Integrating participatory elements into conventional research projects: Counting the costs and measuring the benefits

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Abstract

Until recently, participatory and conventional approaches to agricultural research have been regarded as more or less antagonistic. There is increasing evidence, however, that participatory methods can be successfully combined with conventional agricultural research. In this paper I present experience from three subprojects of a long-term Thai-Vietnamese-German collaborative research program on "Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia" in which participatory elements were integrated into conventional agricultural research as add-on activities.

The first subproject had a focus on "Pests and beneficial insects in fruit orchards". A researcher-controlled experiment with four different treatments (with/without pesticides and with/without mowing) was set up on a farmer's field. The scope of this reductionist approach was broadened by a parallel study on local knowledge of insects with interested farmers by means of group discussions and field visits. This approach helped to set up a list of major pest insects in the subcatchment that could be more intensively studied in the second three-year phase of the project. The second subproject entitled "Efficient water use of mixed highland cropping systems" used farmers' soil classifications to develop a local soil map that enabled scientists to compare local knowledge of soils with scientific soil classification approaches. Through the local soil classification the soil scientist was able to identify soil types that could not be determined during a previous scientific soil survey. While the local soil map differed widely from the scientific soil map, it showed striking similarities with the petrographic map which opens new opportunities for scaling up soil information from the field to the watershed and landscape level in the next phase of the project. The third subproject had a focus on "Integration of cover legumes in fruit orchards". Conventional station-based and on-farm experiments were complemented by farmer-managed trials. In experimenting with cover crops in their hillside orchards, farmers were surprisingly creative. Farmers' experiments also showed that labor availability was the most crucial factor during the establishment phase.

In all three subprojects the costs of studying local knowledge or enhancing farmers' experimentation consisted of additional local personnel (facilitators, local interpreters), opportunity costs of time for participating farmers, and travel costs. However, these participatory elements of the research projects constituted only a small fraction of the total costs (2.8%, 4.2% and 5.6% respectively).

I conclude that conventional agricultural research can be complemented by participatory components in a cost-effective way while producing meaningful benefits in terms of (1) creating synergies by blending scientific and local knowledge, (2) scaling up micro level data, and (3) highlighting farmers' constraints in adopting soil conservation technologies.

1 Introduction

Assessing or measuring success of agricultural research becomes increasingly important for justifying national governments' spending on agricultural research and raising additional funds from international donors. As Alston et al. (1995: 19) put it "[A]gricultural research is an investment in the production of knowledge. It competes with other activities for scarce resources." This also applies to participatory research which is often regarded by its critics as producing only site-specific results, hence lacking reproducibility and being too time-consuming and costly, particular when it comes to issues of scaling up.

There is an increasing body of literature on assessing costs and benefits/impact of participatory research (e.g., Johnson et al., 2001, 2004; Smale et al., 2003; Lilja et al., in press). Only few of them, however, focus on projects in which participatory approaches were applied as add-on activities in conventional agricultural research projects.

Drawing on experience from three subprojects of a Thai-Vietnamese-German collaborative research program on "Sustainable land use and rural development in mountainous regions of Southeast Asia", I compare the costs of conventional research approaches and studies of local knowledge and farmers' experimentation that were added as a complementary participatory component. I argue that many conventional agro-ecological and agronomic studies are rather reductionist, site-specific and expensive, while low-cost participatory, add-on elements can substantially validate the significance of the research for a greater area and for different agro-ecological and socio-economic conditions.

2 Counting the costs and measuring the benefits of adding a participatory component to conventional research projects: Case studies from The Uplands Program

The Uplands Program is a long-term collaborative research program entitled "Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia". Its 16 subprojects represent a range of disciplines, such as soil science, agroecology, horticulture, agricultural economics and rural sociology. A particular feature of The Uplands Program is an "umbrella" subproject entitled "Participatory Research Approaches" whose objective is (1) to support participatory approaches as a cross-cutting issue in all subprojects and (2) to assess the potential and limits of stakeholder participation in different research contexts and research phases.

2.1 Study on pests and beneficial insects in litchi orchards in Mae Sa Noi subcatchment, Chiang Mai province

For the past 20 years, litchi production has been a major source of Hmong farmers' income in Mae Sa Noi subcatchment which is located about 35 km northwest of the northern Thai capital Chiang Mai. Recently, farmers have incurred significant losses from pest insects and started to apply high doses of broad-spectrum, hazardous insecticides, although little is known about whether these measures can effectively control these pests. In order to increase the knowledge of the major pests and their natural enemies and to identify more sustainable pest management strategies, one subproject of the so-called "Uplands Program" has been set up for a period of about three years (September 2000 to July 2003) to study the complex interaction of pest and beneficial insects in litchi orchards.

