched by the herbicide are yellow and stunted, but the rest of the field looks good.....

23-07-90
CDAQ farm visits (Bill Murphy in Vermont) - intensive pasture management/rotational grazing. HM very interested in finishing steers on pasture. Problem is the stabilization insurance, he might be cut because they don't count cattle on pasture....."

Cash crop farm

"06-06-90
Seeded in an extra square meter of rye into subplots. Farmer B has not yet rotary hoed in soya; ground is now moist and some weeds have already reached the 2-4 leaf stages, so it's getting late (!). The soya has come up unevenly.

08-06-90
We took corn plants samples from field #19 and brought them to Macdonald for drying. Took 10 samples from each fertilization treatment.

09-06-90
Farm visit. Early this morning Farmer B had passed the rotary hoe. Doesn't seem to have disturbed the soya, but many weeds are also intact ! They are too high and this rain won't help. He didn't hoe the entire field and there are many weeds, so we are not sure how this is going to turn out..."

Throughout the summer the group also participated in or conducted other activities. For instance, we organized a demonstration of mechanical weed control in cereal. We went, with two members of our group, on a three-day tour of some successful organic and bio-dynamic farms in Ontario. The tour, which was organized by the CDAQ, attracted a busload of farmers from different parts of the province. We also visited Bill Murphy's farm in Vermont.

We also discovered that the MAPAQ had put together a number of programs to encourage the adoption of "environmentally-sound" management practices. One such program was on green manures, and two farmers in our group succeeded in getting a small financial incentive for their efforts. Within the next few months we applied to many of these programs. This is discussed in more detail later.

Fall 1990

Between September and December, we wrote a paper, for academic credits, called "Farming Systems Sustainability - Evaluation and Monitoring: An On-Farm Guidebook" (Nault & Green, 1990). It was an up-dated version of the nutrient budget worksheets that we had done in May, but that we found impractical and too complicated. The paper integrated what we had learned during the summer. Later, this new version was summarized, presented in a workshop in February, and finally transformed into a small Lotus program to calculate field by field nutrient requirements (Appendix 4) and overall farm nutrient budgets (Appendix 5). We used it the following winter to evaluate the fertilization needs of the farms.

The major event of the fall was a demonstration day organized by the group on green manures and corn intercrops. It took place on three farms, and more than 30 people attended. We also made a small video with the help of a consultant (Paul Gaudet, 66 rue Pontiac, Bromont, Qué., J0E 1L0), on green manures and on the corn and polebeans mix. This was presented to another group of farmers from Granby in November.

On December 6, we organized the last workshop of 1990, at which we presented some of the results of the trials (Appendix 6). The farmers who attended added their own observations, and even commented on the financial aspects of some of the practices. Also, we invited other farmers from the region because I wanted to launch the idea of forming a "Club d'encadrement technique". A club is a group of farmers who hire a technical advisor through a government program. The farmers and the MAPA share the cost of the advisor's salary. Only four farmers showed-up, but they all agreed to form a club. The workshop was relatively quiet. In my personal journal I noted my disapointment and questioned the use of group meetings to reach people from the larger farming community.

By the end of December, however, I concluded that this year had been one of the most rewarding of my life.

Winter 1991

In early January, I went to each farmer and individually received their commitment to join a club. Three other farmers who had heard about the club also asked to join. One was a dairy farmer and the other two operated cash crop farms. We were now a group of nine farmers with a name, and throughout the winter we wrote a number of project proposals and sent them to the different government programs for funding. A list of these proposals is provided in Table 6.

Table 6

The group's project proposals

Name of program	Number of projects submitted	Date of Appli - cation	Outcome
Club d'Encadrement technique (MAPAQ)	1 (Club formation)	January 1991	Accepted in May 1991
Promotion de la conservation des sols (Canada-Quebec entente)	3 (Creation of educa - tional material for farmers)	November 1990	All refused in February 1991
Recherche à contrat; entente auxiliaire Canada-Québec sur le développement agro-alimentaire	1 (research project on weed control with REAP)	January 1991	Refused in March 1991
Introduction de nouvelles technologies à la ferme (MAPA)	6 (on-farm demons - trations)	March 1991	3 were accepted and 3 refused in June 1991
Innovation technologique en agriculture (MAPA)	2 (On-farm evaluation of innova-tions	March 1991	All refused in May 1991

Applying to any of these programs requires considerable dedication and effort. Farmers often commented that "what you get out of it is hardly worth the effort you put into it." They were critical, and almost bitter, towards some programs that "are really made to help engineers and consulting firms." Mostly, we found the process frustrating for three reasons: a) these programs seemed to be parachuted down, and the farm has to adjust to them rather than the other way around. and b) we had to delay all decisions that were related to the project until we received an answer. Consequently, when a project concerned the cropping system. and was under consideration when it was time to plan the growing season, we were somewhat paralysed. Usually, we proceeded as if we would not be funded. Finally c) the fieldstaff did not know anymore about the programs than we did. It was impossible, therefore, to receive straight answers the first time around.

On February 6, we held a workshop on soil fertility, fertilization, and nutrient cycling on farm. The farm was presented as a system with a cyclical nutrient flow. The main sites of nutrient losses and gains were highlighted. Also, it was emphasized that each crop requires a certain amount of nutrients that can be supplied by a) the recycling of nutrients on farm, b) the inherent fertility of the soil, and c) externally purchased inputs. Improvement of the farm system could therefore be achieved through strategies that minimize losses and conserve nutrients.

On March 6, most of the group attended a conference on organic agriculture entitled "Où en est l'agriculture biologique au Québec". It took place in Victoriaville, and was organized by the CDAQ. The presentations that generated the most interest among the group were on manure management, which had become a major concern for most of the farmers.

In March we met each farmer individually to plan appropriate crop rotations. We also established, with most of them, a fertilization program for the summer of 1991, and we planned the up-coming trials. Many decisions were made during that time concerning the implementation of the new rotations. manure management practices, and other related adjustments.

On April 16, we held a workshop on the trials. It was straightforward because all of the participants knew what they were looking for. Some of the trials were repeats of the previous year, but they were backed up by the provision of more accurate technical information. For example, we noted that the fall brassica green manures must be seeded before August 20 to produce reasonnable amount of biomass. Other trials were follow-ups, such as the ones on the fertilization rate in corn after oil radish as a green manure. Some trials were new, such as the composting of feedmill wastes. The 1991 trials are summarized in Table 7.

In May, three other cash crop farmers joined the club, which now consisted of 12 members. By then, the group had gained a reputation in the area as being progressive, and I was even forced to refuse some interested farmers because I did not have time to work with any more of them and write a thesis at the same time.

Also in May, the trials were set-up and some new rotations were implemented. We wrote a one page description of on-farm nutrient cycling and described the relationships between soil conditions and crop productivity. This served as a guide for our on-farm evaluation and monitoring program which at this point consisted of five items: a) MAPAQ soil analysis, b) soil profiles, c) weed surveying, d) evaluation of crop yields. These four types of records are to be performed on three fields on each farm. These fields will be chosen because they are representative of the whole farm. Finally e) overall farm nutrient budget (Appendix 5).

Other activities that were planned for the summer 1991 included: a) demonstrations of mechanical weed control in soya, of green manures, and of rotational grazing for beef, b) visits to organic farms in Quebec, and c) attending demonstrations organized by other groups such as the CDAQ.

Table 7

Summary of the 1991 trials

Trial categories:	Number of farms:
1. Green Manures	
- Oil Radish	6
- White Mustard	6
- Red Clover	2
- Alsike and red clover mix	1
2. Corn mixed-intercropping	
- Polebeans	2
- Soyabeans	0
- Grass/legumes/grass-legumes mixes	5
3. Fertilization rate	
- Reduced fertilization rate in corn after a green manure	5
- Reduced fertilization rate in corn after a plowdown of hay with or without manure	3
- 0 Nitrogen fertilization in soya	2
4. Mechanical and cultural weed control	
- Rotary hoe vs finger weeder vs Rabewerk in soya	1
- finger weeder in corn and cereal	1
- Delayed planting and cultivation in corn	3

cont'd

Table 7 cont'd

5. Compost	
- composting of farm yard manure with different amounts of straw or different handling methods	2
- composting of feedmill waste products with different amounts and types of fibrous materials mixed in	2
6. Winter cereal survival	
- Testing a mix of winter cereals	1
- Testing a spring cereal and/or canola	2
7. Use of organic product	
- testing the crop enhancement properties of an organic product made recently available on the market	2

CHAPTER 4: RESULTS AND DISCUSSION

Part 1: Results

Introduction

In this section, two sets of results are presented. They correspond to the two original goals of this action research: a) to create more sustainable farm systems, and b) to explain the process by which these systems evolve.

In the first part of this section, changes in management practices at the farm level, and changes in the knowledge, skills, and perspective of the participants are listed. This is to show that the approach taken, and the activities pursued and described in the previous chapter, were effective in creating more sustainable farm systems.

In the second part, the process by which these changes took place is explained. The process was discovered first by observing recurrent patterns of activities. These patterns were then categorized according to the stages of the group's process of change.

Creation of more sustainable farm systems

Six characteristics were used to describe the six farms at the start of the experiments (Table 5). In June 1991, similar information was again recorded, and this is compared with the pre-experiment condition in Table 8.

