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Final report

project

Evaluation and adoption of improved farming practices on soil and water resources, Bohol Island, Philippines

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1 Acknowledgments

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2 Executive summary

Key objectives of this project were to demonstrate, quantify and provide examples to farmers of the environmental and farm-level economic benefits that can be realised by implementing selected best management practices for soil, water and crop management in shallow sloping landscapes.

In addressing these objectives, the Project team established improved practice and conventional practice farmer managed demonstration (FMD) sites in the upper Inabanga and upper Abatan watersheds in Bohol Province. The sites were characterised as highly erodible soils on sloping uplands and which included a corn-cassava cropping rotation. The Inabanga sites were located in the municipalities of Carmen, Sierra Bullones and San Carlos/Pilar, while the Abatan watershed site was located in the San Isidro municipality

All the sites were topographically surveyed, geo-referenced and characterised to determine site soil and water components, including physico-chemical properties, soluble and exchangeable cations, pH and nutrients. Gauging stations with on-site weather station and automatic water flow and sampling equipment were used and regularly monitored. Initial 5-year cropping schedules were reviewed and updated for sequential cropping periods. Socioeconomic monitoring was carried out through interviewing and keeping of detailed farm journals by the farmer-cooperators.

The Project demonstrated that improvements in the growing of traditional crops such as corn and cassava can improve farm incomes. However, the returns available for farmers were significantly increased by both improving crop production techniques and soil management practices. The most effective improvements in soil management were the use of natural vegetative strips and contour ploughing, better soil nutrient management, irrigation and appropriate crop establishment.

Inclusion of high-value vegetables such as sweet pepper, eggplant, ampalaya and ginger were effective in raising farmer gross margins. When these crops were added to traditional cropping mixes such as corn or cassava the farmers' gross margin invariably increased. When vegetable crops were grown alone, without the other traditional crops, this again further increased farmer gross margin.

Farmer Field School training was critically important in making the improvements effective. Farmer Field Schools were shown to be highly effective in training farmers, individually, and in enhancing family and LGU understanding of the potential of improved farming practices. The Schools were able to increase skill levels from "backyard" or novice vegetable farmers to skilled farmers within one cropping season through the use of the Field Schools approach. The first two Farmer Field schools were run by East West seeds and, subsequently were organised and run locally by the LGUs and Farmer-Trainers.

Monitoring results from the Project demonstrated that natural vegetative strips (NVS) are effective at reducing the movement of soil and nutrients down the slope, validating their application in managing sloping, fragile soil profiles. Additionally, incorporation of hedgerow crops such as pineapple, banana or coconut into the vegetative strip can assist in strengthening the NVS and also contribute to gross margins.

3 Background

Soil erosion and associated loss of crop productivity and degraded water resources are serious threats to agricultural livelihoods in upland areas of the Philippines. Soil erosion is particularly important in the Central Visayas region of the Philippines, due to high seasonally concentrated rainfall, steep slopes and highly erodible soils. Within the province of Bohol, 45% of the island is designated as agricultural land and supports the farming practices of 80% of the island's population of over 1.2 M. The population growth rate has been increasing over the last 10 years to approximately 3% per year. However, 60% of the agricultural land has slopes greater than 18% and receives more than two metres of rainfall a year. The Inabanga watershed is the largest watershed of Bohol Island with more than 50% of the 61,000 ha area currently used for agriculture.

The impacts of common cropping systems on soil and water degradation and farm incomes in the Inabanga watershed were studied in project LWR/2001/003 (2002 to 2006). The main cropping systems that were identified and studied included: agroforestry; woodland; oil palm; corn/cassava; grassland; irrigated rice and, rainfed rice. Key environmental and socioeconomic effects of these land use systems were measured including:

- Site characteristics (soil, slope, erodibility)
- Soil loss, runoff water volume and quality, nitrogen and phosphorus losses as well as changes in stream water quality in response to rainfall events
- Contribution of each landuse system to the siltation of Malinao Dam, located in the Upper Inabanga watershed
- Agro-socio-economic issues and income to farmers in the watershed using data from 1058 households (including 114 barangays of 19 municipalities).

The data were then analysed in a GIS framework, developed for project, and this tool was used to identify areas of the Inabanga watershed that are at high risk of soil erosion.

The key findings of the project were:

1. Areas at highest risk of soil erosion ('hotspots') were identified and mapped.
2. The cultivation of corn/cassava on steeply sloping, highly erodible soils was the major contributor to soil erosion. It resulted in 57 tonnes of soil/ha/year being lost compared to 0-5 tonnes/ ha/year for the other cropping systems studied.
3. Corn/cassava also resulted in the highest runoff in total and as a percentage of rainfall: 34% compared to 27%, 17% and 18% respectively for grassland, irrigated rice and agro forestry.
4. The high soil loss combined with high runoff means that corn/cassava cultivation is also the main contributor to siltation of the Malinao Dam.
5. Corn/cassava cropping resulted in the lowest economic returns to the farmers.