2.1.1 Objectives of the study and methods applied

For the development of alternative strategies of pest control, the first information needed is to know which are the major pests and the degree of damage they cause. In addition, the major natural enemies of these pests need to be identified. Therefore, one objective of the study was to analyze the arthropod community of the litchi orchards, to identify the major pest species and their natural enemies and to record their abundance and occurrence during the different seasons.

The subproject started with a general collection of agro-ecological data from different farmers' fields. These farmers were neither integrated into the knowledge generation process, nor were they well informed about the purpose of the project. At the behest of the project leader, the research associate established an on-farm-experiment. Negotiations with the field owner led to a research contract in which the rights and duties of both parties were agreed upon. The on-farm experiment was predominantly researcher-controlled; the farmer followed the instructions of the research associate as to the management of the trial. The plot was subdivided into four equal parts of 0.3 hectares in order to analyze the influence of different weeding practices (regular weeding versus no weeding at all) in combination with different pest management strategies (typical pesticide application versus no pesticide application) on the arthropod fauna and tree undergrowth vegetation in the orchard. A great variety of methods (insect traps, hovering, intoxication, direct observation) were applied to catch pests and beneficial insects in the experimental orchard and identify them in the laboratory.

Shortly after the setup of the trial, the limitations of this reductionist approach became obvious. It was not possible to determine spatial distribution patterns of insects and their migration behavior and temporary habitats in different life-stages. Following discussions between leaders of this subproject and a member of the subproject "Participatory research approaches", a study on local knowledge was initiated, involving a group of farmers interested in the subject. The study carried out jointly by members of the two projects was combined with feedback for farmers on the research results of the on-farm experiment and a joint analysis of the findings.

Regular meetings with individual farmers and group discussions were organized in order to get information about pest problems and farmers' strategies to cope with these problems. Farmers were encouraged to make regular checks in their orchards and bring typical insect species in different life-stages for analysis by the scientists and for discussions about the reasons for their occurrence and their lifecycles and habitats. A problem of the meetings was the fluctuation of participants, ranging from four to 18 farmers. Field excursions with farmers and demonstrations of pest and beneficial arthropods were also organized occasionally.

2.1.2 Results of the study and benefits of integrating local knowledge of insects

One of the results of the 'scientific' part of the study was a detailed knowledge of the major pests invading the experimental plot during the three-year research phase. Another outcome was the effect of different combinations of pesticide treatments and undergrowth management on the occurrence of pests and beneficial insects. These results, however, could not be easily extrapolated to the subcatchment level because of lack of spatial data.

In contrast to this reductionist approach, the elicitation of local knowledge and local observation helped to gain an idea of the major pest insects in the whole subcatchment that can be more intensively studied in the second three-year phase of the project (which started in September 2003 and will go on until June 2006). The farmers also emphasized the importance of studying the interaction between fruit orchards and adjacent forest areas, an approach which has been integrated into the current phase. One of the participating farmers had developed his own hypothesis on the occurrence of a certain pest. He stated that the Asian ambrosia beetle (*Xylosandrus sp.*) could only be found on those trees in his orchard which he had girdled in order to induce flowering. His theory was that girdling increases the sugar content of the sap, which attracts the beetle. An entomologist could confirm that it is likely that the beetle is only found in girdled trees, although his explanation differed from that of the farmer: he suspected that girdling is physically 'injuring' the tree, which would make him more vulnerable to bark-feeding beetles.

Another important outcome of the interaction between farmers and scientists was that the awareness could be raised about the ineffectiveness of certain pest management strategies against particular insects, such as spraying of pesticide against a scale insect (*Laccifera lacca*) and various bark-feeding insects (e.g., *Indarbela dea*, *Xylosandrus sp.*). In sum, the participatory component laid the ground for identifying promising biological and integrated pest management strategies which are currently tested in on-farm experiments.