Table 8

Farm descriptions 1991 (Note: H= Hay; C= Corn; CS= Corn Silage; S= Sorghum; Ce= cereal; WCe= Winter cereal; W= Wheat; WW= Winter Wheat; B= Barley; SB= Soyabean)

FARM A

Background Information	Prior to 1990	As of June 1991
Main production	Cash crops	Cash crops
Cultivated land base	122 ha (39 ha is owned by brother & is needed for hay)	155 ha
Rotation	Unclear but roughly: H-H-H-C-C-C-W-B-WW	Adoption of two rotations: 1- H-H-H-2(C-SB-WW); 2- H-H-H- 5 to 6 years of cereals-legumes
Fertilization	Chemical fertilizer & manure (from brother)	Reduced chemical fertilizer (based on nutrient budgets) & manure & green manure
Manure management -storage -application	Solid manure, no liquid catch 50 to 70 Tons/ha every 5 to 6 years; spread in the fall, usually on the hay and plowed under	Same 25 to 50 Tons/ha every 3 to 4 years; spread on the green manure, incorporated superficially
Weed management	Chemical (broadcast herbicide) & mechanical (cultivation in corn)	Chemical (broadcast herbicide according to need); mechanical (cultivation in corn, soya and cereals); cultural (through rotations and soil fertility)

cont'd

Table 8 cont'd

FARM B

Background Information	**Prior to 1990**	**As of June 1991**
Main production	Cash crops	Cash crops
Cultivated land base	150 ha (10 ha owned, 140 ha rented)	Same
Rotation	Almost monoculture grain corn (130 ha of corn)	Adoption of two rotations: 1- (on 10 ha) C-SB-Ce + green manure of clover-C-SB-Ce-H-H, and 2- Started C-SB
Fertilization	Chemical fertilizer (same rate every where)	Chemical fertilizer (varying rates) & green manure & compost of feedmill wastes
Manure	-----	-----
Weed management	Chemical (broadcast herbicide) & mechanical (cultivation)	Chemical (herbicide banding in corn) & mechanical (cultivation in corn and soya) & cultural (rotations)

cont'd

Table 8

FARM C

Background Information	Prior to 1990	As of June 1991
Main Production	Beef finishing feedlot	Same
Cultivated land base	65.3 ha arable & 28 ha pasture	Same
Rotation	H-H-H-H-C-C-C-C-B	H-H-WCe+green manure-CS-Ce; Rotational grazing on the pasture lands
Fertilization	Chemical fertilizer and liquid manure	Use of chemical fertilizer only when necessary (decision based on nutrient budgets & knowledge of the field); manure & green manure
Manure management		
-storage	liquid, under ground reservoir	Same (plans for aeration)
-application	spreading is contracted, 50000 to 70000 litres/ha, in the fall, every 4 to 5 years, plowed under	same except 20000 to 40000 litres/ha, on the green manure in the summer, incorporated superficially
Weed management	Chemical (broadcast herbicide) & mechanical (cultivation in corn)	Mechanical (cultivation in corn) & cultural (rotations, mixed cropping with corn and soil fertility)

cont'd

Table 8 cont'd

FARM D

Background Information	Prior to 1990	As of June 1991
Main production	Dairy	Same
Cultivated land base	86 ha	65 ha
Rotation	H-H-H-H-C-CS-C-CS-Ce	H-H-H-CS-Ce+green manure-CS-Ce
Fertilization	Chemical fertilizer & solid manure	Reduced chemical fertilizer & manure & green manure
Manure management -storage -application	Piston system, solid manure no liquid Tons/ ha, in the fall, on the hay, every 3 to 4 years, plowed under	Same
Weed management	Chemical (broadcast herbicide)	Chemical (broadcast herbicide) & mechanical (cultivation in corn) & cultural (rotations and mixed cropping in corn)

cont'd

Table 8 cont'd

FARM E

Background Information	**Prior to 1990**	**As of June 1991**
Main production	Dairy	Same
Cultivated land base	83 ha	35 ha
Rotation	H-H-H-H-C-C-C-C	H-H-H-WCe+green manure
Fertilization	Chemical (broadcast herbicide) & solid and liquid manure	Use of chemical fertilizer according to needs only; manure & green manure
Manure management		
-storage	Chain & elevator, solid manure, earthen catch for liquids	Same, except more straw in the barn to eventually make compost with the solid part
-application	Spread in the fall, where possible, quantities undetermined plowed under	Mostly applied onto the green manure, incorporated superficially; some on the hay between cuts
Weed management	Chemical (broadcast herbicide)	Chemical (broadcast herbicide according to needs) & cultural (rotation)

cont'd

Table 8 cont'd

FARM F

Background Information	Prior to 1990	As of June 1991
Main Production	Dairy	Same
Cultivated land base	122 ha	Same
Rotation	H-H-H-C-C-C-(S1/2 +C1/2)	H-H-H-1/2C+1/2S-Ce+green manure-C; planning rotational grazing for dry cows and heiffers
Fertilization	Chemical fertilizer & liquid manure	Reduced use of chemical fertilizer; manure & green manure
Manure Management		
-storage	Liquid, outdoor reservoir	Same except planning manure aeration:
-application	On sorghum in the spring, on corn in the fall, 50000 to 80000 litres/ha	On sorghum in the spring, on the green manure in the summer, 25000 to 45000 litres/ha
Weed management	Chemical (broadcast herbicide) & mechanical (cultivation in corn)	Chemical according to needs; mechanical (cultivation in corn); cultural (rotation, mixed cropping in corn, and soil fertility)

Changes are evident in most categories and on all the farms. These changes will encourage the farm's evolution toward sustainability, because the new practices tend to enhance natural processes and cycles, through rotations, increased soil cover, improved manure use and composting, and green manures. Also, mechanical and cultural approaches to weed management have been incorporated, and a more rational use of chemical herbicides and fertilizers is being adopted.

The use of these alternative management practices implies changes at the personal level also. These changes can be divided into three main categories: a) knowledge acquisition, whereby our improved understanding of the agroecosystem allowed us to choose appropriate practices, b) skills acquisition, whereby we acquired the ability to effectively use and generate these appropriate practices, and to design and manage more benign systems, and c) perspective transformation, whereby our attitudes and values evolved towards an environmental paradigm.

These personal changes are prerequesites to sustainable agriculture because they provide the knowledge to choose, the skills to act, and the perspective to evaluate alternatives, and, consequently, to think and act with ecological responsibility and consistency.

The farm-level managerial changes presented above provide signs that personal changes from all three categories have also taken place. Evidence of this is provided in Table 9, where comments made by the participants are listed. These were spontaneous comments that were recorded in the journal of activities.

Table 9

Farmers' paraphrased comments showing three types of personal changes

1- Knowledge Acquisition

Farm A: I learned that there is life in the soil and how important it is. I understand better some of the principles of organic farming. I am starting to see the relationship between the different aspects of the soil and the role that manure can play.

Farm B: I know how to read a soil analysis. It is good to calculate an overall farm nutrient budget. It makes you realize how to rationalize the fertilizer use.

Farm C: I can see how the new rotation will enhance the productivity of my soil, and provide some weed control as well. The green manures allow me to use my manure more effectively. I feel I am hitting two birds with one stone.

Farm D: I am proving to myself that ecological practices can work. Also, I was surprised to see how well the white mustard competed with the quackgrass. The most frustrating thing now, is I know that I am not using the full potential of my manure.

Farm E: I have enough fertility coming into the farm through the purchase of feed, to cover all my crop nutrient requirements. I have to find a way to store separately my liquid and solid manure.

Farm F: I can see that it makes much more sense to use the green manure and apply the liquid manure on it, than to put the slurry on the fields in late fall. We are planning now to aerate the slurry so as to reduce its toxicity for soil microbial activity.

2- Skills Acquisition

Farm A: I am more careful in the design of my experiments. I pay more attention to what goes on in the field.

Farm B: (Comments made during a demonstration on mechanical weed control in soya that this farmer hosted) The rotary hoe works only if you can catch the weeds at a very early stage. You have only a short period of time when it is effective, and the weather can really spoil it for you.

Farm C: It was useful to see how other farmers are managing their farms without herbicides or fertilizers. I knew I could get away without the herbicide but I was not sure about the fertilizer.

Farm D: I can manage my farm to produce more protein. In fact, besides the polebeans in the corn silage, I am going to experiment with lupine.

Farm E: I am moving towards a rotation with hay, winter cereals and green manure. This way, I should have the straw for the composting of the solid manure.

Farm F: With the price of grain corn, it is worth it to incorporate the cereal and the green manure in our system. The brassicas, however, do not work with oats.

3- Perspective Transformation

Farm A: We have to learn to live in harmony with nature rather than exploit it.

Farm B: I am concerned about pollution and soil conservation, but because of the expansion of the nearby town, I use the land mostly to my financial advantage.

Farm C: I would like to see a more harmonious relationship between man and nature.
I am more confident in what I am doing and I don t care so much what the neighbours are thinking anymore.

Farm D: I can be more self-reliant.
Ecological agriculture is raising our awareness of nature.

