FROM PROBLEM TO IMPACT: A CONCEPTUAL MODEL FOR INTEGRATIVE, FARMER PARTICIPATORY RESEARCH FOR SUSTAINABLE AGRICULTURE

Elske van de Fliert and Ann R. Braun[1]

International Potato Center (CIP), ESEAP Regional Office,
P.O. Box 929, Bogor 16309, Indonesia.

SUMMARY

This paper offers a conceptual model for integrative, participatory research for sustainable agriculture aimed at achieving impact. The purpose of the model is to provide a systematic framework for farmer participatory research that can guide the design of projects, their analysis and the documentation of results. In the model, explicit boundaries are drawn between research and development, development and extension and between extension and implementation. The objectives, activities and actors associated with each of these realms are described; and the desired focus for monitoring and evaluation during the whole process is clarified. Examples are provided from three case studies of participatory projects with a retrospective analysis and self-critique based upon the model.

INTRODUCTION

Farmer participatory research has received increased attention and recognition since the "Farmer First" (Chambers *et al*., 1989) and Participatory Technology Development (Jiggins and De Zeeuw, 1992) concepts were first introduced in the late 1980s. Acceptance of the important role that farmers can play, if given a chance, in agricultural research, development and extension has considerably grown. More and more mainstream institutions have realised that generating standard technologies is not enough to achieve impact in farmers' fields covering a range of agroecological and socio-economic conditions, particularly those in resource-poor and risk-prone areas. This change in perception is widespread and has been internalised by several centres of the Consultative Group on International Agricultural Research (CGIAR) through a System-Wide Initiative on Farmer Participation and Gender Analysis (System-wide Programme on Participatory Research and Gender Analysis, 1997). Many other organisations are also implementing innovative measures to involve farmers in the technology development process. Research intending to contribute to the development of sustainable agriculture will have to consider the ecological and socio-economic diversity of the agricultural production systems, and the role that farmers play (and have played for centuries) in managing these systems in a certain way and with certain objectives. Such considerations call for integrative and participatory approaches.

In approaches such as on-farm and farming systems research, farmers are often considered as research subjects or passive components of the system under investigation. In contrast, farmer participatory research advocates farmers' involvement as collaborators, or at least joint decision makers, at all stages of the process and places particular emphasis on their participation at the early stages of problem definition and setting of research objectives. Benefits of such an approach include early definition of the criteria that farmers use to assess technology (System-

[1] Present address: Centro Internacional de Agricultura Tropical (CIAT), Apartado Aéreo 6713, Cali, Colombia.

wide Programme on Participatory Research and Gender Analysis, 1997) and the development of adaptable technological guidelines, rather than standard technologies, to meet user needs and preferences. Hence, the likelihood of location-specific adaptation and implementation of these guidelines becomes much greater, as has been shown in many publications (e.g., Haverkort, *et al.*, 1991; Bentley, 1994; Sperling *et al.*, 1993).

The early involvement of farmers in the research and development (R&D) process usually leads to the formulation of a problem tree with many ramifications, rather than a single clear-cut problem. This difference in perception between farmer-users and scientists stems from farmers' more integrated, holistic view of farm management, as opposed to that of the discipline-oriented scientists, who are taught to break problems up into manageable parts. The participatory approach often leads to the need to address complex interrelated problems that require attention to numerous related sub-problems. Consequently, this requires an integrative, multidisciplinary perspective from teams, which can include discipline-oriented specialists. Farmer involvement in the R&D phases will also contribute to the identification of appropriate extension mechanisms and methods to share innovative approaches with larger numbers of farmers. The contemporary focus on sustainable agriculture does not imply large-scale transfer of standard technologies, as has been the mode for a long time, but it involves location-specific, informed practice and consensual decision-making in agroecosystem management. This requires collective farmer learning about technological innovations consisting of flexible guidelines to be adapted and enhancement of problem-solving and decision-making capacity, on the one side, and facilitation of human platform building for resource use negotiation and collective decision-making at the larger ecosystem level (Röling and Jiggins, 1998), on the other side.

