Global Theme on Agroecosystems

Report no. 38

Improved Livelihood System of Farm Households through Community Watersheds

Learnings and Insights from Thailand and Vietnam

International Crops Research Institute for the Semi-Arid Tropics

Citation: Mula Rosana P, Wani SP, Wangkahart Thawilkal, Thang NV and Supama Y. Improved Livelihood System of Farm Households through Community Watersheds: Learnings and Insights from Thailand and Vietnam. Global Theme on Agroecosystems Report no. 38. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 56 pages.

Abstract

Identifying the socio economic contributions of the integrated watershed project on farm households in Thailand and Vietnam was the end goal of the one-month study conducted in January 2006. Data was obtained with the use of an interview schedule, field visits, focus group discussions, and key informants. Findings on the biophysical aspects of the watershed were used for investigating the contributions of various interventions on the agricultural and social system of farmers.

Awareness and adoption of the different technological packages are high except on the installation of soil and water monitoring instrument. Less interest by farmers for soil and water monitoring instrument should be dealt by spreading awareness of their importance. Modifications in farmers' agricultural systems included a change in cropping system such as addition of new crops (legumes and fruit trees), new varieties, adjustments in the cropping calendar and investments in aquaculture as well as poultry. Apparently, these have contributed to the improvement in income levels, enhancement of community participation, and fulfillment among household members. The trainings and exposures provided to farm households opened windows for self-help group formation and alliances/partnerships.

A contributing factor to gains obtained in the watershed project has been due to the inculcation of the sense of ownership among farmers. And this explains the clamor for continuous capacity building in the form of technical assistance, various types of information, education and communication (IEC) materials, and market price information to ensure sustainability of the initial gains. The SCOT analysis and transects, which are validated from implementers' perspective showed strong resemblance with farmer-respondents' needs assessment. Alongside the development of other potential resources, there were expressions for relevant extension support, market and credit assistance, and more innovations in agri-related livelihoods like pasture-based livestock and agro forestry. On the social aspect, an understanding of problems and the ways in which affected farm households respond to them can be used as an enabling mechanism for watershed initiatives specifically in developing appropriate framework for evaluating, informing, and educating farm households.

This publication is an output from a research project *Participatory Watershed Management for Reducing Poverty and Land Degradation in SAT Asia [RETA 6067)* supported by Asian Development Bank (ADB)

Global Theme on Agroecosystems
Report no. 38

Improved Livelihood System of Farm Households through Community Watersheds

Learnings and Insights from Thailand and Vietnam

Mula Rosana P, Wani SP, Wangkahart Thawilkal, Thang NV and Supama Y

ICRISAT

International Crops Research Institute for the Semi-Arid Tropics
Patancheru, Andhra Pradesh, India 502 324

Asian Development Bank
0401 Metro Manila
0980 Manila, The Philippines

2007

About the Authors

P Mula Rosana	Special Project Scientist, ICRISAT, Patancheru 502 324, Andhra Pradesh, India
SP Wani	Principal Scientist (Watersheds) and Regional Theme Coordinator (Asia), Global Theme on Agroecosystems, ICRISAT, Patancheru 502 324, Andhra Pradesh, India.
Wangkahart Thawilkal	Project Site Coordinator, Office of the Agricultural Research and Development (OARD), Khon Kaen, Thailand
NV Thang	Deputy National Coordinator, Vietnam Agricultural Sciences Institute (VASI), Hanoi, Vietnam
Y Supama	Researcher, Office of the Agricultural Research and Development (OARD), Khon Kaen, Thailand

Acknowledgments

This article would not have been feasible without the scientific and moral support from a number of individuals: Dr William D Dar, Director General for his unrelenting encouragement; Drs Cynthia Bantilan of ICRISAT, Amita Shah of Gujarat Institute of Development Research (GIDR), Ahmedabad, India, and KV Raju of Institute for Social and Economic Change (ISEC), Bangalore, India, for the review and providing suggestions on the paper and Drs P Pathak and K L Sahrawat for some nuggets of advice.

I sincerely thank Mr R Sudi for verifications of my data, Mr I Nageswara Rao and Mr KNV Satyanarayana for providing secretarial, administrative help and page setting of the script and Ms Shalini N for editorial assistance.

I gratefully acknowledge our collaborators Drs Supatra Donsophon, Somak Idippong, Banyong Toomsan, Pranee Srihaban, Anuwat Potinam, Somjit Khantasuvan and to the respondents of Tad Fa and Wang Chai watersheds in Thailand and Drs Pham Quoc Gia, NT Chinh and to the respondents of Thanh Ha and Huoang Dao watersheds in Vietnam for providing necessary help during my field data collection.

Contents

1. Introduction

An integrated approach in watershed management has enormous potential for managing natural resources. In this approach, protecting and conserving natural resources can happen while equally securing livelihood for farm households. This is elaborated in the output of this research conducted in four sites, where watershed interventions started at different periods. This research is part of the 'Participatory Watershed Management for Reducing Rural Poverty and Land Degradation in SAT Asia' supported by the Asian Development Bank under RETA 5812 and RETA 6067.

With hardly any livelihood options in rural areas of India, Thailand, Vietnam, and China, farm households depend considerably on their land resources. Overexploitation of land due to population pressure has had deleterious effect on people and environment. The various activities of the project revolve around how farm households in these countries were able to maintain productivity of over-used land resources by adopting improved soil and water technologies developed through years of R&D by the International Crops Research Institute of the Semi-Arid Tropics (ICRISAT).

The specific components of the project are geared on rainwater conservation, reduction of land degradation, and replenishment of soil nutrients through biological nitrogen fixation. Improved technologies of the components are integrated in farm households' crop and livestock management to sustain productivity and incomes.

Watershed activities in ICRISAT-led consortium in the nucleus watersheds (Tad Fa, Thailand and Thanh Ha, Vietnam) started in late 1999 and scaling-out in the satellites (Wang Chai, Thailand and Huoang Dao, Vietnam) commenced in 2003. Despite the satellite watersheds' recent involvement in the project, some positive changes have been noted. These are discussed in the succeeding sections of this report.

1.1 Objective

The primary objective of this study was to conduct an assessment of the watershed interventions implemented in four communities. The two major research questions were related to the benefits of the soil and water conservation (SWC) interventions, and the major changes that took place in the farming system and their effects on social processes. The primary source of information was obtained from farmers who are direct users and managers of interventions. Some of the findings are substantiated by key informant interviews of implementers.

The specific objectives are expressed in the following research questions:

- **What are the different biophysical benefits of the SWC interventions observed by farm households?** Whenever development projects are introduced into societies, the benefits are often contested. Such is the case of the community watersheds (CW) where the promotion of agricultural productivity due to a package of technological inputs in soil and water management is a subject of study. As gleaned in Table 1, a number of indicators showing quantitative increase in water level, less runoff and soil erosion, expansion of cultivated area, and change in farming system are evident. These are all relevant data sets for disclosing impacts. However, some gaps have to be expressed. These kind of data need to be translated in forms which could provide inferences not only of project performance but also on the depth of contributions to households, which is the other research question.

- **What are the effects of the improved biophysical benefits on households' livelihood system and social processes?** The gains on the natural resource-base correspondingly result to a change in livelihood as well as in social processes like household norms and values. The initial goal of watershed interventions is the improvement of biophysical resource and later moves on to create a more complex change, which is either planned or unplanned. For instance, after having attained an increase in water level in wells, productivity is anticipated to improve. This could mean better yield, better income, and some savings, which correspondingly suggest more disposable cash for satisfying needs.
- **What constitute the capacity building program of the community watershed project and what are the future activities to sustain the benefits?** While technologies are key to improve livelihoods, building on the capacity of would-be users and their self-esteem are also important. For instance, if farmers are able to write their names (which is an unplanned effect of the watershed project), it is too important an achievement to ignore. On top of this, there is the need to sustain the gains of success of community watersheds. This needs mechanisms to regularize flow of relevant information (technological support) and proposing systematic monitoring and evaluation, involving a high degree of local participation.

2. Approach

Livelihood development is best understood by documenting changes and responses of households to changes brought by various watershed interventions. Figure 1 shows the schematic diagram of variables and the perspective that guided the inquiry.

In many reports prepared by the agroecosystems group, watershed interventions have made very significant contributions in communities. Through interlocking elements of institutional arrangements and partnerships of various forms, package of technological inputs initially revolving on water and soil conservation and rehabilitation, capacity building, and research, some planned outcomes are anticipated. These include reduction in soil erosion, increase in water recharge in soils, and increase in water levels in wells. With improved biophysical environment of households, change(s) in household activities takes shape, which affect their relationships within the household and the community. This is corollary to Nelson and Maredia's point of view (1999) who claim all biophysical changes have social and economic counterparts to which negative and positive values are attached.

Investigating the impact of 'new and/or improved' development efforts through household's analysis is relevant and fitting since a microeconomic framework like a household represents all the socio-economic processes that could be used to make plausible inferences of a wider socio-economic system. Household analysis has been proven to yield significant findings in revealing relationships and behavior to any given change such as technology, income, policy, labor and preferences (Castillo 1993 and Juster and Stafford 1991).

The biophysical and the social systems are the two variables where change is observed as a result of the different watershed interventions. Table 1 summarizes the major effects of the soil and water conservation interventions on the bio-physical component. In turn, these interventions are assessed in their pursuit of improving people's welfare, which serve as the ultimate yardstick of impacts. As McPeak and Doss (2003) aver, accurate measures of household's welfare are pre-requisites for assessing the progress of development and the design of effective and efficient poverty alleviation programs. In the same manner, a mixture of qualitative and quantitative methods is very reliable in

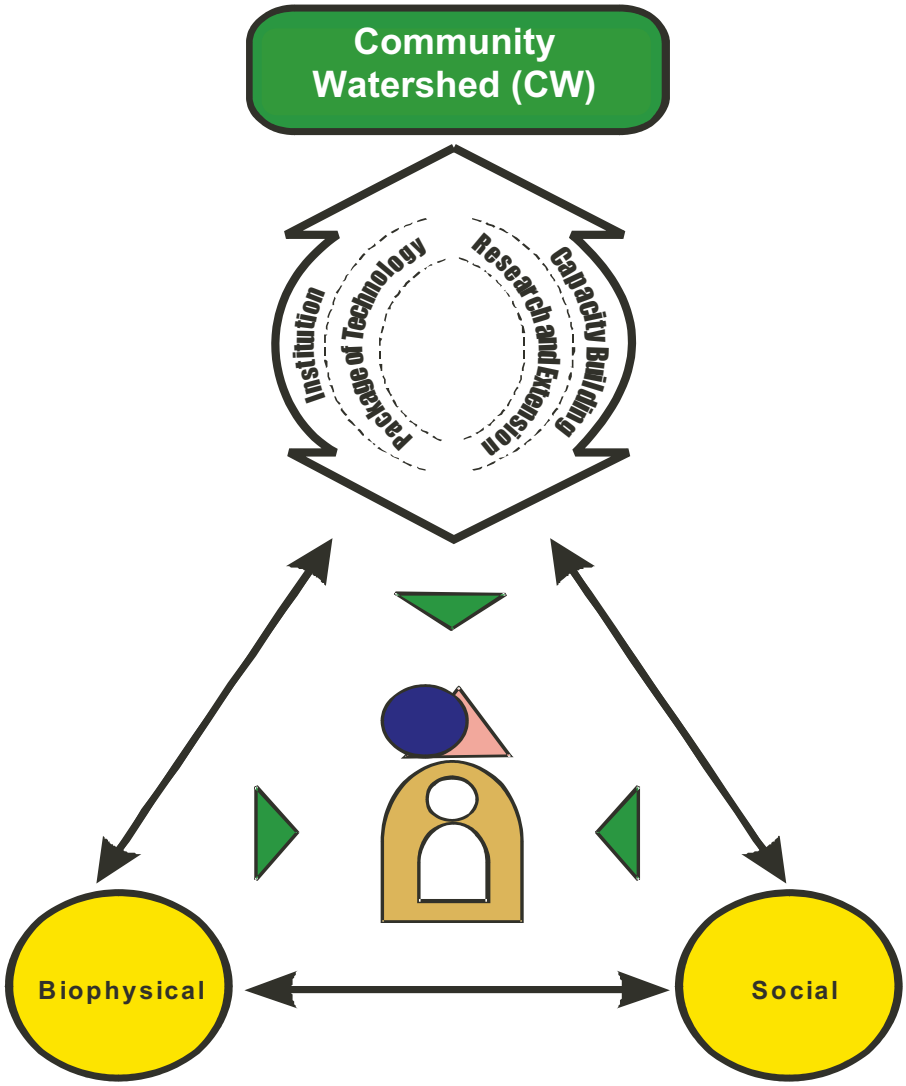


Figure 1. Schematic diagram of key variables and the perspective that guided the inquiry.

analyzing effects of user participation on the research process and in producing multiple types of impacts (Fujisaka and White 2004).

Soil and water management interventions such as storing, harvesting, distributing and utilizing have effected improvement in soil productivity for crop production and livestock raising. In turn, this increased income of farm households. In brief, appropriate water management could resuscitate the once degraded lands (either overused by excessive cultivation or grazing) for peoples' subsistence (at the immediate hierarchy of needs). However, access and control of these benefits are at the disposal of a few people. This brings to light another facet of this research where new insights on impact was drawn such as non-market benefits like the flow of ecosystem services (i.e. distributional and equity impacts) needed in sustaining basic life support functions of an agroecosystem (Freeman et al. 2005).

Across the sites, data shows remarkable adoption (as well as adaptation) of technological fixes as indicated by the results of the biophysical indicators of the different household resources (soil and water), cropping and livestock systems, and sociological aspects including governance (institutional arrangements). The latter is critical (another facet) in watershed projects for two reasons: as a means to understand the dynamics of the biophysical change with the social environment and as leverage for external support (decisions on continuity, modification, expansion or stoppage). A promise of success is embedded in a good mix of local organizations (through which people can participate) and institutions like donors and the national agricultural systems.

The issue of sustainability is another subject of the inquiry. It's about being able to determine the constraints faced by households and the community with regard to the implementation of watershed interventions and not just on sustained support from outside entities but also on what household or the community does to sustain the investment and improved biophysical resources. Sustainability, in this case, means sustainable stewardship of resources, which is a value in itself and offers condition for livelihoods to be sustained for future generations (Chambers and Conway 1992).

2.1 Respondents' Selection

Respondents were identified with the assistance of implementers. The main criteria used in South Asia are location of households' farm in the topo sequence (upstream, midstream, and downstream) and size of landholdings (small – less than 1 ha, medium – 1-3 ha, and large – above 3 ha). These were validated during the pre-testing period in order to address the issue of representativeness.

Primary data was collected through individual interviews and focus group discussions (FGDs). An average of 12 farmer-respondents randomly selected from the different elevations (downstream, midstream, and upstream) were interviewed using an interview schedule (Appendix 9). Individual farmer interviews were substantiated by FGDs and case studies. Two FGDs with an average of 6-7 farmer-respondents and representatives from collaborating agencies who served as interpreters were in the FGDs. Case studies on a few important topics were also done to have better understanding of the impact. Dovetailed with the interviews were field visits, review of secondary materials, and discussions with consortium members. In Thailand, data was collected from January 24 to February 7, 2006 and in Vietnam, from February 9 to February 19, 2006.

Two very important issues that needed careful planning during the data collection phase included:

Time. The temporal dimension is a critical issue in this research. The timeliness of the data was carefully considered to address reliability. Since some of the data required is by recall, there was a need to be cautious about the period of the information solicited. The data under the category 'before' refers to information one year before the implementation of watershed interventions, hence, 1998-1990 for Tad Fa and Thanh Ha and 2000-2001 for Wang Chai and Huoang Dao.