Farm E: I want the farm to look good. I am planting windbreaks and a small sugar bush. The trees are not for me, but for the next generation. The aesthetics of the countryside are very important.

Farm F: We are moving towards a more environmentally-friendly agriculture. We owe it to the environment and the future generations.

In the next section, the process by which these managerial and personal developments have taken place is described. The potential of the participatory approach to enhance such changes, as well as its compatibility with the development of a sustainable agriculture are demonstrated.

I have written the next section in such a way that the reader may understand how the model unfolded for me. This way, the reader can follow my thoughts, and understand not just the actual interpretation of the events, but also how I arrived at this interpretion.

Explanation of the process of change

The main events that took place in the field are summarized in Table 10. It was possible to divide these activities into two main categories, "theory" and "practice", which, I repeatedly noticed, cyclically fed into one another. I noticed that this pattern is also evident in this thesis (descriptions and interpretations).

These broad categories were further divided into a number of stages. The first of these stages happened at the beginning of each year. Both in January 1990 and 1991, we discussed, in a workshop, a rather general view of the farm. In 1990, we focused on rotations in general, and in 1991, on the nutrient cycles on farm. I tentatively called this sub-category "General system's description".

After that, both in the workshops and in individual meetings, came a period of discussions that went from the general to the particular (seeding rates and dates, quantity to apply etc.). This happened in both years. I tentatively called this period "exchange".

Following the exchange stage, the trials were set-up. This was a very active time, particularly in 1990, when three types of activities took place. These were: a) the trial set-up and follow-up, b) participation in farm tours and demonstration days, and c) soil evaluations. Originally, however, I referred to this complex stage simply as "trial".

These emergent patterns are displayed in Fig. 4.

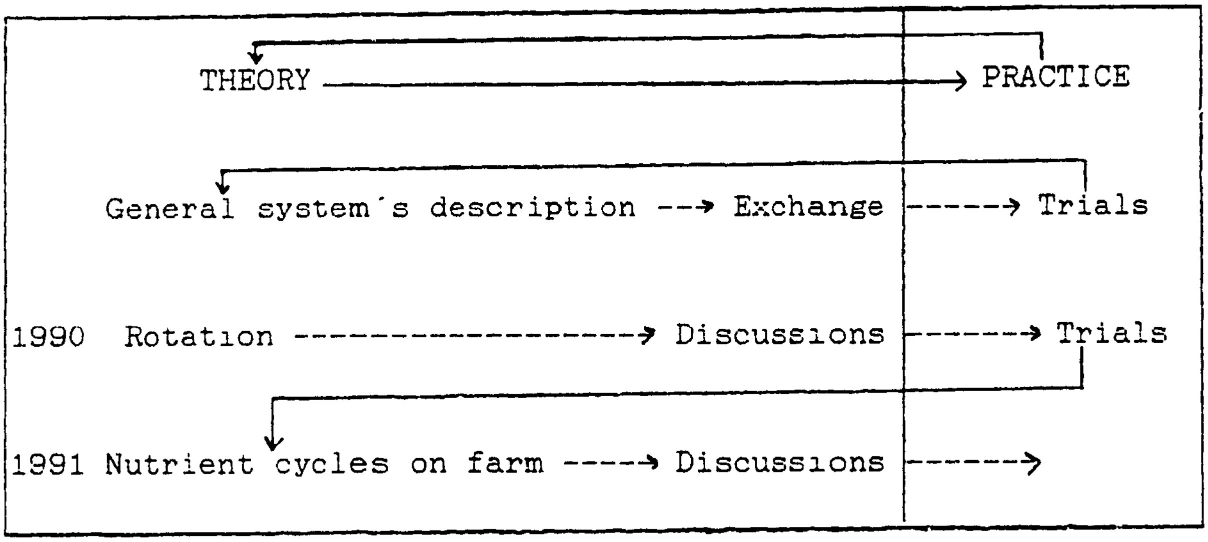
Table 10

Summary of events

TIME

January to February 1990	Meeting with the "syndicat de gestion's" advisor	Introduction with farmers; (theory).	First group workshop; general concepts of soil fertility and weed control; (theory).
February to April 1990	Individual farm visits: overall rotations; (theory).	Second workshop: broad information; (theory).	Individual farm visits; rotations and associated practices; third workshop, trials preparation: (theory).
May to December 1990	Trial set-up and follow-up; information fact sheets; nutrient worksheets; (practice).	Soil evaluation; farm tours and demonstrations (practice).	Fourth workshop: trial evaluation; club formation: (practice).
January to April 1991	Fifth workshop: nutrient cycling and soil fertility; (theory)	Application to government programs and attendance to organic farming conference.	Individual meetings; sixth workshop; rotations, fertilization programs and trial preparation; (interface theory and practice)
May to Summer 1991 (planned)	Trial set-up and follow-up; (practical)	Farm and soil evaluation and monitoring; (practical).	Farm visits and demonstrations (practical).

Figure 5. Emergent patterns of activities



Each of these steps builds a momentum for the next, revealing, thereby, the existence of a dynamic process. These categories began to emerge in early 1991. My thoughts at that point were influenced by Kolb's (1984) theory on experiential learning, Fritz' (1989) on creativity, Savory's (1988) on holistic resource management, and most of all by Paulo Freire's (1970) "pedagogy of the oppressed".

By April 1991 I had written the first draft of the description of the activities, and new stages and details became apparent. I was then able to break the whole period into eight recognizable stages. These are described below.

Stages of the process

Stage 1: Preparation. The first stage is the "preparation" that precedes the actual project. This took place between May and December 1989. It was a time when we scanned the literature, met people, and visited farms to build-up a background of knowledge on organic farming.

Stage 2: Gaining access. The advisor of the "syndicat de gestion" facilitated our access to the farms. She sent out our invitation to the farmers and helped us obtain a room for the first meeting.

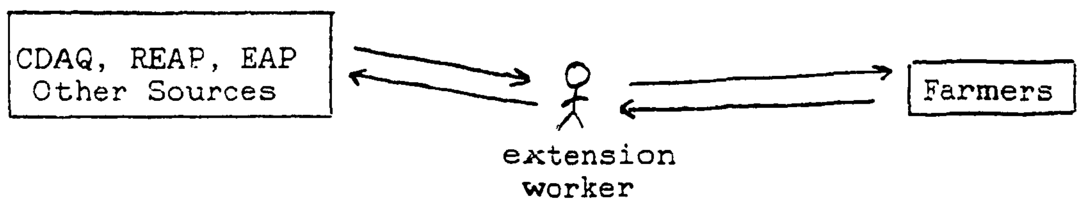
Stage 3: General system's description. This stage includes the first group meeting, at which the project was presented, and the first individual meetings, when we attempted to obtain an overview of each farm.

Our work was presented as a farm improvement project, through the use of "better" rotations and associated farming practices (green manures, cover crops, etc.).

Stage 4: Convergence. This stage took place between the first workshop on February 15 and the end of April 1990. I originally had called this the "exchange" stage. In this stage, the information traveled back and forth between us and the farmers. This stage is similar to what Blackburn (1989) calls the "convergence model". In this model, the extension worker and the farmer share their understanding and interpretation of a new farming practice until "they achieve convergence, a level of mutual understanding that is sufficiently congruent to allow action to be taken" (p.110).

Most of the information that we shared was gathered during the preparation stage and from our readings and consultations with expertise in REAP, CDAQ and EAP. At the end of this stage, the farmers had decided what they were going to try, and they had enough information to do it. This stage is illustrated in Figure 6.

Figure 6. Convergence



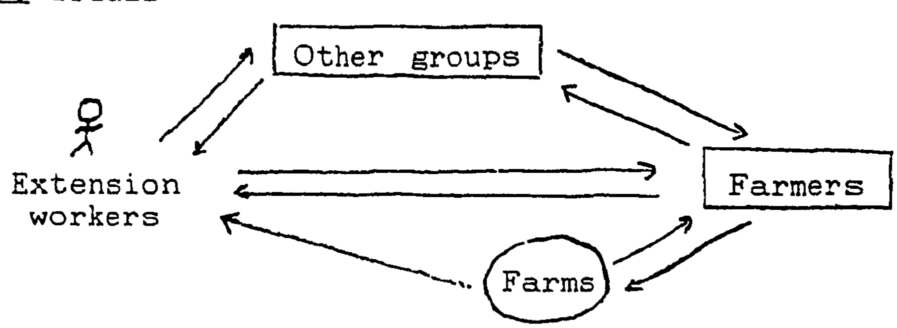
Stage 5: Trials. This stage took place between May and December 1990. It started with the establishment of the trials, and ended with a workshop on trial evaluation. Three types of activities took place during this period:

- First, there was trial establishment and follow-up.

- Second, there was a series of "extra-curricular" activities: demonstrations and farm tours organized by the group or others. This was a hands-on stage. We were consolidating the trials with new ideas and new knowledge from a number of sources.

- Third, was the monitoring and evaluation of the farms, which consisted mainly of performing the Bourguignon's soil evaluation technique. This stage is presented in Fig. 7.

Figure 7. Trials



Up to this point, my concern had been focused on conducting participatory research, with an emphasis on deciding what to try, and on the setting-up of the test plots. At the end of 1990, the group decided to form a club, and the farmers agreed to contribute towards a salary for the advisor. As such, all participants became involved in much more than simply a university project; and it changed the focus from on-farm participatory research, to participatory farm development.

