Discussion Paper

No 98-14 October 1998

Practising Evolution: Theory for Understanding and Evaluating Participatory Research

Michael E. Loevinsohn
International Service for National Agricultural Research
The Hague, The Netherlands

Paper presented at the International Seminar on *Assessing the Impact of Using Participatory Research and Gender Analysis,* organized by the System-wide Program on participatory Research and Gender Analysis (SWP PRGA), Quito, Ecuador, September 6 - 9, 1998.

International Service
for National Agricultural Research (ISNAR)
P.O Box 93375
2509AJ The Hague
The Netherlands
Tel: (+31) (70) 3496100
Fax: (+31) (70) 381 9677
Email: ISNAR@CGNET.COM
Internet:WWW.CGIAR.ORG:80/ISNAR/

Abstract

Research and development that aim to stimulate farmers' experimentation demand something of a paradigm shift. Such "collegial" or "empowering" participation requires altered attitudes, new skills and changed incentive structures. But what is there to impel people and their institutions to make these changes? This paper addresses one factor: the lack of a theoretical understanding to guide the development of participatory research and help to situate it in science. The theory required is one that is useful in real time, that helps R&D workers make better choices.

Participatory or not, applied research is the search for effective solutions to real world problems, in as efficient a manner as possible. Scientists working in a conventional mode can draw on a large body of theory validated by experience when they design their research. Researchers contemplating PR also confront design choices, though of a fundamentally different nature: they can at most influence the research process, not unilaterally control it. Unfortunately, in the absence of useful theory, observations about the effectiveness of design choices are made independently of each other. There is little basis for accumulating experience and predicting what will work. There is no means to assess the trade-offs or synergies that might result from different design choices. What is needed is a framework that would help to organize observations, suggest hypotheses about what will work and show how these can be tested in practice.

This paper argues that evolutionary theory can provide a good part of the needed framework. It first describes how evolution can be used to explain the processes of change in agricultural systems. It then shows the relationship between the design choices of PR and the principal parameters of evolutionary dynamics. Finally it shows how the effects of design choices made by PR initiatives can be assessed, using examples from Kenya and Rwanda.

Practising Evolution:
Theory for Understanding and Evaluating Participatory Research[1]

Michael E. Loevinsohn[2]

Introduction

Research and development that aim to stimulate farmers' experimentation demand something of a paradigm shift. Such "collegial" or "empowering" participation (PR from here on) requires altered attitudes, new skills and changed incentive structures. But what is there to impel people and their institutions to make these changes? This Symposium contributes to one element: the empirical base from evaluation to show the effectiveness and efficiency of PR. But what is still lacking is a theoretical understanding that would guide the development of PR and help to situate it in science. The theory required is not of an abstract, second-order variety, but one that is useful in real time, that helps R&D workers make sense of experience, and make better choices.

Participatory or not, applied research is the search for effective solutions to real world problems, in as efficient a manner as possible. Scientists working in a conventional mode can draw on a large body of theory validated by experience when they design their research. Standard texts provide guidance on how to efficiently answer research questions, to a specified level of confidence, using the tools of experimental blocks, replicates, stratified sampling and so on, statistical methods such as ANOVA, and analytical tools like stability analysis. Researchers contemplating PR also confront design choices, though of a fundamentally different nature: they can at most influence the research process, not unilaterally control it. Such choices include:

- how many farmers to work with, organized in how many and what kind of groups?
- how to enlarge the range of concepts and options available to farmers?
- with what frequency to assist people in coming together to discuss and review their experiments and innovations?
- how far to facilitate contact among groups that would not normally interact?
- whether to attempt to reform farmers' experimental practices? and
- what use to make of the research station as a venue for farmer-led or jointly managed experimentation?

Currently, researchers have little basis, beyond intuition and trial-and-error, to guide their design choices. In the absence of theory, observations about the effectiveness of design choices are made independently of each other. There is little basis for accumulating experience and predicting what will work. There is no means to assess the trade-offs or synergies that might result from different design choices. What is needed is a framework that can help to organize observations, suggest hypotheses about what will work and show how these can be tested in practice.

This paper argues that evolutionary theory can provide a good part of the needed framework. PR's attempts to support farmers' experimentation and problem solving are essentially an effort to stimulate the evolutionary processes that have shaped agriculture and permitted it to adapt to diverse and changing conditions. Specifically, it is argued that the changing pattern of practices that farmers employ in their use of the land and resources is the result of a continuing process of evolution based on the basic Darwinian mechanisms of generation of novelty, selection, recombination, movement and preservation

---

[1] Paper presented at the International Seminar on *Assessing the Impact of Using Participatory Research and Gender Analysis*, organized by the System-wide Program on Participatory Research and Gender Analysis (SWP PRGA), Quito, Ecuador, September 6 - 9, 1998.
[2] International Service for National Agricultural Research, The Hague, Netherlands

of inventions. The paper then shows the relationship between the design choices of PR and the principal parameters of evolutionary dynamics. Finally it shows how the effects of design choices made by PR initiatives can be assessed, using examples from Kenya and Rwanda.

Evolution in agriculture

Although the Darwinian paradigm was first advanced to explain the diversity and adaptedness of life-forms, an increasing number of disciplines, from economics to linguistics, have in recent years come to recognize that innovation processes in the cultural and other realms can be understood in these same terms (e.g. Toulmin 1972, Cavalli-Sforza and Feldman 1981, Nelson and Winter 1995). What is common in each case is that innovation proceeds from multiple sources and is incremental, rather than definitive. But while the basic processes are the same; specific mechanisms differ. In the cultural realm, variant practices (different ways of speaking, of producing, etc.) are selected and become dominant within a population, not as a result of the differential mortality and reproduction of the people who use them, as in natural selection in the biological realm, but rather because certain variants are taken up more readily, are retained longer and are passed on to other practitioners more frequently than others. Successful variants are preserved in the cultural realm, not in the genetic material, but through learning and teaching, buttressed by socially enforced rules and the extended memory of writing or other media. Thus the changing pattern of cultural practices is not the outcome of something *like* a Darwinian process, it *is* a Darwinian process, as much as the one that lies behind the changing virulence of a pathogen on a region's once resistant maize crop.