Despite the growing recognition for integrative, farmer participatory research, many institutions and individual researchers still choose to apply approaches dominated by narrow technical and economic perspectives, neglecting complementary social and more macro perspectives (Röling, 1997). This may be for the valid reason that basic disciplinary research is needed, or for the less valid reason that researchers have not been trained to deal with, or do not feel comfortable with, holistic and social dimensions. Despite positive prognoses about the future of participatory research given, for instance, by a number of scientists in the CG system (e.g., Ashby *et al*., 1995), such work is threatened in many CGIAR centres given the current funding and policy climate (Fujisaka, 1994). Additionally, the scientific value of participatory research is often questioned, especially from the standpoint of replicability and the less formalised definition of evaluation criteria. Indeed, not much participatory work can be called scientific according to the methodological criteria used in conventional research (Holland, 1997). However, before considering whether failure to fulfil scientific criteria is positive or negative, it should be determined whether conventional research offers the best solution for tackling the problem. This depends on the actual objectives and expected impact of the research, which are not always made clear in efforts to evaluate experiences and impact of participatory projects. Many participatory research activities are of a pilot nature, and impact has rarely been documented systematically. The literature abounds with inconsistent, confusing jargon, supposedly for lack of methodological training for scientists on farmer participatory research approaches. The boundaries between research and development, development and extension, and extension and implementation are often vague or absent. Identification of research and development phases and the definition of objectives for each of them are often neglected. Enhanced consensus on the purpose and principles of participatory farmer research approaches, and a better understanding of methods and the characteristics of each of the process phases can help make participatory research more relevant, efficient, and scientific.

This paper provides a conceptual model for integrative, farmer participatory research and development in the context of sustainable agriculture development aiming at achieving impact in farmers' fields. The paper is complemented by insights from three case studies which use the model as a framework for analysis. The cases assess how successfully each project discerned the different phases in the research and development process and analyse the effect of confusing the phases on project evolution. Finally, the paper describes how the model can be applied to design or analyse other projects.

CYCLING FROM PROBLEM TO IMPACT

The model for integrative, farmer participatory research for sustainable agriculture aiming at impact described here, was partly developed as a framework for project design and evaluation in the context of the UPWARD[2] and CIP-supported "Sweetpotato Integrated Crop Management (ICM) and ICM Field School Development" project in Indonesia[3]. Given that the project was designed according to the model, and that the model was adapted as the project advanced, a high degree of congruence between model and project can be expected. Two other UPWARD projects, i.e. a Bacterial Wilt Project in Nepal and a Potato IPM Project in the Philippines, provided the case study material presented in this paper (see boxes)[4]. The design of the Nepal and Philippines projects was not based upon the model, and the corresponding case studies are based upon its retrospective use for analysing these experiences.

It is emphasised here that the model does not intent to be a cookbook containing recipes to be followed rigidly, nor should it be considered something fixed and final. The diversity of approaches common to farmer participatory research is one of its strengths. Through the model we aim to demystify some concepts and terminology often used erroneously or inconsistently, and to provide a systematic map of our way to navigate in integrative, farmer participatory research.

The framework

Farmer participatory research projects aim at achieving tangible impact by encouraging farmer involvement at all stages. It is not always clear what is meant by impact; therefore the concept should be clearly defined from the start. This paper defines impact as *achievements directly related to the overall goals of the activity*; i.e., improvement of sustainable livelihoods of rural families in a certain region. Achievement of impact is a very ambitious goal requiring both qualitative change (e.g., farmer capacities, practices, collective action, support system) and quantitative change (e.g., a considerable number of people reached and income generated). Careful planning at each project stage to achieve (1) appropriate problem definition and setting of objectives, (2) successful generation of applicable information or innovations, and (3) appropriate development and use of dissemination mechanisms and their effective implementation, can contribute to the achievement of this kind of impact. Such research and development activities demand a team of practitioners (farmers), technical and social scientists. The farmers provide the holistic perspective, share what works and what needs to be improved in the current system, set the evaluation criteria for innovations in accordance with their

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[2] User's Perspective With Agricultural Research and Development, which is a CIP-affiliated network of Asian researchers doing participatory R&D in rootcrop systems.

[3] More detailed information about project methodologies and achievements can be found in UPWARD publications (UPWARD, 1996; 1997).

[4] The full document (see Van de Fliert *et al.*, 1998) may be obtained from the authors.

objectives for farming, and test possible innovations. The technical scientists share new technological information that may provide options for improvement, and methodologies for testing the options. The social scientist help identify the constraints and opportunities in the support system, seek ways to reduce the constraints and enhance the opportunities, and translate technological innovations into farmer learning objectives.

Figure 1 presents a possible route from problem definition to impact in the context of sustainable agriculture development. The framework emphasises iterative phasing or cycling of activities and a division of major responsibilities among different actors in the process, by distinguishing three main activity realms, i.e.:

- Research and development.
- Extension and implementation.
- Monitoring and evaluation.

These realms are strongly interconnected and activities in the individual realms will partly overlap in time and space. Additionally, the process is not limited to a linear set of sequential activities, but allows back and forth movement between the activity realms. A predisposition of this model is that intensive farmer training is needed to achieve the objectives of enhanced problem-solving and decision-making capacity, and platform-building[5]. These objectives have to be considered and anticipated during all phases of the process.

