

Recognising a Climate for Sustainability: Extension Beyond Transfer of Technology

Elske van de Fliert¹

Abstract

Sustainable agriculture emphasises the fundamental role of the human component in the production system, as opposed to conventional agriculture, which centres on technologies. Therefore, it is characterised by the abilities and behaviours that farmers display, such as the knowledge and skills they possess, decision-making processes they apply, and individual and collective actions they take. This has strong implications for extension development and organisation, in that the methodologies applied should be oriented towards enhancing farmer capacities favourable to sustainable agriculture, rather than towards achieving adoption of standardised technologies. These capacities include sound ecological knowledge, observational, analytical and experimental skills, and inclination towards collectivity to allow farmers to make better, informed decisions for location-specific agro-ecosystem management. Extension approaches favouring this type of learning are participatory, experience-based and adaptable. Needs and opportunity assessment, participatory technology development, defining the implications for farmers of the implementation of an innovation, and development of a concomitant learning curriculum (first for farmers and then for facilitators) are among the sequential phases for solid extension development for sustainable agriculture. Applying underlying principles of participatory capacity development, rather than fixed, condition-specific models, provides a generic framework for extension development under diverse ecological and socio-cultural settings.

Introduction

Sustainable agriculture has become the name of the game in agricultural development, after we learned the hard lesson that intensive, high-external-input agriculture does show increased production of some major food crops under certain conditions but also results in serious degeneration and pollution of the environment in both potential and marginal areas. The concepts of regenerative and sustainable agriculture were first mentioned in the early 1980s (Harwood, 1990). Initially, most efforts concentrated on the biophysical context and the development of sustainable technologies that would avert the negative side-effects of so called 'modern' agriculture or even regenerate affected agro-ecosystems (e.g. Altieri, 1987; Edwards *et al.*, 1990; Reijntjes, *et al.*, 1992). However, there is increased awareness that both biophysical components and processes and human factors need to have equal attention, because they are intrinsically connected. Rölting and Wagemakers (1998) speak about the "five interlocking dimensions of the transformation to sustainable farming", which are:

¹ Integrated Pest Management Specialist/Coordinator of the Working Group on Participatory Research and Learning, International Potato Center, Regional Office for East and Southeast Asia and the Pacific (CIP-ESEAP), Bogor, Indonesia

- ◆ Agricultural practices
- ◆ Learning those practices
- ◆ Facilitating that learning
- ◆ Institutional frameworks that support such facilitation
- ◆ Conducive policy frameworks

The management of change from conventional to sustainable agriculture along each of these dimensions requires consideration of the entire, complex, hard and soft system, because change in one aspect affects the other aspects. An increasing number of interesting experiences across the globe have been reported along these lines over the past decade (e.g. Van de Fliert, 1993; Pretty, 1995; Hamilton, 1998; Somers, 1998). These experiences lead to the conclusion that learning required for effective implementation of sustainable farming practices, or better ecosystem management, can only be achieved by facilitation using methodologies that are in concert with the nature of sustainable production systems, and within the context of institutional and policy frameworks supporting ecologically sound agriculture. This type of facilitation contrasts with the transfer of technology paradigm for agricultural extension which, for decades, has been strongly embedded in agricultural extension systems all over the world, particularly those applying the Training-and-Visit model introduced by the World Bank (Benor and Harrison, 1977). Whereas transfer of technology served the promotion of standardised, prescribed, single-component technologies and aimed at straightforward adoption of these technologies, extension for sustainable agriculture should serve to facilitate holistic change processes at the farm, farmer, group, ecosystem and institutional levels.

This paper describes both generic concepts and concrete cases, which all find a base in our own experiences within the context of integrated crop management research and development programs in Southeast Asia. It provides an analysis of the nature of sustainable agricultural practice and of the implications for farmer learning and implementation. It elaborates on our experiences in developing and institutionalising farmer field schools for sweetpotato integrated crop management in Indonesia, Vietnam and the Philippines. Finally, as a synthesis of lessons learnt it presents a framework for sustainable agricultural program planning and evaluation.