Evolutionary theory has yet to be consistently applied to understand changes in agricultural practices. The application is a logical one: change clearly emerges from multiple sources, within and outside agricultural communities, and "adaptation", a central notion in evolution, has as clear a meaning in relation to the practices of farmers working in specific environments as it does for organisms in nature. But if evolutionary theory is to be useful, it has to do more than explain, retrospectively, change that has occurred over centuries or millennia. It must clarify the dynamics of contemporary systems as they respond to acute and sharpening pressures over seasons and years, and suggest interventions, particular design choices, that can support those responses. It is in this sense that PR can be seen as applied evolution.

Five basic processes underlie Darwinian evolution in either the natural or cultural realm (Loevinsohn 1997, Loevinsohn and Simpson 1998). In the context of agricultural practices, these processes are driven by the decisions of farmers, acting alone or in concert:

<u>Invention</u> In the natural realm, new variants of an organism emerge as a consequence of mutation in the genetic material. In the cultural realm, novelty results from farmers inventing or discovering a variant of some existing practice and implementing it. The variant[3] may emerge within a community, or be introduced from without. The variant can be as straightforward as a change in the depth of planting or as difficult to bring off as a new rule governing a collectively managed pasture. Unlike mutations in the natural realm, inventions are far from random and more likely to be beneficial than harmful: individuals reflect and discuss before they implement an idea. Nevertheless, as in nature, the true worth of a variant can only be judged after it has been tried.

<u>Selection</u> In nature, organisms with different traits survive and reproduce with varying success. Those producing the greatest number of viable offspring are best represented in subsequent generations: this is the essence of natural selection. In the cultural realm, selection is driven by farmers' choices of whether to take up a variant that they encounter, or themselves devise, and whether to continue using it. Taking up a variant adds a member to the population of users of that variant, i.e. a birth; abandoning it reduces the population by one, i.e. a death. In aggregate, these

[3] "Variant" and "option" are used interchangeably in this paper.

decisions define the birth and death rates of the variant and hence its changing prevalence. I return to this below.

Farmers often test variants in small trials or experiments before deciding whether to use them at full scale. Not all practices, however, can be tested at reduced scale (the rule governing use of a common pasture, for example), and farmers may not always be in a position to wait (as when lost seed stock must be replaced). In other cases, farmers may be sufficiently convinced of a variant's promise on the basis of what they have seen in someone else’s field that they will use it directly at full scale. Although farmers vary in the criteria that guide their selective choices, and may use different criteria over time, cultural norms, socio-economic stratification and external pressures (e.g. market standards) help to limit this variation.

<u>Recombination</u> In the natural realm, the recombination of new and existing traits, through genetic mechanisms like cross-over and hybridization, gives rise, over generations, to increasingly complex innovations. Similarly, in the cultural realm, the development of complex agricultural innovations, as well as the integration of all but the simplest innovations into existing farming systems, involve recombination. The integration of fish culture, for example, into an irrigated cropping system may only be feasible with changes in crop calendars, pest management and water control practices, and possibly altered labour arrangements within the household. Finding an acceptable (as judged by farmers) combination of these elements takes time, certainly more than a single season, and requires repeated testing. Although many acts of recombination are based on the adjustment and adaptation of practices by individual farmers, important social elements are often involved. The exchange of ideas, experiences and opinions about an innovation can take place in a variety of informal settings. Such exchange generally occurs within a limited circle of people, or peer group (Loevinsohn, 1997; Simpson, 1998).

<u>Perpetuation</u> The perpetuation of successful variants in the natural realm is achieved through genetic inheritance. In the cultural realm, agricultural variants are maintained through the processes of learning and the maintenance of material. The knowledge-based, or 'soft,' parts of agricultural variants live on in the mind and are taught by users to others of their generation or their offspring. Customs, cultural norms and sanctions may bolster the continued use of certain practices, and these too evolve over time (Barnett, 1953). Writing and other forms of extended memory may similarly help preserve innovations. Variants that exist in a 'hard' form, such as seeds and tools, are perpetuated through storage and exchange mechanisms operating at the household, community and wider levels. As the newly emergent variants of one period become the established practices of the next, the stage is set for their own replacement as conditions and needs change.

<u>Movement</u> In the natural realm, variants move across the landscape, mate and reproduce, under their own power or assisted by various physical or biological vectors. In the cultural realm, the movement of variant agricultural practices is in large part dependent on the movements of farmers. As individuals travel, they take with them knowledge (and sometimes material) of their own practices, and examine variants that they encounter. They may exchange knowledge or seed with farmers they meet, though sometimes the exchange is less than consensual (interesting varieties may be harvested at night). In their travels, and at rest, farmers also come into contact with information and materials from various other sources (e.g. researchers, extensionists, representatives of NGOs and private businesses), and transmitted through different means (e.g. meetings, radio broadcasts and printed material). The extent of an individual's contact with these different sources can vary greatly, depending upon their opportunities for interaction, which, in turn, are often strongly influenced by a range of social factors (Simpson, *in press*).

These decisions and actions contribute to two important parameters that shape the spatial and temporal dimensions of evolutionary change (Figure 1).

Neighbourhood Size (Ns) In population biology, the genetic neighbourhood denotes the extent to which individuals are genetically isolated. Where organisms find their mates within small, scattered groups, inbreeding increases and genetic diversity is lost (Wright 1969). This threatens the ability of the population as a whole to respond to challenges, natural and physical. Analogous processes are at play in the evolution of culturally transmitted agricultural practices. Here, **Ns** can be thought of as the number of instances of a practice (or the number of practitioners) that farmers typically encounter. Where farmers are extremely isolated, the likelihood that they will encounter variation in the practice and, potentially, find something better than what they already employ, is limited. Change will then depend on farmers inventing something on their own, and progress will slow to a trickle.

Yet a large **Ns** also has its risks. In large, freely communicating populations, farmers will be continually bombarded with new information. Diverse ideas, particularly ones that take time to pursue through repeated trial and experimentation, may not survive. Perhaps more importantly, farmers in such situations may not find the support and encouragement to pursue a different approach that sometimes exists in small, self-organized groups. An intermediate degree of isolation may be the most conducive to creativity in evolution. Insights from Wright (1969) and others on evolution in natural populations, suggest that unusual genetic combinations are more likely to emerge within small groups. Some of these combinations may be favorable and these will spread within the wider population if the links among groups are not too infrequent. There is evidence that similar effects are at play in culturally-mediated evolution. I will return to this a little later.

