Sustainable farming systems can improve the living conditions and stabilize the ecological balance in the highlands of Northern Thailand. Concept development, training and extension activities in agriculture, soil and water conservation and agroforestry are the major tasks of a regional rural development programme there. Christoph Backhaus describes experiences with yield surveys in the highlands and gives outlines for a new approach.

From data collection to farmer assessment

Christoph Backhaus

As the activities of our programme are implemented by agencies of the Royal Thai Government, any concept or approach applied must be feasible in this context and must be agreeable to the staff concerned on all levels. Monitoring of adoption and impact has always been an important topic for the programme. with varying acceptance by the extension staff. Recently, extensionists have shown increasing interest to participate in this process as part of everyday extension work. This hopefully provides a good starting point for the project to adjust its approach to monitoring.

Assessing yields in farmers' fields and analysing reasons for yield differences are necessary and important means of evaluating the impact of project recommendations. However, in diverse environments and with diversified farmers' practices, the meaningfulness of conventional yield measurement surveys is rather limited. In a 3-year survey of a large sample of farmers, no significant correlation could be found between the so-called "adoption performance" as monitored in farmers' fields and the yields measured in the same plots (Robert et al. 1989). The major problems encountered in the yield measurement surveys are listed below.

Bias in data collection

The necessary data could be collected with a relatively high degree of accuracy by a team of enumerators who lived in the area for almost six months. If possible, the data were collected by observation or measurement, but some crucial information had to be asked from farmers, because it could not be directly observed in the field. However, a farmer who thinks he is expected to have followed a particular recommendation of the project would not always frankly tell an interviewer that he has not. This not only restricts the accuracy of the data collected about farmer adoption, but also biases the farmers' statements why certain recommendations or systems will not work. A farmer who knows that his rice yield is low because he could not weed as early as recommended due to labour constraints, will most likely give the interviewer another reason. Thus, farmers' perception of fixed recommendations causes an inevitable bias in adoption surveys. However, yield measurements which cannot be related to the farmers' actual practice and/or adoption of recommendations are of rather limited use.

Diversity of conditions

The diversity in the natural conditions such as soils and climate in mountain areas means that numerous factors determine crop performance. A huge sample is required if significant correlations are to be found by statistical analysis (assuming that the information describing the relevant yield-determining factors can be collected at all). More important: if diversity in farmers' conditions is very high, but the results can only describe an average situation, the meaningfulness of the results is more than doubtful.

The farmer is presented with the data measured in his fields and is asked to state reasons for the differences between the traditional and the sustainable farming plot. Photo: John Connell.

Thus, the main result of the survey was that, under highly diverse conditions, the usefulness of fixed, generally applicable recommendations is very restricted.

In such a diverse environment and under varying socioeconomic conditions, each farmer has to apply a different set of recommendations, considering the particular situation of his farm. However, where is the extension system which can provide the tailor-made advice to thousands of small-scale farmers, especially in highland areas with their communication and transport problems?

As a consequence, in 1989 TG-HDP interrupted its yield measurements for one season and has subsequently changed its approach to measuring impact. In the coming season, yields will be measured again, with farmers instead of from them. The yield measurements will become part of the extension process, rather than merely a data collection activity. Here, we can only outline the survey approach as it is planned at present, based on our previous experience, but we cannot yet report about the pros and cons of the new approach.

Introduction and sample selection

The sample selection starts with a meeting with the group of villagers participating in the programme. The concept and purpose of the survey is outlined, as well as the cooperation expected from a farmer whose yield is measured. Farmers who have been in the sample of previous yield measurement surveys are especially encouraged to participate, as their yields can then be compared over time. If more than one third of the participating farmers (the desired sample size) want to join the survey, randomization is done by drawing lots in the meeting, so that farmers understand why they are in the sample or not.

Yield measurements

Although most farmers grow a large variety of crops, only the yields of upland rice are measured, because this crop is by far the most important for the majority of families. Because upland rice reacts very sensitively to land degradation, it can be regarded as an indicator for ecological sustainability.