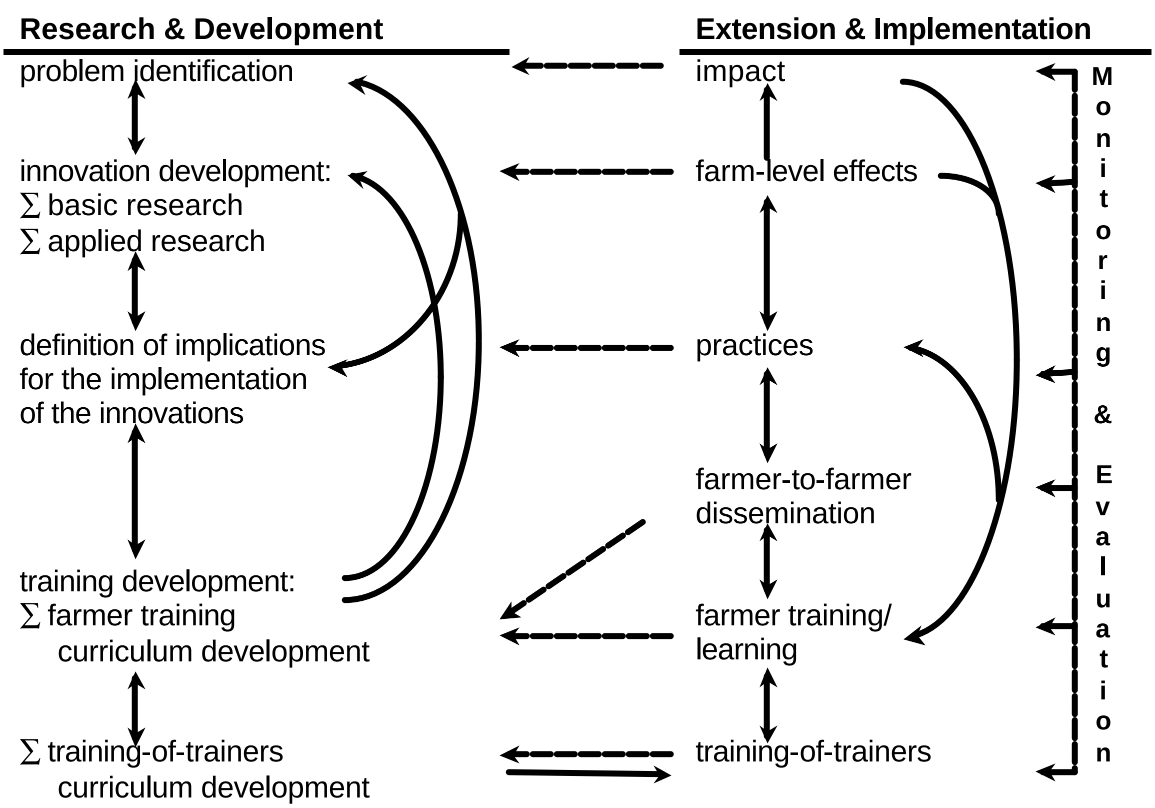

Figure 1: Framework for integrative, farmer participatory research aimed at impact.

[5] Other methods, such as farmer research committees (Ashby *et al*. 1995) or farmer-run action research facilities (Ooi, 1998), may also foster farmer learning if designed in accordance with their learning styles and needs, but these are not elaborated here.

In conventional research and transfer of technology systems, research is seen as the exclusive domain of scientists, extension as the distribution of the message by an army of officers of a formal extension service, and implementation as the straightforward adoption of the recommended technologies by the farmers. In farmer participatory research for sustainable agriculture, however, the research and development realm (the left leg in the figure) consists of co-creative processes to identify the problems, generate new information and innovations, consolidate them with adequate existing farming practice, and then translate them into learning objectives and activities for enhanced farmer performance. These processes are likely to be highly iterative and synergistic. The right leg of the framework (extension and implementation) contains the phases during which efforts are made—either in a formal or a non-formal settings—to share the innovation with larger groups of farmers, who then test, evaluate and internalise (or reject) them in their farming practices, finally leading to impact. The monitoring and evaluation realm forms a maze involving and collating the other two realms by observing and measuring what happens during training and implementation, and relating and/or feeding back this information to the research and development realm for further adjustment or impact assessment. A summary of objectives, activities and actors for each realm is presented in the sections below.

The research and development realm

The major mission of agricultural research institutes has been to increase global food production and to minimise the effects of production-reducing factors. The scientists' task therefore implies both the development of novel technologies and the solving of problems that arise in the systems developed. Research is often divided into basic and applied modes. These are complementary, both being indispensable in the process of conventional and participatory development of innovations. In participatory research, the topic under investigation is not determined solely by researchers—as is often the case in conventional research. Whether the development initiative derives from the farming community or from outsiders (researchers, development workers), scientists together with the community should clearly identify problems and needs to set the agenda for further activities. Constant identification of changed needs is required throughout the process to adjust the activities accordingly.