The extent to which farmers move and are prepared to exchange knowledge of variants and material elements such as seed is an important determinant of **Ns**. Characteristics of the practice also affect **Ns**, notably its spatial scale. For example, farmers who spend their lives within a large irrigation system will encounter only one example of certain irrigation practices. At the same time, they may come across numerous crop varieties or tillage practices. Features of the socio-economic and physical environment that affect **Ns** include stratification in communication by gender, ethnic or other social traits, and heterogeneity in farmers' management objectives and in the conditions they farm in. Farmers might reside in the same village and yet, in these terms, be in separate neighbourhoods.

Invention Rate (Ir) In natural populations, the rate at which new variants appear is determined by the mutation rate, the probability of change occurring in a given gene per individual each generation. The genes underlying certain traits mutate faster than others, and organisms with shorter generation lengths innovate genetically faster than the longer lived (hence the evolutionary success of bacteria). The invention rate for culturally-transmitted traits, like agricultural practices, can similarly be thought of as the rate at which new variants of a practice appear per practitioner in a given period. Characteristics of the practice that influence this rate include what might be referred to as its generation length: the longer it takes before variants can be judged, or multiplied, and thus pass on to other potential practitioners, the lower will be **Ir**. As well, the time and effort required to get potential partners to agree on implementing changes, as in common property practices, will also depress **Ir**. The rate is affected positively by farmers' propensity to invent and to recombine old and new variants of a practice. This may be stimulated and focused by the security farmers feel (the likelihood they will benefit from successful innovation) and by, for example, environmental challenges, new marketing opportunities or new knowledge. Factors that tend to perpetuate existing variants will depress **Ir** for those practices.

Together these two parameters, **Ns** and **Ir**, determine the rate at which farmers encounter new options (Figure 1). When they do, farmers exercise their selective judgment of whether to take up any of them and whether to continue to grow them. In aggregate, these decisions determine birth and death rates of the options. Non-selective forces, for example the effect of war or extreme weather, add their part to the death rates. Birth and death rates combine to determine rates of increase of the options. Options that have consistent rates of increase, or decrease, lead to changes in land use practices.

Assessing change

Four broad criteria can be used to assess change in land use practices, indeed to characterize the performance of any evolving system (Table 1). They are essentially different perspectives on the change process. Actual PR initiatives will pursue objectives that represent a particular mix of these criteria, weighted in some manner. In pursuit of these criteria, partners in an initiative make design choices, guided by available and feasible options, and by what they know of their utility. Their experience with these choices, properly evaluated, can improve the information available to others, leading to a gradual improvement in the effectiveness of PR. The four criteria also have a certain pedigree in evolutionary theory and from this background further, broader hypotheses emerge that can guide design. Of course, success in achieving these criteria depends as much on the skill with which design choices are implemented as on the choices themselves, and this learning-by-doing is critical to building professionalism in PR[4].

Table 1. Characteristics of change in evolving agricultural systems

• Speed:	How fast and over what area does change occur
• Significance:	How large is this change?
• Equitability:	How evenly does the change occur across different social strata?
• Continuity:	How broad and durable is the change process?

The design choices that initiatives make will influence one or more of the 5 basic processes described above and illustrated in Figure 1. Qualitative and quantitative analytical tools, including some adapted from population biology and demography, can be used in assessing the impact of these choices in terms of the criteria and on different features of the system portrayed in Figure 1, whether on the basic evolutionary processes themselves, on **Ns** and **Ir**, on the rate of increase of particular land use options, or on the "final" parameter, change in land use practices. Coordinated assessment at more than one point can strengthen the imputation of a causal link between the design choice, changes in land use and further impacts, social, economic or environmental (Loevinsohn et al., 1998). It must be recognized that the schema shown in Figure 1 is inaccurate to the extent that it suggests the evolutionary process is linear. No change is ever final.

In what follows, I outline a few illustrative hypotheses about the types of action that can contribute to each of the four criteria and provide examples of the assessment of design choices in PR initiatives.

1. Speed: The rate at which practices change on farms within a given area.

[4] "Efficiency" may also be an important criterion: how much investment from the perspective of a particular actor is required to obtain change of a given magnitude? To an extent, farmers' judgments of efficiency are integrated into their selections: if they do not find what they need in the time they can spare or at a price they can afford, they withdraw from the process. From the perspective of an R&D organization, the amount of effort it must invest to be able to work with local research depends on its history, organization and other features. A different framework, one that opens up the "black box" of the organization itself, is required to assess these aspects.

Hypotheses: Design choices that maximize either or both **Ns** and **Ir** will enhance speed. Among those available to increase **Ns** are:

- facilitating visits among practitioner groups;
- using radio or other media to connect practitioner groups; and
- introducing the options employed by other practitioners (enlarging the "basket").

Design choices that can be used to increase **Ir** include:

- focusing innovation by introducing a promising new option or marketing opportunity;
- rewarding invention or providing other incentives or support to innovation,
- enabling farmers to grasp principles underlying the agroecosystems they manage;
- reducing the risks of experimentation, especially for "bulky" practices with large minimum sizes, for example, by making experiment stations available to farmer groups or by simulation in some form.

An example from Rwanda illustrates an analysis focused on the speed of change. At issue was the selection and spread of bean varieties through farmer-to-farmer diffusion (Box 1). Here the interaction with the local innovation system was quite limited and the principle design choice was to give farmers small packets of seed of particular varieties, some introduced, some researchers' selections from local varieties. Speed is seen to vary according to the degree to which varieties are appreciated by farmers and the favorableness of the environment. The evaluation used a simple demographic model (Leslie matrix) to estimate the rates of increase of these options, and to project the change in their use over a period of several years. More sophisticated models incorporate the eventual saturation of local demand that leads to a flattening of the growth curves, and the spatial dimension of spread (i.e. taking account of where those who take up the varieties actually farm or reside (Loevinsohn *in press*)). Nevertheless, the simple model provides a useful indication of the early fate of new options, whether they are likely to expand in the near future, or whether they are headed for local extinction.