In the fields of the farmers in the sample, farmers and small teams of trained enumerators measure the yields in the "traditional" plot and in the "sustainable farming" (SF) plot, where farmers are supposed to have applied some of the project recommendations. Two methods of measurements are applied: replicated crop cuts in three 20 m2 plots per field, and measurements of the total volume (in traditional units) of the crop from the whole plot. The latter is conducted by farmers on their own, in order to compute the measurements in yield per unit area.

Evaluation

The yield measurements will be evaluated in two steps:

- interviews with individual farmers, during which the farmer is presented with the data measured in his fields and is asked to state reasons for the differences between the traditional and the SF-plot and (if available) for the differences over time.
- group meetings held in the village, to which all farmers participating in the programme are invited, regardless of whether their yields have been measured or not. The discussion in the meeting will be based on the measured differences between yields. Charts will be used in which each line represents a farmer and the yields measured in his fields. The remaining columns show the reasons for yield differences as suggested by farmers and whether or not these reasons apply for each farmer (see figure).

Farmer assessment

Another method will be to group farmers according to their yields and to ask them to find out the most important yield-determining factors which can be identified as the common differences between the groups, related either to the field characteristics or the management techniques applied. The extension worker as moderator can – if necessary – raise additional topics and ask farmers to find out whether they are also yield-determining factors.

The results of the meeting will be noted in the chart and presented to farmers in a summarized form after the meeting. (Even if most farmers cannot read and write, it was found that visualization of meeting results increases their understanding, if a combination of text and pictures is used on charts and if the charts are well explained to them. In addition, the use of writing in village meetings provides a stimulus for participation in literacy programmes.) The chart will be kept and made available as an entry point for further group meetings.

The results from each group meeting will also be presented in the monthly meetings of the area extension staff, when the results from about 20 such group meetings are summarized and evaluated by the extensionists. As the outcome of this evaluation, the extensionists will suggest to the project and their agencies how technical recommendations for the crops concerned could be adjusted and how the concept for next year's yield measurement surveys could be improved.

Thus, the purpose of yield measurements is a learning activity for farmers and extensionists and shall also provide the necessary information for concept adjustments. ■

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Production risk and soil management

It appears that through environmental degradation, poor management, and inadequate stewardship, the capacity of the soil to buffer against yield variance is being eroded. Consequently knowledge of the nature and causes of yield variability and how this relates to risk becomes very important.

Soil management minimizes risk through applications of the following principles and techniques:

- **Increasing the soil rooting depth.** This is fundamental because it increases the volume and in many cases the reliability of supply of moisture and nutrients to the plant. Rooting depth can be increased using techniques such as deep tillage, land forming (broad beds, ridges, etc), soil drainage, and sometimes lime application to neutralize the effect of aluminum toxicity at depth. (Crops or varieties with relative deep rooting systems often have better drought resistance (ed.)).
- **Increasing the organic matter content.** This applies particularly in situations where organic matter levels are naturally low, or where levels have been reduced through degradation. Techniques may involve zero tillage, improved surface mulch management, additions through composting, organic fertilizers or green manures, or stimulation of underground biomass production.
- **Better soil moisture management.** This is perhaps the soil factor which is the most critical for ameliorating production risk. In areas with excessive periods or amounts of precipitation, land drainage and land forming may be necessary. In semiarid and arid areas various techniques of moisture harvesting, coupled with improved soil physical conditions to enhance storage (by way of the above mentioned techniques), can be used. In either case, the aim is to improve the supply of moisture available to the plant, thereby reducing the risk of crop failure.

From: Dumanski, J. 1989. Understanding and evaluating crop production risk. IBSRAM Newsletter, No. 13, September 1989.

Criteria for assessment

Assessing technology for sustainable agriculture requires a set of criteria that covers all aspects of sustainability. The ILEIA Workshop looked at possible criteria and their indicators so as to develop a checklist.