Sustainable agriculture: what makes the difference?

Altieri (1995) defines sustainability from a primarily agro-ecological perspective as “the ability of an agroecosystem to maintain production through time, in the face of long-term ecological constraints and socio-economic pressures”. A more comprehensive characterisation is given by Reijntjes *et al.* (1992), who list five features necessary for an agricultural system to be deemed sustainable: it must be ecologically sound, economically viable, socially just, humane, and adaptable. To better understand what this means for agricultural extension, we should first analyse what implications these definitions have for individual farmers and farming communities.

1. Sustainable agro-ecosystem management requires sound knowledge of ecological processes, and how these processes can be optimally used and enhanced, rather than hampered, in farming practice. Examples are predator–prey interactions for natural pest management, requiring farmers to be able to distinguish between pests and natural enemies, or nitrogen fixation for efficient nutrient management, for which farmers need an understanding of plant nutrients, soil bacteria and the effects of management practices on the soil.
2. The core of good management is to promote a healthy crop. But this has many aspects, such as soil, water, seed, and a healthy ecosystem as a whole, and the interrelatedness of those aspects. Technologies applied should be considered a tool, rather than an end in themselves, and should be compatible. They should serve the overall goal of keeping the ecosystem healthy, while interfering only minimally with useful ecological processes. This makes farming complex. Although farmers normally have a much more holistic view of their farm enterprise than researchers or extensionists, assessing the compatibility of individual technology components and ecosystem aspects, which all together configure the complexity, is not that easy and may not come naturally. Farmers will need to learn to manage diversity and complexity by making effective use of the interaction of the various ecological factors and processes (Thrupp, 1996).
3. Each farm has its specific biophysical and socio-economic characteristics, which is why production systems promoted should be adaptable. Moreover, farm conditions vary over time in response to seasonal influences, which relates to both weather and market conditions. Location and season specificity requires farmers to be informed, analytical, proactive and flexible. Skills that can be acquired to become better decision makers are, for instance, field observation, agro-ecosystem analysis, experimentation, and farm economic and market analysis.
4. Sustainable farming is favoured by high biodiversity in the (larger) agro-ecosystem, which encourages relative stability of pest and disease populations at low, undamaging levels. In many intensive cropping systems in developing countries, fields cultivated by individual farmers are small, often smaller than 0.5 ha and sometimes only 500 m². Pest and natural enemy populations, and even water and nutrient flows, in one field are strongly influenced by those in the neighbouring fields. Individual implementation of sustainable practices may be less effective than when implemented collectively over large areas, requiring some sort of community organisation.
5. Infrastructure should be conducive to adequate and timely implementation of practices that were decided upon after a well-informed decision making process. This relates to availability of production inputs and labour, access to credit facilities and markets, and opportunities for collective community action.

Extension for sustainable agriculture: people rather than technology-centred

Conventional extension systems, particularly in developing countries, have been designed as a mechanism to transfer technologies developed at research institutes to the farmers. Farmers

are seldom involved in agenda setting for technology development, or in testing and evaluating the technologies. In a typical linear flow of information, researchers convey technologies to subject-matter specialists, who train extension workers, who in turn, through directive training sessions and/or demonstration plots, try to persuade contact farmers, who are then supposed to extend the message to the follower farmers. The primary aim of this transfer of technology paradigm is straightforward adoption of the technology. This model seemed effective for the promotion of single component technologies, such as the introduction of high-yielding varieties of rice in Asia in the 1970s, particularly among those farmers who happened to fulfil the necessary requirements for adoption, including availability of or access to capital, labour and fertile land. However, it has been heavily criticised for failing to reach resource-poor farmers adequately and to respond to greatly varying needs of farming communities, particularly those working under marginal conditions (Cox *et al.*, 1998). For long, and in line with their main objectives, appraisal of these extension systems applied indicators on the basis of predicted levels of adoption of the technology, such as area planted to new variety and yield increase (Garforth and Harford, 1997), and tried to show causal relationships between these effects and the extension services (Murphy and Marchant, 1988). The main variable for evaluation of the extension process was the number of visits by the extension worker to the farmers, and no attention was paid to more crucial aspects such as farmer practice and decision-making leading to the farm level effects measured. Additionally, reasons for non-adoption were not investigated but may be crucial; for instance, no access to factors other than those provided by the intervention only, such as credit or markets (Röling, 1992).