Another example from Rwanda comes from a more thoroughly participatory initiative (Box 2). Here, analysis focused on the effects of one its main design choices: bringing experimenting groups into contact once a season and allowing them to explain and demonstrate to each other the different innovations they were pursuing. This conscious attempt to enlarge **Ns** made possible, among other effects, the rapid spread of one particular option in the collective management of irrigation. Evaluation focused on the change in land use practices over a period of a few seasons. In this case, a complete census of the irrigation options in use was possible.

2. **Significance:** The size of the change that the new option represents. How much better is it, judged in the terms of utility that practitioners value?

Hypotheses: Larger "jumps" are more likely where the search for potential solutions, including more complex and less obvious ones, is more comprehensive. As mentioned earlier, insights from evolutionary theory and from group dynamics suggest that large **Ns** may be inimical to such comprehensiveness. A number of cohesive, somewhat isolated groups are better able to act on diverse ideas than a large, unstructured group in which the "central tendency" is likely to rule.[5]. Through mutual support, such groups are also better able to maintain a purpose and pursue a line of reasoning across several seasons, which may be required to develop a complex practice.

This hypothesis has clear implications for the design of participatory R&D. An example, drawing on

[5] A similar logic often leads conference organizers to break from plenary to working group sessions when careful deliberation of complex topics is sought.

the Rwandan initiative described in the preceding case, examines the effects of choosing to work with a particular kind of farmer group, whether more or less tightly structured, open in membership, and experienced in cooperation, on success with a complex innovation (Box 3). Here, the evaluation focused on **Ir**: indicators were the frequency of experimentation and the diversity of the experiments conducted by the two types of group. The smaller, more cohesive *coopératives,* with a history of working together, showed themselves better able to pursue experimentation on green manuring than the looser *associations*. Though in principle green manuring could be implemented by individuals acting on their own, it was in many ways a more complex practice than the collectively managed one of delivering water to group members, and took longer to develop. All the groups took up peripheral canals, yet only the *coopératives* made any real headway with green manuring.

Significance is also likely to be favoured by design choices that increase **Ir** by focusing it on a limited number of problems (one or perhaps two) and by promoting recombination, through such measures as regular evaluation of options by practitioners.

3. Equitability: The evenness of the change across different social strata.

Hypotheses: The spread of new options to and within different social groups may be impeded by problems of communication (disjoint Neighbourhoods) and/or by failures of technology generation (impediments to innovation leading to low **Ir** in particular Neighbourhoods). Design choices available to counteract the first problem include measures to increase contact among the strata (for example, by striving for balanced participation in the participatory initiative) or to make the options they practise and develop mutually accessible. Design choices to counteract the second problem include measures to stimulate experimentation in particular strata, based on analysis of their situations. This might involve, for example, encouraging the formation of stratum-specific groups, or enlarging the “basket” of options to meet the specific needs of the stratum. The tools of gender/user analysis are critical to understand where equity problems lie and to suggest feasible design choices. The evolutionary perspective provides a context for their application.

In a participatory IPM project in Kenya, it was found that labour and knowledge-intensive options were not spreading among one group of farmers, women tea growers, who experienced severe labor shortages (Box 4). Analysis, building on the demographic methods used in Box 1, showed that this was due, not to problems of communication, but to an inappropriate basket of “seed” options and to the erosion of local institutions that elsewhere had stimulated technology generation and adaptation.

4. Continuity: The breadth and durability of the change process[6].

Hypotheses: Central to continuity is the capacity, both individual and institutional, to adapt practices to different situations and to altered conditions. The health of the innovation system as a whole is of concern here: if any one of the five basic mechanisms is weak, the ability to adapt may be compromised. From a continuity perspective, an intervention is assessed in terms of the breadth and durability of its effect, for example, in how far it brings about a more than transient increase in farmers’ ambit of movement and thus **Ns**, or a more than temporary flourish of invention around one topic. Design choices relevant to **Ns** include:

- ensuring a continued flow of ideas and options to groups;
- encouraging links among groups and helping them locate other groups facing similar problems; and
- enhancing access to information from a variety of other sources.

[6] N.B. Continuity of the process of change, not the persistence of any particular option.

Design choices relevant to **Ir** include:

- emphasizing principles that will stimulate and sustain invention and possibly affect the way farmers make their selective decisions;
- allowing farmers to discover these principles, rather than simply being told them;
- supporting local institutions that promote discussion of options and/or that are able to pursue collective and joint action;
- again with respect to collective and joint action: honing skills in forming and leading groups and in working with formal sector institutions; and
- on a longer time frame, reforming school curricula to encourage inquiry and experimentation.

The Kenyan project cited above sought to enhance farmers' capacity to manage resources on a continuing basis. Box 5 outlines how its success in these terms was assessed.

Conclusion

The hypotheses suggested above are, it should be repeated, far from exhaustive. Many more can be proposed, drawing on experience and theory. Evolution should prove an accommodating host, leaving ample space for contributions from other theoretical directions. For example, in the large national IPM programs of Southeast Asia, the work of Jürgen Habermas (1984) is said to be useful in understanding how ideas are generated and recombined in farmer groups (P.E. Kenmore, *pers comm.*, 1996). Evolution provides a framework on which all such contributions can be placed and it suggests methods to assess their impact in terms of change in farmers' practices. It is through this repeated testing and hypothesis generation that theory should advance and provide ever more useful insight into what works.

It also bears emphasizing that the evolutionary framework can be employed in evaluating the impact of conventional as well as PR initiatives, or of "functional" (consultative) participation that does not aim at stimulating farmers' independent research. All these approaches should, in principle, accept to be judged by the extent to which they contribute to change in farmers' practices. If allying with local research is worthwhile, the effects should be visible in terms of the criteria suggested here: the speed, significance, equitability and continuity of the change that results. The evolutionary perspective provides a language and a set of concepts to think about and discuss these criteria, and a framework that helps to link action to effect.

References

Barnett, H.G. 1953. *Innovation: The basis of cultural change*. New York: McGraw-Hill Book Co.

Cavalli-Sforza, L.L. and M.W. Feldman 1981. *Cultural Transmission and Evolution: A quantitative approach*. Princeton: Princeton University Press.