The study of local insect knowledge also gave us a more realistic picture of farmers' ecological knowledge. We knew from other studies in the northern Thai highlands that ethnic minority farmers use their intimate knowledge about insects, e.g., to determine soil fertility (Tinoco-Ordónez, 2003) and to make weather predictions (Choocharoen, pers. comm.). No such luck in our study in the Mae Sa Noi subcatchment: since litchi farming is a relatively new practice for Hmong farmers and some of the insect species have invaded the orchards only recently, many farmers do not have much knowledge about these insects. For many of them no local names existed, and terms for "larvae" and "caterpillars", for instance, were used interchangeably. Beneficial insects were practically unknown. We also could not detect a uniform classification system in the form of a "Hmong insect taxonomy", but found that farmers' knowledge and classification skills were fairly heterogeneous. Aside from differences in education and age, one major underlying reason was that many farmers sell the entire harvest to traders at the time of fruit setting when the yield can already be roughly estimated. The traders would then take over the responsibility for applying fertilizer and pesticides, while the farmer's task is reduced to irrigating the trees during dry periods. Hence, most farmers do not regular check their orchards for insects, which raises concerns about the future prospects of Integrated Pest Management (IPM), a system that relies strongly on collective action and a functioning monitoring system of pest insects.

2.1.3 Comparing the costs of eliciting local knowledge and generating scientific knowledge of pests and beneficial insects

The costs of generating scientific knowledge of pests and beneficial insects are extremely high (Tab. 1). The study needs to be fairly long-term (at least three years) to avoid seasonality biases. Specialized staff with profound taxonomic knowledge is necessary to determine the thousands of insects that are caught each month. Collecting a wide range of insects with different movement patterns (flying in different heights, crawling, etc.) and other behavioral characteristics requires highly sophisticated traps and regular field visits to check the traps. In this particular study traps were monitored every second day, which was only possible with a Thai research assistant and a local Hmong assistant (a relative of the field owner).

Table 1. Costs of the scientific study of pests and beneficial insects

Cost category	Details	Costs in EUR
Personnel	Foreign junior researcher (3 years), Thai research assistant (2 years), local assistant (2 years)	96,940
Equipment	Diverse insect traps (malaise traps, light traps, etc.), binocular, laptop	14,670
Consumables	Plastic bottles for collecting insects, nets, small insect traps, chemicals, etc.	5,595
Travel costs	Three international flights (Germany-Thailand-Germany), trip to research plot (three times weekly)	10,740
Total costs		**127,945**

Table 2. Costs of the study of local insect knowledge

Cost category	Details	Costs in EUR
Personnel	Foreign senior scientist as project advisor (4 days), foreign junior researcher (9.5 days), Thai facilitator (16 days), interpreter for ethnic minority language (5.5 days)	3,229
Opportunity costs of time	Farmers' participation in five group discussions (evening) and various field visits (during daytime)	106
Travel costs	Twenty visits to the village (gasoline, maintenance, etc.)	285
Consumables	Small plastic bottles for collecting insects, pens, markers, paper	25
Total costs		**3,645**

As compared to the costs of the 'scientific' study, the local knowledge study was relatively inexpensive. The major part of the costs was additional labor: a facilitator for the meetings and discussions with farmers[1], a Hmong interpreter for some of the meetings and advice from a foreign senior scientist on participatory research methods. The second most important cost factor was travel costs: several trips to the village were in vain because farmers were not always available due to unforeseen events, such as funerals or even police raids during an anti-drug campaign. Owing to the relatively low household income and the fact that most discussions were held in the evening when farmers were free, the opportunity costs of farmers' time were comparably low. Material costs (consumables) were negligible.

2.2 Local and scientific soil classification in the Black Lahu village of Bor Krai, Pang Ma Pha district, Mae Hong Son province

In this section, we describe the processes of recording local knowledge of soil characteristics in Bor Krai, a Black Lahu community in Mae Hong Son province, northern Thailand, and blending it with scientific knowledge. The survey was conducted by a multidisciplinary group of scientists, namely from soil science, agricultural extension, farming systems and rural sociology, during the dry season (October to May) 2004/2005.

[1] We were lucky to be able to recruit a female German biologist who was fluent in both Thai and German and familiar with the local culture due to previous studies in the area.

2.2.1 Objectives of the study and methods applied

Detailed soil information on watershed scale remains scant in northern Thailand, particularly on sloping land where traditional soil mapping approaches are arduous and time-consuming. The major objective of this study was therefore to identify a more efficient way to scale up soil information to the watershed level. One of the study areas was Bor Krai, representing a typical limestone area[2].

The soil scientist determined the soil types according to the FAO's World Resource Base classification through collection of soil samples which were later analyzed in the laboratory (cf. FAO, 1998). In total, about 356 field augerings and 23 soil profile descriptions were carried out for an area of approximately 8.5 km^2. The scientific soil classification was accompanied by a petrographic mapping exercise (Choocharoen, Schuler et al., 2005).