As described above, sustainable agricultural systems centre on people rather than technologies. Consequently, extension efforts promoting such systems should focus on capacity building of people, which is then expected to lead possibly to adoption but more likely to adaptation of the technological guidelines provided using ecological knowledge and decision making skills acquired. It seems obvious that such competence cannot be achieved through brief, instructional, classroom training, as is the predominant training mode of the conventional technology transfer mode of extension. A consistency is needed between what is to be learned and learning methods (Röling and Van de Fliert, 1998). Mastering ecological knowledge is only effectively achieved by building on existing knowledge through discovery learning. Skills can only be effectively acquired when actually practised. Location-specific adaptation of technological guidelines should be based on local field-testing and evaluation using farmers' criteria. Collective decision-making and action, and individual and group empowerment, are best installed through collective learning and enhanced group dynamics. This calls for interactive, participatory, field-based and experimental learning processes.

The application of novel farmer extension methodologies has implications for training of trainer models applied. Promoting people-centred sustainable systems involves facilitation of interactive learning processes rather than simply instruction, as is the case in the transfer of technology paradigm. Developing capacity of facilitators requires a methodology consistent with the approaches future trainers are expected to apply, because we tend to teach the way we

have learnt ourselves; for most people with a formal education this has been in an instructional mode (Van de Fliert, 2000). Traditional teaching habits need to be unlearned. Instead of eliciting straightforward answers, facilitators should try to raise questions to let farmers think and discover answers for themselves. Instead of classroom teaching, facilitators should set up activities and experiments in the field; this requires thorough planning and accurate season-long implementation and monitoring. Instead of determining the training content, trainers should listen to farmers' analyses, conclusions and needs, and react flexibly. Instead of assuming an expert role, trainers should consider the farmers as the experts and build on the farmers' existing knowledge and experience. Therefore, trainers need to experience how it feels to learn by discovery, by hands-on field activities, and by building from existing knowledge. They need to go through the experience of carrying out all cultivation practices themselves—essentially to become farmers themselves—in order to build respect for farmers and enhance their own self-confidence in their interaction with experienced farmers (The Indonesian IPM Program, 1996).

Farmer field school for learning and development of sustainable agricultural practices

A training model that provides opportunities to farmers to become competent agro-ecosystem managers was developed by the FAO Inter-country Rice IPM Program in Asia², and piloted in Indonesia in 1989 (Matteson *et al.*, 1994; Kenmore, 1991). The model is called the 'farmer field school' (FFS)—farmers go back to school in the field, their daily work place. The training strategy, founded on non-formal education principles, emphasises learning by doing, and empowering farmers to identify and solve their own problems. Participation, self-confidence, and collective action and decision-making are fostered during the experiential learning process (Van de Fliert, 1993). An IPM FFS lasts for a whole growing season, involving a group of up to 25 farmers in weekly sessions of, on average, four hours. The trainer is not an instructor, but a facilitator of the experiential learning process. In each weekly session, participants monitor the observation plots, and small groups undertake an agro-ecosystem analysis and present their findings to the rest of the participants. Special sessions deal with locally occurring field problems, or provide opportunities to discover processes, causes and effects of phenomena occurring in the field. Additionally, group dynamics exercises enliven the school, strengthen the coherence of the group, and make the members better aware of the importance and dynamics of group processes.