It was recognised that the opportunity existed for farmers to reduce some of the negative aspects of current practices, especially those used for the cultivation of corn/cassava on steep, marginal soils by implementing better practices and using the existing landcare approaches to provide training and encourage adoption. Practices with the highest likelihood of making improvements, identified in the previous project, were promoted and evaluated. The practices included:

- establishment of Natural Vegetative Strips (NVS) which means leaving 1 to 2 m contour strips uncultivated or planted with perennial crops as a way of reducing soil erosion;
- higher planting densities and use of plastic mulch which are likely to improve crop yields and returns;
- improved management of crop nutrient supply by use of legumes which can provide significant amounts of nitrogen to subsequent crops;
- growing cover crops or crops which produce high organic matter residues (e.g. sweet corn) which can be incorporated into the soil or left on the soil as a surface mulch; an additional benefit of this practice is weed suppression;
- aspects of a minimum tillage annual crop production systems, which the team has trialled in Australia, comprising of maintenance of a soil covering crop or cover crop residue and planting subsequent crops through this mulch layer. Improvement in the soil profile and removal of the need to cultivate has been demonstrated;
- introduction of alternate sequence or inter-cropping with corn/cassava with higher value crops such as bitter gourd, sweet peppers, runner beans, squash and sweet corn.

After an external review of project LWR/2001/003, ACIAR agreed to continued its focus on Bohol and consider a new project in 2006. The project, reported here, built on the soil erosion, hydrologic and financial lessons learned in Project LWR/2001/003 and joined forces with community-based implementation activities funded by ACIAR and other agencies. It also promoted practices and production systems, as noted above, aimed to reduce soil erosion and improve long term farming profitability, and work with ICRAF who have developed linkages to promote uptake of these techniques by farmers. The Project was developed after discussions and close consultation with ICRAF and built on the experience and expertise developed through the earlier ACIAR Projects LWR/2001/003 and ASEM/2002/051.

4 Objectives

The overall aim of the project was to promote the adoption of improved farming on highly erodible soils on steeply sloping uplands in two upper watersheds in Bohol. This was achieved through the implementation and demonstration of erosion amelioration practices, and measurement of the environmental, economic and agronomic consequences.

Objectives

1. To implement and critically assess soil conservation and water management improvements at farm scale in corn-cassava cropping areas of the upper Inabanga watershed.

2. To determine the impacts of implementing improved practices on soil and water resources, crop production and socio-economic conditions in the upper Abatan watershed.

3. To promote adoption of best practices for soil, water and crop management

5 Methodology

Objective 1: To implement and critically assess soil conservation and water management improvements at farm scale in corn-cassava cropping areas of the upper Inabanga watershed.

BSWM and ICRAF both played key roles in data acquisition, technical management of sites and in the development and delivery and training. Unfortunately, however, there were no senior BSWM staff permanently located in Bohol. BSWM senior management gave a firm commitment to locate a senior staff member to Bohol to coincide with the start of this project and to coordinate on-Bohol activities. ICRAF had one professional staff member located in Bohol, with enough seniority to operate independently of his head office in Los Baños. The staff officer, Geramil Cordero, had well established links with farmers in both the San Isidro and Inabanga study areas.

Farmer Managed Demonstration (FMD) sites were established in the four Inabanga municipalities which have signed a memorandum of understanding with BSWM/DENR/ICRAF. The MOUs included an ongoing commitment to assist in contribution funds/materials to help cover site running costs.

Of these sites, three were selected by a joint team of ICRAF, BSWM, DENR, farmers and local MAOs and the Australian team for implementation of land use improvements and for the collection of soil, crop and socio-economic data, as set out in Activity 1.1, above. Preliminary site visits identified three potentially suitable sites which were sufficiently contained with good monitoring points. These sites were located on highly erodible upland soils where a corn:cassava rotation was the previous landuse, since that cropping activity was identified in LWR/2001/003 as the most highly degrading cropping practice which was evaluated. A further three sites were selected by the team as control sites.

To validate the impact of improved practice implementation, baseline data were collected including: soil physico-chemical properties (texture, aggregate stability and erodibility (Emerson Test), bulk density), soluble and exchangeable cations, pH, EC, nitrate, %OM. The improved and control sites were instrumented with auto samplers, operated as described in Objective 2, below. Weather stations were installed on four sites for continuous monitoring. Soil capacitance moisture monitoring equipment with sensors at 10, 20 30 and 50 cm depth and a data logging capability were installed on one improved and one control site and used to monitor crop water use and calculate water infiltration. Data from the improved sites (runoff and soil erosion, crop yields and economic returns) was compared to control sites.