New farming techniques have to fit into the specific and complex agroecological, socioeconomic, cultural and political setting of the farm. They have to contribute to satisfying the needs and objectives of the farm household. A technique may be multifunctional and may have a positive, negative or no impact on any of these needs or objectives, but the impact of the complete system of techniques used should achieve all of them. If sustainability is sought, the new technique should also contribute to meeting the objectives for sustainable agriculture (see "Local economies – framework for assessment").

Criteria and indicators

To be able to analyse if a technique fits the local setting and to what extent it contributes to meeting the objectives for sustainable agriculture, criteria are needed as a framework for assessment. To be able to measure the performance of a technique according to each criterion, quantitative or qualitative indicators are needed.

When different techniques are being compared, only those criteria need to be examined on which the alternative techniques have different impacts. Where complex, multifunctional techniques such as agroforestry are being assessed, the exercise can be rather complicated. Techniques function in combination with other techniques and can influence each other's performance in a positive (synergy) or negative (competition) way. It may therefore be necessary to compare sets of techniques, e.g. chemical fertiliser + improved seeds + pesticides vs organic manure + stress-resistant indigenous seeds. This makes the exercise even more complicated.

On account of differences in, e.g., agroecological and household settings or differences in needs and objectives, farm systems are highly diverse. Therefore, techniques that suit one farm will not necessarily suit another. Also within one farm, differences between fields with respect to, e.g., soil condition or distance to the farmhouse may demand different techniques to meet the same objective.

When choosing techniques, farmers may not always be aware of the implications with respect to sustainability. Often, there may be no alternative, if farmers do not have access to the necessary resources (e.g. land, nutrients, labour, cash, skills) and/or viable techniques are not available.

Supporting farmers

Outsiders such as fieldworkers, researchers and policy makers can support farmers in their decision-making. For example, researchers can increase the understanding of the ecological processes involved in farming and sharpen the criteria that could be used. They can also provide farmers with useful indicators, or support them in monitoring the performance of techniques and farm systems. Fieldworkers can strengthen farmers' capacity to assess technology with a view to sustainability.

Policy makers have a responsibility to add the interests of the nation as a whole to farmers' decision-making, introducing criteria such as "food security for the nation", "affordable level of imported inputs" and "favourable balance between food and cash production". The needs of the farmers to keep their systems sustainable and of the society to be nonpolluting must be kept in mind. Ensuring that farmers have access to the necessary resources (e.g. land, inputs, infrastructure, credit) and bringing in legislation to enhance sustainability are also tasks of the policy makers. But these support activities will be effective only if outsiders understand the economic complexity of LEISA. This is possible only when farmers and outsiders work together in mutual support of decision-making processes at farm and community level as well as at research and policy level.

Culture may provide criteria that have high priority in farmers' assessment. Photo: Wim Hiemstra.

Participatory Technology Development

For this reason, the ILEIA workshop placed technology assessment in the wider context of Participatory Technology Development (PTD), which consists of collaboration of farmers and outsiders in:

1 analysing the local farming system, including the dynamic aspects, farmers' objectives related to sustainability, felt needs and limiting factors;

2 collecting and selecting technology options that could address the felt needs and/or constraints;

3 trying out these techniques with continuous evaluation and monitoring of their performance;

4 spreading promising techniques more widely, and finding out under which conditions they can be used.

In this process, techniques are examined for their viability and compared with alternatives. It is not expected that the selected techniques provide permanent solutions, as conditions will change over time. PTD therefore aims not only at finding better techniques but also at strengthening local capacity to develop technology. It is meant to motivate farmers to become involved in further technology development to sustain their farm systems.

In Activities 2, 3, and 4 in a technology development process as outlined above, a criteria checklist is indispensable as a reference framework for assessing the relative performance of techniques.