Successful IPM field schools often become platforms for follow-up activities, spontaneously organised, and funded, by the field school graduates; an example is the IPM clubs in Vietnam (Eveleens *et al.*, 1996). During these follow-up activities, the farmer groups study newly occurring cultivation problems, organise collective control measures, set up experiments to further fine tune technological guidelines according to the local conditions, and even get into wider aspects of

² In full: Inter-country Program for the Development and Application of Integrated Pest Control in Rice in South and South-east Asia, Food and Agriculture Organization of the United Nations. Presently, the fourth phase of this programme is being conducted as the Program for Community IPM in Asia. For more information see <http://www.communityIPM.org>.

community development, such as rice–fish culture, collective marketing of produce, and advocacy for fair share cropping agreements (Van de Fliert and Wiyanto, 1996). People-centred extension methodologies enhance farmers’ ability to put in practice what they have learnt, but also teach them how to create and exploit opportunities for further learning.

A framework for sustainable agricultural research and extension

The International Potato Center’s (CIP) sweetpotato integrated crop management (ICM) program in Southeast Asia developed a framework for designing and evaluating participatory research and extension projects, which reflects the five dimensions for the development of sustainable agriculture, mentioned above. The project in Indonesia was designed according to an initial version of the framework, and the framework developed as the project advanced. Then the framework was applied to expand activities to Vietnam and the Philippines.

The framework described here should not be considered something fixed and final. It can serve as a basis for systematically designing and evaluating other participatory projects for sustainable agricultural development, but is not a set of rules to be followed rigidly. Different conditions in different countries and environments will require location-specific approaches and solutions. Our experiences were specific for the context of sweetpotato ICM development in Southeast Asia, where we were dealing with highly diverse smallholder farming systems. Being an approach to sustainable agro-ecosystem management, ICM is complex, hence requiring location-specific, informed decision-making by farmers, and collective action. A predisposition of this framework is, therefore, that in order to achieve the overall objectives of enhanced problem solving and decision-making capacity, intensive farmer training is needed.

Figure 1 shows a possible route from problem definition to impact within the context of sustainable agriculture development (Van de Fliert and Braun, 2000). This framework emphasizes iterative phasing of activities, and a division of major responsibilities among the various stakeholders, distinguishing three main realms of activity:

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

These realms are strongly interconnected, and their respective activities will overlap in time and space. Also, the process is not limited to a linear set of sequential activities, but allows for cycling within and between the activity realms.