As a collaborative effort of researchers and representatives from other stakeholder groups, participatory research should begin with detailed identification of problems and try to gain a understanding of the broad agroecological and socio-economic context. Many methodologies have been developed over the past decades to assist researchers and farmers in participatory problem identification, of which Participatory Rural Appraisal (PRA) has become the best known and most widely applied (Chambers, 1994). Problem identification should lead to the (participatory) formulation of overall project goals and specific research objectives. When users are actively involved in problem identification, analysis and setting of objectives, it is likely that identified needs refer to a variety of problems to be resolved, crossing multiple scientific disciplines (Box 1). When research capacities are limited with regard to either funding or expertise, priorities should be carefully set with the participation of all stakeholders, taking into account the interrelatedness of the various problems. The output of the problem identification phase is a prioritised research agenda. An important component of the problem identification phase is the determination of already existing alternatives to solve the problem(s) that may have to be tested under different conditions, and should later be consolidated with innovations.

The sweetpotato ICM development project in Indonesia was a collaborative effort among sweetpotato farmers from East-Central Java, a local NGO (Mitra Tani), an international agricultural research centre (CIP-ESEAP Region), the Research Institute for Legumes and Tuber Crops, and Duta Wacana Christian University. Although initially designed as an Integrated Pest management (IPM) project, results of the needs identification study re-oriented the project towards ICM at an early stage in order to address farmers' major concerns. The project assessed a range of aspects including:

- The impact of cultivation practices, pests and diseases on production.
- Farmer knowledge of crop health, pests and natural enemies.
- Current crop and pest management practices.
- The marketing system.
- Farmer decision-making capability with respect to crop and pest management and marketing.

In a mid-elevation area (1200-1500 m) of the southern Philippines, vegetable and potato cultivation generates the highest net income per ha, about 8-10 times that of maize. Potato cultivation threatens sustainable use of natural resources because of erosion from up-down ploughing, downstream water pollution from pesticides, and deforestation by farmers seeking BW-free areas. During village-level workshops, researchers, extension workers, farmers and local leaders discussed possible solutions. A potato IPM project was designed to address these issues. As an attractive alternative to potato cultivation, the project gave the farmers seeds of high-value vegetables.

Box 1. Participatory formulation of project goals.

Once the research agenda is set, innovation development follows. This phase is likely to include both a basic and an applied research component. Farmers' involvement in innovation development is particularly desirable at the level of applied research (Box 2). Their role may vary from "analysts and evaluators" (Fano *et al.*, 1996) validating technologies developed, to "research collaborators," determining and testing treatments in their own fields (Ashby *et al.*, 1995; Braun and Van de Fliert, 1997). Whereas basic research is primarily considered the domain of technical scientists, technical and social scientists and farmers are all expected to play a role as actors in the applied research phase. The degree of involvement of each will depend on the nature of the problem and of the possible solutions to the problem. Continuous feedback among the actors doing basic and applied research, as well as reflection on the findings of the problem identification phase, is desirable to ensure the consistency of components developed.

"Development", in the Research and Development context, is defined here as the translation and validation of innovation development outputs in relation to the agroecological, socio-economic and cultural conditions in the target areas. Development should not stop after applied research, which is often considered the final step at the boundary of research mandates. Applied research should be followed up by deliberate attention to the task of training development. Experience has shown that the linear, top-down linkages between research and extension, as practised in conventional transfer of technology extension models, often failed because of inappropriate technology and/or inadequate "packaging" of the extension messages (Röling, 1988).

Within the framework for integrative, farmer participatory research, the first phase of the potato bacterial wilt (BW) project in Nepal fell mainly in the R&D realms. Problem identification was based on a rapid rural appraisal conducted by a multi-disciplinary team including a plant pathologist, entomologist, agronomist, extension worker and socio-economist. Farmers functioned as interviewees and informants. Once problems became clear, possible control methods were investigated by team members doing MSc research. After the IDM methodology had been designed, implementation was discussed with farmers, resulting in a project plan and formation of a Cropping Systems Improvement Committee. The R&D process was iterative within the development, extension and implementation realms, feeding back to the researchers so they could adapt their methodology before attempting it in other villages.