Stage 6: General system's description. The main feature of this stage was the workshop in February 1991, at which the farm system was described as a unit through which nutrients cycle. From then on, our efforts to improve the farms were directed not only towards an improved rotation, but also to the enhancement of on-farm nutrient cycling and elimination of losses.

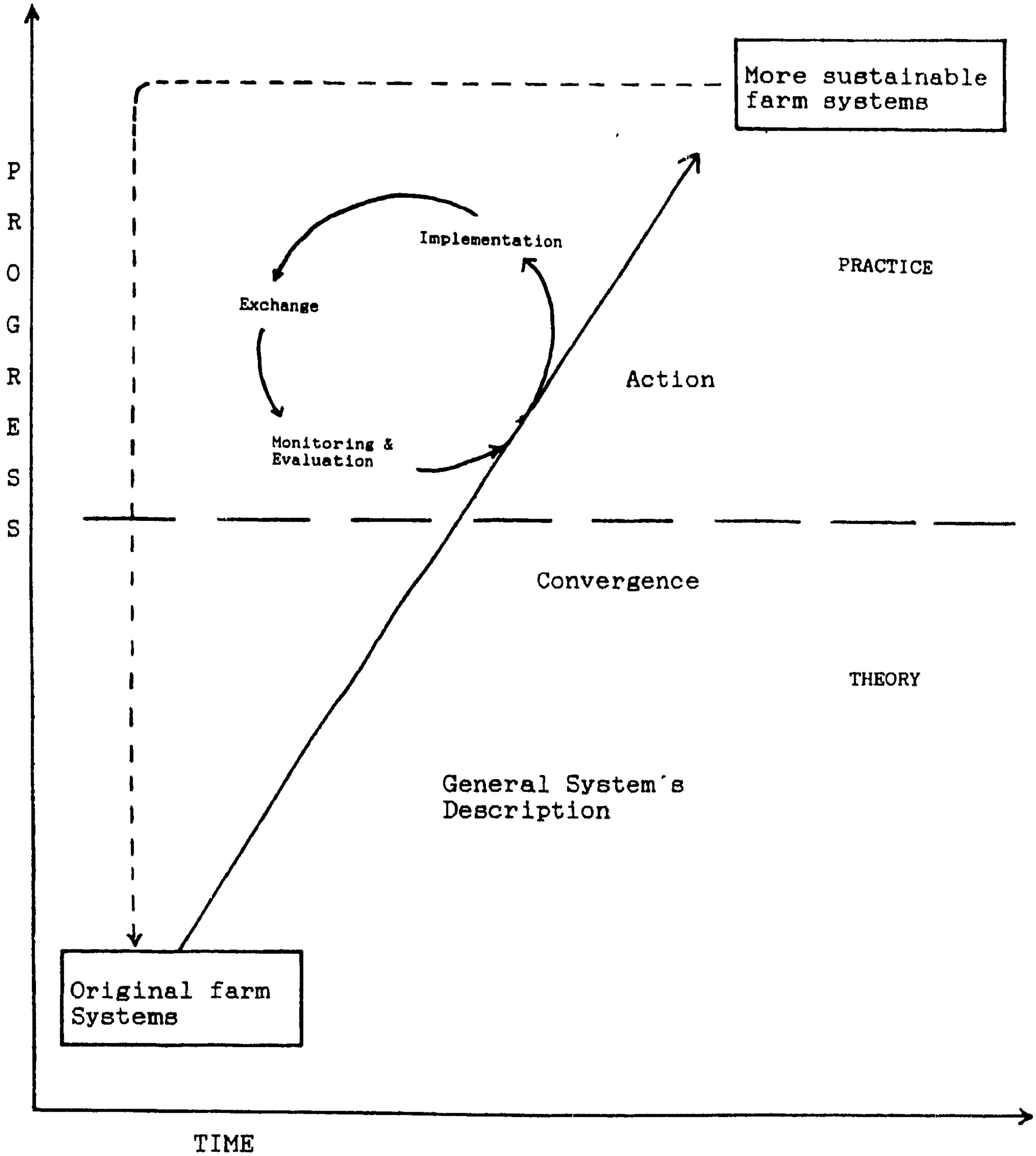
Stage 7: Convergence (revisited). After the workshop on nutrient cycling (February 1991), interaction with government programs became a major preoccupation. For me, these programs were a possible way to continue working with the group. For the farmers, they constituted a possible incentive to adopt "improved" management practices.

Besides these government project proposals, the activities undertaken were the same as those in Stage 3 (convergence). We conducted individual visits to identify the most relevant rotations and trials, and discussed alternative manure management strategies. We planned soil fertilization programs according to past manure application and soil potential. The main difference between Stage 7 and Stage 3 of the year before was that decisions were not just on what to try, but also on what to change in the overall farm management.

In May 1991 we were back into "practice", and I changed the name of the next stage from "trial" to "action".

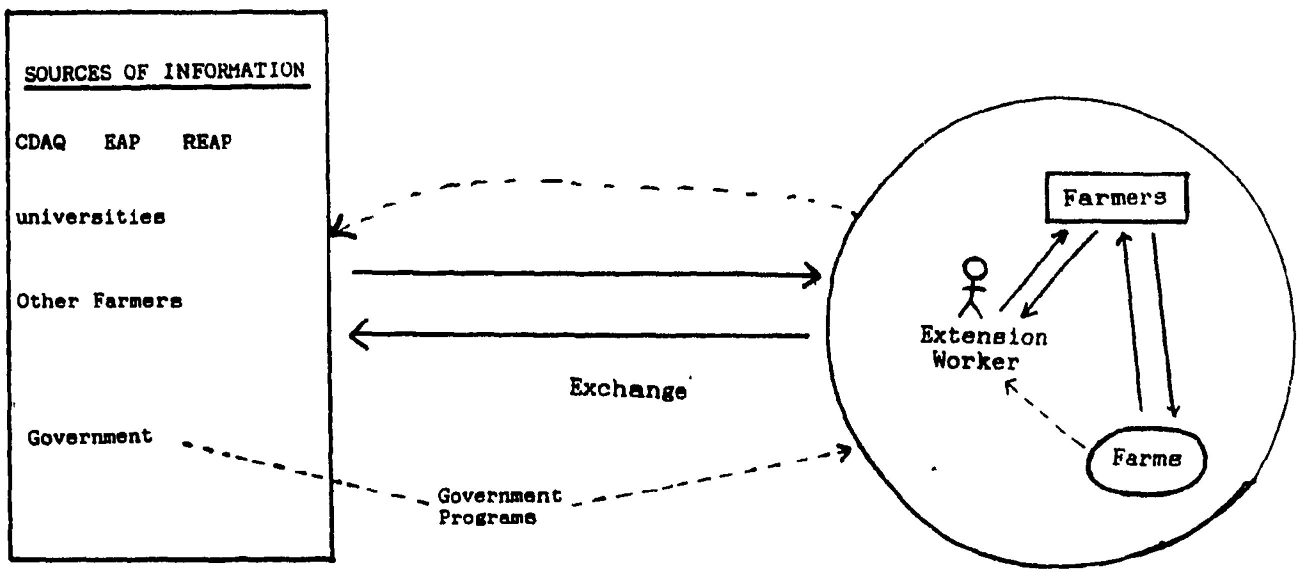
Stage 8: Action. This period is currently (summer 1991) underway. We are planning three main types of activities: a) Implementation: the new rotations are started, trials are set-up and fields are fertilized and managed according to plan. The trials, therefore, are only one of the decisions and plans that must be implemented (thus the new name of this stage); b) Exchange: this set of activities will bring the group into contact with what is going on elsewhere, on other farms and at research stations. It will also be a chance to show others what we are doing, and c) Evaluation and monitoring: a number of criteria will be followed and recorded on each farm. This will serve to eventually draw trends relating to the farm evolution, and will be used as a management tool to make decisions.
The entire process is presented in Fig. 8.

Figure 8. The group's evolutionnary process



The participatory approach used in this project facilitated the developmental process shown in Fig. 8. It also created an agricultural knowledge system consisting of our group (farmers and facilitators) interacting with other groups. This system is illustrated in Fig. 9.

Figure 9. Participatory agricultural knowledge system



In this model, the members of the group are both users and generators of knowledge, and the group itself becomes a medium for exchange. The members are all co-learners and co-teachers. The farms become a main source of knowledge through the "action" stage, and are evolving creations that each farmer constructs. This is the reasoning behind the double-headed arrows between the farmers and the farms.

The dotted arrows represent samples (soil, tissue, manure, yield, etc.) taken by the facilitator as initial criteria to monitor and evaluate the evolution of the farms.

Also, the group interacts with other groups who can also use, generate and exchange knowledge. This knowledge system sets in motion a self-sustaining developmental process, in which the interactions between groups create a dynamic, similar to the one within our group, that pushes the whole system up the developmental path. The key is that nobody has full control over the direction of this development, but everyone can participate in it simply by being members of a support group and in developing their own farms.