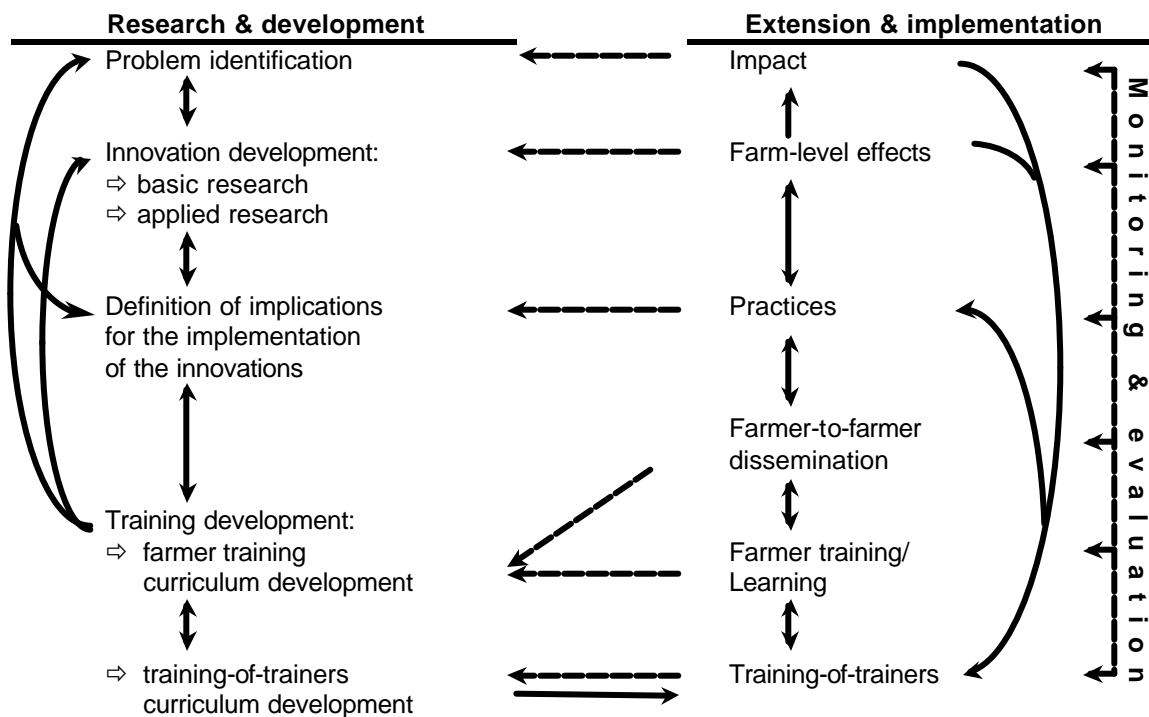


Figure 1: Framework for research and development for sustainable agriculture

Research and development

The research and development realm comprises 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. Participatory research targeting the needs of poor farmers should begin with collaborative identification and analysis of problems, needs and opportunities, in an attempt to gain an understanding of the broad agro-ecological and socio-economic context. This includes the identification of already existing alternatives to solve the problem(s); these alternatives may need to be tested under different conditions, and should eventually be consolidated with innovations. The problem identification phase should lead to the (participatory) priority setting and formulation of the overall project goals and specific research objectives. The final output is a prioritised research agenda.

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. Their role may vary from 'analysts and evaluators' (Fano *et al.*, 1996) validating existing technologies, to 'research

collaborators' determining and testing treatments in their own fields (Ashby *et al.*, 1995; Braun and Van de Fliert, 1997).

'Development' (within the context of research and development) is defined here as the translation of research results into practical applications appropriate to the agro-ecological, socio-economic and cultural conditions in target areas. The development process should not end with applied research. Applied research should be followed up by deliberate attention to training development. To ensure consistency between content and methodology of farmer training, we should not only look at the innovations *per se*, but should 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 assessment of what a change in agricultural practice provoked by the innovations might imply for the farmers. What knowledge, attitudes and skills do they need to implement the new practices and ideas? Answering this question is central to the development of the applied technology, and a prerequisite for the development of training strategy. The process of defining the implications of implementing 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, or even problem identification.

Development of training curricula is the next component of research and development. Preferably, technical and social or extension scientists would share responsibility and farmers and extension officers would be involved in field-testing and validation. Training development implies designing activities, modules and media for farmer training, carrying out pilot studies, and revising the activities, modules and media accordingly. Once the curriculum for farmer training is set, development of a curriculum for training the trainers can begin, preferably applying the same methods as those used for farmer training.

Extension and implementation

Extension and implementation encompass the phases when efforts are made—in either formal or non-formal settings—to share the innovation with larger groups of farmers who then test, evaluate and incorporate (or reject) them in their farming practices. Changing farming practices should ultimately lead to substantive impact.

Extension—defined here as a function of disseminating innovations to a wider audience—is not usually considered part of the mandate of research institutions (Fano *et al.*, 1996). Therefore, suitable mechanisms and partners must be found to perform this function. It is important to ensure that potential partners can carry out extension work efficiently: Scientists can play an important training role here, contributing both technical and methodological skills. These skills may be complemented by those of GO or NGO extension workers, who have a comparative advantage as communicators at the village level. However, potential trainers must themselves be trained before they can run a curriculum according to the training model specifications. The participation of accomplished trainers is critical to success in the field. Training programs should

also address farmer interaction and horizontal communication requirements from the start—during the planning stage.