Habermas, J. 1984. *The Theory of Communicative Action*. Beacon Press.

Nelson, R. and S. Winter. 1982. *An Evolutionary Theory of Economic Change*. Cambridge: Harvard University Press.

Toulmin, S. 1972. *Human Understanding: The collective use and evolution of concepts*. Princeton: Princeton University Press.

Loevinsohn, M.E. 1997. "Evolving Agricultural Systems and the Design of Participatory Research. In CIAT *New Frontiers in Participatory Research and Gender Analysis*. Proceedings of the International Seminar on Participatory Research and Gender Analysis for technology

Development, Sept. 9-14, 1996, CIAT, Cali. Pgs. 199-208.

Loevinsohn, M.E. (*in press*). Evolving Agricultural Systems and the Practice of Farmer Participatory Research. ISNAR Research Report. International Service for National Agricultural Research. The Hague, Netherlands.

Loevinsohn, M.E., Mugarura, J. and A. Nkusi. 1994. "Cooperation and Innovation by Farmer Groups: Scale in the development of Rwandan valley farming systems. *Agricultural Systems* 46:141-155.

Loevinsohn, M.E., G. Meijerink, and B. Salasya. 1998 Developing Integrated Pest Management with Kenyan Farmers: Evaluation of a Pilot Project. Paper presented at the International Seminar on *Assessing the Impact of Using Participatory Research and Gender Analysis*, organized by the Systemwide Program on Participatory Research and Gender Analysis,Quito, Ecuador, September 6 - 9, 1998.

Loevinsohn, M.E. and B.M. Simpson, 1998. Practising evolution: a framework for participatory FSR&E. Paper presented at the 15th International Seminar of the Association for Farming Systems Research-Extension, 29 November - 4 December, Pretoria, South Africa

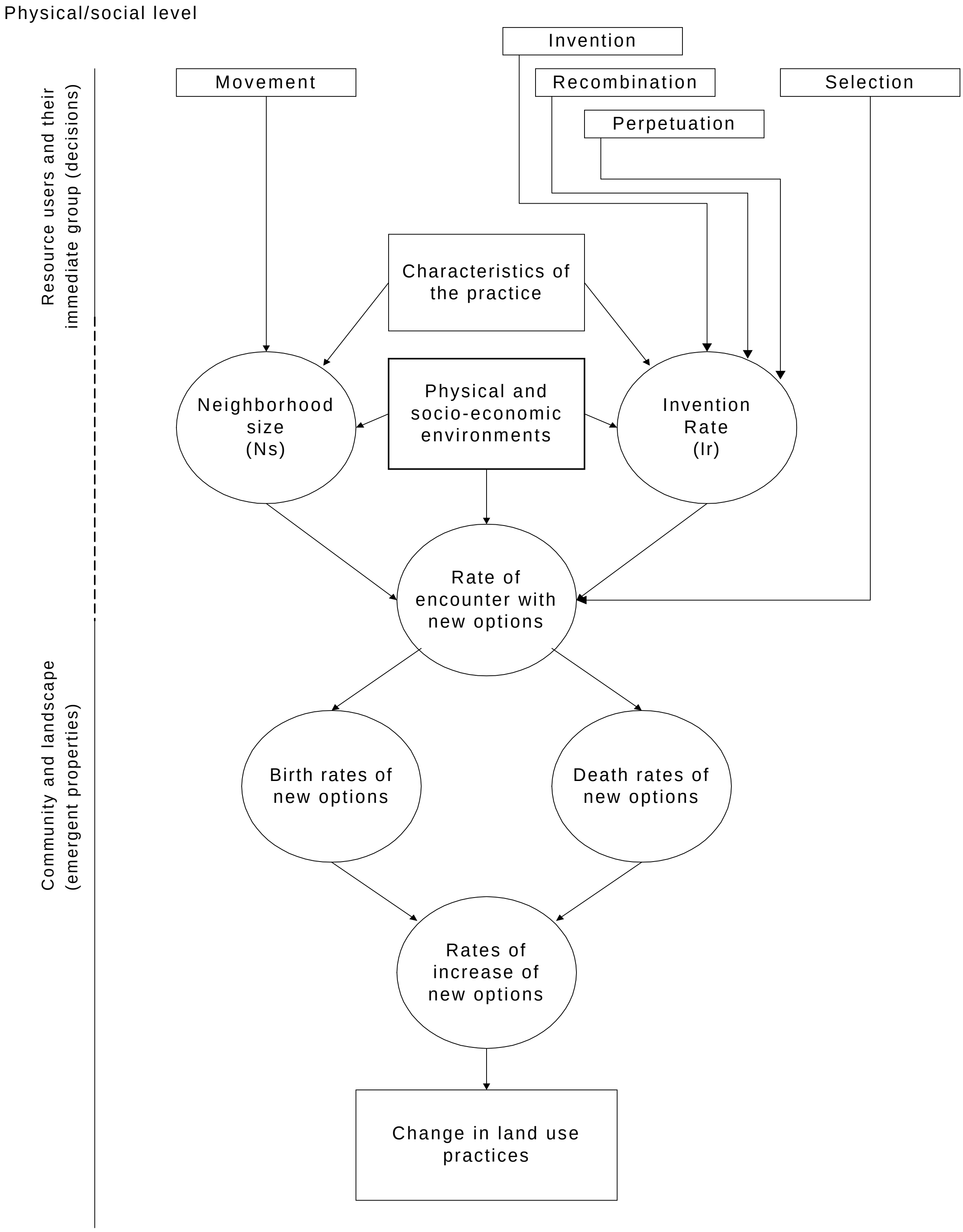
Simpson, B.M. *in press*. Structure and the iternal dynamics of change in local knowledge systems: towards a conceptual understanding." *Development and Change*.

______. 1998. "Investing in People: Farmer competencies, creativity and supportive social networks in the *Projet Pisciculture Familiale*, Zaire." *European Journal of Agricultural Education and Extension* Vol 5 (2).

Sperling, L. and M.E. Loevinsohn. 1993. The dynamics of adoption: distribution and mortality of bean varieties among small farmers in Rwanda. *Agricultural Systems* 41: 441-454.