After 17 months of field work using this participatory approach, I have been able to identify the process that describes how this group progressed and changed. I have also described the new knowledge system that has emerged. In the following section of this thesis, I describe the relationship between the participatory model and the process of change, and indirectly with the development of sustainable agriculture. Also I explore the significance of this relationship for the "new" or "future" roles of extension agents.

Part 2: Discussion

Introduction

The previous analysis provides a basis for understanding the dynamics of personal and farm development, and the role that extension workers can play in these. In the first part of the following discussion, I suggest that the source of development is not in the adoption of new technological packages, but rather, in the process of change, such as the one previously described. Most importantly, I relate outcomes such as empowerment and awareness to this process, and, indirectly, sustainable agriculture is linked to the participatory approach.

In the second part, I criticize the conventional view of the extension agent in his/her role as a disseminator of information, and emphasize instead the need to be the facilitator of a developmental process. I then argue that the choice is not one of role, but one of personal paradigm that guides one's actions.

In the third part, I discuss the restraining and driving forces likely to play a role in the implementation of a participatory knowledge system on a large scale.

Participatory extension and sustainable agriculture

The existence of developmental processes is well recognized in the extension literature. For example, Rogers (1983) describes a five stage adoption of innovations process. Leonard-Barton (1988) describes a more in-depth adaptation process. She states that "initial implementation of technical innovations is best viewed as a process of mutual adaptation, i.e., the reinvention of the technology and the simultaneous adaptation of the organisation" (p.253). Her model describes a cyclical process where, over a period of time, both the organisation and the technology are significantly different than what they were at the onset of implementation.

However, these processes are appreciated only for their obvious outcomes, i.e.. the adoption of the innovation, or the change in the organisation. Their importance, however, goes far beyond their obvious outward signs. Strange (1988) provides a useful example. At one point in his book, he describes his involvement in an energy project for small farms, during which farmers learned to build home-made energy-saving devices. To his surprise, he found that the use of the new devices, and of other technical measures associated with them, could only account for 31% of the energy saved. The other 69% resulted from a change in the overall behaviour of the farmers towards energy consumption. He writes: "When farm families gained a sense of responsibility, of ownership and control over the technology, they behaved in a more resource conserving manner in all areas of their farm life...The process, more than the product, was the source of success" (p.228). The process gave the farmers the necessary background to use the technology effectively.

Further evidence of the importance of the process is provided by Kolb's (1984) theory of experiential learning. According to Kolb, "learning requires both a grasp or figurative representation of experience and some transformation of it" (p.42). The "grasp" can take place in two modes: a) through the absorption of reality via the different senses (apprehension), and b) through ordering this reality by words, description and models (comprehension). The transformation of this reality can also take place in two modes: a) through intention, by reflecting on the observations of the reality, and b) through extension, by acting on that reality.

Each of these modes represents a way of knowing. Learning and development are seen as adaptations to the world by cyclically using all four modes. The ability to use and integrate all four modes in any circumstance represents the highest level of development. Bawden et al. (1984) summarizes this model by writing: "Problems **start** with a situation of perceived mismatches being experienced. David Kolb and his colleagues suggest that effective problem solving proceeds from this first step as a cyclical process involving three more steps of i) observation and reflection; ii) conceptualisation and generalisation; and iii) action to validate (p.216)".

Paulo Freire (1970) identified a similar pattern of learning through reflection and action. He saw in it the "practice of freedom, the means by which men and women deal critically and creatively with reality and discover how to participate in the transformation of their world" (p.15; in the foreword by Richard Schaull).

Therefore, processes, such as the one described in this thesis, become extremely important when one is concerned with development, freedom and empowerment. Such is the case with sustainable agriculture because these (development, freedom, empowerment) are necessary for consistent responsible actions and thoughts. The involvement and commitment of farmers to the development of their farms in particular, and of agriculture in general, transcends the actual practices generated and used. In fact, the most significant outcome is that participants, ultimately, become responsible for the creation of their future, and, consequently, responsible for the future. In the end, ecological practices are not dictated by an external advisor, or by outside pressure. They are the result of a wealth of technical, ecological and self-awareness and knowledge, and are part of a life style that is, by definition, sustainable.

The participatory model described above provides an appropriate developmental environment. This environment is the result of the interactions that take place between members who accept to learn from one another, and who work together to improve their particular situations. Also, the model is based on respect for the freedom of the participants. Originally, the farmers have to accept to search for improvement in their management practices. They have to "want to want". This decision activates the learning process, which is further enhanced in the support group by the participatory extension strategies and the dynamics of the group.

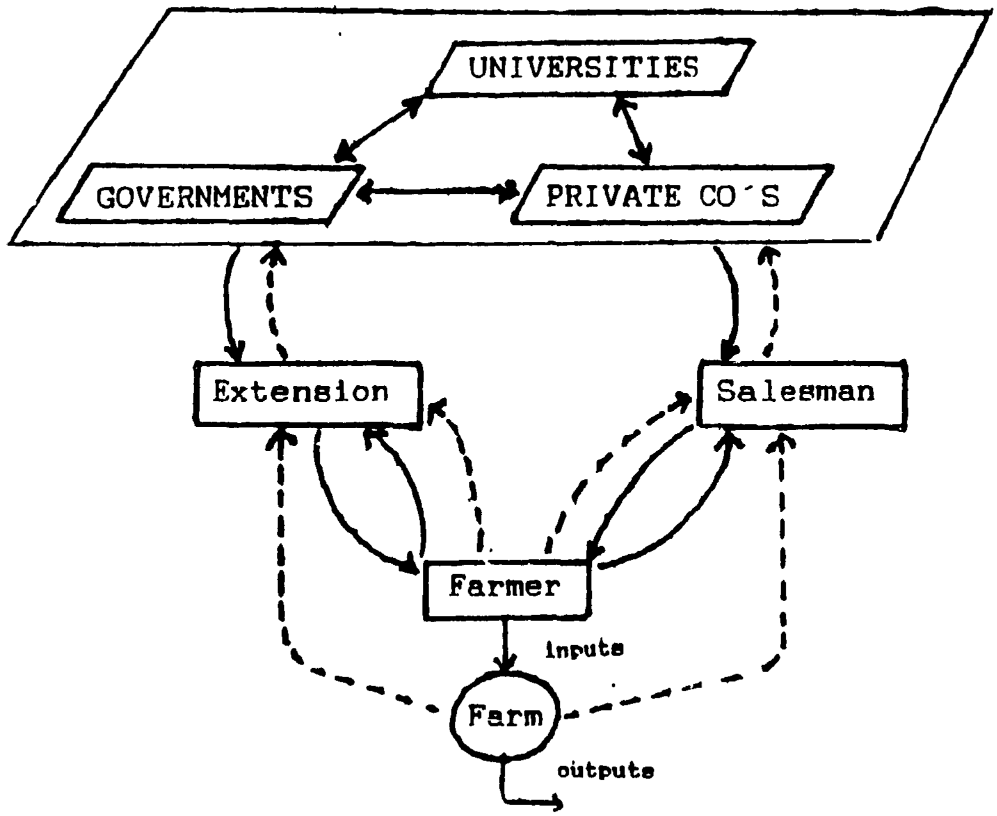
The implication is that the focus of the extension worker's role must shift from one of disseminating information, to enhancing the learning process through the formation of support groups and the use of participatory strategies. Francis et al. (1990) state that participatory strategies in extension are a necessary response to a rapidly changing world. They argue that at least some research has to be conducted on-farm, and the responsibilities of research and extension have to be shared with farmers. They suggest a more educational role for extension, but of the kind that leads to empowerment. They write: "Farmers share in gathering and evaluating information; they also share in the risk of applying these practices. This is empowerment through education." (p.160).

Extension worker as facilitator of the farm development

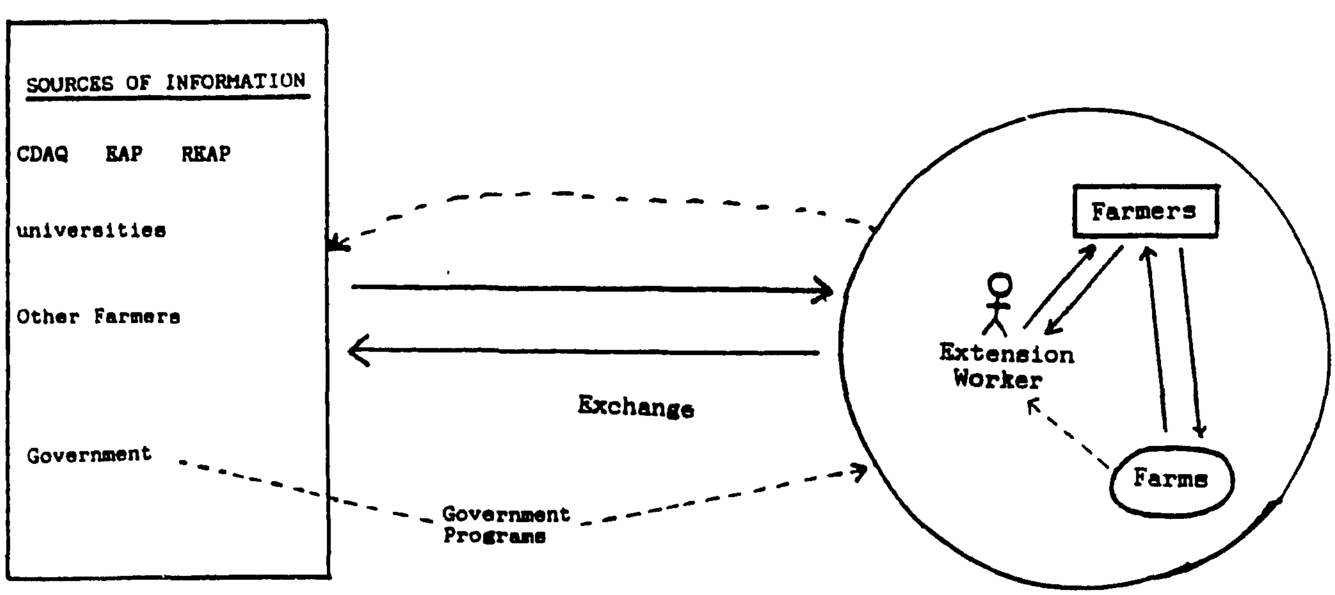
In the current view, extension workers bring innovations to the attention of farmers. The adoption of the innovations is seen as the desirable end, and is the focus of the extension worker's (or salesman's) convergence effort. Nitsch (1985) is very critical of extension workers who "tend to see themselves primarily as agricultural experts with an obligation to provide farmers with scientifically based knowledge. This knowledge, it is assumed, will help farmers run their farms more efficiently and improve their living conditions." (p.1-2)