The major actors in the implementation realm are, of course, the farmers. Farmers decide to implement, adapt or reject an innovation. Enhanced knowledge and skills—obtained through training, contact with fellow farmers or any other form of learning—are catalysts for change in farming practices. The ability to adapt guidelines rather than follow a standardised recommendation 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. Response mechanisms, however, are critical in this realm because farmers often receive contradictory messages from other sources (e.g., promotional campaigns by commercial companies selling alternative inputs), which could lead to confusion. Questions arising during implementation need to be addressed by trainers, whose role includes supporting the adjustment process and helping communications between farmers and researchers.

When farmers' capacities and practices change, tangible effects at the farm level can be expected. These may include yield increase, reduction of expenditures, or more balanced ratio of pests to natural enemies in the field. When such changes occur on a larger scale, an even broader impact can be expected, such as the improvement of rural people's livelihoods and/or a healthier environment. If initial outputs prove beneficial to farm families, they will most likely be disseminated further, contributing to a general increase in the knowledge base of the farming community.

Monitoring and evaluation

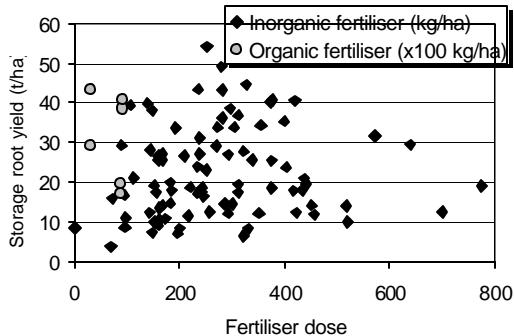
The monitoring and evaluation realm overlaps and collates the other two realms. Researchers must observe and measure what happens during training and implementation, and must relate and/or recycle the information back to the research and development realm for further adjustment or impact assessment. Systematic monitoring and evaluation of projects ensures the capacity to make adjustments before it is too late, to learn from experiences, and to justify the research investment. Rapid feedback is critical when farmers are presented with new variables (for example, a new variety, a new technology, or a more complex, integrated innovative approach). Monitoring and evaluation of clearly defined indicators should generate valuable feedback for adjusting current project methodology, improving future research and development, and providing examples for other projects. Evaluation indicators should always relate to the objectives and expected outputs of each phase. For sustainable agriculture this means that well-defined indicators focus as much, or more, on people and the environment than on technology and economics.

Box 1

Development cycle for crop nutrition management components in sweetpotato ICM FFS

Needs assessment

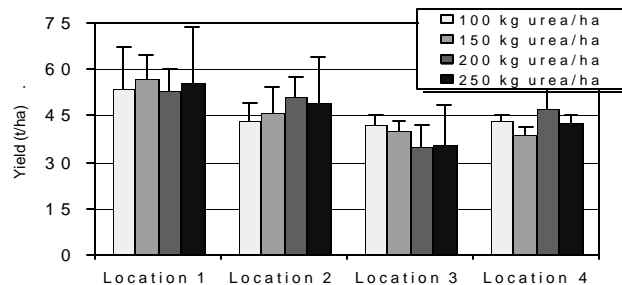
- ◆ Farmers' fertiliser management practices seemed highly inefficient, and no correlation between fertiliser dose and yield could be identified.



- ◆ Farmers admitted that they had never received extension on sweetpotato production. They were either following traditional practices or applying recommendations for rice production to the sweetpotato crop.
- ◆ Farmers expressed interest in learning about general crop management practices, particularly fertiliser application, to help them increase yields and reduce expenditures.

Technology development

- ◆ To verify inefficiency in (nitrogen) fertiliser application, farmer researchers conducted experiments to study the effect of urea dose on yield in four locations. No significant difference was found among treatments, indicating that the lowest dose, or less, would be adequate.



- ◆ Literature references reported the importance of the N:K ratio, urging farmer researchers to test this out in their fields. A positive response of potassium application to sweetpotato yields was found.
- ◆ The importance of organic fertiliser was stressed and tested under various conditions.
- ◆ Fertilisation guidelines composed included (1) the use of as much organic fertiliser as possible and (2) a method for calculating fertiliser needs based on expected yield and amount and type of organic fertiliser.