On the improved sites, best management practices were implemented. These practices included:

- establishment of Natural Vegetative Strips (NVS);
- higher planting densities and use of plastic mulch which are likely to improve crop yields and returns;
- improved crop nutrition;
- use of cover crops or crops which produce high organic matter residues (e.g. sweet corn) which can be incorporated into the soil or left on the soil as a surface mulch;
- aspects of a minimum tillage annual crop production systems, noted in Section 2.1, above; and

- alternative crop sequencing or inter-cropping with corn/cassava with higher value crops such as bitter gourd, runner beans, squash and sweet corn.

Decisions on which soil management and agronomic improvements were implemented on particular sites were determined jointly between BSWM/ICRAF/Australian team/Farmer-manager teams. Where most appropriate, practices that were profitable and reduced soil erosion were promoted for accepted or existing cropping sequences which did not rely on completely changing the cropping sequence in the erosion prone areas. Engaging and involving the farmers who managed the demo sites and ICRAF staff were critical to success of the project.

Funding for the implementation of these improvements in FMDs came, primarily from the collaborating municipalities, as agreed in already signed MOUs with four municipalities (consumables such as fertilizer, seed, etc.), from the ACIAR project (instrumentation, some consumables and expertise) and from ICRAF for training.

Baseline agronomic and socio-economic data including crop yields, level of inputs, input costs and market prices were collected and collated by ICRAF staff and farmers in collaboration with the Australian team at relevant points in the cropping cycle (e.g. after sowing, midway through the cropping cycle and after a harvest) for the duration of the project and then compared to similar data from the control sites using farm budgeting techniques. In addition to this, input was sought from the extensive array of agribusiness studies and other project outputs, e.g. the ATI (Agricultural Training Network), coordinated through the PCARRD network of farmer scientists.

Engaging and involving the farmers who managed the demo sites was coordinated by ICRAF staff and was critical to success of the project.

Objective 2:

2. To determine the impacts of implementing improved practices on soil and water resources, crop production and socio-economic conditions in the upper Abatan watershed.

Two paired-watershed sites on upland corn/cassava rotations on erodible soils, one where land use improvements had been in place for approximately five years, and a nearby matching site where no improvements had been made were identified by a joint team of ICRAF, BSWM, farmers, local MAOs and the Australian team. A suitable upland site with NVS and alternative crops such as bitter gourd, runner bean, bananas and squash and ideal hydrological profile for monitoring was identified in the San Isidro municipality at Masonoy.

Water samples were collected by autosamplers and water flow, nutrient/sediment loads and other relevant variables at representative sampling points were measured and integrated with soil moisture and weather station climatic data. Water flow and climatic data were monitored on a continuous basis, while autosampling of water were triggered on an event integrated basis, developed and calibrated specifically for each site. Sample analyses included pH, conductivity, suspended solids, nitrogen and phosphorus components. Climatic data included rainfall, wind speed, wind direction, solar radiation, air temperature, soil moisture and relative humidity. Baseline physical data included: soil physical properties including texture, aggregate stability and erodibility, bulk density and soil chemical properties. Baseline agronomic and socio-economic data including crop yields, level of inputs, input costs and market prices were collected via survey from farmers within the watershed. These were collated and analysed to determine economic

returns using farm budgeting techniques by the Australian team in collaboration with the BSWM staff.

Ongoing review of the data was used to evaluate how the site management practices have worked for the previous year, and the plan for the following cropping year was adjusted accordingly.

This data was used to verify and quantify the effectiveness of long term landuse improvements such as NVS and alternative crops to corn/cassava on fragile upland sites in Bohol on a broad scale. The data is now being used to strengthen the case for agencies such as ICRAF to confidently promote these practices in other similar upland areas in the Philippines and beyond, resulting in improved socio-economic standards for farmers and reduced environmental pressure on scarce land and water resources in the region.

Objective 3:

To promote adoption of best practices for soil, water and crop management

A key feature of this project was a strong collaboration between BSWM/Australian team on data acquisition and measurement and ICRAF/landcare/LGU staff on developing and delivering training at the farmer level. While training would not of itself result in adoption of improved land use practices, it importantly made farmers and others aware of the potential benefits of improvements. This must be considered an important step on the road to adoption

ICRAF staff in Bohol provided the critically important expertise and networks required to ensure that the improved soil management and agronomic techniques were effectively communicated to local farmers, facilitating the flow of benefits to these farmers and the wider community.

Coordinated by ICRAF, local landcare FMD teams were established in collaboration with ICRAF, LGUs and with technical input from BSWM. The teams have developed a continuing schedule of training activities and, with team guidance, identified sources of ongoing support. The instrumented FMD sites were the focus for conducting farmer training.