Wright, S. 1969. *Evolution and Genetics of Populations, vol. 2, The theory of gene frequencies*. Chicago: University of Chicago Press.

Figure 1: Evolution of land use practices



Box 1: The demography of novel bean varieties in Rwanda

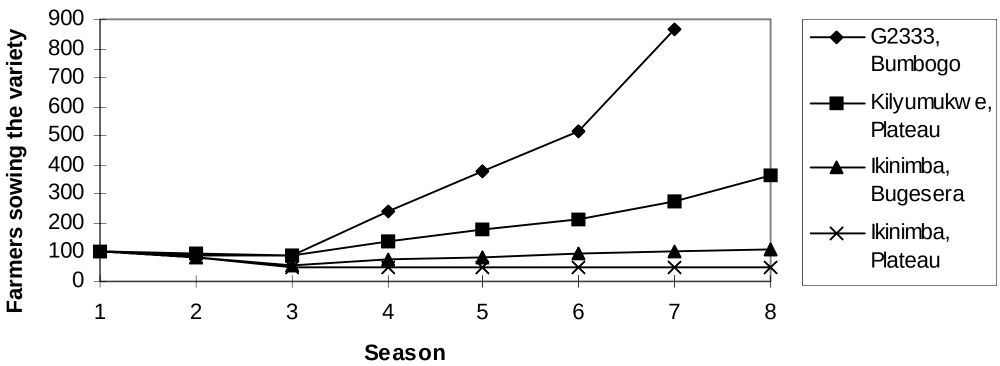
Researchers of the Institut des Sciences Agronomiques du Rwanda conducted trials with farmers on 3 bean varieties in 3 regions of the country. This occurred before formal institutions had begun to multiply or promote the varieties, so that farmers' assessments of their worth and the frequency with which seed was passed from farmer-to-farmer determined their rate of spread.

Researchers visited the original farmers at least three seasons after they had received the seed to assess whether they were still growing the variety and, if not, when and why they had abandoned it. Researchers also asked whether, when and to how many other growers the farmer had distributed seed. The first set of data was used to calculate death rates; the second set to estimate birth rates. Death rates were correlated with farmers' judgments of the varieties (which had been assessed earlier and independently). But deaths also occurred for reasons unrelated to a variety's characteristics. Some farmers had lost a variety they valued due to flood or drought, and others had been forced to eat the seed. These non-selective, involuntary losses occurred most frequently in the first seasons after a farmer received the variety when she was still growing it on a small area, and affected poorer farmers disproportionately.

Reproduction, resulting from a farmer distributing seed to a neighbor, friend or relative, usually began two or more seasons after the farmer received the variety. Once they started, distributions were often limited in number and restricted socially to relatives and close friends. Differences in birth rates among varieties were marked.

The rate of increase, the balance between birth and death rates, was estimated using a standard demographic model, the Leslie projection matrix (Figure 2). Some varieties are seen to move hardly at all or even to regress; others spread rapidly. The favorableness of the agricultural environment, the variety's productivity, and farmers' appreciation of it are key factors. The climbing bean G2333 is well regarded by farmers and is very productive in the relatively favourable Bumbogo region, has the highest rate of increase of any of the four cases. Kilyumukwe outperforms Ikinimba in the southern Central Plateau, reflecting farmers' appreciation of the variety for its grain and culinary qualities. Ikinimba had consistently low appreciation scores there, primarily because of its susceptibility to disease. However, it is highly regarded for its drought tolerance in the more climatically extreme Bugesera region. Yet it is seen to barely increase in this region. A high degree of non-selective mortality due to environmental and socio-economic factors appears to be responsible (From Sperling and Loevinsohn 1993)

Figure 2: Estimated rate of spread of novel bean varieties in three regions of Rwanda



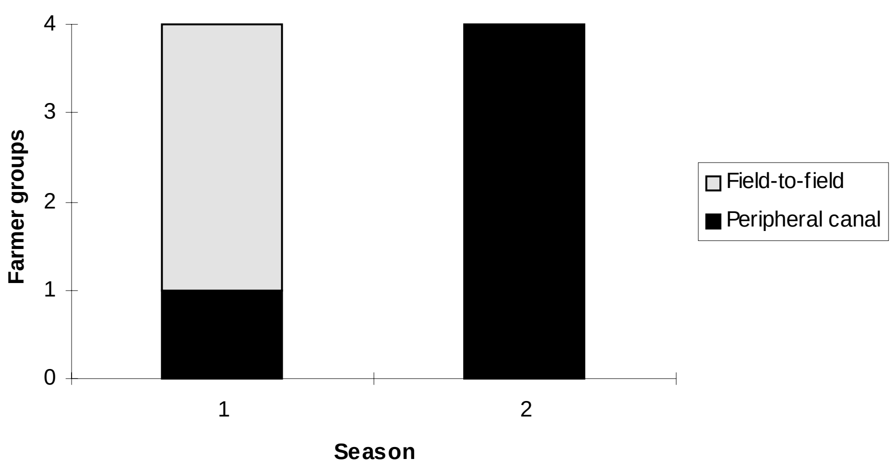
Box 2: Innovation in Rwandan valleys: collective irrigation practices

A project of the Ministry of Agriculture involved researchers and farmers in the search for ways to intensify production in highland valleys in southern Rwanda. Discussions identified a number of possibilities, some from farmers' experience, others suggested by researchers. Among the latter were several on which no formal applied research had yet been conducted in the country. One of these was the integration of rice into highland agriculture above 1400 m and into small farmer managed systems. The basis of the research relationship was that farmers were free to try whatever options they chose and implement them as they saw fit. Researchers undertook to provide advice and seed for farmers' trials. But they stipulated that they could only work with groups, however organized. Four groups, of two types, agreed to work with the researchers. Two were "coopératives", formalized groupings that had been in existence for several years and for the most part cultivated collectively. The other two were newly organized, informal associations of field neighbors who collaborated as and when necessary. Researchers attempted to stimulate innovation by several means: through weekly visits during which experiments were discussed; by organizing "traveling seminars" in which, once a season, groups visited each other to observe and discuss the experiments they were conducting; and by bringing farmers to a lower altitude station where experiments were proceeding in parallel.