In the Philippines, the "Community-Based Pest Management for Sustainable Vegetable Production" project involved the Northern Mindanao Agricultural Integrated Research Centre, the Municipal Agricultural Office and UPWARD as part of the Sustainable Agriculture and Natural Resources Management Program (SANREM), funded by USAID. Sixty-three farmers (six groups and four individuals) experimented with alternative seed sources (true potato seed and quality seed tubers); and four groups in different villages participated in establishing IPM pilot sites as a basis for developing a sound technology and training curriculum.

Box 2. Pilot experimentation sites involving farmer groups.

Moreover, consistency is needed between the nature of the innovation and that of the extension approach and methods applied to convey the innovation to farmers (Röling and Van de Fliert, 1997). Therefore, to ensure consistency, we should look not only at the innovations *per se*, but also define the capacities that practitioners need to implement them, as well as the requirements for the support system (input supply, markets, etc.). This leads to an analysis and definitions of what a change in agricultural practice by the developed innovations implies for the farmers. What knowledge, attitudes and skills will they need? This is central to the development phase and needs attention before efforts are focused on training development. The importance of this phase is clear in the contrast between "simple" technological innovations (e.g., the introduction of an improved variety) and complex, sustainable agricultural approaches such as integrated pest, nutrient or crop management. Adoption of a new variety can be evaluated by quantifying the area planted to it. In contrast, for Integrated Pest Management (IPM) and other complex practices, the overall expected output of "improved problem-solving and decision-making capacity and platform building" has to be translated into an extended set of clearly defined operational indicators in order to design appropriate training activities enhancing such knowledge, skills and organisation. Traditional linear, content-oriented approaches—often pre-packaged in the form of diffusion materials—have not proven effective for the more complex processes inherent to the development of a sustainable agricultural system (Matteson *et al.*, 1994). The characteristics of such an approach are knowledge intensive with both a macro and a micro perspective, tend to be location specific, and require analytic problem-solving and decision-making skills in order to be sustainable. Consequently, there is a need to explore the concomitant communication methods required for a successful outcome. Additionally, the process of defining the implications for implementation of the innovations may provide new insights for problem identification and/or raise issues that need to be fed back to the phases of applied or basic research.

The framework in Figure 1 shows training *development* as the next component of the R&D leg; hence still the responsibility of scientists. Preferably, this responsibility is shared by technical and social or extension scientists, and of course farmers, where appropriate. Training development implies the design of activities, modules and media for farmer training, based on the definition of the implications for the implementation of the innovations. Field testing of these activities is part of the development process (Box 3).

In Indonesia, Sweetpotato ICM technology was developed through:

- Analysis of farmers' practices as documented during needs identification.
- Experiments conducted by farmer researchers.
- Experiments at the CIP field station.
- Literature review.

The technology was revised after testing in a pilot ICM Farmer Field School (FFS). The ICM FFS curriculum was based on pilot FFS activities:

- Testing a rice IPM FFS model as a basis for sweetpotato ICM FFS.
- Designing a tentative sweet-potato ICM FFS curriculum and a Training-of-trainers curriculum based on FFS evaluation.
- Conducting, evaluating and revising the FFS and training-of-trainers curricula, documented in a 250-page manual for FFS facilitators.

Box 3. Curriculum development for sweetpotato ICM.

Only when the curriculum for farmer training is set, can we begin thinking of a curriculum for training-of-trainers, preferably applying the same methods as those to be used in farmer training. Extension officers (either GO or NGO) rarely have the capacities to do this job given their limited training in non-formal education and methodology development, which requires skills different from those needed to be a good extension worker (Box 4).

In the second phase of the Philippines potato IPM project, the national IPM programme "Kasalikasan" joined the project, offering a nine-day training-of-trainers event, followed by an FFS (twenty weekly sessions) for farmer groups.

Facilitators felt insecure because the training-of-trainers had been too brief to adapt the technology and curriculum to local conditions and different crop requirements, i.e. from cabbage to potato, since potato crop management technologies for mid-elevation areas were not available. Additionally, considering the actual problems farmers were facing with regard to the overall production and marketing system, the technology and training curriculum should have taken the entire cropping and post-harvest cycle into account. Given their limited experience with the IPM FFS, the trainers fell back into an instructive rather than a facilitative teaching mode.

The trainees had difficulties in internalising not only the major FFS concepts but also those related to potato IPM. experiments conducted in the FFS testing multiple treatments made it difficult to reach clear conclusions or to enhance farmers' experimentation skills. Given logistic constraints, the trainers were unable to provide full-scale technical and methodological backstopping. Their support was limited to technical presentations during the FFS sessions.

Box 4. Training-of-trainers in the Philippines potato IPM project.