In the interview schedule, some critical queries were repeatedly posed to ensure substantiation. Results obtained from individual interviews were triangulated by FGDs, case studies, actual field visits and from implementers. Being able to integrate and compare insights through the results of the different data collection tools enhanced an understanding of the impacts.

Interpreter. Having interpreters in the team facilitated data collection. However, in Thailand where two English speaking team members served as interpreters; one being directly involved in the project and not so fluent with the English language and the other as a 'newcomer' who is not so familiar with

the project, was an advantage since they cross-checked on each other with respect to the translation of the questions and responses of the interviewee.

Providing the interview schedule to implementing partners in Vietnam and Thailand prior to the data collection facilitated the translation of the questions in the lingua franca of the sites. Result of the pre-testing was used as the springboard for discussing the process of data collection, especially on the criteria of respondents' selection. The technical staff of the implementing institutions assisted in elaborating the topo sequence of the watershed site, which facilitated in the identification of respondents from the upstream, midstream, and downstream.

2.2 Data Analysis

Descriptive analysis using frequency counts and means was used in the study. Case studies provided the means for elaborating other important topics. Simple estimation on input-output estimation was also done.

3. Findings

The CW projects, which adopted a holistic approach and guided by the tenets of integrated genetic and natural resource management (IGNRM), have been found to make significant contributions in livelihood improvement. Watershed projects were a response to minimize the effect of agriculture on the natural resource-base and to realize the potential of the advances made in the germplasm improvement programs, especially for the rural poor (CGIAR Interim Science Council, 2002). The integrative nature of CW (Appendix 1) is to make this happen since it allows a better understanding of the relationships of the different components of the system and could be the focal point where new technology and innovations developed by ICRISAT and other programs converge, are tested and demonstrated on a field scale (Prasad et al. 2005). Specifically, the hydrology of the watershed becomes the starting point for integrating interventions in crops, livestock, and collective actions as well as various forms of stakeholders' participation. ICRISAT has made a significant headway in integrating these elements. Guided by this system, the primary conclusion derived from this study is that the achievements on the various soil and water conservation interventions have improved the farming system of households, which is their major source of livelihood.

3.1 Consortium Membership

Thailand consortium members are the following:

- Office of the Agricultural Research and Development (OARD, Region 3) of the Department of Agriculture provides the over-all country management and coordination
- Department of Land Development (DLD) handles land issues and provides financial support to pond development
- Khon Kaen University (KKU) coordinates the research and demonstration component
- International Crops Research Institute of the Semi-Arid Tropics (ICRISAT) spearheads the project, provides technical inputs and other logistics
- Asian Development Bank (ADB) provides the financial support to the project

Vietnam consortium members are the following:

- Vietnam Agricultural Science Institute (VASI) provides the over-all country management and coordination
- International Crops Research Institute of the Semi-Arid Tropics (ICRISAT) spearheads the project, provides technical inputs and other logistics
- Asian Development Bank (ADB) provides the financial support of the project

3.2 Package of Intervention

The initial interventions in the watershed are anchored on abating soil and water problems. Improvements achieved from the initial activities were used to understand the other elements (crops and livestock) of the farm enterprise. This provided the basis for implementing specific farming technologies as well as establishing on-farm demonstrations (both as a show window cum research) for better appreciation. Equal attention was also made on capacity building, especially that of farmer who is the major decision-maker in adopting agri-technology innovation. Lastly, a focus on institutional building formed part of the entire package.

Based on the interviews, farmers' resources including his knowledge and capacity were considered and integrated in the project's consortium approach. While in the process of conducting field activities in soil and water conservation, continuous intervention identification cum implementation in other resources took place. This gradually contributed to socio-economic improvement of farm households and the landscape of the watersheds.

The major activities implemented in the sites include the following:

- Consultation and meetings between and among consortium members and the communities
- Characterization of the production system
- On-farm trials and demonstrations (researcher-managed)
- Farm visits
- Community organizing and strengthening
- Monitoring and evaluation

3.3 Research Questions

3.3.1 What are the different biophysical benefits of the SWC interventions observed by farm households?

A baseline data with which to compare current conditions is helpful in identifying change(s) brought by any form of interventions. The production system, its biophysical elements are important indicators for determining the change brought about by SWC interventions.

Production system. The agricultural interventions introduced in the watersheds of Thailand and Vietnam are based on the output of earlier studies on the characterization of the production system of the areas. Table 1 summarizes the soil and water management interventions and their effects on the biophysical system as synthesized in the various reports of GT-AES from 2003 to 2004. There is

sufficient rainfall in all the sites ranging from 1220 mm to 2020 mm. However, the problem lies in the topo sequence of the area where moisture is not conserved. The situation is also exacerbated by the intensive cultivation and other inappropriate cultural management practices of farm households.

There is quantitative data to show increase in water level, reduced soil runoff, and change in farming system.

Thailand. In Tad Fa, data gathered shows a significant reduction of runoff in farms from 364 mm to 169 mm after treatment and soil loss from 15.3 t h^{-1} to 12.8 t h^{-1} after treatment. Crop diversification happens such as the cultivation of other legumes like cowpea and sunn hemp, fruit trees like *longan* and *litchi*, vegetables and *Vetiver* grass. In Wang Chai, at the time of the study, there was not much data available to show the contributions of SWC activities except on crop diversification.

The specific interventions undertaken are as follows:

- Cultivation of tree crops and *Vetiver* grass around ponds and on contour with steep slopes, especially in Tad Fa where the slope ranges from 5% to 8%
- Cultivation of other legumes and vegetable crops
- Crop intensification through crop layering and mixed cropping
- Construction of ponds
- Practice of integrated pest management

Vietnam. In Thanh Ha, micronutrient and *Rhizobium* applications have been adopted. There were about 200 water-harvesting pits in Thanh Ha, which contributed in recharging the soil. The levels in wells showed a significant rise from 1.5 m to 2.5 m in Thanh Ha and about 2.5 m to 3 m in 10 open wells of Huoang Dao. In both sites, crop diversification and intensification were common.

The specific interventions undertaken are as follows:

- Introduction of legumes (improved varieties) and other crops like watermelon to improve cropping system
- Introduction of polyethylene mulching
- Planting of *Glyricidia* on contours and pineapples
- Staggered trenching
- Construction of physical barriers (like stone bunds, bench terraces, contours) and supplementary physical structures (like pits, contour canals, percolation tanks)
- Application of micronutrients

The endowments of the watersheds are quite distinct. However, similar agricultural interventions were implemented because of similar problems. Water availability is the major constraint expressed by the farmer-respondents, except for those at the downstream section of the Wang Chai watershed. The Uborrat dam, which gives farmers access to irrigation, allows for two paddy crops. Those located at the upper stream contend with rainfall, which explains the need for ways and means to conserve and improve water availability.

Awareness and involvement to interventions. Farmer-respondents and some of their household members have participated in at least one or more of the different components of the on-farm demonstration or training and farm visits.

Table 1. Production system of the different watersheds in Thailand and Vietnam				
Particular	**Tad Fa, Thailand**		**Wang Chai, Thailand**	
	Before	**After**	**Before**	**After**
Soil type	Clayey (30 cm, clay ↓)		Sandy (90%)	
Runoff and soil erosion	**2001-2003** Crop-based (Untreated): Runoff: 364 mm Soil loss: 15.3 t ha^{-1} Tree-based (Treated): Runoff 169 mm Soil loss: 12.8 t ha^{-1}		**2003-2004** Crop-based: Runoff : 210 mm Soil loss: 4.21 t ha^{-1}	
Nutrients	Low in fertility	Significant increase in organic matter and N content	Low in fertility	
Water sources	Ponds and wells		Ponds and wells	
Average rainfall (Piara Singh, AVR Kesava Rao and K Srinivas, 2005)	1220 mm		1231 mm	
Crops	Maize. Legumes, and Fruit Trees	Maize, Legumes, Vegetables, Other fruit trees, and *Vetiver* grass	Rice, Sugarcane, Legumes, and Mulberry	Rice, Sugarcane, New varieties of legumes, Mulberry, Vegetables, and *Vetiver* grass
Legend: Before – Prior to implementation of interventions: After – After the implementation of interventions				

Cont. Table 1. Production system of the different watersheds in Thailand and Vietnam.				
Particular	**Thanh Ha, Vietnam**		**Huaong Dao, Vietnam**	
	Before	**After**	**Before**	**After**
Soil type	Red-yellow Ferralitic	Red-yellow Ferralitic	Red-yellow Ferralitic	Red-yellow Ferralitic
Runoff and soil erosion (NV Viet, HM Tam, NT Chinh, NV Thang and A Ramakrishna 2005)	2000-2001: Rainfall 1369 mm; runoff 79 mm	After: Seasonal runoff due to good infiltration		No data
Nutrients (NV Viet, HM Tam, NT Chinh, NV Thang and A Ramakrishna 2005)	• Acidic in nature and with very poor organic matter, medium potassium and very low phosphorous content (NV Viet, NV Thang, A Ramakrishna and SP Wani 2005)	• Micronutrient applications (grow more and comax) increases groundnut yields by 10 to 24% and soybean yield by 14 to 22%. Rhizobium application reduced N requirement by 15 to 30 kg ha^{-1}	• Acidic in nature and with very poor organic matter, medium potassium and very low phosphorous content (NV Viet, NV Thang, A Ramakrishna and SP Wani 2005)	No data
Water level (NV Viet, HM Tam, NT Chinh, NV Thang and A Ramakrishna 2005: Personal Communication with Piara Singh) -near check dams -away -water table		• Significant rise (1.5 to 2.0 m) in water level in wells was recorded in treated watersheds. The water level fluctuations were less and stable water yield during summer. • 200 water harvesting pits • Water tanks		• 2.5-3 m rise in (10 open wells) (TD Long; NV Thang, and SP Wani 2005) • 200 water harvesting pits • Water tanks
Average rainfall (NV Viet, HM Tam, NT Chinh, NV Thang and A Ramakrishna 2005)		2020 mm		1585 mm (ICRISAT ADB Report 2004)
Legend : Before – Prior to implementation of interventions: After – After the implementation of interventions.				

Cont. Table 1. Production system of the different watersheds in Thailand and Vietnam.				
Particular	**Thanh Ha, Vietnam**		**Huoang Dao, Vietnam**	
	Before	**After**	**Before**	**After**
Crops (ICRISAT ADB Reports and TD Long; NV Thang, and SP Wani 2005)	Rice, Sweetpotato, Cassava Maize, Groundnut, Tea, Soybean, Fruit trees	• Improved cultivars of soybean (DT 12), groundnut (l 16 and l 17), and mungbean (T 135) were expanded to large areas in Thanh Ha watershed during autumn-winter season of 2003 and spring 2004. Soybean and groundnut gave more benefit than maize • Area under maize declined from 380 ha to 148, while area under groundnut, mungbean, and soybean increased from 18 ha to 250 ha changing the crop agro-biodiversity factor from 0.25 in 1989 to 0.6 in 2002. • Crop management practices on groundnut and maize and application of biofertilizers to groundnut, soybean, maize and in Than Ha watershed increased the economic yields of crops by 8-16% with reduced N application. The farmers incorporated the groundnut, soybean and into the maize- and cassava-based systems • Watermelon cultivation using groundwater transported through pipes • Use of polyethylene mulch which resulted in doubling yield of crops like groundnut	Maize, Rice, Cassava, Soybean, Tea	• In Vietnam, high yield varieties of soybean (VX 93) and groundnut (L 14) were sown in additional 50 ha in Huoang Dao watershed. • Fruit trees with water conservation technology • Use of polyethylene mulch which resulted in doubling yield of crops like groundnut • Introduction of elephant grass as fodder (ICRISAT ADB 2005) • Intro of wild *Arachis* as soil cover in litchi gardens (ICRISAT ADB 2005)

Soil and water conservation (SWC) structures. Farmer-respondents were all aware of the different SWC with some having ponds, pits, open wells, and bunds. However, awareness among the respondents on the physical barriers like check dams and weather instruments was very low. At Thanh Ha, for instance, no one was aware of the runoff recorder and sediment samplers. Hence, there is a need to stress on this in succeeding initiatives, not just for creating awareness but also for building a sense of responsibility among the community to maintain and sustain these components. It must be instilled in farmers about not only on the kind of data generated by these instruments but also on how the data could enlighten them to improve their farming system.

Figure 2. (L) A pond in Wang Chai watershed, Thailand and (R) a pit in Huoang Dao watershed, Vietnam.

Moreover, water-harvesting pits are not common in Thailand. Field visits showed that farmers from Wang Chai and Tad Fa invest more on pond development as government provides subsidy for the construction of farm ponds. In addition, this could also be explained by the size of landholdings where Thailand farmers have bigger farms than Vietnam. Stone bunds, on the other hand, are quite common in Vietnam than in Thailand where bunds are constructed with soil.

The adoption of on-farm demonstrations that includes introduction of new crops, modification of the cultural management practices (i.e. crop rotation, multiple cropping, organic farming, and integrated pest management) and development of ponds (by planting crops, fruit trees or grass along the periphery) is high as shown in Table 2.

There is no adoption of organic farming among farmer-respondents in Thailand. This is not that farmer-respondents lack interest in organic farming, but it is because of their lack of awareness about improved

Figure 3. Intensive cropping and crop diversification in Huoang Dao, Vietnam. Inset: Pineapple integrated with fruit trees.

practices like IPM, crop rotation with legumes, composting, and the use of bio-fertilizers (obtained from their training). An inference drawn from this is the wide scope of an organic system of production. This has been a cause of debate due to several interpretations and definitions. Adopting some of the elements can make their products have an organic brand. However, others have very rigid standards. Kirchman and Ryan (2004) raised an important concern on the subject of organic farming. They claimed that nutrient additions through a variety of means other than synthetic fertilizers contribute to fertility maintenance but not directly to feed plants. This can be an important area for research because of growing interest in organically produced crops. An important insight from this is the increasing farmers' awareness on organic production in the watersheds. In CW, crop production with minimal damage to the soil and environment is espoused through the technology on integrated pest management (IPM) and integrated crop management (ICM).

Vietnam's farming system is best described by intensive cropping. In an area of about 1,000 square meters, farmers cultivated four kinds of vegetables. According to farmer-respondents, maximizing the utility of their land by practicing multiple cropping is dictated by a perception that if one crop fails, the other crops could serve as fallbacks (food source and income) (Figure 3). This is a form of coping strategy (Box 1).

Table 2. Farmer-respondents' involvement in project interventions

Interventions	THAILAND		VIETNAM	
	Wang Chai (N=15)	**Tad Fa (N=12)**	**Thanh Ha (N=12)**	**Huoang Dao (N=10)**
1. Small Infrastructure (%)				
• Ponds	73.33	58.33	66.67	100
• Bunds	93.33	33.33	100	100
• Pits	-	-	100	100
• Check dams	-	-	-	-
• Installation of instruments	-	16.67	-	-
2. On-Farm Demonstration (%)				
• Crop diversification	53.33	100	100	100
• Crop rotation	100	100	100	100
• Multiple cropping	100	-	100	100
• Organic farming	-	-	100	100
• Pond improvement	100	75	-	-
• Integrated pest management	60	75	100	100
3. Training & Farm Visits (%)				
• Training (composting & biofertilizer)	100	75	100	100
• Self help group formation	100	33.33	-	-

Box 1. Multiple Crops for Security in the Midlands of Northern Vietnam

Figure 4. Multiple cropping system in Thanh Ha, Vietnam.