Information on local soil classification and spatial soil type distribution was collected during a joint survey using a range of participatory methods like group discussions, semi-structured interviews with key informants and participatory mapping. The first step of the knowledge elicitation was to identify farmers with an outstanding local knowledge on soil, based on their practical experience. The scientists and a key informant elaborated together a list of 11 male and female farmers whose knowledge on soil properties of the area was said to be above average. These farmers were mainly older persons, who have lived and worked in the areas for several years and own land on different sites in the village area. In the next step these farmers were openly asked in a group discussion about the soil types they could distinguish and the parameters for this classification. This approach gave a general overview about the local soil knowledge and the results were the basis for the following investigation. To obtain a more detailed and specific local soil classification, farmers were also asked individually during field walks about the main soil types and properties. The farmer led the research team to specific sites, according to his or her soil classification. On site the farmer were interviewed about main soil properties like water infiltration rate, water retention, fertility and suitability for crops (Choocharoen, Schuler et al., 2005).

Farmers were also interviewed in their homestead. During these interviews the collected soil sample were shown and the farmers were asked to identify and name the soils. In a final group discussion, farmers were presented all soil samples, which they had to sort and rank according to different parameters to cross-check the former information and to obtain a group consensus about the classification. In the last step a participatory soil mapping exercise was carried out. Farmers were asked to identify different soil types according to the local classification on many different sites on a topographic map. To facilitate the farmers' orientation, the map contained roads, streams, springs, and specific landmarks like rocks and caves. The scientist, who did the scientific soil classification, and his local Lahu assistant had an excellent knowledge of the area, and thus were able to give the farmers sufficient spatial information while elaborating the map. Since the topographic map was geo-referenced, the local soil map could be digitized with Arcview and used for further analysis and comparison in a Geographic Information System (Choocharoen, Schuler et al., 2005).

2.2.2 Results of the study and benefits of integrating local knowledge

Similar to other studies on local soil knowledge (e.g., Ettema, 1994; Talawar and Rhoades, 1998; Barrera-Bassols and Zinck, 2003), Lahu farmers in Bor Krai classified

[2] Similar studies were carried out in granite and sandstone areas to cover the major petrographic units of the northern Thai highlands.

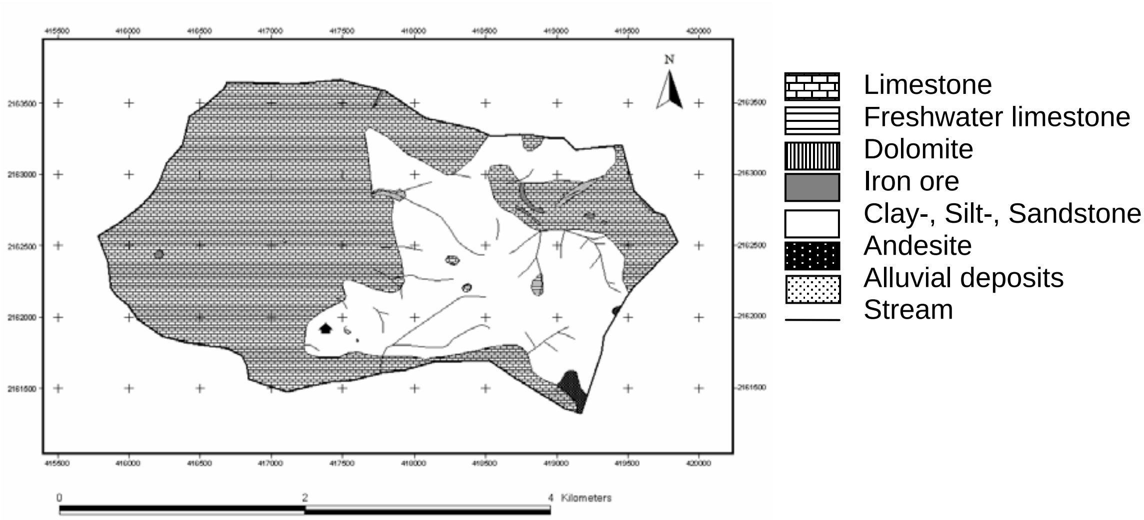
soils according to recognizable and easily identifiable properties in the field. Their main criteria for classification were topsoil color, hardness, consistency, suitability for different crops, and yield potential. During a ranking exercise it was confirmed that the major criterion for soil classification was color. Farmers distinguished between four main soil types, black, red, orange and yellow. The farmers were then asked to map these four soil types on a topographic map. With this approach, the local soil map reflected a rather rough distribution of the soil types. Many variations in color and texture farmers mentioned during the field survey were neglected during the local mapping process.