Each of the groups appropriated rice culture rapidly, although no more than a handful of the farmers had previously touched a rice plant. Innovations in several directions were necessary. Figure y shows the rapid change that occurred in irrigation management. Two practices coexisted the first season. Three of the four groups employed field-to-field irrigation, in which water passed from the field nearest the diversion to others in turn. The other group relied on a peripheral canal that fed each field directly. By the second season, all had gone over to the peripheral system, building canals up to 1 km in length. The first traveling seminar proved decisive. The greater efficiency and equity of the approach was clear and farmers from other groups could speak to colleagues who were learning to make it work..

Some of the institutional arrangements that made collective irrigation management possible (for example, rules and enforcement mechanisms for maintenance labour) also spread rapidly, although innovation continued over several seasons to deal with problems of free-riding (people evading collective tasks knowing others will complete them). The groups also quickly found appropriate scales of cooperation for tasks such as nursery preparation and protecting rice crops against birds. The traveling seminar hastened convergence among the groups in all these practices. They had less effect in terms of cropping patterns and rotations, which tended to reflect local physical conditions, the economic orientation of the groups and their scale of management (Loevinsohn, Mugarura and Nkusi, 1994).

Figure 3. Changes in irrigation practices among farmer groups.
Time is measured from the beginning of rice cultivation in the valleys.

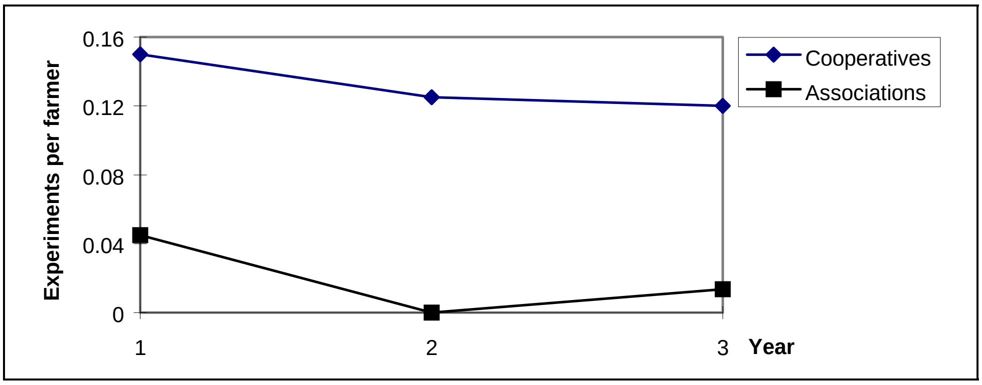


Box 3: Innovation in Rwandan valleys: green manures

Among the possibilities for intensifying valley agriculture discussed with farmers in the project described in Box 2 was the use of local *Sesbania* species as green manures. No formal applied research had yet been conducted in the country on this theme. Farmers, for their part, knew the trees well, but not the practice of green manuring.

As we have seen, farmers rapidly found solutions to several problems related to the integration of rice in their farming systems. Progress was slower with green manuring. The idea of turning under a crop was unfamiliar and fertility was not perceived as a major constraint in the valleys. Initial trials also encountered numerous obstacles: germination and nodulation were often poor, drainage often impeded *Sesbania*'s growth and pest infestations were at times devastating. As Figure 4 illustrates, the rate at which innovations were generated and tested was low in both coopératives and associations, but relatively higher in the former, and it remained higher over 3 years. The coopératives persevered in the face of the difficulties, recombining ideas about when, where and how to grow *Sesbania* in order to produce a useful quantity of biomass. The close and long-standing relationships among the coopératives' members helped maintain a common purpose when the interest of some individuals waned. After the leader of one coopérative told researchers the group was no longer interested in *Sesbania*, they heard the next week, from another member, that the group still wished to pursue some ideas. It was this group that eventually identified what appeared the most promising option, in which *Sesbania* was sown between sweet potato mounds, then incorporated *in situ* or in neighboring fields. Maize yield was increased 30% in this way in one trial. The results suggest that self-structured groups with demonstrated cohesion and regular contact make more persistent and dynamic research partners than those whose members have little ongoing relationship. That advantage may be particularly important in difficult areas of natural resource management. Experience in the valleys indicated it was less significant in research on a more straightforward technology like rice varietal selection (Loevinsohn, Mugarura and Nkusi 1994).

Figure 4: Experimentation with green manures by two types of farmer groups



Box 4: Meeting the needs of women in labour-scarce households

In the Kenyan highlands, a joint project of the International Institute of Biological Control, the Ministry of Agriculture, Livestock Development and Marketing, the Kenyan Institute of Organic Farming and the Coffee Research Foundation conducted a series of Farmer Field Schools for smallhold coffee and vegetable producers. The FFS is an approach to enhancing capacity to manage resources by enlarging the concepts and principle's that farmers have at their disposal. This is done through discovery-based learning, in groups generally of 15-20 that meet in and beside the fields, through a season. The importance of trying out options, whatever their source, and continuing experimentation after the FFS, is repeatedly stressed.

An evaluation 1 ½ years after the end of the first FFSs assessed the changes that had occurred in farmers' practices, as well as the economic, social and environmental effects of these changes. FFS graduates were asked what planned innovations they had made in specific crops, whether they were still using the innovation and with which other farmers they had discussed their experience who showed real interest. From this information birth and death rates were calculated as in the case described in Box 1. Farmers were also asked the source of the innovation.

A number of options that had been introduced and tested in the FFSs were taken up by graduates without further modification, with little mortality and were diffused quite rapidly to other farmers. Other options, such as botanical pesticides, proved more problematic. Graduates encountered difficulties including lack of efficacy under field conditions and labour constraints. Figure 5A indicates that botanical pesticide practices are, on current trends, likely to evolve differently in the tea and non-tea growing areas. In the latter, diffusion is outstripping abandonment and the practice (more accurately suite of options) is set to spread. The sources of farmers' innovations are diverse (Figure 5B): some use what they tried in the FFS, others have modified these options (a few significantly), some use their own ideas, while others have taken up ideas of other farmers.