Mr Za is 45 years old from the midlands of Huoang Dao, with five (5) children to support, and has a land area of about 1.1 hectare, which is slightly higher than the average of 0.8 hectare per household. He is primarily dependent on the land. Most often, he hardly puts the entire area to productive use because of inadequate irrigational facilities. With his pond widened (5 x 5 meters), water being available during dry season for his ducks, several small pits that reduce water flow and new crops that can be grown due to conserved moisture, Za claims better prospects of his cropping system. However, his practice of allocating areas for several other crops in one season, a common practice in Huoang Dao and in societies with fragmented land (Castillo 1999), is hinged on the perception that food and income must be ensured. Having more crops means the failure in one crop could be buffered by the productivity (yield and income) of the other crops.

In his farm, there are patches of different crucifers like cabbage, Chinese cabbage, and leeks alongside a bigger area of transplanted rice. He has also tried planting watermelon and adapted polyethylene mulching, which he finds financially rewarding. In his homestead are also some eggplants, herbs like mint, and fruit trees like *longan*. There are also three cattle in the stable, pigs, and chicken at the courtyard.

Za's case epitomizes that less-endowed resource farmers are more likely to participate in developmental interventions. His situation shows the uncertainty of his livelihood, which he by all means need to deal with. There is the surfacing of other opportunities to improve livelihood, where for instance, Za integrated duck raising for subsistence and some cash. Coping strategies, specifically adaptation (Davies 1993) and management of resources under a problematic situation (Barnett 1993) like scarcity are important manifestations for a better understanding of livelihood system. Gaining insight into their responses suggests that watershed interventions need not always be 'new' but can also be traditional and drawn from local resources (Scoones 1992). Many studies have shown that adaptations of farm households in response to a livelihood problem are varied and borne out of their several years of dealing with the situation. Past experience and existing knowledge, in most cases, are drawn upon where responses become sequential. It also suggests that strategies developed do not always represent clear-cut, mutually exclusive alternatives (Mula & Niehof 2000 and Abdoellah 1993).

Training and exposure. Another component of the watershed interventions is training and some field exposure. All of the respondents including their household members have undergone training and a few have been introduced with the concept of self-help group (SHG) formation. In Thailand, for instance, women, mostly respondents' wives who had the chance to be part of a cross visit

sponsored by the project learnt some insights of cooperative work (Box 2). To date, women have organized themselves and put up their SHGs on fish sauce, soap making, shampoo, fish feed, etc. In Wang Chai, there are two SHGs (having 8 to 10 members each) established as a result of the CW intervention. The small-scale activities of women show the local level resource mobilization, use and management. In Vietnam, extension system has been found to be a major driver for promoting agricultural production. The various trainings for the CW initiatives were conducted with a new perspective where local involvement was emphasized (Figure 5 and 6). Similarly, like the Social Forestry Support Programme (SFSP) in Vietnam (http://www.iirr.org/PTD/Cases/Hoang.htm), CW provided for the effective transition from state-directed protection of forests to local level and people-centered forestland management through the development of social forestry approaches and training activities. A study made by the University of Arkansas in 2002 as reported by Verderosa (2002), in the Mekong Delta reveals that interventions to help very poor locals, specifically the change in the approach to agriculture, do not only require the introduction of high yielding crops but also a great deal of education - changing the atmosphere of learning and teaching that includes organized credit and setting up a women's union and farmers' association.

Figure 5. Training and farm visit in Thanh Ha, Vietnam.

Figure 6. IPM demonstration in Wang Chai, Thailand.

Box 2. Women's Role in Securing Livelihood

More exposure and participation in various activities of the watersheds provided opportunities for women to craft their own domains for meeting day-to-day demands of the household. Supatra of Wang Chai watershed took the lead for organizing the women in her community. Some of the projects initiated were on fish sauce and soap making, which are two important commodities for households. During the conduct of this study, SHG formation was a recent initiative. According to Supatra, the primary objective of the SHGs is to cater to households' needs, which later can become a potential source of cash.

In spite of Supatra's limited time due to running her convenient store in the village, she extends help in organizing women. She says that these initiatives minimized household expenses. Moreover, she claims that with only modest capital, these activities enabled women to have their own source of cash, which made them happy. Supatra appreciated Yen of OARD who is instrumental for opening this window for her and other women. Their visit to another province, as part of the capacity building in the watershed project, led them to meet Mrs. Songbay, who served as their trainer for soap/shampoo making.

From the above example, connectedness and social support can open opportunities for collective action and prospects for economic activity. The case also illustrates that social networks assume the function of information dissemination and generating advice about problems, give access to material resources, and have an emotional support function (Chamala 1996; Carey 1988).

3.3.2 What are the effects of the improved biophysical benefits on households' livelihood system and social processes?

Farm households have different resources (Mula 2000, Chambers & Conway 1992 and Ross et al. 1994) and these are the means to satisfy a system's demands. Resources, to a large extent, determine the livelihood security of households. Beyond the major factors of production, which are regarded as precursors to farm households' productivity, the ways in which these factors are managed during slack or abundance situations provide invaluable insights in understanding the success of watersheds. Specific watershed interventions have been included to illustrate the contours and dynamics of CW approach in relation to the various elements of the farming system. As in this research, watershed serves as the platform for integrating biophysical and social accomplishments for resource-poor farm households.

The succeeding section discusses the effects of the change in biophysical resources on farm households' livelihood resources. This covers the following topics: household resources, livelihood change and development, advantages of changed farming system, factors contributing to livelihood stability, and social capital.

Household resources. The different resources of farm households are shown in Table 3.

The concerted efforts of consortium members in community watershed made significant improvements in domestic and irrigation water supply, according to farmer-respondents in all the sites. The DLD's support on the construction and/or rehabilitation of ponds, plus the technical advice of KKU and ICRISAT improved water resources and agricultural productivity. Pond size ranges from 4 × 8 to 5 × 10 meters in area and depths of about 1-2 meters. In Wang Chai, where ponds are recent interventions (only in 2003), farmers cultivated more trees and V*etiver* grass and also observed robust and better yields of fruit trees. A 30% increase in the yield of their longan and litchi was reported in Tad Fa watershed (Figure 7). Farmers likewise claim of better productivity on farms located around the ponds during the FGD in Tad Fa.

Pond development in Thanh Ha and Huoang Dao are very important both for crops and livestock. Irrigation water is obtained from this source while domestic water is obtained from wells. Pits measuring about 1 × 2 meters, depth of about 0.5 to 1 meters, and a distance of about 5 to 7 meters depending on the contour are common in the two sites of Vietnam (Figure 2). These are very effective in reducing soil and water erosion and at the same time conserving moisture, according to farmers during the FGD. During a field visit of a farmer's litchi plantation, the pits had even closer distance and dug in quin cunx formation. Fruit yield increased to about 30-40%, says the farmer. Individual farm owners pay the cost of this intervention, which according to them do not require much investment except for labor during digging and in maintaining the pits like dredging and removing weeds. The farmer-respondents' litchi farm, which measures almost a hectare, is cleaned by three household members in seven days. In Huoang Dao alone, there are about 200 water-harvesting pits (Long et al. 2005) (Figure 8).

Figure 7. Pond in Wang Chai,Thailand. Inset: Vetiver grass grown around the pond.

Figure 8. Pits constructed in an orchard in Huoang Dao, Vietnam.

Farmer-respondents in all the four watersheds expressed positive remarks on the various watershed interventions introduced by the project. The significant effects are obvious for Tad Fa and Thanh Ha. As shown by the trials, Thanh Ha farmers in 2003 produced groundnut at 0.69 t ha^{-1} in the farmers' practice and 0.94 t ha^{-1} in the improved practice. Maize yields increased from 3.4 t ha^{-1} grain in the farmers' practice and 3.6 t ha^{-1} in the improved practice. In Tad Fa, trials have proven the benefits of groundnut cultivation in increasing the outputs of upland rice and maize (ICRISAT ADB Report 2004).

Livestock is another asset of farm households in the watersheds. Tending small and native breeds of livestock are common. Cattle is primarily used for draught power and occasionally sold. Poultry, specifically chicken and ducks, are mostly utilized for home consumption and as a source of cash. The average heads of poultry in Vietnam is almost three times the average production in Thailand. Preference for small livestock is partly a response to problems of grazing (as in the case of Vietnam) and partly due to ease of management, as in tending and selling (Scoones 1992) (Figure 9). The ponds in Vietnam are used not only as source of irrigation but also as sanctuaries for ducks. Tending duck is another very important livelihood, especially among women household members.

Figure 9. Livestock tending in Thanh Ha,Vietnam.

Formal and informal sector are farmers' sources of credit. Cooperatives, government (state), and NGOs are emerging as important since their interest rates as are less compared to banks. Among the farmer-respondents of Vietnam, credit is availed from different formal sources and from relatives. In Thailand, farmer-respondents draw their credit from four formal sources. However, informal sources like friends and relatives are the most sought because of lower interest rates and absence of paper works. This works best with relationships build on trust. At times, negotiations can even happen like delayed payments. However, farmer-respondents as much as possible avoid delayed settlement of loans since this can jeopardize relationships. Losing one's face will never be compromised, according to farmer-respondents.

Market facilities for household needs and farm inputs and for their products are made in markets closest to their homesteads. In Tad Fa and in Huoang Dao, access to market becomes very difficult during the wet season because of the poor condition of the roads. Middlemen are considered as 'necessary evils' since they facilitate trading transactions and sometimes credit to farmers at the interest rates of friends/relatives (from zero to 10 % interest).

The crop area in northeast Thailand is much higher than in Vietnam. The highest average crop area per household is in Tad Fa, which is about 4.30 hectares. This is slightly higher than what Supama et al. (2003) reported where the average is 3.0 hectare. With livestock as an important livelihood asset, the need for grazing is imperative. In Vietnam, where there is a shortage of grazing areas, cut and carry is mostly done. The average crop area for Vietnam, as seen in Table 2, is below one hectare, which is similar with the findings of Long et al. (2005) and Magnus Jirström and Franz-Michael Rundquist who estimated it to be below one hectare (0.06 ha for rice/vegetable farm). However, average upland farm area is estimated at 0.10 hectare.

Table 3. Household resources.

Resources	THAILAND		VIETNAM	
	Wang Chai (N=15)	**Tad Fa (N=12)**	**Thanh Ha (N=12)**	**Huoang Dao (N=10)**
1. Domestic Water Source (%)				
Sources				
• Rainwater	100	100	100	100
• Pond	100	75	100	100
• Open wells	-	-	100	100
• Groundwater (piped water)	100	33.33	-	-
Assessment				
• Much improvement	86.67	75	100	100
• Slight improvement	100	25	-	-
2. Irrigation Water Source (%)				
Sources				
• Rainwater	100	100	100	100
• Pond	100	75	100	100
• Pits	-	-	100	100
• Open wells	53.33	-	100	-
• Groundwater (piped water)	-	33.33	-	-
Assessment				
• Much improvement	33.33	67	100	100
• Slight improvement	60	22	-	-
• No change	13.33	11	-	-
3. Livestock Resource (%)				
• Cattle	33.33	67	100	100
Average	(7)	(7)	(5)	(6)
• Poultry	100	100	100	100
Average	(11)	(11)	(35)	(29)
4. Credit Source (%)				
Formal				
• Banks	33.33	33	30	20
• Cooperatives	20	22	-	50
• Government	20	11	100	10
• NGOs	-	-	63	30
Interest rate (% per annum)	(0.5-12)	(6-12)	(0.5-14)	(0.5-14)
Informal				
• Relatives/Friends	53.33	100	100	60
Interest rate (%)	(5-10)	(0-10)	-	-

Cont. Table 3. Household resources.

Resources	THAILAND		VIETNAM	
	Wang Chai (N=15)	**Tad Fa (N=12)**	**Thanh Ha (N=12)**	**Huoang Dao (N=10)**
5. Market Facilities (Buying and Selling) (%)				
• Direct to/from the market	100	100	100	100
• Middlemen	100	78	100	100
6. Land Use (%)				
***Crop Area** (hectares)*				
• Less .08	-	-	75	20
• 0.09-1.0	26.67	-		40
• 1.1-2.0	26.67	-	25	40
• 2.1-3.0	33.33	-	-	
• 3.1- 4.0	13.33	66.67	-	-
• Above 4.0	-	33.33	-	-
Average (hectares)	(2.5)	(4.3)	(0.07)	(0.95)
Grazing area	(n = 5)	(n = 8)		
• Less 0.08	-	33.33	-	-
• 0.09 - 0.16	-	8.33	-	-
• 0.17 - 0.24	33.33	-	-	-
• 0.25 - 0.32	-	33.33	-	-
• 0.33 - 0.40	20	-	-	-
• Above 0.41	20	25	-	-
• Cut and Carry	26.67	-	-	-
Average (hectares)	(0.56)	(0.33)	-	-
Homestead				
• 0.01-0.05	87	92	92	70
• 0.06-0.10	13	8	8	20
• 0.11-0.16	-	-	-	10
• 0.17-.21	-	-	-	-
Average (hectares)	(0.26)	(0.015)	(0.03)	(0.56)

With respect to livestock tending, farmers feed their cattle with crop waste derived from crops grown in peripheral areas as well as those from the homegardens. In Thailand, where the settlement pattern is clustered, the boundaries of homegardens are quite distinct. Homegardens are planted with food (mostly for home consumption) and non-food crops. Mulberry trees are quite common, which are very important for silkworm rearing. Almost every household in Wang Chai, particularly elderly women, is engaged in home-based silk weaving. This is a traditional industry and a good source of cash. However, this is a dying industry because of the lack of interest of the younger generations. In turn, this explains the non-maintenance of mulberry trees (a source of food for silkworms) among households. The OARD, which is a consortium member and implementer, has taken interest towards the sustainability of this industry by promoting mulberry tree planting.

In Vietnam where settlements are dispersed, homegardens form part of their crop area, which explains the smaller landholdings and homesteads. In spite of this, farmers still grow a few stands of food crops and some grass for their cattle.

Livelihood change and management. According to the World Commission on Environment and Development (WCED, 1987), livelihood security means 'adequate stocks and flow of food and cash to meet basic needs.' The definition incorporates the concept of security, which refers to secure ownership of or access to resources and income-generating activities and sustainability, which refers to the maintenance or enhancement of resource productivity on a long-term basis. The key to a secure and sustainable livelihood is when farm households are able to manage the change(s) in their resources. Below are the strategies employed in the cropping system as a result of improved irrigation.

Cropping system. With better irrigation sources and moisture conserved, farmer-respondents' cropping system showed much improvement (refer to Table 4). Farmer-respondents improved their cropping system from monocropping to crop rotation after their primary crops consisting of rice, maize, and fruit trees. Farmer-respondents diversified with new crops and new varieties of legumes and vegetables and other plants like *Vetiver* and *Glyricidia*.

In the different topo sequence of the Tad Fa watershed, black cowpea and sunn hemp are the new additions in their cropping system. In the upland area, more economic crops, specifically fruit trees, are integrated with *Vetiver* grass. The latter is used specifically for soil erosion control. Livestock integration is also a significant change in the farming system, basically attributed to feed/fodder resources. In Wang Chai watershed, the cultivation of legumes such as groundnut and black cowpea is a significant change in the cropping system. Legumes are also cultivated after 2-3 times of sugarcane ratooning. This intervention has been found to increase the organic matter and N content of the soil as shown by the results of groundnut nodulation (ICRISAT ADB Report 2005). Fruit trees, para rubber, *Jatropha* and *Vetiver* grass are new additions in the midstream and upland. At the downstream level, the ponds have dual function - as a source of irrigation and/or as a sanctuary of poultry or fish culture. (Figure 10 and 11).