Checklist for sustainability

The need to use a consistent set of criteria to cover all aspects of sustainability is not yet generally recognised or applied. Therefore, the ILEIA workshop saw as its task to propose a holistic, sustainability-oriented checklist of criteria. This checklist (see box) will need further improvement and should be adapted after field testing.

The farm system

If achieving sustainability of a farm system is a deliberate objective, the performance of techniques must be related to all aspects of sustainability: productivity, security, continuity, identity. The performance of each individual technique should be related to that of the system as a whole. For this, profound knowledge of the farm system, including its history and processes of change, is needed. Although the workshop focused mainly on the checklist for technology assessment, a list of key words was compiled to analyse farm and livelihood systems.

HISTORY
- origin of the settlement
- outside impact: influence, market incorporation, exposure to ideas and methods from outside (extension)
- population growth
- social and ethnic struggle

ECOLOGY ("carrying capacity")
- resource base of present farming systems
- which local resources are underexploited, in balance or overexploited?
- level of pollution
- ecological diversity

SOCIAL/POLITICAL
- ownership of and access to essential resources
- division and organisation of labour (quantity and quality)
- gender/class/age/ethnic/caste social relations, as affecting resource use
- inheritance patterns
- institutional power and control within village and at state level

CULTURAL
- consciousness of ecological situation, including pollution
- values and attitudes, affecting resource use and labour
- norms and sanctions
- religion and spiritual motivation
- gender, age and class issues
- experimenting capacity and learning habits (hierarchy, formal education)
- food habits

ECONOMIC
- degree of market orientation
- household survival strategies (on- and off-farm activities)
- food sufficiency and access to food
- credit and indebtedness
- nonmonetary exchange systems
- infrastructure: roads, access to markets, government services
- availability and affordability of external inputs.

These factors are all thought to influence farmers' motivation for change and hence the techniques chosen. The motivation can lead to spontaneous change ("autonomous technology development") or may need outside support ("participatory technology development").

Complementarity of criteria

Different actors are involved in technology development: farmers (women and men), development workers, researchers, policy makers. These actors use different criteria to assess technology and/or give different priorities to them. There is overlap, tension and complementarity between these criteria. To make a checklist that contains the criteria of all actors, ILEIA invited persons from these different groups to take part in the workshop. In small working groups, the participants gave their opinion as to which criteria should be included and what importance should be given to each criterion with a view to sustainability. Also indicators were discussed, but to a lesser extent.

The farmers in the workshop were especially interested in criteria concerning the farm level, whereas the policy makers were more interested in those concerning the entire nation, e.g. general food security, foreign currency balance. Development workers had the most holistic vision.

Complementarity of indicators

The farmers' group proposed mainly visual indicators. For example, for soil quality, they proposed soil life, colour, structure, temperature and depth; organic matter content; yield as indicator of fertility; amount and type of vegetation; presence or absence of certain weeds; and incidence of certain plant pests and diseases. The researchers preferred measurable indicators such as yield (in kg), cost/benefit ratio, gross margin, marginal rate of return (in monetary units), nutrient levels and balance, organic manure needed per ecozone/soil type/year/crop/ha, soil erosion (t/ha). These indicators often complement each other.

The relative importance given to the different criteria depends on the personal vision of the person applying them and the specific farm situation, which will change over time. Technology choice will therefore be very farmer-specific. Only in a continuous process of conscious adaptation toward sustainability can the right balance between the different objectives be found.

Rapid appraisal needed

As low-external-input farming systems are often complex, diverse and risk-prone, a holistic assessment of farm systems and techniques is not easy. Farming Systems Research (FSR) is being criticised for its time- and cost-consuming analysis process which, however, is still far from holistic. For example, many environmental impacts are left out as they are difficult to measure in their complexity (Worman et al 1990). It can even be questioned whether outsiders can make a holistic assessment of farm systems and techniques in a time- and cost-efficient way. Often, the assessment is limited to a minimum data set (TSBF 1990, Scherr & Muller 1991). This means, however, that only indications can be obtained of the performance of the techniques and of the system.