Initially, the training was based on the implementation of “best bet” practices to address problems identified in ACIAR project LWR/2001/003. As data on the effectiveness of improvements was collected, this was then used to guide the selection of ongoing improvement strategies. The crop yield and socio-economic data was also incorporated into the training programs to demonstrate the economic benefits and provide incentive to farmers operating in fragile environments of adopting improved practices. Training also incorporated aspects of farm budgeting based on the farm budget model developed throughout the project. This provided a powerful decision making tool to assist farmers in determining which practices would return them the greatest economic benefit.

In a series of learning forums, local language training, technical guidance and promotional materials was developed and provided. In order to facilitate the development of a regional training capability, an active Train the Trainers course was initiated and resulted in formal accreditation of Farmer Trainers. Programs for visitation of the study sites by regional (Central Visayas) farmers and agriculture/land-use planners was organised through promotion of demonstration nodes/facility at Pilar and other Inabanga watershed sites, the San Isidro site and also regional study sites in Leyte.

6 Achievements against activities and outputs/milestones

Objective 1: To implement and critically assess soil conservation and water management improvements at farm scale in corn-cassava cropping areas of the upper Inabanga watershed.

no.	activity	outputs/ milestones	completion date	Achievements / Comments
1.1	Select 3 sites in the upper Inabanga watershed, with highly erodible soils on steeply sloping uplands, which include a corn-cassava rotation, where improved practices can be implemented, and paired with nearby control sites.	Established three pairs of improved and matched control monitoring sites within the upper Inabanga watershed, with operators competent in monitoring and maintenance techniques. /	May 07	Site areas were selected
		Project inception completed and consultations held. Cooperation MOUs finalised.	Jul 07	Project inception meeting was held in Bohol with good representation by Stakeholders. MOUs of cooperation were signed.
		Sites identified and initially characterised.	Jul 07	Initial field survey for soil characterisation of sites was carried out in May 07. Further survey was completed in Nov 07
			Oct 08	Site mapping and georeferencing updated
1.2	Determine the conservation practices, improved agronomic practices to be implemented on demonstrations farms with input from ICRAF, BSWM, DENR, MAOs, relevant NGOs, farmers and the Australian team.	A compilation of improved practices (Best Management Practices – BMPs), with engagement of stakeholders in ownership of site practices and aims. /		
		Farm plan agreed upon and achievement of stakeholder ownership of management of demonstration sites		BMP options and constraints reviewed with input by farmer co-operators.
			Jul 07	An initial farm planning schedule was presented during the inception meeting. This plan was further developed into a 5-yr cropping plan during workshops in Sep 07.
			Oct 08	Cropping plan revised to reflect previous cropping outcomes.
			Jul 09 – Apr 10	Ongoing cropping schedules are developed with farmer cooperators.

1.3	Develop the sites into Farmer Managed Demonstration (FMD sites by implementing improved practices, instrumenting and maintaining improved and control sites.	Three FMDs and three control sites established covering approx. 2 ha each and engagement of about 12 farmers. / Sites instrumented and cropping management implemented Team competent to undertake monitoring activities	Jul 07 Sep 07 Oct 08 Nov 08 Jul 09 – Apr 10	Cropping schedules were determined in Jul 07, however, ongoing modification is required to deal with climatic and pest control adaptations. There has been some delay in completing instrumentation due to the need to obtain landowner approval. The tenant farmers cannot give authorisation. Approval has now been obtained for all sites and instrumentation is currently being commissioned on-site. Delays with construction contractor were resolved in Jul 08, weirs have been completed and instrumentation is in place and commissioned. Monitoring team trained in sample collection and data gathering using the commissioned instrumentation. Sites are well established, however, there have been problems in maintaining the capacity of the farmer-cooperators to carry out cropping inputs, including fertiliser application and planting materials, which have been recommended but not provided. The project is now directly supplying these materials to the farmers.
1.4	Quantify soil and water losses (erosion and hydrological), soil moisture and soil profile characteristics on the six sites over the four years of the project; develop data collection protocols for soil and water loss. .	Consolidated understanding and report on comparison of soil and water losses and soil moisture characteristics on the three paired sites. / Dataset for Yrs 1-4.	Dec 07 Jul 08 – May 09 Jul 09 – Apr 10 Dec 10	The yr-1 dataset has been completed and is undergoing review. Data collection is ongoing Site facilities and protocols have been established, however, due to field staff changes and issues related to a new “cross-posting” policy within the BSWM there have been staff availability problems, data gaps and lags in data incorporation into the GIS framework.