The very structure of Quebec's agricultural knowledge system is arranged to transfer technologies onto farms, rather than to facilitate a developmental process. This is illustrated in Fig. 10, in which the current system is also contrasted with the one developed in this project.

Figure 10. Quebec's agricultural knowledge system



Participatory agricultural knowledge system



In the Quebec model, the major institutions sample the farm (dotted arrows) for soil base saturation, soil erosion, manure types and nutrient content, acreage grown, farmers characteristics, etc. The information is then filtered by these institutions, and some of it comes back to the farmers, through recommendations packaged into a program or a product to be applied at the farm level. Nowhere is reflection and action integrated. In fact, these have been dichotomized, the institutions doing the thinking and finding the solutions, and the farmers implementing them. Furthermore, the solutions are conceived for a reality of the farm that has been filtered twice once by the background (values, status, education) of the scientists, and then again by the methods of data collection and analysis.

Both, the approach used by extension agents (transfer of information), and the structure of the current agricultural knowledge system, prevent the establishment of developmental processes, and, indirectly of sustainable agriculture. There are two main reasons for this.

First, the current approach and structure are based on the implicit assumption that individual behaviour, and behaviour changes, should be controlled from the outside. On the contrary, they should be the result of internal processes. The behaviours of free, aware and empowered adults should be (and are) controlled from within. Seen from the sustainability angle, the current modelstands at the wrongend of the locusof control scale.

Second, behaviours that would be socially and environmentally responsible - sustainable - are necessarily grounded in whole situation (social and environmental context, and internal needs), or rather in the experiencing of the whole. A knowledge system must allow each individual involved to do this (experience the whole). Anything short of this, anything that separates people from their environment, that dichotomizes reflection and action, or that splits thoughts and feelings, is bound to maintain behaviours that are irresponsible and ill-founded. The separation is institutionalized in the current structure. Researchers, extension agents, farmers, consumers are all removed from one another, separated by their individual disciplines and specializations, and by cultural, political and geographical ditches filled with a flow of incomplete information and misconceptions.

Furthermore, extension agents usually omit the steps that would help them grasp the system in its entirity. They, rather, focus on the innovations, on how it should be done, and on immediate and measurable results. They do not take the time, nor the risk, to describe and explain the interactions of the support systems, and their view of the entire system.

The participatory model resolves these problems by shifting the control, and the responsibility, onto the shoulders of everyone involved in agriculture. The message is that "you can make a difference". Also, both the structure and the approaches tend to integrate people in their world. The contrast between the current and participatory models is appreciated in Table 11

Table 11

Contrast between current and participatory knowledge systems

Criteria	Participatory model	Current model
Locus of control	Inside: participants are responsible for creating their future.	Outside: experts know best.
Knowledge	Knowledge generation, transfer, and use are integrated.	Knowledge generation, transfer, and use are separated.
Social integration	Researcher, extension agent, and farmers are the same, or are bound to the same reality.	Researcher, extension agents, and farmers are separated, performing different roles on fragmented realities.
Social interaction	Farmers are creative members of a network.	Farmers are at the lower end of a hierarchical structure
Focus of activity	On process.	On product.

Because extension is at the interface between knowledge generation and use, it can significantly influence the development of agriculture. The direction of this development will depend on the role that extension workers decide to play. To put it simply, if they focus on process, and on learning, sustainable agriculture has a fair chance of being established. If, however, they continue to channel their efforts towards the transfer of innovations, it is likely that the current agricultural crisis (Table 2) will only worsen.

Extension workers must be able to do three things to become facilitators of learning. First, they must go through a learning process to heighten their own knowledge about themselves and the system in which they operate. Planning and conducting this action research project and preparing this thesis provides an example for this kind of exercise. This implies that extension workers must reach within, and define their "personal paradigm" or those assumptions that guide their behaviours. Consequently and concurrently, they must critically appraise what they do and the system in which they do it, and then take appropriate actions. Facilitating the group´s development is, therefore, the "action" stage of the extension worker´s own development.

Second, extension agents must see themselves as co-learners with the farmers. Every time they go to a farm they must realize that they are there to learn as much as to teach. This is necessary, together with their awareness of their "personal paradigm", to exchange and explain their perceptions of the farm reality and their choices of "improved" farming practices. This is the starting point of an extension agent-farmer relationship that will avoid misunderstanding and a paternalistic ("for your own good") approach, which is a subtle form of oppression.

Finally, they must be able to recognize at what stage they, and their clients, are within the change process, and have the the knowledge and the skills to fulfill the adequate role (if any) for the situation.

Gartner (1990) describes similar qualities that the next generation of extension workers must possess. He writes: "The primary quality that this person must possess is an ability to appreciate the totality of the farming system, from within and without..." That person "will be more than a facilitator according to the "Rural vacuum" theory; and he will be more than just a "research distributor" for he will have the technical competence to conduct his own research and to interpret the results of others, including farmers, for use in specified farming systems." (p.341)

Finally, by taking on a facilitator's role, extension facilities can greatly affect the structure of the knowledge system. They can do this in two ways: a) directly, by serving as a link between the reality of the farm and its abstraction in the research station, and, thereby, playing a role in establishing research needs and priorities, and b) indirectly, by conducting, in collaboration with farmers, farm-specific research and developing appropriate technologies. This would help to "institutionalize" the informal research network, and other alternative research approaches and priorities.

Implementation of the participatory model

The formation of numerous participatory groups, and the development of a network that would reach deep into rural areas will not be an easy task.

Obstacles to the implementation of the participatory model on a grand scale will obviously be raised by those whose power is threatened, and whose livelihood is based on farmers' dependency.

Barriers will also be set-up by all people, including farmers, who fear freedom and the responsibilities attached to it. In a sense, it appears much easier to put the blame on the outside, and to be the good little person who does what he/she is told.

However, there are also driving forces. First, there is increasing concern for the environment, and the realization that sources of pollution, and causes of degradation are multiple and interrelated. Solutions are no longer simple and single, but multiple and integrated. This calls for integrating approaches and models.

Second, established farmers, especially dairy farmers or those with animals and crops, are starting to realize that they can maintain production and income by replacing chemical inputs by site-specific information. The formation of groups of farmers hiring a "private" advisor to supply this kind of information makes a lot of sense, and more so as prices of inputs go up.

Also, young people, hoping to start in agriculture, are faced with a next to insurmountable financial barrier. Alternative arrangements that somehow reduce the burden of debilitating debt and dependency have to be found. Such arrangements are likely to include integration and interactions with other community members and support groups. This is happening at a time when consumers are increasingly concerned with their food, and show a desire to participate more actively in food production. I am referring here to groups involved in "community supported agriculture" projects and "community land trust". In these projects, food production is tied (often by a legal contract involving all parties) to both the needs of the consumers and the well-being of the supporting environment.

Strategies for implementing the participatory model will, therefore, include any action that would serve to form a group, creating thereby the adequate environment for wholistic development. Such actions will include: a) those that strengthen the bonds between farmers and consumers. A catalyst person or organisation could offer a service to link interested consumers and farmers, and to help them find solid agreement grounds.
b) Those that strengthen the bonds between farmers, and help them become more self-dependent and self-reliant. This was the role I played in this project. Universities could, therefore, have an interesting role to perform by setting up a graduate action research program with an emphasis on community action. Similarly, government programs, such as the "club d'encadrement technique", could be designed to better serve this growing demand.
c) Those that help networking such as the production of a Québec on-farm trial directory, a computer "phone-in" line, group workshops and visits, and the strengthening of resource centers where people can get information and contacts.

The success of the implementation of the participatory model will obviously require the involvement of people from all places in society. These people need not be solely the "movers and the shakers". More importantly is that their life style creates a pull for a society that could simply fulfill their needs.