The watershed interventions in Vietnam, specifically Huoang Dao led to an intensive use of farmers' field by cultivating new varieties of their traditional crops (rice and maize) as well as new crops such as fruit trees. As reported by Nguyen Phuong Thao (http://www.globalfoodchainpartnerships.org), 85% of Vietnam rural households are involved in vegetable, fruit and flower production. The southern part, which includes these watershed sites produced two thirds of fruits and vegetables. The whole year round, legumes were cultivated at the downstream of the topo sequence. At the midstream, pineapple was interspersed with fruit trees and legumes with cassava. Livestock raising improved to a large extent and so was their fish culture. A similar trend is observed in Thanh Ha, but the cultivation of watermelon, sugarcane, groundnut and mungbean expanded in other brigades of Thanh Ha, specifically at the midstream portion. (Figure 12 and 13)

Farmers' statements on their present farming system as indicated below reveal a mélange of benefits, especially in their agricultural livelihood system.

- My first time to grow soybean showed very good yield. I had also about 60-70 % more water because of my improved pond.
- I have 5 ponds but still I am faced with insufficient irrigation. I have also difficulty in obtaining credit because of high interest rates and also I need a guarantor if I want to borrow.

- The use of biofertilizer has been very beneficial. Before, I just made use of commercial fertilizer and pesticides. Now (at the time of the interview), I collect cow dung and use them. The molasses trap is very useful in my cabbage crops.
- My rice yield increased to about 20-30 %. I am also able to cultivate vegetables and my mungbean yield was very good last year.
- I am able to raise fish in my pond, have ducks and still have water for my vegetables.
- Before we just had LDD visiting us, now we also get KKU who gives us technical advice.
- My soil improved by growing legumes like sunn hemp but this crop is difficult to harvest. Caterpillars abound the plant, which cause severe itching.

Glyricidia has been grown on bunds as a vegetative barrier against soil erosion and also as a source of green manure to improve soil fertility. *Glyricidia* in Thanh Ha watershed can withstand extreme climatic conditions like drought and produce a huge quantity of leaf and young branches of about 24 t ha^{-1} per month. Further, it is not vulnerable to pests and diseases, and unlike *Leucaena*, which is also a legume-fixing plant, *Glyricidia* does not become a weed and is not invasive. It is a fast-growing perennial tree that can be pruned 6 to 8 times a year and provides 80-100 tons of N rich biomass (ICRISAT ADB Report 2005). In addition, the cultivation of elephant grass catered to the demand for more fodder for their improved livestock system.

Based on an input-output estimation (Appendix 2) of three major crops in Wang Chai, sugarcane has the highest capital requirement. Planting legumes is a viable intervention because of the crop's low input requirement, good yield, ready market and provides nitrogen to the soil. Rice, on the other

Table 4. Livelihood change.

	THAILAND		VIETNAM	
Particulars	**Wang Chai (N=15)**	**Tad Fa (N=12)**	**Thanh Ha (N=12)**	**Huoang Dao (N=10)**
Cropping System				
Before (%)				
• Monocropping	100 rice-rice	100 maize-maize	100 rice-rice lower area	100 rice-rice lower area
• Fruit Tree - Maize / Fruit Tree-Vegetables			100	
• Rice – Legume	40	-	-	-
• Rice – Sugarcane	80	-	-	-
• Maize – Vegetables	-	67	-	-
• Fallow	53.33	100	-	-
After (%)				
• CP (crop rotation/tree based)	-	16.67	100	100 food trees & lumber
• CN (composting, green manuring, growing crops around pond)	-	16.67	100	100
• CPT (integrated pest management)	-	16.67	100	100
• CP + CN	-	58.33	100	100
• CP + CPT	60	33.33	-	-
• CN + CPT	100	-	-	-
• CP + CN + CPT	100	100	100	100
	-	-	-	100

Legend: CP – Crop Production: CN – Crop Nutrition (i.e. *Glyricidia)*: CPT– Crop Protection.

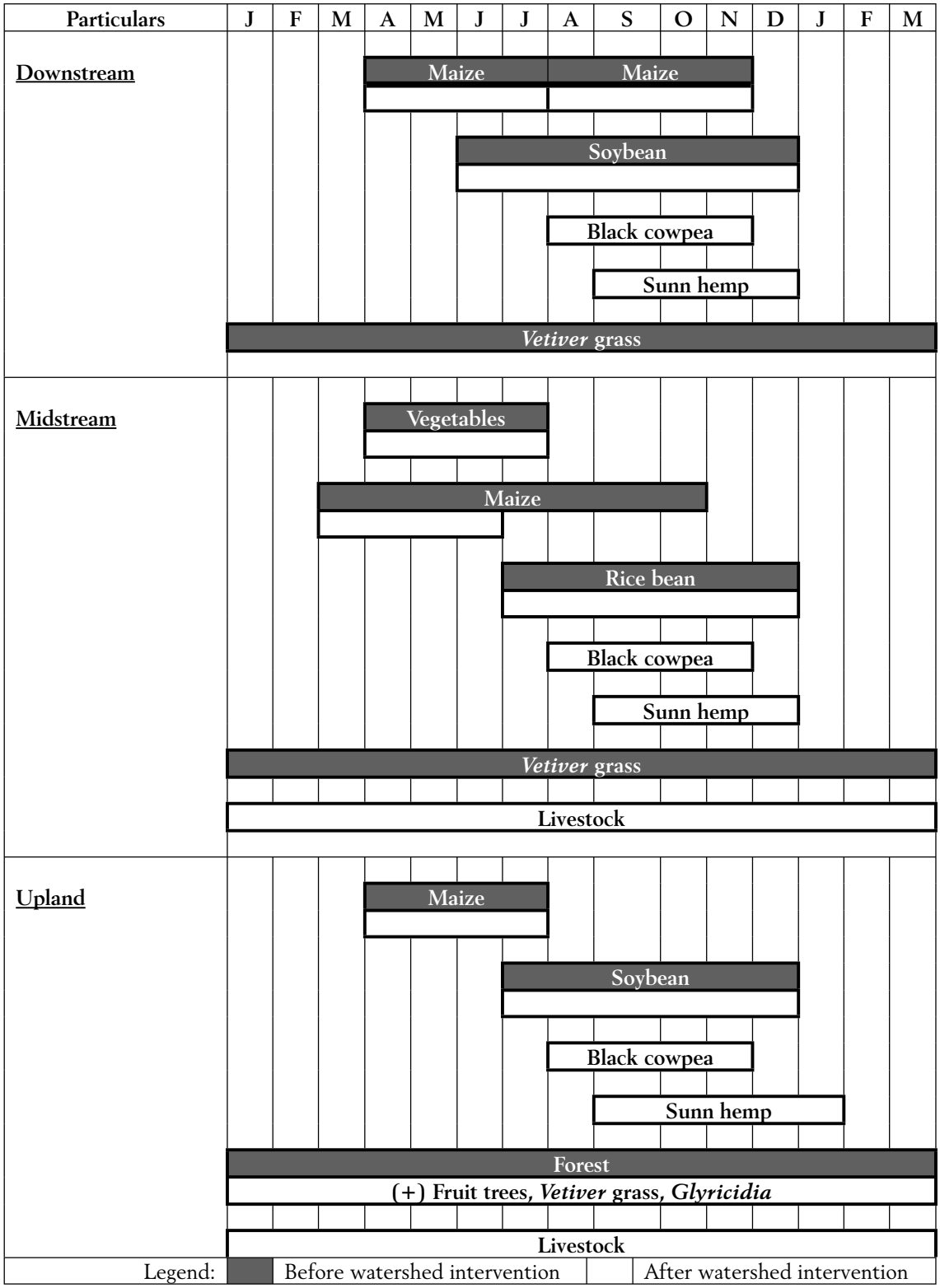


Figure 10. Cropping calendar of Tad Fa, Thailand.

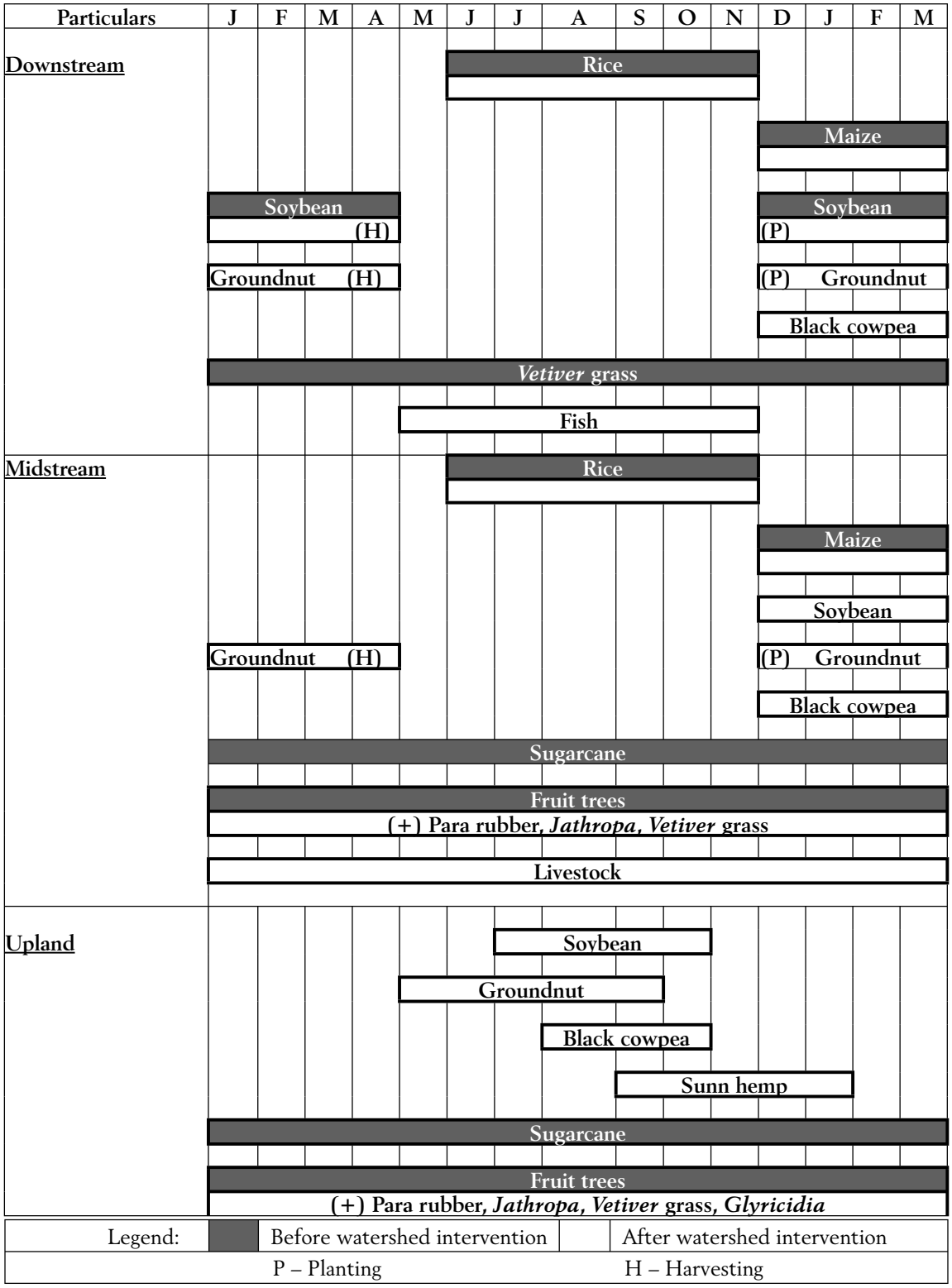


Figure 11. Cropping calendar of Wang Chai, Thailand.

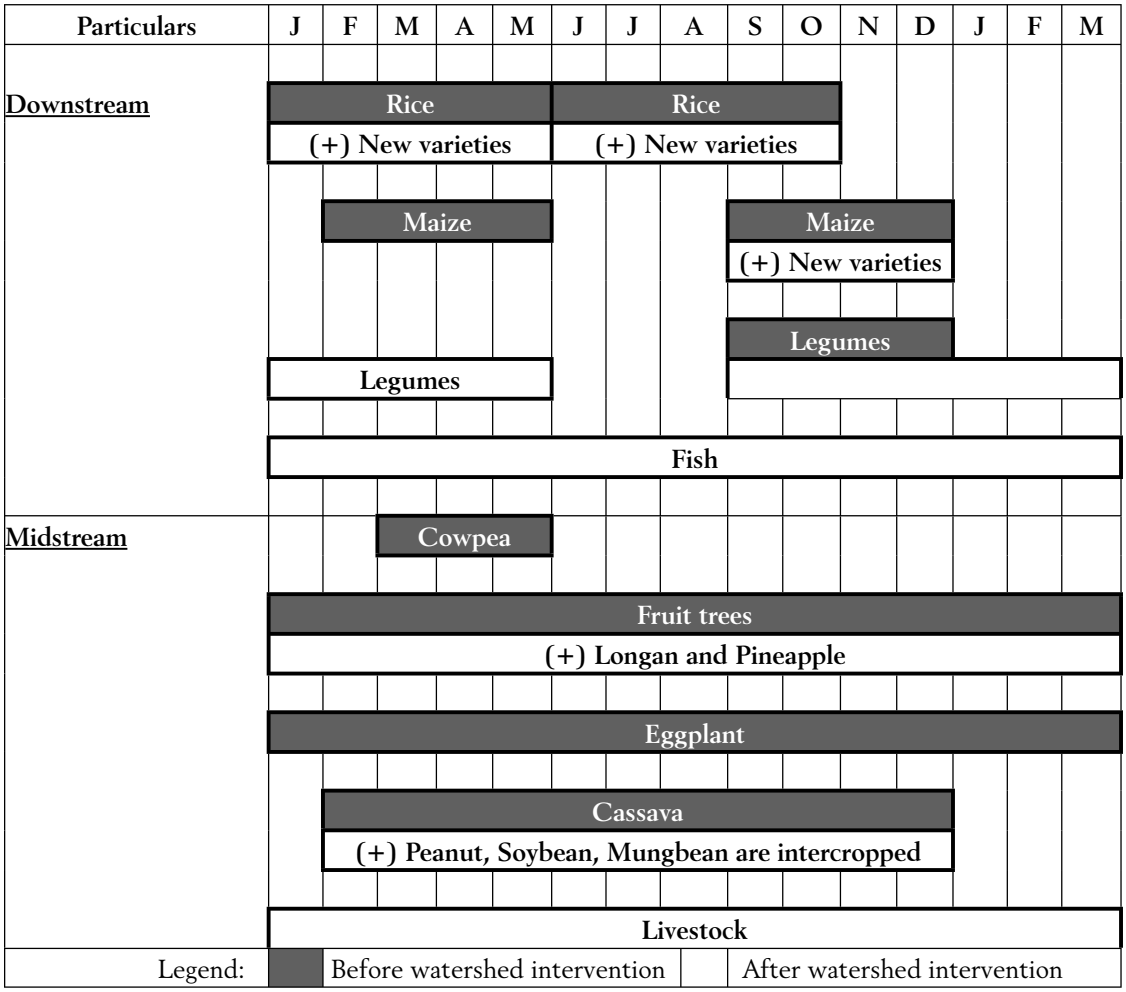


Figure 12. Cropping calendar of Huoang Dao, Vietnam.