The extension and implementation realm

Extension—understood here as a function of disseminating an innovation to a wider audience—is not normally considered part of the mandate of research institutions (Fano *et al.*, 1996); therefore suitable mechanisms and partners have to be found to facilitate dissemination (Box 5). To ensure that these partners can do their job well, scientists can play an important role as they have both technical and methodological skills. Extension workers of GOs or NGOs, on the other hand, have a comparative advantage as communicators at the village level, although they may contribute to the development process as “pre-testers” of new training methods. They must, however, have obtained appropriate training themselves in a training-of-trainers programme before they can be expected to run a training curriculum according to the model. The involvement of accomplished trainers is critical to the success in the field.

Transitions from the R&D to the extension phase are not usually smooth given the traditionally weak linkages between these realms. In the case of a community approach to potato BW management in Nepal, a multi-disciplinary team from the Lumle Agricultural Research Centre (LARC) promoted a multi-pronged Integrated Disease Management (IDM) approach that included:

- Widespread awareness of the seriousness of BW.
- Elimination of infected planting material.
- A three-year ban on growing potatoes.
- Crop rotation with non-host crops.
- Disease-free seed
- Roguing of self-sown potatoes.
- Farmer education on IDM.

Pilot-scale activities were initiated in two villages. After three years, the project was extended to two more villages. Positive results in two villages showed that the community approach was effective for managing BW. Failure in the other two villages was due to some farmers' unwillingness to respect the ban.

Analysis based on the integrative, participatory research framework suggests that the first phase reflected an iterative R&D process within the development, extension and implementation realms, feeding back to the researchers to adapt their methodology before transferring it to other villages. The second phase should have been conceptualised as a scaling-up activity within the extension and implementation realms. Expansion was strongly hampered by the continued involvement of the researchers, who failed to transfer responsibility to existing extension mechanisms. The project had not anticipated impact on a larger scale at the work-plan preparation stage, where researchers would gradually hand over tasks to the extension system and the farmers.

Box 5. Transition from R&D to extension in the potato IDM project in Nepal.

In many developing countries, extension services lack the human resource capacity --in terms of both quantity and quality of staff --to reach a critical mass of their target audience effectively (e.g., Röling, 1988). Much of the information reaching farmers is disseminated by other farmers, either directly by conveying experiences or indirectly by showing them an example of practices implemented in the field and the resulting effects. Recent experiences with IPM training in several Asian countries have shown the positive impact of involving farmers as trainers, and of enhancing farmer networks in order to support farmer-to-farmer dissemination deliberately (Eveleens et al., 1996; Braun, 1997). Farmer facilitators must be selected with care and given additional training on facilitation methods. At the same time, a training programme needs to address farmer interaction/network requirements at the planning stage (Box 6).

Trainees from six major sweetpotato-growing districts in four provinces of Indonesia made work plans for ICM FFS implementation with funds from the National IPM Programme and the local government. It was originally intended to scale up from a small core group of farmer master trainers (most had been farmer researchers in an earlier stage of the project). This proved untenable, their potential as field school facilitators having been overestimated. Although they felt confident as researchers, they felt much less so as trainers for lack of experience with the FFS training approach. A new plan for scaling up involved the national IPM programme (farmer) trainers.

One possible mechanism in this process was under-utilised; i.e., farmer-to-farmer dissemination. This option could have been anticipated by (a) clearly defining the expected output relating to awareness raising on sweetpotato ICM within the farming communities where sweetpotato ICM field schools are conducted, and (b) more specifically, developing activities in the field school model addressing farmer-to-farmer dissemination.

Box 6. Farmers as trainers.

For sustainable IPM or ICM projects, where considerable problem-solving and consensus decision-making capacities and platform-building efforts are required, farmers need more process-oriented training and support. A literature review of self-reliant and self-managed projects (Brekelbaum, 1990, 1994) identified various essential skills for farmers, including:

- Critical thinking.
- Diagnosing and solving problems.
- Formulating and prioritising objectives.
- Developing and implementing action plans.
- Communicating effectively.
- Systematising information and analysing results critically.
- Identifying indicators for quantitative and qualitative monitoring and evaluation.
- Developing external linkages, both horizontal and vertical.
- Showing solidarity.

In the case of IPM/ICM, farmers also need to understand the complex interactions between host plant/pest, plant health/tolerance, population dynamics and other ecological principles. This type of knowledge and skills development not only requires interaction over a period of time, but also special facilitators who are themselves capable of handling these processes. The training-of-trainers would therefore need to contain the same learning processes as the training for farmers, to ensure that the trainers have experienced the process of enhancing their knowledge and skills.