1.5	Activity 1.5: Develop and implement protocols for collecting data on agronomic practices and economic consequences of improved practices compared with unimproved practices. Using farm budgeting methods quantify level of inputs and input costs, productivity and market price and overall returns to farmers.	Identification and evaluation of socio-economic consequences of introducing improved practices and recommendations of those that are acceptable to farmers. Three case studies documenting practices used on each of the FMDs and the associated impacts of improved practices on soil and water losses as well as on net farm income as compared with control sites. / Initial assessment completed Case studies documented and correlated with full dataset	Sep-Oct 07 Ongoing Apr 09 Ongoing Jul 09 – Apr 10 Dec 10	Farmer surveys and interviews were completed. Farmer cooperators were key respondents. Additionally, 63 farmers were surveyed, during the period, in the Upper Abatan / San Isidro area. The results from surveys, to date, have now been analysed providing baseline information on which to compare the control and improved site in the Abatan/ San Isidro area. Protocols were updated and implemented in early 2008 for continuous collection of agronomic practices and economic data including inputs, input costs, yields and returns. These protocols include the use of on farm calendars, reference maps and farm journals to be filled in by cooperators with regular assistance from BSWM staff. These data collection protocols are to be continued through years 3 and 4 of the project to gather the full set of data necessary for the development of the case studies. The annual cost and return analyses of the data is being used to make adjustments to farm plans. Budgets have been developed for each of the improved and control sites based on cropping seasons from the last three years. In the final six months of the project, these data sets will be completed and used to illustrate the

			Nov 11	economic impacts of the improved practices in comparison to the unimproved sites in the case studies. These budgets indicate which farming practices and which crops were most successful in improving economic returns in relation to those that were most successful in improving soil and water losses.
1.6	Activity 1.6: Manage data using GIS framework developed as part of project LWR/2001/003.	A consolidated database, documenting site profile and existing baseline information, incorporated into a GIS framework, is established. / GIS Framework to allow data overlay and data relationship evaluation; framework available for training and planning.	Feb 08 Oct 08 Ongoing Jul 09 – Apr 10 Dec 10 Nov 11	All sites have been surveyed and geo-referenced for incorporation into the GIS Framework. All economic and agronomic data, chemical and physical data collected is coded, and updated at regular intervals, for incorporation into the GIS framework Data reviewed and ongoing input.
1.7	Activity 1.7: Review annually management plans and provide feedback on findings to date and collaboratively update the management plan for each site.	Annual site management plans, with 'ownership' by all parties. / Workshops held. FMD management plans updated	Sep 07 and Mar 08 Oct 08 and Feb 09 Jul 09 – Apr 10 Dec 10 Dec 11	Cropping management has been reviewed with the stakeholders and outcomes have been incorporated into the 5-yr cropping plan. Cropping plans reviewed updated, with concurrent updating of FMD management plans. Initial 5-yr cropping plans have been revised after each cropping season to address problems and drought conditions.

PC = Partner Country, A = Australia

Objective 2: To determine the impacts of implementing improved practices on soil and water resources, crop production and socio-economic conditions in the upper Abatan watershed.

no.	activity	outputs/ milestones	completion date	Achievements / Comments
2.1	Identify and characterise one improved subwatershed in the upper Abatan watershed which includes erodible soils on steeply sloping land where erosion control measures have been implanted for at least 5 years, and which is suitable for monitoring soil erosion and runoff; identify and characterise, as above, an unimproved control subwatershed in the upper Abatan watershed.	A collaborative understanding, set out in an MOU between LGUs, farmer cooperators and ACIAR team, in the selected pair of subwatersheds is achieved. Datasets detailing agronomic inputs and cropping productivity developed in each watershed. /		
		Sites identified and initially characterised. MOUs completed.	Jul 07	Comment as in 1.1, above.
		Baseline data report characterising sites.	Jul 07	Comment as in 1.1, above.
			Oct 08	Site mapping and georeferencing updated
			Feb 09	Site soil surveys updated to include within-site detail which is important in evaluating site-specific land management.
			Jul 09 – Apr 10	Site mapping and georeferencing has been updated to capture changes in NVS-Alley configuration and cropping plan changes.
2.2	Establish monitoring facilities and protocols with stakeholders' input and train operators to collect data and maintain sites.	Instrumented sites and monitoring team established.		
		Sites instrumented and monitoring team trained	Jul 07	Comment as in 1.3, above
		Data base in GIS framework to allow evaluation of landcare practices.	Feb 08	Sites have been surveyed and geo-referenced for GIS Framework.
			Jul-Oct 08 and Feb 09 Ongoing	During site visits by BSWM staff, guidance has been provided to cooperators and their families for the collection and recording of agronomic and economic data into farm journals and review of cropping plans.
			Jul 09 – Apr 10 Dec 10	Site facilities and protocols have been established, however, due to field staff changes and issues related to a new "cross-posting" policy within the BSWM