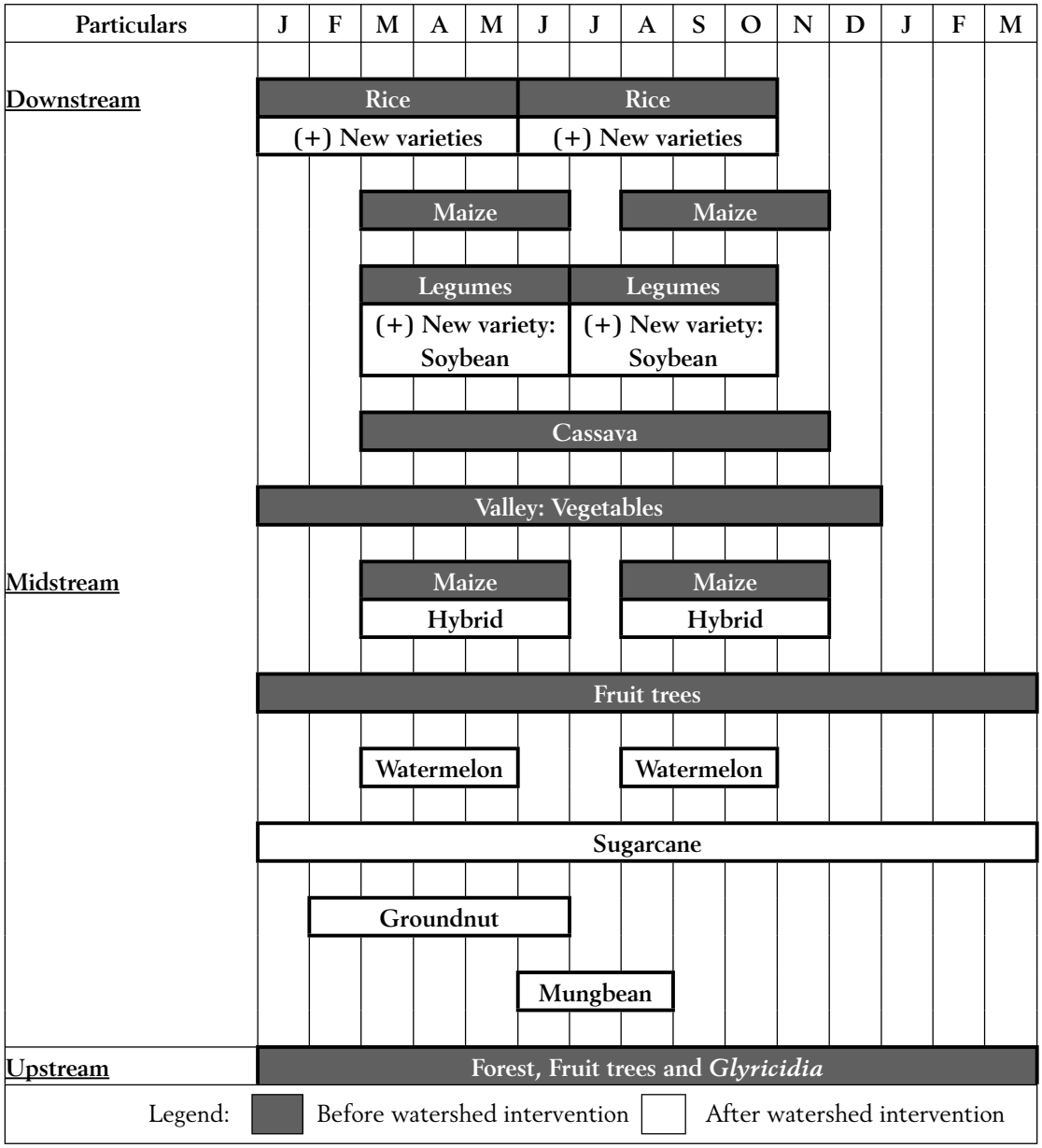


Figure 13. Cropping calendar of Thanh Ha, Vietnam.

hand, is a major crop in both countries. Even under extreme situation of inadequate water, rice farming is difficult to abandon. Existing norms and values determine, to a large extent, management and interpretation of the environment. This in turn, will determine how a biophysical resource like land is put to productive use. In an area where livelihood security means more rice, the advent of inadequate water for irrigation will not prevent farmers from its cultivation. This explains that even if the capital requirement for rice cultivation is higher than other crops and that Vietnam farmers' claim that 'there is no money in growing rice', they yearn for improved yields and most importantly, the maintenance of quality since this is their staple food. Off late, there is demand for more traditional varieties of rice, which might mean lower yields but may also mean higher prices.

Farmers in these watersheds are also engaged in crop nutrition and crop protection management practices that made farming more stable. In Tad Fa, for instance, farmers practice 'layering' where short-maturing crops like vegetables and legumes are interspersed with existing fruit trees. This system maximizes the utility of their area. And together with knowledge of composting, application of green manure, and growing of crops around ponds, livelihoods have improved (Box 3). This shows the significance of watershed as a means and an end for tapping all possible micro niches where substantial food and cash can be obtained.

Mr Vareedee's case is one other example showing other opportunities for improving livelihoods. The chain of social network he earned from his active participation in the watersheds activities made him a focal point for information exchange.

Box 3. Vareedee and His Sunn Hemp (*Crotolaria juncea*) Cultivation

In Tad Fa, growing of sunn hemp as one of the initiatives of the ICRISAT's consortium project is a great stride towards a more secure livelihood for Mr. Vareedee. Almost all households in the area have sunn hemp cultivation. According to Vareedee, one of the respondents, said that sunn hemp grows very well with less inputs, under poor soil condition, and with very little moisture. Sunn hemp, being a legume, improves soil structure. The biggest incentive farmers get from its cultivation is a ready market. The DLD buys all farmers' production through its volunteer who is a farmer from the community. To date, the DLD volunteer in Tad Fa has not only become an intermediary to the project implementers but also serves as community's source of agricultural information. Recently, he has also done the leg work for a self-help group (SHG) on sunn hemp seedbank, which is anticipated to pave for a more organized growers association.

Figure 14. Vareedee with his sunn hemp.

Sunn hemp was introduced in the area sometime in 1999 by DLD. Since then it has become a major crop in the area besides maize. According to a DLD key informant, a net profit of 10,000 baht ($ 235.3 US) could be realized from a 20 *rai* (3.2 hectare) area with an estimated production of 1,000 kilograms.

Indeed, sunn hemp does not only render cash to farm households but also improves soil health. The only disadvantage, according to respondents and DLD staff, is its difficulty in harvesting and threshing. Farmers have to grapple with extreme itchiness caused by a caterpillar common in the crop.

Advantages of the changed farming system. Improvements on the biophysical component such as improved soil structure, reduced runoff and soil erosion, and improved soil moisture are some advantages observed in the biophysical component. This is corroborated by the findings by earlier studies made by ICRISAT and other consortium members. Socio-economic observations such as better yield, more income, reduced input use, access to other food types and access to learning are additional advantages, according to farmer-respondents. With respect to their cultural and religious activities, they have more time to visit temples and better support to community activities. (Table 5). Data on the table also implies the circumstances and priority concerns of farm households. The low percentage of 33.33% attribution to improved soil structure in Wang Chai watershed means that soil erosion and moisture conservation are of utmost importance. Among those who claimed that they were able to fulfill their cultural and religious activities, this is attributed to farm households having more resources as a result of improved farming system. In Thanh Ha, where farmers are basically subsistence, thus requiring intensive and continuous cultivation of cash crops, the improved cropping system like in the successful cultivation of watermelon (Appendix 3), led to at least 31.67% of the respondents being able to provide support to community events like the provision of some cash donations.

As one can deduce from Table 1, farmer-respondents' claim on improvements of the biophysical components like improved soil structure (physical and chemical properties) are over stated since it takes about 10 - 15 years to achieve a significant change on this aspect. However, these observations or claims by farmers are based on their own indicators such as yield, reduction of agricultural inputs (pesticides and fertilizers), and 'new' cultural management practices such as green manuring. The implication of this is the need for a holistic thinking for addressing a problem situation such as inadequate irrigation. When this is done, a significant change in yield can be achieved.

Table 5. Advantages of the 'changed' farming system.

	THAILAND		VIETNAM	
Particulars	**Wang Chai (N=15)**	**Tad Fa (N=12)**	**Thanh Ha (N=12)**	**Huoang Dao (N=10)**
1. Biophysical Observation (%)				
• Improved soil structure	33.33	67	100	100
• Minimized soil erosion	93.33	100	100	100
• Improved soil moisture	80	100	100	100
2. Socio-Economic (%)				
• Better yield	93.33	100	100	100
• More income	80	100	100	100
• Reduce input use	73.33	58.33	100	100
• Access to other food types	93.33	100	66.67	100
• Access to learning	100	100	50	100
3. Cultural and Religious Activities (%)				
• More time to visit temples	100	100	100	100
• More support to community events	93.33	100	31.67	100

As earlier mentioned, growing legumes after sugarcane cultivation is highly beneficial. Consistent results have been shown by the trials conducted between 2004-2005 by KKU on integrated nutrient management. Moreover, the experiments in Wang Chai showed significant differences in N and P contents in different preceding crops before sugar cane. Pigeonpea gave the highest N return to the soil while maize and sun hemp stover were among the lowest (ICRISAT ADB Report 2005).

Factors contributing to livelihood stability. An affirmative response by all the farmer-respondents is made when asked whether their farming livelihood has improved and made more stable. Indicators of their livelihood stability include better income, food, and most importantly conservation of their fragile environment. These are because of interventions, namely crop diversification, pond/pit structure, and other soil conservation techniques (Table 6).

Food security is central in the discussion of livelihood. In the watershed initiatives, a change in farming system like intensive cropping, means more food and more income at farmers' disposal. Looking at livelihood and food security issues from the natural resource-base (soil and its various elements), production practices should not clash with the goals of environmental protection/conservation. In the watershed approach, we see a close link between resources and the formulation of strategies, which can make livelihood and food sustainable.

Obviously, the three interventions (crop diversification, physical structures like ponds/pits, and other soil conservation techniques) combined together contributed significantly to their livelihood stability. Across watersheds, there is a slight shift in pattern. In Wang Chai, farmers considered pond development as an important intervention for their livelihood stability while in Tad Fa, soil conservation is important. In Thanh Ha and Huoang Dao, all the factors are regarded as equally important.

An inference from this finding is the severity of constraints across sites. Water scarcity is a priority concern of Wang Chai; hence, the need for pond development. In Thanh Ha, severe soil erosion is the key factor affecting their livelihoods.

Table 6. Factors affecting livelihood stability.

	THAILAND		VIETNAM	
Factors	**Wang Chai (N=15)**	**Tad Fa (N=12)**	**Thanh Ha (N=12)**	**Huoang Dao (N=10)**
1. Factors (%)				
• Crop Diversification (CD: fruit tree integration & planting legumes)	100	100	100	100
• Pond/Pits/ Development (PD)	100	66.67	100	100
• Soil Conservation (SC)	100	100	100	100
			Ranking	
2. Combination of Factors (%)				
• CD + SC	4	2	2	1
• CD + PD	3	3	2	1
• PD + SC	2	4	2	1
• CD + PD + SC	1	1	1	1

Social capital. The implementation of watershed activities through consortium approach revealed evidence of improved agricultural productivity and social benefits. In the four sites, there is gainful employment for other farm household members. The training and cross-visits component of the watershed initiatives led to SHG formation for women. This contributed in the enhancement of their self-esteem. Community empowerment was enabled by the creation and/or strengthening of local institutions. In Wang Chai watershed, SHGs were formed which served as sources of income among women. Community participation was enhanced since locals were united by a common goal of improving their productivity. This is evident in the various case studies presented.

3.3.3 What constitute the capacity building program of the community watershed project and what are the future activities to sustain the benefits?

A capacity development program for farm households in the watersheds requires to be anchored on the various biophysical interventions. It is important that user sensitivity is incorporated in the program as farm household members have various roles, needs, and problems. Moreover, there is also the need to contend with second generation problems in any intervention, which explains the need for a dynamic capacity development program.

Major constraints and suggestions. Insufficient water is a problem faced by all the respondents in the four watersheds (Table 7). '*There is still much potential to maximize productivity of our present farming system provided we have a good source of* water' was the articulation of most farmers during a focus group discussion in Vietnam and Thailand.

In Wang Chai, other problems needing attention are pests and diseases and soil erosion (especially in their ponds). In Tad Fa, pests especially caterpillars in sunn hemp and diseases, and soil erosion are the problems. In Vietnam, there is an expressed perception that soil erosion, unstable price of farm produce and inputs, inadequate extension services, and inadequate credit facilities are as equally important as having no adequate water.

Table 7. Major problems and constraints

	THAILAND		VIETNAM	
Problems/Constraints	**Wang Chai (N=15)**	**Tad Fa (N=12)**	**Thanh Ha (N=12)**	**Huoang Dao (N=10)**
Soil erosion (%)	80	41.67	100	100
Insufficient water (%)	100	100	100	100
Unstable price of farm produce and inputs (%)	-	-	100	100
Inadequate extension services (%)	-	-	100	100
Inadequate market facilities (%)	-		-	-
Inadequate credit facilities (%)			-	100
Pests and diseases (%)	93.33	58.33	-	-
Itchiness in sunn hemp (%)	-	100	-	-

Continuous capacity building is needed to go hand in hand with the different biophysical interventions and to sustain achievements in the watersheds (Table 8). This can lead to farm households' empowerment, where they learn by doing and their interactions with co-farmers as well as technicians become more meaningful.

Table 8. Capacity building requirements.

	THAILAND		VIETNAM	
Particulars	**Wang Chai (N=15)**	**Tad Fa (N=12)**	**Thanh Ha (N=12)**	**Huoang Dao (N=10)**
Nature of capacity building (%)				
• IEC materials	93.33	75	75	100
• Technical support	93.33	100	100	100
• Cross visits and training	100	67	100	100
• Market price information	93.33	100	-	-
Suggestions to maintain sustainability (%)				
Pond subsidy (%)	100	-	100	-
Groundwater development (%)	100		-	-
Technologies to improve soil fertility & water availability (%)	100	-	-	100
New varieties and new crops (%) (*Jathropa* & Para rubber)		100	100	100
Livestock improvement (%)	-	-	100	100
Exposure and training (%)	-	100	100	100
(Address) Land tenure (%)	-	100	-	-

Other types of capacity requirement as expressed by the farmer-respondents include continuous technical support and information, education and communication (IEC) materials as most of these watersheds (Tad Fa and Huoang Dao) are not easily accessible during the rainy season. With this condition of the watersheds, IEC materials in popularized version need to be made available. Accessibility (road and communication networks) is key to improving livelihoods of rural people in Vietnam (Alther et al. 2002). All of the farmer-respondents' expressed the need for these print materials as references and to be abreast of technologies. In Thailand, the only IEC material received is the newsletter of the DLD, which does not even contain farm tips. The issue on market price information as expressed by the farmer-respondents of Thailand is a concern that might not be directly addressed by capacity building. However, when farmers are empowered and are able to organize themselves (i.e. SHG), issues related to marketing and credit facilities can be addressed. Women, who had the opportunity to be part of the cross-visits, gained insights about cooperatives. They were able to organize themselves and set up SHGs to meet some basic household needs.