The major actors in the implementation realm are, of course, the farmers who decide to implement, adapt or reject an innovation promoted to them. Enhanced knowledge and skill—obtained in training events, through contact with fellow farmers or any other form of learning—are expected to lead to a change in farmers' farming practices. At this stage scientists have no direct role in the process and have to rely on feedback through monitoring and evaluation efforts as to how farmers respond to the innovation. At most, in pilot sites, scientists can work together with farmers to adjust guidelines according to the specific conditions. Many theories have been developed to explain the process of adoption of innovations (Rogers, 1995); but in sustainable agriculture, **adaptation** to farm-specific conditions is considered a more valuable output than the straightforward adoption of a new technology or methodology. The ability to adapt guidelines is evidence of farmers' enhanced capacity to experiment, analyse, evaluate and, finally, solve many of their own problems without having to depend upon external advice.

Feedback mechanisms, however, are critical in this realm because farmers often receive contradictory messages from other sources (e.g., promotional campaigns by commercial companies that sell inputs) that could lead to confusion. Questions arising during implementation need to be addressed by trainers whose role is also to support the adjustment process and help bridge communications between farmers and researchers.

When changes occur in farmers' capacities and practices, effects at the farm level can be expected, for instance, yield increase, reduction of expenditures, and more balanced pest and natural enemy population ratios in the field. Such changes occurring on a larger scale are expected to result in a broader impact, such as improvement of rural people's livelihoods and a healthier environment. Effects and impact achieved, when beneficial to farm families, are expected to trigger further dissemination and learning within the farming community.

The monitoring and evaluation realm

Scientists re-enter the scene as direct players in this realm. Systematic monitoring and evaluation of projects assures the capacity to make adjustments before it is too late, learn from experiences and justify the research investment. Rapid feedback is critical where farmers are unfamiliar with a new crop, a new technology or a more complex, integrated innovative approach. In participatory projects, monitoring and evaluation should be planned and implemented in conjunction with the farmers. In many research institutions, economists are in charge of evaluating research projects; hence evaluations often focus on cost-benefit analyses of novel technologies. For integrative research projects dealing with sustainable agriculture, economic analysis alone is insufficient since it will not reflect project objectives that are human resource oriented.

In order to be able to justify the R&D investment, the monitoring and evaluation system should be designed to consider the outputs in relation to the objectives set for each R&D phase separately. The expected outputs of the activities and elements in the extension and implementation realm should relate directly to the objectives of the activities in the R&D realm at the same horizontal level (see horizontal links in Figure 1). Is the impact of the activities consistent with the overall goal? Are the farm-level effects in accordance with the nature of the innovation (for instance, reduction of pesticide load on the farm ecosystem as a result of IPM practices)? Have farmers' capacities and practices after training reached the levels required for implementation of the innovation? Do dissemination mechanisms result in effective farmer-to-farmer communication? Are the processes of farmer education and training-of-trainers compatible with the curriculum design? The indicators for monitoring and evaluation should also derive from these outputs. This implies that to obtain impact, scientists should seek mechanisms for incorporating extension and implementation requirements when setting objectives for R&D. Monitoring and evaluation of clearly defined indicators should generate valuable feedback to the scientists for further R&D, if needed. This information can then be used effectively to adjust the R&D activities further, if needed, or serve as an example to other projects.

This is a huge task; and when budgets are restrictive, evaluation efforts tend to be limited to the elements that donors require; i.e., mostly the data traditionally collected by economists, such as yield and economic returns. In the case of sustainable agriculture, however, evaluation indicators should relate consistently to the project objectives, which, if defined well, will focus on people and their environment as much as, or even more than, on technologies and economics (Van de Fliert, 1998). We have learned that farmers' competence to manage their farms independently under the specific conditions they themselves know best is the key to improving sustainable farming systems and thus to sustainable livelihoods. Solid documentation based on evaluations focusing more on the human factor and interactive processes in agricultural development could play a pivotal role in understanding further the changes needed (Box 7).

The Indonesia sweetpotato ICM project deliberately phased over the technology (ICM) and training (FFS) models developed to the existing extension mechanisms—i.e., through training-of-trainers and backstopping of farmer training—in an attempt to anticipate larger scale impact.

Indicators of the integrative nature of the project:
- Change of project scope from IPM to ICM.
- Multidisciplinary collaborators including 8 farmers.
- Specialised input for specific research activities for which no expertise existed on project team.

Indicators of the participatory nature of the project:
- Farmer researchers' intensive participation at all stages except proposal writing.
- Level of community involvement (farmers, traders, consumers) at problem identification stage and pretesting of models.

Consequently, research addressed farmers' needs and contributed highly to validation of guidelines and methods developed. ICM guidelines were therefore readily accepted by farmers attending FFS, as well as by the government institutions in charge of root crops. Nevertheless, the farmer researchers raised the issue of how their research activities would directly benefit their fellow farmers, which had not apparently been the case. The discussion showed clearly that perceptions about "impact" differed. Impact, as defined in the model, cannot be expected only from participatory technology development activities and should therefore be avoided as research still carries risk. On the other hand, benefits of research should—to the extent possible—be tangible to motivate farmer interest in participating. At the same time, monitoring and evaluation activities should identify factors leading not only to success but also to failure, including indicators dealing with the human factors.