no.	activity	outputs/ milestones	completion date	Achievements / Comments
				there have been staff availability problems, data gaps and lags in data incorporation into the GIS framework.
2.3	Quantify soil and water losses (erosion and hydrological), soil moisture and soil profile characteristics over seasonal cropping periods with all data entered into the GIS framework	Data set documenting environmental outcomes and differences between the improved and unimproved sub watershed for use in ongoing training events. / Data set documenting environmental, agronomic and socio-economic outcomes	Sep-Oct 07 Jun 08 – May 09 Ongoing Jul 09 – Apr 10 Nov 10 Nov 11	Comment as in 1.5, above Data has been collated and reviewed to guide FMD site management and cropping. Data review for soil and water processes is ongoing, noting the problem issues in 1.4 and 2.2, above. Data sets documenting all economic outcomes are almost complete. These data sets have been created from farm journals completed by farmer co-operators. The farmer co-operators were provided with farm maps and cropping calendars to assist in the recording process.
2.4	Collect survey data to quantify the productivity of crops, input costs, marketable yields, market prices and overall economic returns on all farms within the improved and unimproved sites.	Understanding of the long term impact of BMP on crop productivity and economic returns to farmers within the 2 sites is determined and reported. / Annual reports assessing the long term impact of BMP on crop productivity and economic returns to farmers within the 2 sites.	Dec 07 Oct 08 Ongoing Jul 09 – Apr 10 Dec 10	Review of socioeconomic outcomes was carried out in Dec 07 A comprehensive system of data collection has been implemented as per 1.5. Cost and return analyses have subsequently been conducted for sites on both Upper Inabanga and Abatan watersheds, with preliminary data indicating a number of superior crops in terms of economic returns to farmer cooperators. These results have been used to make proactive and adaptive adjustments to farm plans as noted in 2.6, below. Data is reviewed on a cropping season basis, with a view to capturing changed practices and climatic impacts on a more meaningful seasonal basis.

no.	activity	outputs/ milestones	completion date	Achievements / Comments
2.5	Using survey results develop comparative farm budget models for the improved and unimproved sites.	Budgeting model developed from survey productivity and economic data for use as an extension/training tool in demonstrating economic benefits of improved practices to farmers. / Annual budget models Final, four year consolidated model	 May 08 May 09 Ongoing updating Jul 09 – May 10 Nov 10 Dec 11	 Budget models developed in Dec 07 will be used in 08 training workshops. Preliminary cost and return analyses have been conducted for all improved and control sites for 2007/2008 cropping seasons. This has provided the first full set of data to be used in developing the budgeting model and case studies over the next 2 years. Comparative farm budget models have been developed for both the improved and unimproved sites. Their design allows direct comparison between sites, both improved and unimproved. These will be combined to form the final four-year consolidated model at the conclusion of the project.
2.6	Review annually management plans and provide feedback on findings to date and collaboratively update the management plan for each site.	Adaptive management plan with input from all stakeholders via stakeholder workshops. / Workshops held Updated, adaptive management plan established.	 Aug 07 Sep-Oct 07 Mar 08 Oct 08 – Feb 09 Jul 09 – Dec 09 and Apr 10 Dec 10	 A series of Stakeholder workshop training sessions have been held to review and update cropping and management plans. Training sessions have involved BSWM, ICRAF, DAR and a commercial agricultural supplier, East-West Seed Co. As noted in 2.4, above, management plans are reviewed after each cropping season.

PC = Partner Country, A = Australia

Objective 3: To promote adoption of best practices for soil, water and crop management.

no.	activity	outputs/ milestones	completion date	Achievements / Comments
3.1	Engage farmers and LGUs in reviewing, interpreting and communicating the outcomes of landcare, monitoring and assessment activities.	Establishment of local landcare FMD teams, established in collaboration with LGUs, with a continuing schedule of training activities and identified sources of support. /		
		Established management teams.	Jul 07	Local FMD teams have been formed and training workshops held on farm planning, farm journal keeping. LGU officers have taken part and have contributed services and supplies, including fertiliser and ploughing fuel.
		Training workshops held.	Aug 07 Sep-Oct 07 Mar 08	
			Oct 08 and Feb 09	Training sessions have involved BSWM, ICRAF, DAR, LGUs and a commercial agricultural supplier, East-West Seed Co.
			Jun 09 Aug 10	Workshops and Cross-Site visits held for San Isidro and Inabanga farmers.
		Video productions promoting farmer training and new practices	Oct 10 Apr 10 Jun 10 Dec 11	Produced videos showing improved practices, in local dialect with English subtitles.
3.2	Develop strategies for continued training for collaborative agencies and NGOs to support & fund effective sustainable practices, including development of landcare activities, learning materials and “train the trainer” course materials.	Training handbook/guidebook/Manual for trainers produced. /		
		Consultation held and strategies/guidelines agreed upon	Jul 07	Training strategies were reviewed in the inception meeting and updated further, in response to farmer-cooperator requests and suggestions in Sep-Oct 07.
		Training materials, training handbook/ guidebook/Manual for trainers available for use by stakeholders.	Oct 08 and Feb 09	Training materials, including a handbook/manual have been drafted with input from ICRAF, BSWM and East-West Seed Co.
			Sep 09 – Apr 10 Dec 11	Produced and distributed fact sheets and simplified manual for improved practice application and vegetable production