To sustain the benefits experienced by the farmer-respondents, their suggestions revolved around livelihood stability. There is the need for additional subsidies to build or improve ponds, groundwater development, and technologies to improve soil fertility, according to farmer-respondents in Wang Chai. In Tad Fa, they have learnt the potentials of a biodiesel plant particularly *Jatropha* and good

income from Para rubber growing and would want to try on these ventures. Others anticipate for more exposure and agricultural training, and about how they could obtain instruments to their farm lots. In Tad Fa, they only have the rights to cultivate the lands. Land tenure is an issue that might be worth looking with respect to the sustainability of watershed initiatives.

Among farmer-respondents in watersheds of Vietnam, suggestions made are pond development, new varieties and new crops, livestock improvement and more exposure/training.

Institutional arrangement. Complementation between and among members of the consortium is efficient and effective as reflected by the significant impacts made in Thailand and Vietnam watersheds. Consortium approach definitely works best especially when members are able to do their share and are willing to negotiate (Hall et al. 2004). Forging partnerships with an institution that allows taking on other responsibilities without sacrificing its primary function is a trait of a genuine consortium spirit.

Thailand. The dynamics of interaction with members of the implementing organizations and locals indicate a functional relationship. This holds true with provincial support having witnessed and participated in the field day on integrated pest management (IPM) where different organizations, farmers as well as NGOs converged and expressed their positive feedbacks on the IPM demonstration. The consortium approach adapted in Thailand reveals that cooperation is required to develop sustainable farming systems and improve resource management. The recent experience of several highland development projects in Thailand indicates that a coordinated community-based approach based on a participatory land-use planning process is needed to generate improvements in the living conditions of the highlands.

Partnering with an academic cum research institution provided the students a social laboratory to understand realistic situations. For the implementing institution, this meant additional hands to undertake demonstration.

The dearth in extension services such as technical assistance and IEC materials as expressed by the farmers require attention. Enjoining the participation of the Ministry of Extension might be an idea worth exploring to ensure the clamor for relevant materials.

Vietnam. The distance of the two watershed sites proved to be a difficulty for monitoring and evaluation. State support, which is the local link of Vietnam Agricultural Science Institute (VASI), should be made more active and vigorous. The extension system of Vietnam that emerged after the collectivization period has been much focused on production using training and demonstration plots with little attention to natural resource management or socio-cultural dimensions of production systems (Hirsh and Cheong 1996). Many poor farmers, especially forest dwellers, said they cannot access extension services because they are in remote areas.

According to some staff of DLD, OARD, VASI and Khon Kaen University (KKU), commonality of interest and mandate among these institutions bind them together. There were no major problems with the operation of the various components of the projects. There is transparency, said one staff. In fact, most claimed having benefited also with the capacity building program like cross visits, conferences, and training. The only threat, in so far as project implementation is concerned, is the fast turnover of leaders and staff, which creates some discontinuity.

Consortium approach works best especially when members are able to do their share and are willing to negotiate (Hall et. al 2004).

4. Conclusions and Recommendations

In the foregoing discussions, notable changes in the biophysical conditions of the watersheds are revealed. Estimates on biophysical change are based on earlier researches conducted in the area. Investigating impacts of watersheds from the biophysical perspective provided the platform for understanding not only the agricultural system but also of social dynamics and behavior (i.e. coping mechanisms/strategies).

Awareness and adoption of the different technological packages of the watershed projects are remarkable except on the aspect of hardware installation for determining agri-related issues like runoff and soil erosion.

- Awareness building should be dovetailed with deliberate efforts of explaining the significance of every intervention, activity, hardware, and/or infrastructure to inculcate ownership among the locales. A strong sense of inclusion in mainstreaming the development of farmers' own communities, taking collective actions to their problems and constraints, and enjoining certain degree of guidance from 'outsiders' ensures commitment for greater participation.
- In this study, the importance of awareness building concerns not only for reasons of information but should attempt to educate, take decisions and make farm households participate in technological revolutions as in the case of organic farming.

Prasong Jantakad and Carson (1998) postulated a number of points based on their experiences in implementing the Highland Development Programme in Thailand. These can also be points to be talked about in favor of the CW.

- The community has an important role to play in resource (land, water, and forest) management as it is the closest to these resources. This explains the serious empowerment of the locals in the management of whatever hardware or infrastructure installed in their communities
- A community that accepts the responsibility to manage local resources must need to clearly understand the purpose of each designated area and its proper conservation and utilization for the benefit of the community members.
- Development agencies should support local communities in terms of exchange of knowledge and ideas to solve communities to develop appropriate rules and regulations.
- Networking and increased cooperation between neighboring villages has the potential to improve the achievement of successful resource management. Through the adoption of the nucleus-satellite approach, scaling out of the CW interventions has been facilitated.

The alteration of farmers' production strategies was the most distinct feature of the change effected by watershed interventions. One is the distinct modification of the cropping system, which includes addition of new crops (legumes) to ensure soil health like availability of nutrients (i.e. N) and improved varieties to maximize production, adjustment in the cropping calendar to maximize the moisture in the ground, and multiple cropping to secure food and income. This in turn resulted in a change on input use such as amount of fertilizers and pesticides. The positive change in the farming system of the respondents shows the viability of watersheds as the means for understanding and improving livelihoods.

The tangible improvements in the natural resource base of watershed dwellers have caused corresponding changes in their socio-economic/cultural resource base. People's perception and attitude toward these improvements - worth of an environment (a resource in itself) are relevant

indicators of the impact. The over-all response by farmers to innovations of the watershed project is high. It opened opportunities to improve livelihood system. These include skills development or enhancement through training and exposure, SHG formation, building partnerships and alliances, and provision for personal and community involvement. Interestingly, the adaptations farmers have employed in their production system, are forms of coping strategies (Box 4). The concept of coping is one facet to deal with because this can elicit the extent of the problem situation and the way(s) in which affected farm households respond. Understanding this will become an enabling mechanism for watershed initiatives in developing an appropriate framework for evaluating, informing and educating farm households accordingly.

This also explains the need for continuous capacity building to ensure that the initial achievements can be sustained and even made better and relevant to resource-poor farm households. As part of the capacity building, there should be mechanisms for building strong sense of inclusion among the locals where they can be made to participate and make their own decisions. This basically is an element of user sensitivity where different users' needs or requirements are factored in to all forms of interventions.

- Organizations delivering projects that form part of their social responsibility need concrete strategies for the phasing out stage. In this study, for instance, there is intense desire for relevant extension support like technical assistance, various types of IEC materials, and market price information. Addressing these concerns in the watershed project is not difficult because of its 'soft boundaries' where various objectives can be incorporated and partnerships as well as alliances at different levels can be made. This indicates that with watersheds, various types of institutional innovations can happen.
- SWOT analysis in Thailand reveals other opportunities to enhance the development of the two watersheds (Appendix 4). Existing resources will have to be tapped fully for maximum benefit. The Uborrat dam, which is a source of irrigation among those in the downstream part of Wang Chai, can be tapped for fish farming. The waterfall in Tad Fa has potential for harvesting the water for domestic and irrigation purposes and also as an ecotourism destination with some investments on infrastructures like roads. Some areas in Tad Fa are underutilized for lack of water and capital. Raising livestock has great potential in these watersheds. With respect to social capital, the strong interest among the locals and even for joint collaborations among organizations already working in the area can be explored to advance the initial success of the watershed initiatives. There seems to be an ageing group in the watersheds. Sensitivity to the interest of vulnerable groups like women, children, and the elderly should also be a cause of concern in development projects.
- Transects of the watersheds in Vietnam and Thailand (Appendix 5,6,7 and 8), which are based on implementers' perspective show strong resemblance of farmer-respondents' requirements. Low lying areas necessitate for more infrastructure development and improvement, more soil and water management, marketing assistance, agricultural extension like technical support, and credit facilities. In the midstream, there is the addition of pasture-based livestock and grazing management, and agroforestry. In the upland area, community based forest management is called for because of declining forest resources.

Security in livelihood and food requires an understanding of the various elements of the natural-resource base. Whatever interventions like production practices to be introduced should not jeopardize the goals of environmental protection and conservation. The CW approach has made significant headway in integrating environmental protection strategies with productivity enhancement of the different farm resources.

Box 4. System of Coping in Watershed-Related Problem Situations

Change dictates the development of coping strategies and/or adaptations. Definitions on coping strategies made by Anderson (1994), Brouwer (1993), Frankenberger and Goldstein (1990) and Barnett (1993), Chambers and Conway (1992) recognize a problem situation in prevailing resources and that these resources need management. In short, coping strategies infer actions or over-all ways in which individuals and possible collectivities consciously manage a socially recognized crisis.

Interlocking issues contribute to the problem situation in the four watershed sites. The crux of the matter is the deficiency of water (moisture) to sustain crop productivity. The areas being rainfed accounts for excessive soil loss, especially the topsoil. The problem is likewise exacerbated by the topography and cultural management practices of the locals. Prior to the watershed interventions introduced in the area, the locals have learnt to cope with the situation and these have been the knowledge-based with which watershed interventions have started.

Among the mechanisms employed by the locals in a situation of inadequate water, low productivity, slack cash and food are:

- **Diversification**. This is practiced but has not been well planned. Farmers are aware of intercropping and crop rotation but they did not have better crop options and at the same time they had traditional practices, which needed improvement. Among the locals of Vietnam, intensive cultivation in a small parcel is one of the ways to cope with economic constraints and possible crop failure. This includes exploration of other agricultural environments or microniches like border plots, homegardens, periphery of ponds and even interspersing short maturing crops with trees.
- **Developing new income generating activities**. Tending livestock like cattle, poultry and fish farming have been known by farm households. However, inadequate grazing has been a setback and the drying up of their ponds make it difficult to undertake fish farming and even poultry like duck farming in Vietnam. In Thailand, household-based silk industry has been a form of coping for cash among households.
- **Protection**. Farm households are also aware of the need to protect the natural endowments of their watersheds. This explains their stoppage of slash and burn and even the harvesting of trees.
- **Social networks**. The kinship network proves to be a reliable source of economic and social coping. Social networks can be a form of capital (Reimer and Bollman, 1997). As contained in Box 3, Vareedee who has volunteered to be a cooperator for sunn hemp cultivation by LDD, earned him some opportunities of becoming a middlemen for the community and even as a farmer leader.

A significant topic under this is women's contribution in economic activities. Women are managers of specific domains like the homegardens, curators of genebanks, caretakers of small livestock, and handlers or processors of small grains (Mula, 2000). In Thailand watersheds, many of the women, especially the elderly group, are involved in small enterprise development like silk weaving. In Vietnam watersheds, they are the managers of vegetable farming.

5. References

Abdoellah OS. (1993). Transmigrants and Adaptation, INRIK Department of Anthropology, University of Pajadjaran, Bandung, Indonesia, University of Leiden, Leiden, The Netherlands, pp. 1-15.

Alther C, Castella JC, Novosad P, Rousseau E and **Hieu TT.** (2002). Impact of Accessibility on the Range of Accessibility on the Range of Livelihood Options Available to Farm Households in Mountainous Areas of Northern Vietnam, in Castella JC and Quang Dang Dinh (eds), Doi Moi in the Mountains: Land Use Changes and Farmer's Livelihood Strategies in Bac Kan Province, Vietnam, The Agricultural Publishing House, Hanoi, Vietnam.

Anderson M, Bechhofer F and **Gershuny J.** (1994). The Social and Political Economy of the Household, Oxford University Press, pp. 2-5, 20-21.

Barnett T. (1993). On Ignoring the Wider Picture: Asia Research and Sobbing Social Scientist, Institute of Social Studies, Badhuisweg, The Hague, pp.7-13.

Brouwer J. (1993). Rural Peoples Responses to Soil Fertilkity Decline: The Adja Case (Benin), PhD Dissertation, Wageningen Agricultural University, The Netherlands.

Carey JW. (1988). Health, Social Support and Social Networks in Rural Andean Community of Southern Peru, Journal on Humanities and Social Sciences, vol. 49, no. 10.

Castillo GT. (1999). A social harvest reaped from a promise of springtime: User-responsive, participatory agricultural research in Asia. In: Facilitating Sustainable Agriculture: Participatory Learning and Adaptive Management in Times of Environmental Uncertainty (eds.) N.G. Roling and M.A.E. Wagemakers. Cambridge University Press, United Kingdom. pp. 198-200.

Castillo G. (1993). Where Food and Population Meet: The Filipino Household Among Other Households, UP Center for Integrative and Development Studies, in cooperation with the University of the Philippines, Los Banos, Laguna, Philippines p. 8.

Chamala S. (1996). Adoption of Formal Agricultural Credit by Opinion Leaders and other Farmers in Differentially Developed Villages of Bangladesh, Savings and Development, vol. 20, no. 4, pp. 431-445.

Chambers R and **Conway G.** (1992). Sustainable Rural Livelihoods: Practical Concepts for the 21st Century, Institute of Development Studies, University of Sussex. pp. 1-20.

CGIAR Interim Science Council (2002). Research Towards Integrated Natural Resources Management: Examples of Research Problems. Approaches and Partnerships in Action in the CGIAR. (www.sciencecouncil.cgiar.org)

Davies S. (1993). Are coping strategies a crop out? Institute of Development Studies, University of Sussex, pp. 60-72

Fujisaka and **White D.** (2004). Ex Post Methods to Measure Natural Resource Management Research Impacts, February, p. 7

Frankenberger TR and **Goldstein DM.** (1990). Linking Food Security with Environmental Sustainability Through An Analysis of Coping Strategies. In: Growing our Future (ed.) K. Smith. Kumarian Press, New York.

Freeman HA, Shiferaw B and **Swinton SW.** (2005). Assessing the Impacts of Natural Resource Management Interventions in Agriculture: Concepts, Issues and Challenges, in B. Shiferaw, Freeman, H.A., and Swinton, S.M. (eds), Natural Resource Management in Agriculture: Methods for Assessing Economic and Environmental Impacts, Cromwell Press, Welshire, United Kingdom, p. 6.

Hall A, Sulaiman RV, Yoganand B, Raina RS, Clark NG and **Naik GC.** (2004). Institutional learning and change: Towards a capacity-building agenda for research. A review of recent research on post-harvest innovation system in South Asia. In: Innovations in Innovation: Reflections on Partnership, Institutions and Learning, ICRISAT, Patancheru, India, pp. 207-210.

Hirsh and **Cheong G.** (1996). Natural Resource Management in Mekong River Basin: Perspectives for Australian Development Cooperation. (http://www.mekonginfo.org)

Hoang Huu Cai, Felber R and **VO Hung.** (1999). PTD Community-Based Forestland Management to Build Up a Farmer-led Extension System in Social Forestry: Case Study From Vietnam. (http://www.iirr.org/PTD/Cases/Hoang.htm)

ICRISAT. (2003). Water, Soil and Agro-diversity Management for Ecosystem Resilience. Annual Report 2003, Global Theme on Agroecosystems. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 160 pp.

ICRISAT. (2004). Land, Water and Agro-diveristy Management: Agroecosystem Development. Annual Report 2004, Global Theme on Agroecosystems. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 180 pp.

Jirstrom M and **Rundquist F.** (2005) Determinants of agricultural diversification in Vietnam: changes at the farm level in the Mekong and Red River deltas

Juster FT and **Stafford FP.** (1991). The Allocation of Time: Empirical Findings, Behavioral Models, and Problems of Measurement, Journal of Economic Literature, June, p. 471-522.

Kirchman H and **Ryan MH.** (2004). Nutrients in Organic Farming – Are there advantages from the exclusive use of organic manure and untreated minerals. pp. 1-2.