Box 7. The impact of farmer participation in all project stages.

APPLICATION OF THE MODEL

The diversity of ecological zones and farming systems requires a flexible approach to research and development. Additionally, the complexity and interrelatedness of cultivation problems in small farm systems within the context of the total support system is poorly served by strictly disciplinary research approaches. An example is the increasing occurrence of aphids and other insects on rustic crops like sweetpotato in Indonesia. Injudicious insecticide use triggering resurgence has partly contributed to this situation, but the main cause is higher-than-necessary levels of nitrogen fertiliser applied by the farmers every season. Over-fertilisation leads to faster population growth of aphids. Although storage root yield may be reduced as a consequence of excessive nitrogen application, some farmers believe they can get a higher price if the crop looks green and lush when a trader comes to the field to negotiate purchase of the standing crop. Pest, fertilisation and marketing issues are interwoven so it would be of no use to develop and disseminate aphid control strategies without touching upon the other issues and making sure that farmers understand their interrelatedness.

Another example of the need for a change of course in R&D is the evolution that IPM underwent during the past decade, particularly in rice-based cropping systems in Asia. IPM's first principle of "grow a healthy crop" implies attention to a wide array of cultivation practices contributing to the prevention of pest attack in an ecologically sustainable way (Van de Fliert, 1998). In IPM development for sweetpotato in Indonesia, where pest pressure is only low to moderate in most seasons, farmers demanded greater emphasis on cultivation practices other than pest control strategies, and on marketing strategies, resulting in a change in project focus to ICM. This also occurred in sweetpotato IPM programmes in Vietnam and Uganda (Braun and Van de Fliert, 1997). ICM in Indonesia goes as far as developing training activities to enhance the marketing skills of farmers' who perceive this to be their major problem. The relationship between cultivation problems and market diversification becomes clear here: better crop management contributes to more efficient production, enhancing the prospects for using the crop as a raw material where farmers can get added value through processing and thereby improve their livelihood (Braun *et al.*, 1995).

When facing situations as complex as this, scientists with narrow disciplinary training may choose to combine forces with colleagues from other disciplines and with farmers having the necessary holistic perspectives. Integrative and participatory, co-creative approaches to R&D recognise the human factor as the core element to attain synergistic outputs and impact. The importance of determining and then reconciling the different perspectives of each of the stakeholder groups cannot be overly stressed. When the different realms and disciplines are brought together, communication often breaks down. Although it takes time and energy to achieve this, it is critical to project success (Box 8).

In the potato IPM FFS project in the Philippines, the training-of-trainers FFS was intended as an arena to develop appropriate technology guidelines and concomitant extension exercises. Both trainers and trainees interpreted the project more as an effort to promote potato-vegetable cultivation without taking into account technological limitations. Farmers were active in the FFS experiments, but given the complex nature of the high-value vegetable-potato production system, their participation was difficult at several stages, especially those of planning and problem identification. The structure did not permit sufficient farmer participation in either technology or training development. Moreover, project actors had different perceptions of the realm they were working in, resulting in confusion among research, development and extension objectives.

This divergence of perceptions was further aggravated by non-participatory nature of the problem identification process. For lack of carefully defined and prioritised problems, FFS trainers recurred to materials from the cabbage IPM FFS approach. They were less open to developing new extension methods and viewed technology dissemination as more important than technology development. Consequently, the project suffered for lack of clear consensus as to the objectives and systematic planning and implementation of activities in anticipation of farm-level effects and impact. As a result of the problems encountered during the Training-of-trainers-FFS cycle, there was inadequate adjustment to local conditions.

Box 8. The importance of a shared perspective in complex multi-disciplinary projects.

The model presented herein is meant as a tool to facilitate the simultaneous phasing of such R&D activities. The nature and severity of the problem will determine the depth of integration and participation needed to reach the desired impact effectively and efficiently. This can be decided only on a case-by-case basis, by factoring into the model information needs, possible solutions, records of experience, expertise and funds available. When certain steps cannot be taken due to limited resources (e.g. funds, mandates, connections, adequately trained people), alternatives should be sought to guarantee the desired impact, or objectives should be adjusted in line with a more realistic expected impact.

If used flexibly within a condition-specific context, this model will yield a different experience each time it is applied. The experience of navigating this model just once increases the likelihood that integrative, farmer participatory research and development processes can be extended to similar problems in different regions and/or different commodities, thereby optimising research output and impact.

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