CONCLUSION

In this project, participatory extension strategies were employed within a support group consisting of six farmers and a University team, and a participatory odel was constructed, to create more sustainable farm systems.

In this thesis, I have described the activities conducted by the group, and the resulting farm and personal changes. I have also explained the process involved in these changes. The main stages of this process, in chronological order, include: a) a "general description" of the farm system is given to show how the farm, or a particular aspect of it, is perceived; b) this is followed by a period where sharing of information takes place until the extension worker and the farmer "converge", i.e., they reach a level of mutual understanding sufficient for action to be taken. This stage is called "convergence", and, within this project, it focused around environmentally-sound farming practices; c) the third stage is called "action", and it consists of three main types of activities. In this study, the first involved the implementation of what had been decided upon during the "convergence" stage; the second consisted of participation in farm visits and demonstrations; and in the third, the farm evolution was monitored and evaluated.

The importance of this process goes beyond the adoption of the new practices or some other obvious changes within the management of the farm. It was demonstrated that the process is a learning and developmental process, whereby human beings acquire the ability to think critically and act consistently in every unique situation, and therefore, it leads to empowerment, awareness and freedom. This process is enhanced by the participatory strategies and the dynamics of the support group, and thus, the relationship between the participatory model and sustainable agriculture was established.

This relationship has implications for the role of extension workers and, ultimately, for the structure of the agricultural knowledge system. The extension worker must become the facilitator of the group's learning. Facilitating, however, is not just a matter of choice. It is part of the extension agent's own learning process by which he/she gains new knowledge, new skills and new perspectives.

For me, this project has been one of the most rewarding experiences of my life. I have learned about the technical aspects of what we, as a group, have tried in our experiments and newly adopted management practices. I have learned how to better communicate and share ideas and understanding with the farmers. And, ultimately, I have learned how to learn. Also, I have become able to clearly define my own assumptions, and make them clear to the farmers and other people around me. Mostly, I have become more critical, more involved, a more "educated citizen" as termed by Spedding (1988). I believe the other participants have also experienced a similar personal development. From our point of view then, this project has been highly successful.

This project points to three areas that need to be developed. First, there is a need to develop the tools that will help extension workers perform their roles within each of the stages of the change process. For instance, tools are missing in the first stage, "general system's description", to appraise a farm and appropriately describe it as a system. Complete and locally-relevant guides for monitoring and evaluating the farms' evolution towards sustainability are lacking. What criteria should we be looking at? How do we measure these adequately on-farm?

Second, there is a tremendous need to train agricultural students to become responsible extension workers. As far as I know, most of the student's formation is oriented towards the "scientific" (i.e., technical, biological, physiological, etc.) aspects of agricultural production. There has to be more emphasis on prepararing students for their future role as communicators and facilitators. They have to be given the opportunity to learn to think critically, and appreciate the social side of their future work as extension agents. This type of training should be built into the methods of education employed, and not left as something that the student is expected to develop merely by his/her presence within the university environment.

Finally, as agricultural sustainability becomes an international priority, there is a need for more "action-research", in which the results are immediately felt by the people, and in the setting of the research project. This type of research has the tremendous advantage of potentially creating, besides scientific/technical research results, changes in the participants themselves that are necessary for the development of sustainable agro-ecosystems. These changes include heightened levels of knowledge and skills, as well as new perspectives that lead to increased awareness and empowerment. These changes are manifested in the ecologically and socially responsible actions of all those involved.

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APPENDIX 1
(Exploratory farm survey)

Name..
Address...
....
Phone...
Production..
....
Farm size...
....

SOILS
-major soil types
-drained/nondrained
-avail. soil anal.

CROPPING SYSTEM

-crops and acreage/incl.yield est.

-rotation

-pests/weeds/diseases

-cultural practices (field prep.,mech.ops.,fz,hc,ic....)
-incl. machinery

-manure management

-particular problems

ANIMAL PRODUCTION SYSTEM

-herd inventory

-nutrition

-health status(by age/prodn groups)
-incl.reprod

-grazing

-housing

-particular problems

APPENDIX 2

Matrix of the conversion to the following rotation:

Alfalfa - Alfalfa - winter cereal + green manure - corn - barley

Field Numbers

Transition Year	1	2	3 A / B	4 A / B	5
0	corn	corn	corn/oats	oats/hay	corn
1	barley + green manure	corn	barley/ alfalfa	alfalfa/ corn	barley
2	corn	barley	alfalfa	winter rye / barley + green manures	alfalfa
3	barley	alfalfa	alfalfa	corn	alfalfa
4	alfalfa	alfalfa	corn	barley	winter cereal + green manure
5	alfalfa	winter cereal + green manure	barley	alfalfa	corn

APPENDIX 3

SOMMAIRE DE LA RENCONTRE du 03 avril 1990

Les essais qui seront effectués cet été incluent:

Categorie 1: engrais verts

Categorie 2: mais intercallaire

Categorie 3: survie des céréales d'hiver

Categorie 4: compost

Sous-categorie: sous-solage, chisel, houe rotative, sarclage

Les rotations visées à long terme sont:

- F1 - F2 - F3 - Mais - Cer.+ E.V. - Mais
- F1 - F2 - Cer.(d'hiv.) + E.V. - Mais - Cer.
- MG - Soya - Cer.d'hiv. + E.V.
- F1 - F2 - F3 - MG - Or.- Cer.d'hiv.+ E.V.- MG - Ble

Categorie 1: Engrais Verts

CULTURES	NOMS
A- Céréales d'été	
i- semis après récolte des céréales:	
- Radis Huileux	Ferme A, C, D, F, E
- Moutarde Blanche	A, D, B, (?)
- Sarrazin	D,
- Autre céréale d'été	
ii- semis dans les céréales:	
- Trèfle	Ferme A
- Vesce Velue	

B- Céréale d'hiver
i- semis après la récolte des céréales

- Radis Huileux — Ferme A

ii- semis dans les céréales:

- Trèfle — Ferme A

- Vesce Velue

C- F3, se servir d'un foin de 3ième année comme d'un engrais vert. — Ferme A, D, E

D- Essais sur cultures suivant l'engrais vert de 1989.
i- après céréales d'hiver et trèfle: essais de différentes doses de fertilisants sur le mais. — Ferme A

ii- après un foin de 3ième année: essais de differentes doses de fertilisants dans le mais. — Ferme B

BUTS IDENTIFIES (durant la rencontre)
- Recycler les nutriments
- Controler les mauvaises herbes (en couvrant le sol, en brisant leur cycle).
- Augmenter la matière organique (à long terme).
- Decompacter le sol (par les racines pivotantes de certaines cultures).

Il faut aussi mentionner:
- Stimuler l'activité microbienne.
- Ameliorer la structure du sol.
- Controler l'erosion.

N.B.: Le choix de l'engrais vert dépend des priorités du champ et des ressources disponibles. Par exemple, le radis huileux peut servir de décompacteur mais necessite l'apport préalable de fumier.

Categorie 2: Mais Intercallaire

CULTURES

A- Mais et soya/fève dans le rang (pour ensilage).	Ferme C, D
B- Mais et: - Trèfle - Raygrass - Vesce Velue - Raygrass + Vesce Velue	Ferme B, C, F

BUTS IDENTIFIES (durant la rencontre):

- Aider dans le controle des mauvaises herbes.
- Augmenter le taux de protéine dans l´ensilage.
- Diminuer l´erosion (en servant de couverture de sol).
- Réduire la compaction du sol à la récolte.
- Peut servir de source de fertilité (les legumineuses dans certaines situations).

Catégorie 3: Survie des Céréales d´Hiver

CULTURES	NOMS
A- Semis "no-till" des céréales d´hiver directement dans les chaumes de soya.	Ferme B
B- Semis de canola, l´automne, avec les céréales d´hiver.	Ferme C
C- Semis d´une céréale d´été avec la cereale d´hiver.	Ferme C, B

BUTS IDENTIFIES (durant la rencontre):

- Augmenter la survie des céréales d´hiver (ce faisant, on augmente aussi la couverture du sol minimisant ainsi l´érosion et maximisant la compétition avec les mauvaises herbes).
- Essayer le "no-till" (et vérifier ses avantages).

Categorie 4: Compost

A voir.

Sous-Categorie

Les essais dans cette catégorie restent à déterminer et dépendent de la disponibilité des instruments. S'il s'averait impossible pour nous de faire ces essais, nous pourrions au moins aller les voir chez quelqu'un d'autre.
En attendant, voici la liste des possibilités:

PRATIQUE	NOMS
- sous-solage, suivi d'un engrais vert stabilisant.	Ferme D
- Chisel; en '89 certains producteurs ont essayé le chisel. On pourra peut-etre évaluer sa performance.	Ferme B, E, F Ferme A
- Sarcleurs (Lely, houe rotative)	Ferme B, F, C, A

BUTS IDENTIFIES (durant la rencontre)

- Controler mecaniquement les mauvaises herbes.
- Reduire les couts.