FFS activity development

- ◆ Soil sampling and observation: discussion on criteria of a healthy soil and how to achieve and maintain it.
- ◆ Discussion on criteria of a healthy crop and how to achieve and maintain it.
- ◆ Experiment on behaviour of inorganic fertiliser in water and soil; discussion on how application methods influence fertilisation efficiency.
- ◆ Sampling of leaves with nutrient deficiency symptoms; discussion on food for plants, function of major nutrients, during different crop growth stages.
- ◆ Discussion on sources of major plant nutrients, fertilisation practices and efficiency.
- ◆ Exercise comparing nutrient content and price per weight unit of nutrients of inorganic with those of organic fertiliser.
- ◆ Discussion and practice on experimental methodology.
- ◆ Economic analysis of the sweetpotato enterprise.

Assessment of post-FFS effects and impact

- ◆ More farmers applied (more) organic manure.
- ◆ Farmers applied less inorganic nitrogen fertiliser.
- ◆ Farmers understand the need for potassium (but cannot always afford it).
- ◆ Farmers observed nutrient deficiency symptoms.
- ◆ Farmers experimented with fertiliser doses.
- ◆ Many farmers obtained a better price from traders.
- ◆ Overall net return from sweetpotato tended to increase.
- ◆ Farmers learnt to learn themselves.

Analysing outputs in relation to the objectives set for each specific phase is depicted by the horizontal links in Figure 1. The expected outputs of the activities and elements in the extension and implementation realm relate directly to the objectives of the activities in the research and extension realm at the same horizontal level. Hence, the evaluation should provide answers to the following global questions: Are the processes of farmer education and training-of-trainers compatible with the curriculum design? After training, have farmers' capacities and practices reached the levels required for implementation of the innovation? Do dissemination mechanisms result in effective farmer-to-farmer communication? Do the farm-level effects concur with the intended objective of the innovation (for instance, was there a reduction of pesticide load on the farm ecosystem as a result of changed practices)? Is the impact of the activities consistent with the overall goal? These horizontal links clarify the idea that in order to achieve positive impact at the farmer, farm and farming community level extension and implementation requirements must be taken into account when setting objectives for research and development.

Box 1 provides an example of how the development of one set of ICM components, i.e. crop nutrition management, was handled using this framework. Each cell in the box describes a major phase in the project.

Conclusions

Purely technology-centred research approaches are no match for sustainable agricultural development, and transfer of technology methods do not meet the objectives of extension for sustainable agriculture. For farmers to be able to practice sustainable agro-ecosystem management they need knowledge of ecological processes, analytic and decision-making skills, and collectivity, while the existence of supportive institutional and policy frameworks are needed to make possible successful and reinforcing implementation. Our experiences in Southeast Asia, although specific to the location, environment and crop, have afforded some generic lessons regarding the development of extension models for sustainable agriculture that can probably be extrapolated to any ecological and socio-cultural setting:

1. Project planning should involve the assessment of needs and opportunities along the lines of the five interlocking dimensions of the transformation to sustainable agriculture.
2. Starting from what farmers already know and do provides a solid base for any possible change. Farmers should evaluate which of their current practices and knowledge are applicable to the transition to sustainable systems, and be given the opportunity to appraise innovations for their potential integration in the production system, using their own criteria.
3. Experiential learning, if it relates well to farmers' existing knowledge, perceptions and skills, is likely to achieve the most effective and applicable results with regard to farmer implementation of sustainable practices. Making that right connection is the most difficult part of designing experiential learning systems, and requires sound actor analysis.

4. Collective learning facilitates collective action, provided that content, methods and group composition are appropriately selected. Learning groups can more easily evolve into effective platforms for communication, action and conflict resolution within the community, as compared to community groups of individuals with diverse interests and no mutual set of concepts.

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