no.	activity	outputs/ milestones	completion date	Achievements / Comments
3.3	Deliver train the trainer courses and provide input into in farmer training courses run by ICRAF, MAOs and NGOs, incorporating practices into landcare and relevant NGO activities, with effectiveness of training evaluated through action research approach.	Provision of 5 training of trainers workshops on agronomic and economic benefits of improved practices, conducted for MAOs, ICRAF and BSWM staff; presentation of 16 training courses for farmers conducted by the above trained MAOs, ICRAF and BSWM staff, with report on outcomes of action research data on the effectiveness of stakeholder inputs, adoption strategies and approaches. /	Aug 07	
		Course developed and presented by established team	Sep-Oct 07	
			Mar 08	Cropping system development planning
				Farm journal and record keeping
			Jun-Aug 08	Vermicomposting training
			Oct 08 and Feb 09	Agro-enterprise marketing training
				Vegetable production orientation
			Sep 09 – Apr 10	
			Jun-Nov 10	Soil management (Natural vegetative strip - NVS utilization), composting and planting training presented – San Isidro and Inabanga farmers
		FFS presented by Farmer Trainers, with support from ICRAF	Dec 11	
				Formal accreditation of Farmer Trainers by LGU and Dept of Agriculture Municipal Agricultural Officers.
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no.	activity	outputs/ milestones	completion date	Achievements / Comments
3.4	Engage LGUs in developing strategies for continued training and support of effective practices.	Establishment of regional training capability, developed through promotion of demonstration nodes/facility at Pilar and other Inabanga Municipality watershed sites, with collaboration and links among agencies engaged in research, extension and policy advocacy strengthened. / Consultations and workshops held. Regional training capability is developed at Pilar, other Inabanga and Abatan watershed sites	Note timelines given in 3.2, above. This is an ongoing activity Oct 08 and Feb 09 Jul 09 – Apr 10 Dec 11 Dec 11	Active involvement and financial contribution has been developed with LGUs for all of the sites in collaborative training and marketing assistance for farmers. Consultations and workshops held for LGUs and farmers from Pilar, Carmen, Sierra Bullones and San Isidro as set out in 3.3, above. Municipalities of Sierra Bullones, Pilar and Carmen, in the Inabanga watershed, have entered into a project co-sharing arrangement in which they provide transportation, training site facilities and limited planting materials in support of FMD sites and Farmer Field School activities. As noted above in Objective 3,3 - Formal accreditation of Farmer Trainers by LGU, Dept of Agriculture Municipal Agricultural Officers, ICRAF and Australian Team.

PC = partner country, A = Australia

7 Key results and discussion

Introduction

As detailed, above in Section 4, a key aim of the Project was to promote and evaluate the adoption of improved farming on highly erodible soils on steeply sloping uplands in two upper watersheds in Bohol. This was achieved through the implementation and demonstration of erosion amelioration practices, and measurement of the environmental, economic and agronomic consequences.

The Project developed and evaluated Farmer Managed Demonstration sites (FMDs), each with improved practice and control-unimproved (traditional practice) management strategies. The sites were located in the upper Inabanga and upper Abatan watersheds of Bohol. Four of the FMDs were evaluated in a Case Study format, with key results discussed below. In results, over all, indicated that the adoption of erosion control technologies such as NVS, either in their original form or with the incorporation of cash crops such as pineapple and banana into the hedgerows, were able to reduce erosion and runoff to the extent that vegetable crops could be grown in the alleys. These technologies teamed with hands on training on better farm management practices and introduction to growing higher value vegetable crops has provided the necessary elements for the improved sites in all four case studies to improve the income returned to their farm and families.

Case Study 1. Carmen: Natural Vegetative Strips (NVS) and improved agronomy

Carmen, Upper Inabanga watershed, site description

This site focussed on a variation of Natural Vegetative Strips (NVS) where cash crops are planted as part of the hedgerow system, in this case pineapples and coconuts. The farmer at the improved site participated in a Farmer Field School (FFS) between January and April 2010 along with other selected farmers and LGU technicians from 3 municipalities, with a total of 46 participants (15 – Sierra Bullones, 13 – Pilar and 18 from Carmen).

The January and February, 2010, FFS trained farmers in best management practices including:

- plastic mulch;
- trickle irrigation;
- F1 hybrid vegetable varieties selected to suit the climatic and market requirements;
- 16 week farmer field school in agronomy provided by East West seeds and project staff;
- correct crop nutrition management.

The control site did not receive any of the improvements provided to the improved site and did not practice contour ploughing or NVS. Details of the cropping history of the improved and control sites are shown in Tables 1 and 2 respectively.