The scientific soil classification according to the WRB standard came up with eight major soil types, subdivided into further subunits. The spatial, patchy patterns of the soil types on the scientific soil map was completely different from the local soil map which was not surprising since the WRB classification is based on a mix of physical and chemical soil properties in different horizons (soil layers) which is in contrast to farmers' focus on top soil properties and easily perceivable, morphological soil characteristics.

On the other hand, the local soil map showed striking similarities with the petrographic map (cf. Fig. 1 and 2). One 'scientific' explanation for the strong correlation between local soil map and the petrographic map was that the iron contents of the parent material have a crucial impact on the subsoil color (Schuler, pers. comm.). As most of the soils in sloping areas of northern Thailand show a certain degree of erosion, the petrographic origin of the soils increasingly becomes a determinant of the soil color and hence correlates strongly with local soil types (Choocharoen, Schuler et al. 2005).

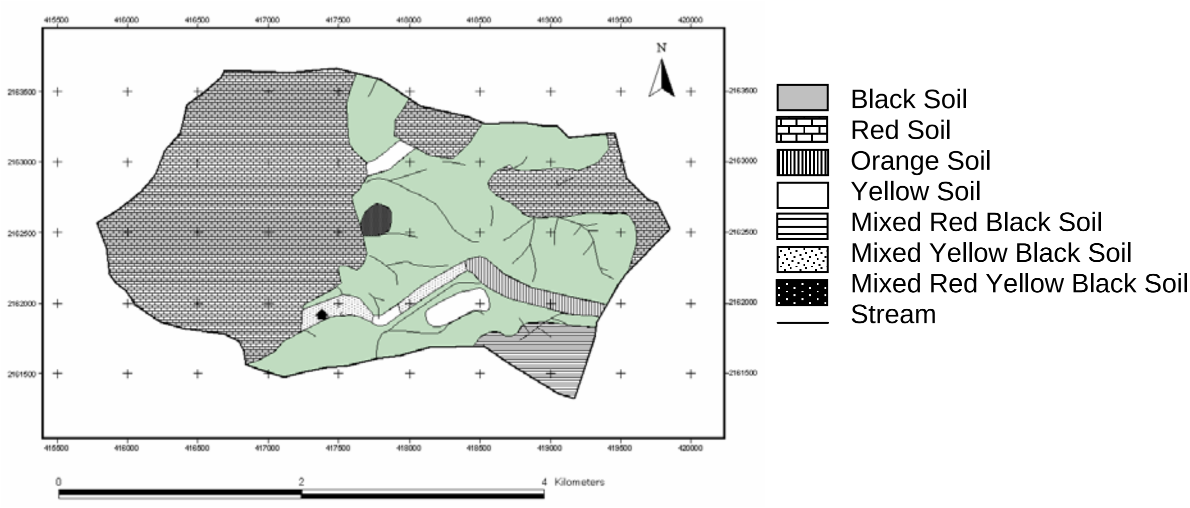
Another outcome of the local soil classification process was that farmers' knowledge of the landscape could help the soil scientist to capture the full heterogeneity of the soil units. One soil type (a so-called *Chernozem*) could only be detected with the help of a local farmer. This soil type was found only a few meters from one of the sampling points for the scientific soil classification.

Figure 1. Petrographic map of Bor Krai



Source: Data and map from Schuler, 2005; as quoted in Chalathon et al., 2005

Figure 2. Local soil map of Bor Krai



Source: Data and map from Schuler, 2005, as quoted in Choocharoen et al., 2005

In sum, these results suggest new research avenues in future phases of our research program: to integrate local soil mapping and scientific knowledge (petrographic mapping) for scaling up soil information from the field to the watershed and landscape level.

2.2.3 Comparing the costs of eliciting local soil knowledge and generating scientific soil knowledge

Laboratory analyses of soil samples are by far the highest cost factor in the scientific soil classification (Tab. 3). To distinguish certain soil types (e.g., to identify the difference between an Acrisol and Ferralsol), very costly analyses need to be conducted. The labor costs of the fieldwork are relatively low by comparison, although taking soil sample in this rough terrain is physically extremely challenging. Costs for equipment and consumables were negligible, since it could be also used for studies in other study areas.