The situation in the tea growing area contrasts sharply. Here, the demands on family and especially women's labor are much greater. Several women reported that they just don't have time to collect plants and prepare the pesticides. This is reflected in a high rate of abandonment of the practice. On present trends, the model suggests it will die out. The source of innovation analysis shows that a smaller proportion of graduates innovated with botanical pesticides than in the non-tea areas and that all of these took their ideas unmodified from what they had learned in the field school. Contributing to this lack of local innovation is that the FFS group ceased to meet in the tea area shortly after the project ended. In the other areas, the group continues as a forum for discussing ideas and practices.

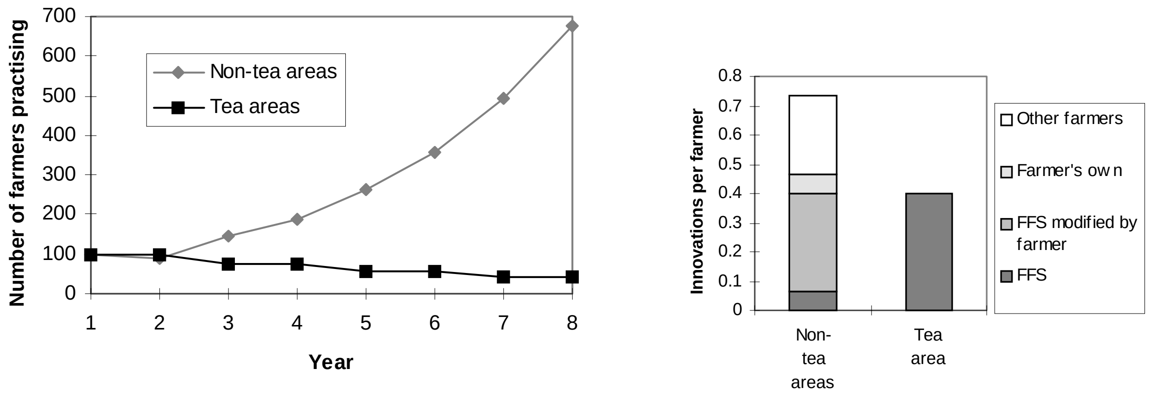
In terms of design choices, the analysis suggests that tea zone farmers, particularly women, would have benefited more from a participatory initiative focused on the development and refinement of time-efficient control methods (for example, through augmentation of natural biological control), rather than the broad capacity-building FFS. This would require a more engaged participation of research-oriented facilitators.

(From Loevinsohn, Meijerink and Salasya 1998)

Figure 5: Dynamics of botanical pesticide innovations on vegetables in the FFS communities.

A. Projected use based on birth and death rates calculated from interviews with FFS graduates.

B. Sources of innovation in botanical pesticides cited by the graduates.

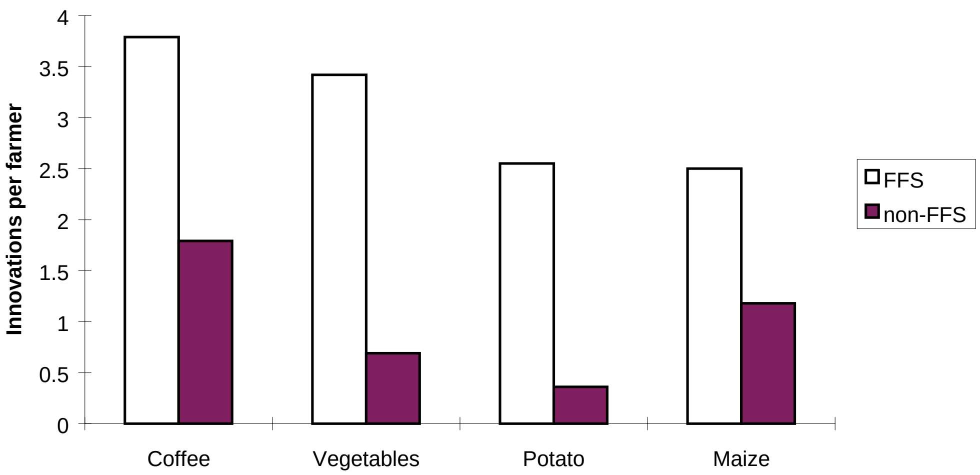


Box 5 Capacity to manage natural resources in Kenya

The evaluation of the Kenyan Farmer Field School (FFS) project introduced in Box 4 also assessed the capacity to manage resources that the FFSs had contributed to at the household and community levels. It divided the issue into two parts. First, to what extent were the graduates able to apply the principles and practices they had learned in the FFS on the different enterprises of their own farms? The FFSs had focused on coffee and vegetables and one of the aspects the evaluation considered was how invention rates on graduates' farms had been affected in both those and other crops. Invention was assessed as the planned innovation, or conscious changes farmers reported having made from one year to the next in any aspect of the management of a given farm enterprise. Figure 6 shows that innovation was significantly greater among FFS graduates than nearby control farmers on both the crops treated in the field school and on two others. This and other evidence suggested that farmers were able to generalize what they had learned.

The second aspect of capacity the evaluation considered was the extent to which farmers were able to apply principles and adapt practices *on a continuing basis*. Definitive evidence was impossible to collect in an assessment at only point and that relatively soon after the FFSs had ended. But qualitative and quantitative indicators of the health of the 5 basic evolutionary processes provided a basis to assess the project's impact on ability to meet future challenges. For example, as regards the movement of ideas and practices, it was found that diffusion from FFS graduates was highly stratified: men diffused mostly to men, women to women. The perpetuation of practices and principles was compromised by the fact that neither men nor women appeared to have diffused much to young farmers under 30 years, who represented only 10% of the "diffused" group. With respect to recombination, the FFS group remained intact and continued to meet and discuss innovations in 3 of the 4 villages. Some of these also took on other functions, such as mobilizing savings for small-scale credit: this diversification may be important to the survival of the groups. However, the groups proved unable to mobilize collective action in agriculture, though members had identified important opportunities. Selection and invention were also considered. The evaluation concluded that, while the project had clearly effected some elements of capacity, there remained important gaps in the capacity of farmers and their communities for continued innovation.

Figure 6. Planned innovations by FFS graduates and control farmers on crops treated in the Field School (coffee and vegetables) and two other major crops (maize and potato). 1996 and 1997 combined.



(From Loevinsohn, Meijerink and Salasya 1998)