Long TD, Thang NV and **Wani SP.** (2005). Cai Tien Quan Ly Nguon Tai Nguyen Thien Nhein Vung Dat Doc Mien Bac Viet Nam. pp. 135, 173-177.

Mcpeak JG and **Doss CR.** (2003). Are Houshold Production Decisions Cooperative? Evidence on Pastoral Migration and Milk Sales from Northern Kenya, Department of Public Administration, Syracuse University and Yale Center for International and Area Studies, p. 16.

Mula R. and **Niehof A.** (2000). Coping with Mother Nature: Households Livelihood Security and Coping Strategies in s Situation of a Continuing Disaster in Tarlac, Philippines. Benguet State Univesrity Research Journal Vol. 29. pp. 97-114.

Nelson M and **Maredia M.** (1999). Environmental Impacts of the CGIAR: An Initial Assessment, IAEG, September, p. 7.

Nguyen Phuong Thao, Bowman JE, Campbell J and **Nguyen Minh Chau.** (2006). Good Agricultural Practices and EUREPGAP Certification for Vietnam's Small Farmer-Based Dragon Fruit Industry. http://www.globalfoodchainpartnerships.org

Nguyen Van Viet, Thang NV, Long TD, Ramakrishna A and **Wani SP.** (2005). Nhung Han Che Va Co Hoi Doi Voi San Xuat Tren Dat Doc O Mien Bac Viet Nam Agrobiodiversity management in Northern Vietnam. In: Cai Tien Quan Ly Nguon Tai Nguyen Thien Nhien Vung Dat Mien Bac Viet Nam (eds) GS.Vs. Tran Dinh K Long-Ths.Nguyen Van Thang-TS, SP Wani (Chu bien) pp. 22-40. Nha Xuat Ban Nong Nghiep.

Piara Singh, AVR Kesava Rao and **K Srinivas.** (2005). Agroclimatic characterization of ADB benchmark sites in India, China, Thailand and Vietnam. PowerPoint presentation. ADB-ICRISAT Project Review and Planning Meeting, 27-29 April 2005, ICRISAT, Patancheru 502 324, India.

Prasong Jantakad and **Carson S.** (1998). Community-Based Natural Resource Management From Villages to an Inter-Village Network: A Case Study in Pang Ma Pha District, Northern Thailand. pp. 1-5

Reimer B and **Bollman R.** (1997). Informal Rural Networks: Their Contribution to Making a Living and Creating Rural Employment. Rural Employment: An International Perspective, CAB International, Wallington, pp. 396-401.

Ross J, Maxwell S and **Smith M.** (1994). Linking Relief and Development, Discussion Paper No. 344, Institute of Development Studies, University of Sussex.

Scoones I. (1992). Coping with Drought: Responses to Herders and Livestock in Contrasting Savannah Environments in Southern Zimbabwe, Drylands and Sustainable Agricultural Programmes, pp. 293-314.

Shambu Prasad C, Hall AJ and **Wani SP.** (2005). Institutional History of Watershed Research: The Evolution of ICRISAT's Work on Natural Resources in India. Global Theme on Agroecosystems Report No. 12, Patancheru 502 324, Andhra Pradesh, India : International Crops Research Institute for the Semi-Arid Tropics. 40 pp.

Suhas P Wani, TK Sreedevi, Yin Dixin, YS Ramakrishna, Thawilkal Wangkahart, and **NV Thang. (**2007). Watershed Management an Entry Point for Improved Livelihoods and Sustainable Development in the Dry Land Areas of Asia. Paper submitted in International Workshop on Ensuring the Future of Drylands : Towards Implementing the MAB Agenda for a Sustainable Future of Drylands" held during 12-15 Nov 2007 at Jodhpur, Rajasthan, India.

Supama Y, Wangkahart T and **Mula R.** (2003). Baseline Survey of Wang Chai Watershed, Thailand. OARD-3.

Thang NV, Tam HM, Ramakrishna A, Wani SP, Pathak P Long TD and **Quat NN.** (2005). Soil and Water Conservation Practices for the Sloping Areas of Northern Vietnam. Pages 171-180 in Book titled Cai Tien Quan Ly Nguon Tai Nguyen Thien Nhein Vung Dat Doc Mien Bac Viet Nam : (Gs. Vs. Tran Dinh Long, ThS. Nguyen Van Thang and TS. SP Wani editors) Vietnam. Nha Xuat Ban Nong Nghiep.

Verderosa C. (2002). Despite Problems, Vietnam Agriculture Makes Strides. (www.uark.edu/depts/rsocweb/viet_articles)

Viet NV, Thang NV, Ramakrishna A and **Wani SP.** (2005). Constraints and Opportunities to Production in Sloping Areas of Northern Vietnam. Pages 125-138 in Book titled Cai Tien Quan Ly Nguon Tai Nguyen Thien Nhein Vung Dat Doc Mien Bac Viet Nam: (Gs. Vs. Tran Dinh Long, ThS. Nguyen Van Thang and TS. SP Wani editors) Vietnam. Nha Xuat Ban Nong Nghiep.

WECD. (1987). Food 2000: Global Policies for Sustainable Agriculture. Rep. to the World Commission on Environment and Development. Zed Books Ltd., London.

World Commission on Environment and Development (WCED). (1987). Our Common Future, Oxford University Press. United Kingdom.

Appendix 1

ICRISAT's CW Model in a Nutshell

The CW model of ICRISAT is guided principally by the Integrated Genetic and Natural Resources Management (IGNRM) approach where the R&D programs consider a balance in agricultural productivity and livelihood opportunities of resource-poor farm households in the semi-arid tropics and rainfed areas. The interlocking constraints faced by Asian farmers like in Thailand and Vietnam are not just confined on enhancing productivity but also in managing the social, institutional markets and biophysical environments. These include a germplasm assembly for continuous crop improvement program, which attends to various concerns/requirements of an array of users; an integrated watershed management, which is a platform for a holistic management of farm households' resources and problem situations; an innovative means of knowledge sharing, which facilitates exchange for crafting new opportunities; and a unique form of alliance through public-private partnership and consortium approach, which hastens scaling and policy change (Wani et al., 2007).

The entire process revolves around the four Es – Empowerment, Equity, Efficiency and Environment, which are addressed by adopting specific strategies prescribed by the four Cs – Consortium, Convergence, Cooperation and Capacity Building (Figure 1).

Figure 1. ICRISAT's community watershed model.

Appendix 2

Input-Output Data for Rice, Sugarcane, and Legume in Wang Chai Watershed, Khon Kaen, Thailand

Particulars	Crops		
	Rice	**Sugarcane**	**Legume**
Planting Date	May or June	March or October	November or December
No. of Ploughing	2	2	1-2
No. of Weeding	1-2	1-2	1-2
Labor Requirement (person days/*rai*)			
• Planting	2-5	1-2	2-3
• Fertilizer/Chemical application	1-2	1-3	1-3
• Harvesting	3-5	2	2-3
Amount of Fertilizer (kg/*rai*)	15-40	20-30	25-30
Capital Requirement (*baht/rai*)	786.2	3,176.6	1,465.5
Yield (kg/*rai*)	349 Home use: 50-75% Sold: 25-50%	8.8 ton Sold: 100%	127.5 Sold: 100%

Source: Yen et al. (2003) Baseline Survey of Wang Chai Watershed, Thailand.

Appendix 3

Cropping System in Thanh Ha Community Watershed, Hanoi, Vietnam

Cropping system	Net income (US $)	Additional profit over traditional system (US $)	% Increase over traditional system
Maize-maize (traditional system)	492	-	-
Maize-soybean	746	254	51
Maize-groundnut	780	288	58
Groundnut-soybean	1079	587	119
Soybean-soybean	1068	576	117
Watermelon-mungbean-maize	1481	989	201
Mungbean-soybean-groundnut	1106	614	125
Watermelon-mungbean-soybean	1803	1311	266

Source: Nguyen Van Viet, Thang N.V., Long T.D., Ramakrishna A., and Wani, S.P. 2005.Nhung Han Che Va Co Hoi Doi Voi San Xuat Tren Dat Doc O Mien Bac Viet Nam Agrobiodiversity management in Northern Vietnam. In: Cai Tien Quan Ly Nguon Tai Nguyen Thien Nhien Vung Dat Mien Bac Viet Nam (eds) GS.Vs. Tran Dinh K Long-Ths.Nguyen Van Thang-TS, SP Wani (Chu bien) pp. 22-40. Nha Xuat Ban Nong Nghiep.

Appendix 4

Strengths, Challenges, Opportunities, and Threats (SCOT) Analysis of Tad Fa and Wang Chai Watersheds, Khon Kaen, Thailand

Strengths	Challenges	Opportunities	Threats
• Interest and willingness of farm households	• Improving capacity of local leadership and cooperation	• Existence of government and non-government organizations	• Land tenure (Tad Fa)
• Potential area (some areas are underutilized)	• Crafting partnerships with other organizations and agencies	• Packages of resource management (Development Approach)	• Lack of attention by other government agencies
• Potential for livestock rearing	• Matching subsidy of outside support and farmers' counterparting	• Outside support and donors	• Climatic change
• LDD volunteers	• Adaptation of technologies in improving soil health (Improving soil property and conservation)	• Interest of organizations for joint collaborative works	• Incentives in participating programs and projects
• Proximity to Uborrat Dam (Wang Chai)	• Weak group membership	• R&D works for the area (i.e. soil health and crop improvement)	• Dwindling resources of partners
• Source of manure for compost	• Pod borer in sun hemp (Tad Fa)	• Potential for Tad Fa waterfall as eco-destination	• Low price of product
			• Inadequate credit and high interest rates
			• Poor road (Tad Fa)
			• Older age group

Appendix 5

TRANSECT OF TAD FA WATERSHED

KHON KAEN, THAILAND

DOWNSTREAM	MIDSTREAM	UPLAND

Farming System: *Grains – Vegetables – Livestock & Poultry*

INTERVENTIONS

- Modernized Small Holder -Agricultural Development
- Infrastructure Development & Improvement (Irrigation, Roads, & Post Harvest Facilities)
- Sustainable Agriculture (to include soil and water management)
- Marketing Assistance
- Agricultural Extension
- Credit Support

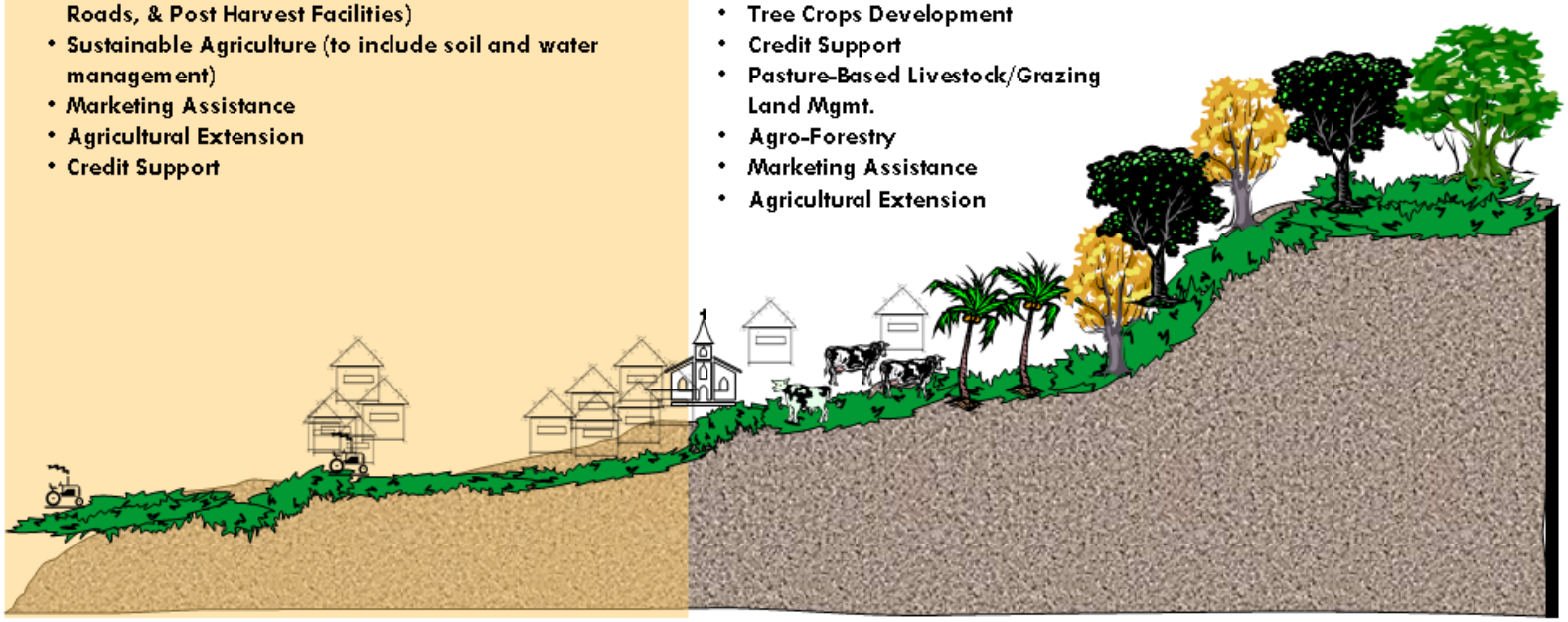
Farming System: *Fruit Trees – Legumes – Grains – Vegetables – Livestock & Poultry*

INTERVENTIONS

- Sustainable Agriculture (to include soil and water management)
- Tree Crops Development
- Credit Support
- Pasture-Based Livestock/Grazing Land Mgmt.
- Agro-Forestry
- Marketing Assistance
- Agricultural Extension

INTERVENTIONS

- Community-Based Forest Management
- Industrial Forestry
- Protected Area Mgmt.