Table 3. Costs of the scientific soil classification according to WRB

Cost category	Details	Costs in EUR
Personnel	Foreign junior researcher (3 months and 1 week), local research assistant (3 weeks), field workers for digging soil profiles (20 days)	8,785
Soil analyses	Labor costs, consumables and investment costs for diverse analyses for eight different soil types (soil texture, water content, organic matter, carbon exchange capacity, base saturation, carbonate content, etc.)	36,945
Equipment/ consumables	Augering equipment, plastic bags for soil samples, etc. (shared cost basis)	150
Travel costs	5 trips to the research area, shipment of samples for further analysis in Germany	435
Total costs		**46,315**

Source: Personal communication by Ulrich Schuler; Manual for Soil Analysis of the Department of Soil Science, University of Hohenheim (Herrmann, unpublished)

The petrographic mapping consisted of an additional month of work by the soil scientist and some help by his local assistant (Tab. 4). The mineralogical analysis in the laboratory amounted to less than one percent of the costs of the soil analysis.

Table 4. Costs of making a petrographic map

Cost category	Details	Costs in EUR
Personnel	Foreign junior researcher (4 weeks), local research assistant (2 weeks)	2,500
Mineralogical analysis	Labor costs, consumables and investment costs for mineralogical analysis	305
Travel costs	2 trips to the research area, shipment of samples for further analysis in Germany	144
Total costs		**2,949**

Source: Personal communication by Ulrich Schuler

The local soil mapping was the cheapest part of the whole mapping exercise (Tab. 5). Aside from the labor input of the soil scientist and his local research assistant, a Thai junior researcher helped in organizing and facilitating individual interviews and group discussions. Minor cost factors were the opportunity costs of farmers' participation and some consumables, such as material for drawing and snacks for the farmers.

Table 5. Costs of elaborating a local soil map

Cost category	Details	Costs in EUR
Personnel	Foreign junior researcher (3 weeks), Thai junior researcher (1 week), local research assistant (3 weeks)	1,824
Opportunity costs of time	Farmers' participation in one group discussion (evening) and ten field visits (during daytime)	30
Travel costs	1 trip to the research area (gasoline, maintenance, car rent)	47
Consumables	Pens, markers, paper, color prints, snacks for meeting with farmers	25
Total costs		**1,926**

Source: Personal communication by Ulrich Schuler

Hence, combining petrographic mapping and local soil mapping can considerably reduce the costs of making fairly accurate maps which might be even more relevant for farmers' land use decisions and land use planning procedures of government agencies than maps based on traditional approaches to scientific soil classification.

2.3 Farmers' experiments with vegetative propagation of *Arachis pintoi* as a complement to researcher-managed cover crop trials

In the hillsides of northern Thailand, erosion and soil fertility depletion are among the major constraints to sustainable production of fruit orchards. In a 28-month study, agronomists of The Uplands Program investigated the potential of various cover legume species for erosion and weed control, soil improvement and as forage plants in smallholder hillside orchards.

2.3.1 Objectives of the study and methods applied

Two on-station trials and one controlled on-farm experiment, each with three replications, were established at three sites of contrasting altitudes. Cover densities, seed production potential and forage quality were assessed with standard agronomic methods.

Hmong villagers of Mae Sa Mai, where the on-farm experiment was conducted, showed particular interest in *Arachis pintoi*, a perennial, stoloniferous legume species. Farmers' experiments with vegetative propagation of *Arachis pintoi* were initiated by a presentation in mid-2003 for around 40 male and female farmers. The participants got actively involved in discussions on potential benefits and risks of growing cover crops in their fruit orchards. The presentation was followed up by a field day, in which seven farmers participated who were particularly interested in the potential of *Arachis pintoi* as animal feed and ground cover in their fruit orchards. Six farmers finally decided to test the cover legume in their own plots. Researchers gave a short instruction into the techniques of vegetative propagation and distributed plastic bags with stolons from research stations based on individual demand of the farmers. The experiments were entirely farmer-managed and jointly monitored by farmers and researchers. Farmers decided on location and size of the experimental plots and were responsible for planting and maintenance (weeding, fertilizing). Planting densities of 50x50cm were recommended by the researcher, but most farmers varied the planting densities according to their own judgment. The researchers distributed field books to the farmers for regular recording of labor and other inputs. As some of the farmers were illiterate, a research assistant helped in keeping the field book. Cover density of *Arachis* in the experimental plots was monitored in monthly intervals during a five-month establishment phase by the researchers.]