METHODES d'ESSAIS

Un essai permet tout d'abord de comparer l'effet ou la performance d'au moins deux traitements. Donc, AU MINIMUM, nous suggerons de diviser un champ en deux pour pouvoir faire une comparaison valable. Par exemple:

Partie 1	vs Partie 2
Radis Huileux	Moutarde Blanche

Notez cependant que plus l'essai est répété souvent dans le meme champ, plus la comparaison devient valable. Par exemple:

1	2	1	2
Radis Huileux	Moutarde Blanche	Radis Huileux	Moutarde Blanche

SECTION 1: NUTRIMENTS PROVENANT DE LA FERME

CHAMP N:14, 15

TABLEAU 1a: AZOTE DU FUMIER

SAISON D' APPLICATION	TONNE(S) PAR HA	Kg de Nam par TONNE	Facteur de disp.	Kg de Nam disp. par Ha	Kg de Norg par TONNE	Facteur de disp.	Kg de Norg disp. par Ha
COURRANTE			1	0		0.4	0
AUTOMNE PASSE	0	1.3	0	0	4	0.4	0
DEUX ANS PASSES	0		0	0	4	0.12	0
TROIS ANS PASSES	50		0	0	4	0.05	10
TOTAL				0			10

TABLEAU 2a: AZOTE DES ENGRAIS VERTS

SAISON D APPLICATION	KILO PAR HA	% d azote	Facteur de disp.	Kg d'N par ha
COURRANTE			0.5	0
AUTOMNE PASSE	2200	0.03	0.5	33
DEUX ANS PASSES			0.25	0
TOTAL				33

TABLEAU 3: FIXATION D'AZOTE PAR LES LEGUMINEUSES

Culture	kg fixes par ha
Mais-grain	0

TABLEAU 1b: PHOSPHORE DU FUMIER

SAISON D APPLICATION	Kg de P par TONNE	Facteur de disp.	Kg de P disp. par Ha
COURRANTE		0.6	0
AUTOMNE PASSE	1.77	0.6	0
DEUX ANS PASSES	1.7	0.2	0
TROIS ANS PASSES	1.7	0	0
			0

TABLEAU 2b: PHOSPHORE DES ENGRAIS VERTS

SAISON D APPLICATION	% de phosphore	Facteur de disp.	Kg de P par ha
COURRANTE		0.6	0
AUTOMNE PASSE	0.006	0.6	7.92
DEUX ANS PASSES		0.2	0
			7.92

TABLEAU 1c: POTASSIUM DU FUMIER

SAISON D' APPLICATION	Kg de K par TONNE	Facteur de disp.	Kg de K disp. par Ha
COURRANTE		0.6	0
AUTOMNE PASSE	3	0.6	0
DEUX ANS PASSES	3	0.2	0
TROIS ANS PASSES	3	0	0
			0

TABLEAU 2c: POTASSIUM DES ENGRAIS VERTS

SAISON D' APPLICATION	% de potassium	Facteur de disp.	Kg de K par ha
COURRANTE		0.6	0
AUTOMNE PASSE	0.043	0.6	56.76
DEUX ANS PASSES		0.2	0

56.76

TABLEAU 4: TOTAL DES CONTRIBUTIONS DES SOURCES DE LA FERME

TOTAL POUR CE CHAMP	N disp. kg/ha	P disp. kg/ha	K disp. kg/ha
No: 14, 15	43	7.92	56.76

TABLEAU 5: BESOINS DE LA CULTURE A COMBLER

A) BESOINS TOTAUX

CULTURE	T prevue par Ha	N		P		K	
		Kg/Tonne recoltee	Kg/ha	Kg/Tonne recoltee	Kg/ha	Kg/Tonne recoltee	Kg/ha
Mais-grain	7.5	24	180	13.3	99.75	16	120

B) BESOINS A COMBLER (besoins totaux-contribution de la ferme)

	N	P	K
Kilo/Ha	137	91.83	63.24

EST-CE QUE VOTRE SOL PEUT VOUS FOURNIR CES QUANTITES?

APPENDIX 5

Budget des éléments nutritifs

(N.B.: Pour compléter le budget, multipliez le %, ou les kg/T, de l'élément - apparaissant en annexe - par la quantité, en kg, de la source)

INTRANTS

SOURCE	QUANTITE (kg)	N (kg)	P (kg)	K (kg)
1- **Grange**	-----	-----	-----	-----
- animaux				
- foin				
- moulée				
- paille				
2- **Champ**	-----	-----	-----	-----
- fumier				
- fertili-sants				
- Fixation d'N (Luz.=150 kg/ha; Trèfle= 100kg/ha; Soya= 50kg/ha)				
Sous-Total 1				

SORTIES

SOURCE	QUANTITE (kg)	N (kg)	P (kg)	K (kg)
1- **Grange**	-----	-----	-----	-----
- animaux				
- lait				
- fumier				
2- **champ**	-----	-----	-----	-----
- céréales				
- mais				
- soya				
- foin				
Sous-Total 2				
TOTAL (1 - 2)				

ANNEXE 1: Contenu en N, P, K du fumier

Sur votre ferme	Moyenne régionale (région 07)	
Résultats (voir note)	**Solide**	**Liquide**
N tot (kg/T)=	6.8	3.5
N am (kg/T)=	1.9	1.6
N org (kg/T)= (N tot - N am)	4.9	1.9
P_2O_5 (kg/T)=	4.0	2.0
K_2O (kg/T)=	5.6	4.4

N.B.: Si vous avez les analyses de vos fumiers, inscrivez les résultats dans cette colonne, et, s'il y a lieu, utilisez ces chiffres pour vos calculs.

ANNEXE 2: % DE NUTRIMENTS DE DIFFERENTS MATERIAUX

Culture	% de nutriments de la mat.seche		
	% de N	% de P	% de K
Luzerne	2.5	.25	1.5
Trefle rouge	2.5	.21	1.3
Vesce velue	3.4	.50	2.4
Mil	1.0	0.14	1.59
Radis Huileux	3.0	0.60	4.30
Moutarde blanche	4.0	0.60	4.30
Sarrazin			
Avoine	1.92	0.33	0.43
Orge	2.0	0.40	0.49
Mais Grain	1.3	0.27	0.29
Mais d'ens.	0.40	0.07	0.30
Soya	6.0	0.59	1.50
Paille de cereale	0.58	0.21	1.53
Criblure de cereale	0.55	0.27	0.73
Coton d'epis de mais	0.40	0.04	0.55
Paille de mais	0.20	0.10	0.30
Feuilles d'arbres	0.80	0.15	0.50
Cendre	–	1.50	4.8
Copeaux de bois	–	0.002	0.009
Phosphate de roche	–	30.0	–

ANNEXE 3: Contenu en N, P et K du lait et de la viande

	Kg de nutriments/ 1000kg de lait ou de viande		
	N	P	K
LAIT	5.5	5.0	3.7
VIANDE	50.0	29.0	6.0

APPENDIX 6

Results of trials, Summer 1990

1- Results of green manure trials, Summer 1990.

Note: In all cases, the weed biomass at the end of the season was negligible.

Green manure	Seeding Date	Seeding Rate (kg/ha)	Biomass, including roots (kg/ha)	% N-P-K
Buckwheat (1 farm)	June 1	50	3950	3.0-0.42-3.6
Oil Radish (avg. of 5 farms)	August 17 to 25	15	2662	2.9-0.58-4.3
White Mustard (avg. of 2 farms)	August 17 to 30	10 to 15	2569	4.0-0.60-4.3
Red Clover (1 farm)	May 25	12	1630	3.0-0.24-2.8
Alsike Clover	May 30	16	2130	2.8-0.26-2.8

2- Results of mixed cropping trials (corn silage - polebeans), Summer 1990.

Note: The corn was seeded at 56810 grains/ha: there were no herbicide used and one cultivation; N.A. = Not Available

Polebeans Seeding Rates	Seeding date	Yield (kg/ha)	% Protein	Energy (Mcal/kg)
0	May 25	13161	10.9	1.62
14202 beans/ha	"	15244	N.A.	N.A.
29640 beans/ha	"	15020	11.7	1.51
42606 beans/ha	"	15584	N.A.	N.A.
56810 beans/ha	"	13880	N.A.	N.A.

3- Results of mixed cropping trials (corn silage + soyabeans). Summer 1990.

Note: The corn was seeded at 78208 grains/ha; there were no herbicide used and one cultivation.

Soyabeans Seeding Rate	Seeding Date	Yield (kg/ha)	% Protein	Energy (Mcal/kg)
0	May 27	17552	N.A.	N.A.
251923 beans/ha	"	12803	8.8	1.59

4- Results of fertilization rate trials in grain corn, Summer 1990.

Note: On all other aspects the management of these plots followed recommended practices.

Farm	Fertilization Rate: N-P2o5-K20 kg/ha	Yield of Grain Corn kg/ha (14% moisture)
Farm A	0-0-0	6355
	89-52-15	6905
	177-105-31	7001
Farm B	0-0-0	8091
	152-119-119	8604
	270-119-226	9018

5- Results of weed control trials in soya, Summer 1990.

Note: On all other aspects the management of the soya followed recommended practices.

Weed management	Yield of soya kg/ha (13% moisture)	Weed Biomass (end of the season) kg/ha
Recommended herbicide	2700	210
Rotary hoed twice, no herbicide	2445	907.5
Recommended herbicide and rotary hoed twice	2668	550