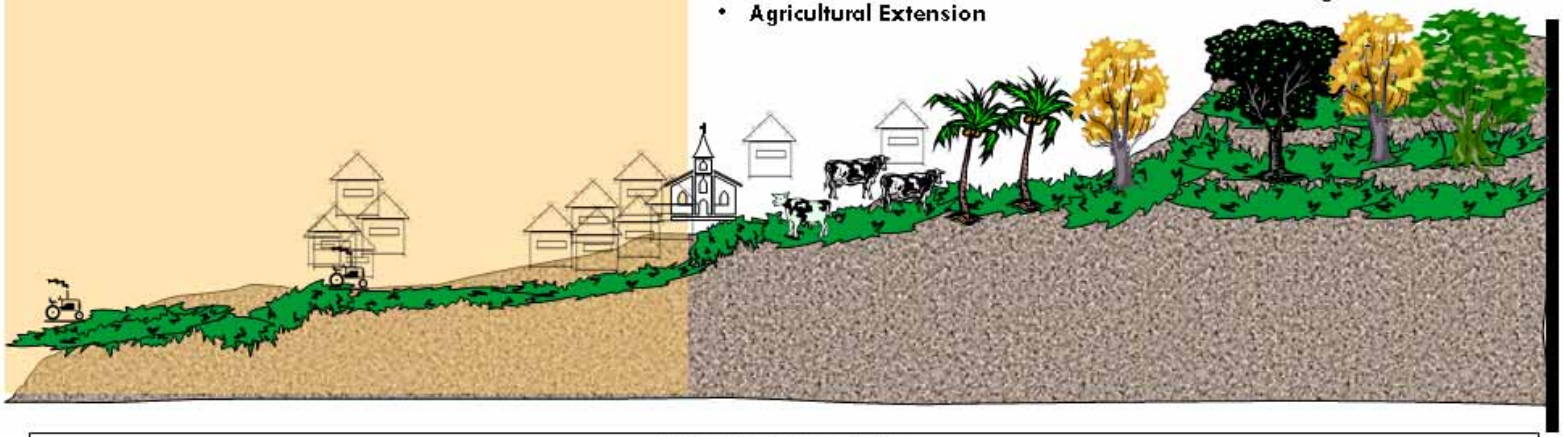
ACCESS TO LAND
BASIC SOCIAL SERVICES
RESEARCH & DEVELOPMENT
SOCIAL CAPITAL FORMATION / COMMUNITY DEVELOPMENT / INSTITUTION BUILDING
GENDER – BASED PROGRAMS

Appendix 6

TRANSECT OF WANG CHAI WATERSHED

KHON KAEN, THAILAND

DOWNSTREAM	MIDSTREAM	UPLAND
Farming System: *Rice – Vegetables – Livestock & Poultry - Fish Culture - Mulberry*	Farming System: Rice – *Fruit Trees – Legumes – Vegetables – Livestock & Poultry – Grass – Sugarcane - Mulberry*	Farming System: Rice – *Fruit Trees – Legumes – Vegetables – Livestock & Poultry – Grass – Sugarcane*
INTERVENTIONS • Modernized Small Holder -Agricultural Development • Infrastructure Development & Improvement (Irrigation, Roads, & Post Harvest Facilities) • Sustainable Agriculture (to include soil and water management) • Marketing Assistance • Agricultural Extension • Credit Support	INTERVENTIONS • Sustainable Agriculture (to include soil and water management) • Tree Crops Development • Credit Support • Pasture-Based Livestock/Grazing Land Mgmt. • Agro-Forestry • Marketing Assistance • Agricultural Extension	INTERVENTIONS • Sustainable Agriculture (to include soil and water management) • Community-Based Forest Management • Agricultural extension • Marketing Assistance



ACCESS TO LAND
BASIC SOCIAL SERVICES
RESEARCH & DEVELOPMENT
SOCIAL CAPITAL FORMATION / COMMUNITY DEVELOPMENT / INSTITUTION BUILDING
GENDER – BASED PROGRAMS

Appendix 7

TRANSECT OF THANH HA WATERSHED

HOA BINH, VIETNAM

DOWNSTREAM	MIDSTREAM	UPLAND

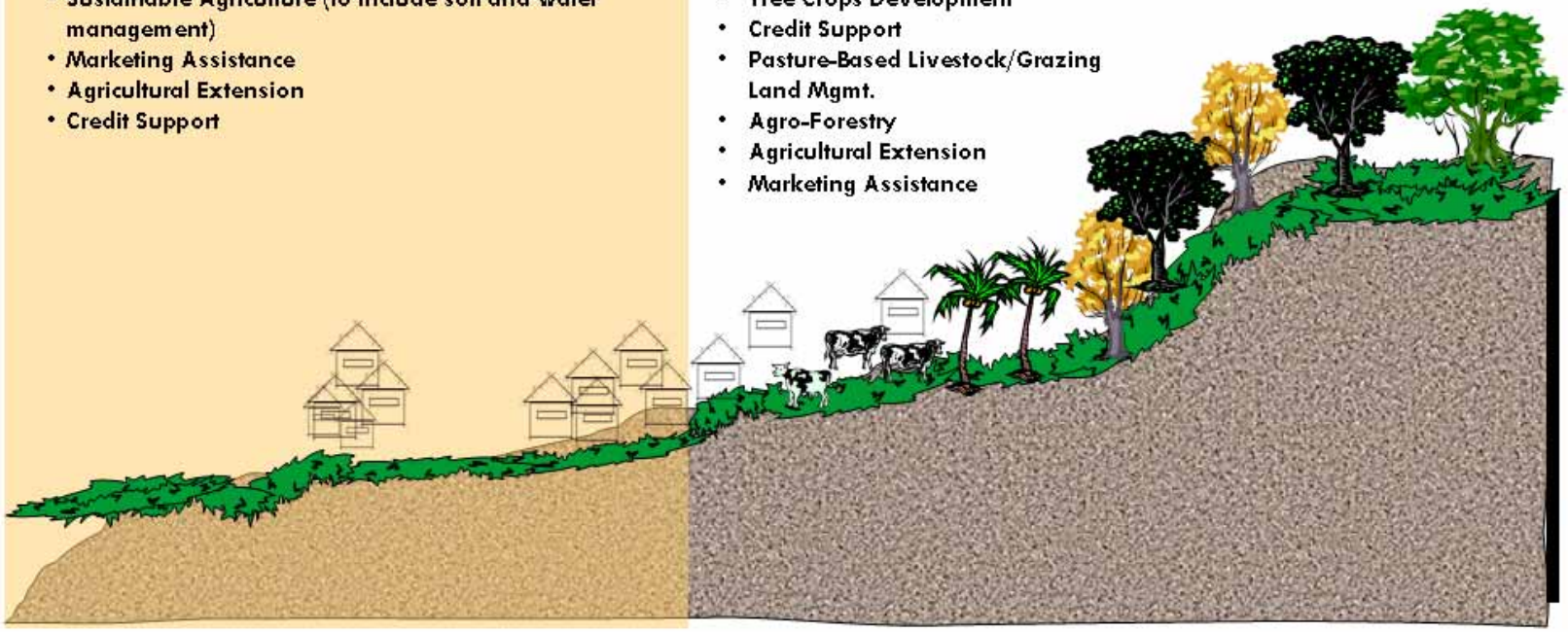
Farming System: Grains – Vegetables – Livestock & Poultry

INTERVENTIONS
- Infrastructure Development & Improvement (Irrigation)
- Sustainable Agriculture (to include soil and water management)
- Marketing Assistance
- Agricultural Extension
- Credit Support

Farming System: Fruit Trees – Maize – Legumes – Livestock & Poultry – Sugarcane

INTERVENTIONS
- Sustainable Agriculture (to include soil and water management)
- Tree Crops Development
- Credit Support
- Pasture-Based Livestock/Grazing Land Mgmt.
- Agro-Forestry
- Agricultural Extension
- Marketing Assistance

Interventions
- Community-Based Forest Management



RESEARCH & DEVELOPMENT

SOCIAL CAPITAL FORMATION / COMMUNITY DEVELOPMENT / INSTITUTION BUILDING

GENDER – BASED PROGRAMS

Appendix 8

TRANSECT OF HUOANG DAO WATERSHED

VINH PHUC, VIETNAM

LOWLAND	UPLAND
Farming System: *Rice – Vegetables – Livestock & Poultry - Fish Culture - Mulberry*	
INTERVENTIONS • Modernized Small Holder -Agricultural Development • Infrastructure Development & Improvement (Irrigation, Roads, & Post Harvest Facilities) • Sustainable Agriculture (to include soil and water management) • Marketing Assistance • Agricultural Extension • Credit Support	INTERVENTIONS • Sustainable Agriculture (to include soil and water management) • Tree Crops Development • Credit Support • Pasture-Based Livestock/Grazing Land Mgmt. • Marketing Assistance • Agricultural Extension

ACCESS TO LAND
BASIC SOCIAL SERVICES
RESEARCH & DEVELOPMENT
SOCIAL CAPITAL FORMATION / COMMUNITY DEVELOPMENT / INSTITUTION BUILDING
GENDER – BASED PROGRAMS

Appendix 9 Interview instrument

INTERVIEW SCHEDULE

Impact Assessment of Integrated Watershed Management Project (IWMP) in South Asia: A Household Perspective

---

ID No.: _____ Date: _____

Country: _____ State: _____ Name of Watershed: _____

1.0 RESPONDENT'S PROFILE

1.1 Name (Optional): _____ Age: _____ Sex: _____

Particulars/Relation*	Age	Sex	Education	Income Sources		Remarks/Observations
				Primary	Secondary	

* Relationship with respect to the respondent

1.2 Household's Agricultural Resources

Land Area

	Size of Area	**Tenure**
Crop Area	_____	_____
Grazing	_____	_____
Residential		
Dwelling:	_____	_____
Homegarden:	_____	_____
Others (e.g. lease-in, lease-out etc.)	_____	_____

Remarks/Issues/Problems _____

_____

_____

Water Resources (Where and Distance)

Domestic Where _____

Distance (with respect to dwelling) _____

Irrigation Where _____

Distance (with respect to farm) _____

Remarks/Issues/Problems (Please take note of sharing arrangement and maintenance)

_____

_____

Livestock Resources (Type and Purpose)

Draught _____

Home Consumption _____

Sale _____

Type and Source of Feed/Fodder

_____

_____

_____

Remarks/Issues/Problems _____

_____

Credit and Market Sources

	Source	**Interest Rate**	**Repayment Scheme**
Sources of	_____	_____	_____
	_____	_____	_____

Remarks/Issues/
Problems _____

_____

_____

	Items and Where	**Distance from Farm**	**Arrangement**
Market	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

1.3 Crop System

Type (P, S, H, and O)*	Crops Grown	Date		Approx. Area	Yield	Income	Tenure	Innovations Made	Remarks/Observation
		Planting	Harvesting						

*Legend: P – paddy: S – swidden: H – homegarden: O – others.

2.0 AWARENESS AND PARTICIPATION IN WATERSHED PROJECT

2.1 Are you aware of any watershed project in the area? _____Yes _____ No
2.2 If yes, when and how did you know of the project?

_____
_____

2.3 What are the technological components of the project that you are aware of? Please specify and describe.

_____
_____
_____
_____
_____
_____

2.4 Of the technological components that you have described, which of these have you implemented? Please provide details such as modifications made on the technology, when are these implemented and what are the effects? (Probe and explain this in detail).

_____
_____
_____
_____
_____

2.5 What are the problems/constraints/issues have you encountered in adapting/ practicing these technologies? How do you suppose to solve these issues and constraints?

Problems/Constraints	**Solutions**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

3.0 CHANGE IN LIVELIHOOD DEVELOPMENT & RESOURCE MANAGEMENT

3.1 What have been the **significant change(s)** in your livelihood activities for the last ____ years (use the time frame since the inception of the watershed initiative)? Please describe even if these are **positive** or **negative** change.

Take note of the following changes: Quantify when necessary

	Before	**After**
Cropping system		
- Change in crops	_____	_____
- Change in yield	_____	_____
- Change in crop area	_____	_____
- Change in cultural management practices	_____	_____
- Change in cropping calendar	_____	_____
- Change in income	_____	_____
Livestock System		
- Stocking or de-stocking	_____	_____
- Source of fodder or grazing area	_____	_____
- Utilization (home consumption, draught power, or sold)	_____	_____
- Income derived	_____	_____

Other Sources of Livelihood

- When did this (please specify the nature of livelihood among occupational groups like carpentry, wage-labourer) become your (with reference to other household members as well) other source of livelihood, what benefits (e.g. income or food sources) obtained, and how these benefits are utilized/invested?

  _____
  _____
  _____
  _____

3.2 What other changes have come as a result of the change in your livelihood? Please elaborate and quantify if necessary/possible?

	Before	**After**
Food Habits	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
Education	_____	_____
	_____	_____
	_____	_____
	_____	_____
Cultural and	_____	_____

Religious Practices	_____	_____
	_____	_____
	_____	_____
Economic and Market System	_____	_____
	_____	_____
	_____	_____
	_____	_____
Health System	_____	_____
	_____	_____
	_____	_____

3.3 From **whom/what** do you attribute to the aforementioned change(s). Please elaborate your response.

3.5 Do you consider your livelihood now more stable than ____ (use the time frame since the inception of the watershed initiative) years back? What could be the three (3) most important factors that have contributed to this livelihood stability? (Please elaborate your response).

3.6 Based on your present system, what are the problems/constraints/issues have you encountered on the following. How do you propose to solve these problems or what are the resources you require? Probe into their responses.

Farming : Take note of conflicts between and among co-farmers, access and control of 'community-owned' resources

Production Management (Irrigation, Pest/Disease, Nutrient Deficiency, Soil Erosion, etc…)

Household : Take note of gender issues, dynamics of decision-making, access and control of household resources

Household Dynamics (Who decides what, Division of Labour, Management/Use of Household Resources)

Community : Take note of management of 'community-owned' resources and institutional support from within and their links to outside institutions

Local Support and Governance (Who are the institutions operating in the area, What type of support are provided, and What are the relations/links between and among these institutions)

4.0 CAPACITY BUILDING PROVIDED

4.1 This is in relation with your awareness of the watershed projects implemented in your area, if you are a part of this project, what were your learnings (identify anything good or bad that you gained from your participation with the project).

4.2 Have you been a recipient of any other forms of training/workshop/activities (besides those that you mentioned in 4.1)? YES or NO

- Awareness, learnings/insights obtained, process of selection, and suggestions on training programs
  - What type of training or activity?
  - When obtained?
  - Where was this conducted?
  - Do you find the training helpful or effective? Why or why not?
  - Brief description of knowledge gained?
  - What are some of your suggestions?

4.3 Awareness, learnings obtained, and suggestions on IEC materials

- Are you aware of the various IEC materials on the project?
- What are these that you have obtained
- Do you find these useful? In what way?
- What are some of your suggestions to these materials? Please specify like how do you want them presented or written?

4.4 Other forms of capacity building required: Besides training and IEC materials, what other ways do you think are relevant to get involvement/participation of other households, institutions, and national government to support the existing watershed project in your area? Identify the stakeholders and then probe to suggestions made.

5. SUSTAINABILITY ISSUE

5.1 What are some of the suggestions you want to improve with the present system of watershed project in your area?

5.2 Do you see your involvement in the project as necessary? If yes, what do you see as your role and responsibilities in the implementation of the project? How should you implement these roles? What prevents you from doing these roles? If no, why?

5.3 Based on your experience/involvement in the project, do you think the project can be sustained? Why or why not? What should be done/made or resources required to sustain the project?

6.0 OTHER REMARKS/OBSERVATIONS MADE

THANK YOU

About ICRISAT®

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

Contact Information

ICRISAT-Patancheru (Headquarters)
Patancheru 502 324
Andhra Pradesh, India
Tel +91 40 30713071
Fax +91 40 30713074
icrisat@cgiar.org

ICRISAT Liaison Office
CG Centers Block
NASC Complex
Dev Prakash Shastri Marg
New Delhi 110 012, India
Tel +91 11 32472306 to 08
Fax +91 11 25841294

ICRISAT-Nairobi (Regional hub ESA)
PO Box 39063, Nairobi, Kenya
Tel +254 20 7224550
Fax +254 20 7224001
icrisat-nairobi@cgiar.org

ICRISAT-Niamey (Regional hub WCA)
BP 12404
Niamey, Niger (Via Paris)
Tel +227 20 722529, 20 722725
Fax +227 20 734329
icrisatsc@cgiar.org

ICRISAT-Bamako
BP 320
Bamako, Mali
Tel +223 2223375
Fax +223 2228683
icrisat-w-mali@cgiar.org

ICRISAT-Bulawayo
Matopos Research Station
PO Box 776,
Bulawayo, Zimbabwe
Tel +263 83 8311 to 15
Fax +263 83 8253/8307
icrisatzw@cgiar.org

ICRISAT-Lilongwe
Chitedze Agricultural Research Station
PO Box 1096
Lilongwe, Malawi
Tel +265 1 707297/071/067/057
Fax +265 1 707298
icrisat-malawi@cgiar.org

ICRISAT-Maputo
c/o IIAM, Av. das FPLM No 2698
Caixa Postal 1906
Maputo, Mozambique
Tel +258 21 461657
Fax +258 21 461581
icrisatmoz@panintra.com

Visit us at www.icrisat.org

538-07