The users of the farm systems are the persons who know them best. To improve system analysis, Rapid Rural Appraisal (RRA) methods are being developed based on participation and self-evaluation of the farm community (e.g. McCracken et al 1988, Lightfoot et al 1990). With these methods it is possible to make cost- and time-efficient agroecosystem analyses which provides ecology-based frameworks for understanding farming systems and identifying problems perceived by the farm communities.

Recently some first attempts have been made to use such RRA techniques in technology evaluation and monitoring (Buck 1990). These attempts should be encouraged, as they provide useful instruments for technology assessment by farmers. ■

Criteria checklist for assessing farming techniques

Productivity

1 Does the technique meet farmer/household needs for kind?
- does it improve food availability, quality and security?
- does it sustain or improve the availability of secondary products (fuelwood, building material, medicines, gifts etc)?

2 Does it meet farmer/household needs for exchangeable products/cash?
- is there a market for the products?
- are prices high enough?

3 Is enough land available to produce farmer/household needs?
- quantity
- quality

4 Do labour requirements fit farmers' labour resources and needs for labour productivity?
- by gender
- by season

5 Do farmers have access to the necessary inputs?
- available
- affordable

6 Do financial requirements fit farmers' monetary resources and needs for cost efficiency?
- by different costs (nutrients, pesticides, hired labour, transport, provisions, bribes, etc.)
- by season

Security

7 Does the technique minimise the risk of
- crop failure (pests, diseases, climate)
- financial failure
- health hazards
- non-availability of external input
- inappropriateness of exotic species

8 Does it leave sufficient management flexibility?

9 Is it based on the use of local resources (e.g. land, water, genetic resources, knowledge, experience, skill) and locally produced inputs?
- are these resources under the control of the farmers?

10 Does it reduce dependency on information, inputs, subsidies, credit and markets?

11 Does it avoid conflicts of interest?

Continuity

12 Does it maintain/enhance soil quality?
- soil life
- soil fertility (macro-, micro-nutrients)
- nutrient balance (macro-, micro-nutrients)
- structure
- water-holding capacity

13 Does it recycle nutrients?

14 Does it prevent/reduce soil/nutrient loss?
- soil cover
- complementary root structure
- water conservation

15 Does it enhance/maintain perennial biomass (grasses, shrubs, trees, animals)?

16 Does it use water in a safe and efficient way?
- water-use efficiency of crops
- overpumping
- drainage

17 Does it enhance diversity (genetic diversity and mixed farming)?

18 Does it reduce toxic effects on people and resources?

19 Does it enhance human health?

20 Are maintenance costs of ecological and economic infrastructure affordable?

21 Does it recycle capital?

22 Does it have neutral or positive effects on systems beyond the farm (watershed, village, downstream areas, nation etc)?
- use of nonrenewable resources
- pollution of air, water, soil
- production of "greenhouse gases"

Identity

23 Does the technique integrate well within the existing farming system?
- agroecological
- socioeconomic
- household conditions
- gender
- evolution

24 Is it feasible to introduce the technique given the existing infrastructure (credit, roads, transportation, support by extension service etc)?

25 Does it fit/strengthen the culture of the farming population?
- social organisation
- religion or values
- preferences
- perceptions of social justice

26 Can it be easily understood by farmers?

27 Is it consistent with government policy?
- does it generate employment opportunities with adequate returns (on-farm, off-farm)?
- does it contribute to regional/national food security
- does it enhance the foreign currency balance?

28 Does it benefit poorer/powerless farmers (men, women)?

Adaptability

29 Has it been practised already by small farmers or has it spread spontaneously?

30 Does it bring rapid, recognisable success?

31 Does it stimulate or allow experimentation/adaptation by farmers?

32 Can it easily be communicated to other farmers?

33 Can knowledge, skill easily be transferred to farmers by training?

Guidelines for use

This is a checklist and not a should-list. People working with this list should feel free to give high or low value to the different criteria, modify and/or skip or add new criteria.