In experimenting with *Arachis pintoi* in their hillside orchards, farmers were surprisingly creative. Some created their own experimental designs, such as varying weed management prior to stolon planting and comparing effects of different light intensities. One farmer planted the cover crops in his tangerine orchard in order to increase the soil moisture and reduce evapo-transpiration. The experimental capacities of farmers in these trials confirm findings of other authors suggesting that farmers' experimentation has a much more formal character than often expected by scientists, and that combining station-based experiments and farmer-managed trials can provide valuable synergetic effects (cf. van Veldhuizen et al., 1997; Sumberg et al., 2003).

2.3.2 Results of the study and benefits of complementing researcher-controlled trials with local experimentation

In the scientific study, *Arachis pintoi* turned out to be one of the best-performing legume species in terms of the potential of forming a dense soil cover within several months, particular in the medium and high altitudes (Tab. 6). It also showed a high nutritive value with a comparatively low fiber content. Hence, agronomist concluded that it was a promising technology for fruit orchards in the Thai highlands.

Data on the participatory vegetative propagation of *Arachis pintoi* could be recorded on experimental plots of five farmers. One member of the initial group of six experimental farmers abandoned the experiment after a few weeks due to lack of time for maintenance of the plot. One farmer subdivided his plot into one part that was treated with herbicides prior to planting *Arachis* and one part that was hand-weeded before planting. Data on cover densities suggest a high variation of ground cover during the establishment phase of *Arachis pintoi* (Table 6). In general, results under 'real', i.e., farmer-managed conditions were much less promising than the results from the controlled trials, although the latter were generated from seeds, while the former were from vegetative propagation which should enable a faster establishment of ground cover. Farmers reported various problems in the first months, such as adverse effects caused by periods of drought, insect pests and weed competition, the latter particularly after using fertilizer. Sensitivity to drought was indicated by the fact that cover densities dropped slightly in all plots at the beginning of the dry season (December, i.e., month 5). A lack of tolerance to herbicide use prior to planting and during the establishment phase that could be observed in the farmers' experiments needs further confirmation in controlled experiments. Labor input turned out to be a decisive factor in establishing *Arachis*. Farmers who frequently weeded their plot (see plots with high labor input in Table 6) achieved the highest cover densities of *Arachis*. In the case of two farmers, weeding time interfered with other economic activities, such as growing vegetables and working off-farm.

Table 6. Comparison of controlled experiments and farmer-managed trials

Degree of partici-pation	**Type of experiment**	**Fertilizer dose**	**Cover density (months after seeding, in %)**				
			1	**2**	**3**	**4**	**5**
	Station (controlled, 3 repl.)	low	2.8	23.1	57.5	86.7	95.0
	Station (controlled, 3 repl.)	high	3.0	30.9	65.8	85.0	93.3
	Station (controlled, 3 repl.)	low	4.5	47.8	96.7	98.3	100
	Station (controlled, 3 repl.)	high	5.0	56.5	97.5	99.2	100
	On-farm (controlled, 3 repl.)	low	2.8	13.5	55.0	91.7	96.7
	On-farm (controlled, 3 repl.)	high	3.0	16.5	49.2	94.2	95.8
	Type of experiment	**Labor input**	**Cover density (months after transplanting, in %)**				
			1	**2**	**3**	**4**	**5**
	On-farm (farmer-managed)	high	12.0	61.6	70.8	80	60
	On-farm (farmer-managed)	high	12.0	50.4	68	90	70
	On-farm (farmer-managed)	low	6.0	9.4	13.2	13.2	10
	On-farm (farmer-managed)	low	5.2	30.4	19.2	18	16
	On-farm (farmer-managed)	low	10.0	34.8	30.8	30	25
	On-farm (farmer-managed)	low	20.0	43.5	70.4	20[†]	25.3

[†] Effect of herbicide application

Source: Data from Schultze-Kraft et al., quoted in "Research report of The Uplands Program – Subproject C1" (unpublished), 2003, p. 241; Neef et al., 2004.

The major conclusion from the farmer-managed experiments was that farmers had to invest a considerable amount of time into the establishment of a crop whose direct benefits accrue mostly in the long term. This confirmed suggestions of other authors that adoption of multi-purpose cover crops may be a complex and slow process (cf. Rivas and Holmann, 2000; Wünscher et al., 2004). We concluded that farmers in our study area are unlikely to adopt cover crops on a larger scale. As cover crops like *Arachis pintoi* can provide substantial indirect benefits for downstream users in terms of reducing erosion and preventing landslides, temporary subsidies to support the establishment phase of the crops may be justified. Such measures, however, will strongly depend on political will and/or lowland residents' willingness to pay for such environmental services.

In sum, the benefits of this participatory element did not derive from an increase in adoption rates of better-suited technologies, as often expected as an outcome of participatory research. It rather helped to avoid future costs of doing research about technologies that are not compatible with farmers' constraints and/or alternative income opportunities (cf. Lilja et al., in press, for the case of ICRISAT's mother-baby trials).

2.3.3 Comparing the costs of researcher-managed field trials and farmers' experimentation with cover crops

The researcher-managed field experiments with cover crops were less costly than most other 'scientific' studies in our research program (Tab. 7). This was mainly due to the fact that the main fieldwork was carried out by a Thai PhD student with a local salary rather than by an expensive foreign junior researcher. The costs of a Thai research assistant and of field workers who were employed on a daily basis were also rather low.

Table 7. Costs of researcher-managed field trials with 14 different cover crops

Cost category	Details	Costs in EUR
Personnel	Thai junior researcher (2.5 years), Thai research assistant (0.5 years), field workers (weeding, etc.)	13,905
Equipment	Diesel mower, field balance, laboratory freezer, greenhouse	2,015
Consumables	Seeds, fertilizer, herbicides, fences, plastic bags, etc.	2,760
Laboratory analysis	Soil analysis, dry matter, feed quality parameters, etc.	8,370
Travel costs	Trip to research plots (two times per week; gasoline, maintenance, etc.)	3,740
Total costs		**30,790**

The costs of the laboratory analyses were comparably high, given that they were carried out at Chiang Mai University where labor costs of technical assistants are very low compared to international standards. Equipment and consumables were also a major cost factor. As the Thai PhD student worked at three different research sites which were visited in regular intervals, the travel costs were rather high.

Table 8. Costs of farmer-managed experimentation with *Arachis pintoi*

Cost category	Details	Costs in EUR
Personnel	Foreign senior scientist as project advisor (1.5 days), Thai junior researcher (3.5 days), Thai research assistant (23 days)	634
Opportunity costs of time	Farmers' participation in village meeting, field day and various field visits, labor input into experimental plots	212
Travel costs	42 visits to the village and the experimental plots (gasoline, maintenance, car rent)	840
Material	Plastic bags for stolons, field books, fertilizer, snacks during village meeting and field day	40
Total costs		**1,726**

Travel costs were also the major cost factor in the farmer-managed trials with *Arachis pintoi*, followed by labor costs, mainly for a Thai research assistant who did regular monitoring visits in farmers' fields and helped in keeping the field books (Tab 8).

Opportunity costs of time were comparably low, mainly because farmers devoted only a small portion of their fields to the experiments. None of them designated an area of more than one percent of the total field size for the experiment. The largest size among the experimental plots was less than 0.1 hectares.

3 Synthesis, conclusions and outlook

In all three cases presented above, the participatory component constituted only a fraction of the costs of the conventional agricultural research project (2.8%, 4.2% and 5.6% respectively). Major cost factors were additional personnel and travel costs, while opportunity costs of time for participating farmers and costs of consumables were negligible.

As compared to these moderate costs, the benefits from all participatory components were much more substantial. In the first case, "Pests and Beneficial Insects", the study of local insect knowledge contributed to widening the reductionist scope of the 'scientific', conventional research component and to getting a more complete picture of the whole subcatchment. Together with the conventional research it also laid the foundation for targeting the major pest insects with more effective and, at the same time, more sustainable pest management strategies, such as applying bio-insecticides and enhancing the population of natural enemies in the second project phase. In the second study on "Local and Scientific Soil Classification" researchers identified a new, cost-efficient strategy for scaling up of soil information from the field to the landscape and regional level. In the next research phase (July 2006 - June 2009), it is planned to combine radiometric data for petrographic mapping with recording of local soil knowledge. It is expected that this strategy does not only reduce the costs of scaling up, but also makes soil maps more relevant for land use decisions. In the third case "Farmers' cover crop experiments" scientists could identify the major constraints and opportunity costs of farmers participating in the trials. Thus, they could obtain a more realistic assessment of the local adoption potential for a specific cover legume and the necessary policy changes that are needed to support adoption of soil conservation measures, if this is a priority of the society as a whole.

I conclude that participatory approaches can inform conventional agricultural research in a cost-effective way by widening the scope of site-specific experimental setups, by supporting the scaling up of micro level data and by highlighting farmers' specific constraints in early stages of the innovation process.

Acknowledgments

I would like to thank Ulrich Schuler for providing me with much of the data needed for the cost comparison in section 2.2.3. The financial support of the Deutsche Forschungsgemeinschaft (German Research Foundation) in carrying out this study is gratefully acknowledged.

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