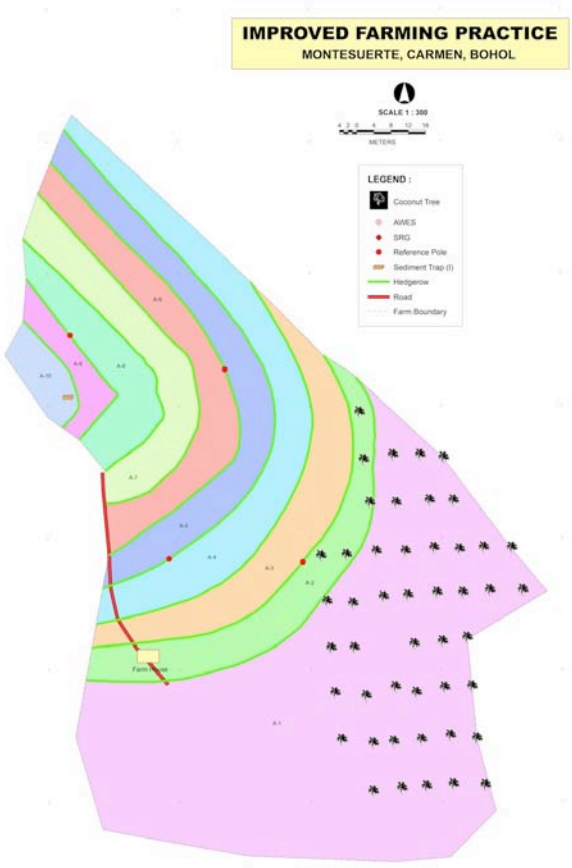

Figure 1: Layout of the Carmen improved site showing the cropping alleys and hedgerows. Improved and Control sites were at elevations of 90 – 105m and had slopes of 3 to 20%.

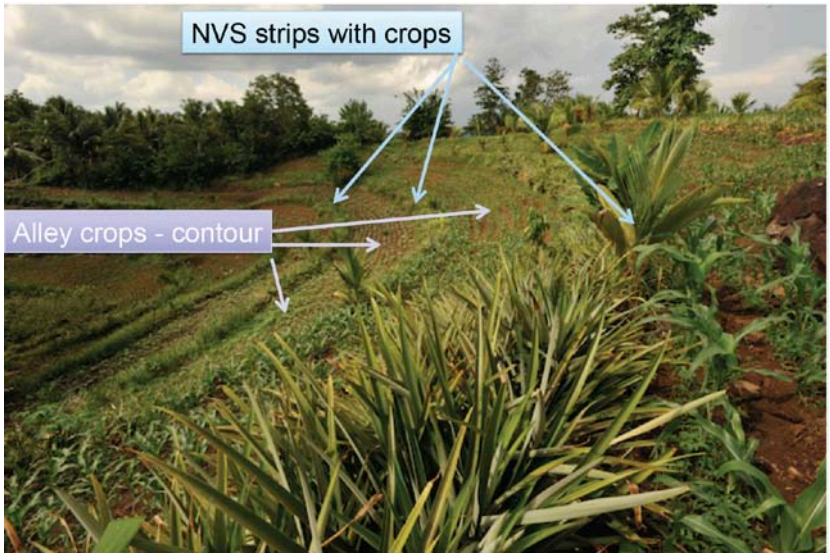

Photo 1: Natural Vegetative strips at Carmen, Bohol. The crop planted in the inter-row area is corn. Pineapples and coconut can be seen planted in the hedgerows.

CROP / TIMING	1	2	3	4	5	6	7
Corn	■	■	■	■	■	■	■
Peanut		■				■	■
Eggplant & stringbeans		■					
Mungbean			■				■
Watermelon			■				
Bittergourd			■				
Eggplant			■				
Sweet pepper			■				
Cassava						■	■
Ginger			■	■	■	■	■

Table 1: Cropping schedule for the improved Carmen site over 7 croppings

CROP / TIMING	1	2	3	4	5	6	7
Corn	■					■	
Peanut		■	■			■	■
Mungbean				■			
Sweet potato					■		■
Taro			■				

Table 2: Cropping schedule for the control Carmen site over 7 croppings

Carmen Results

Corn is an important crop for farmer Aurea Sumagangm at the Carmen improved site. The yields have steadily increased over the four years since the project started up, to the end of data collection in 2010 (Figure 2).

This general increase in corn yield is significant because it is opposite to the trend that is normally observed in the Region, where poor farming practices result in loss of soil and nutrients thus resulting in declining corn yields.

There was a high yield for the third corn crop which corresponded with a ginger crop and application of a high level of residual NPK fertilizer which is the most likely explanation for this result. The intercropping with ginger could also be having an effect, independent of the fertilizer effect, and may warrant further investigation.

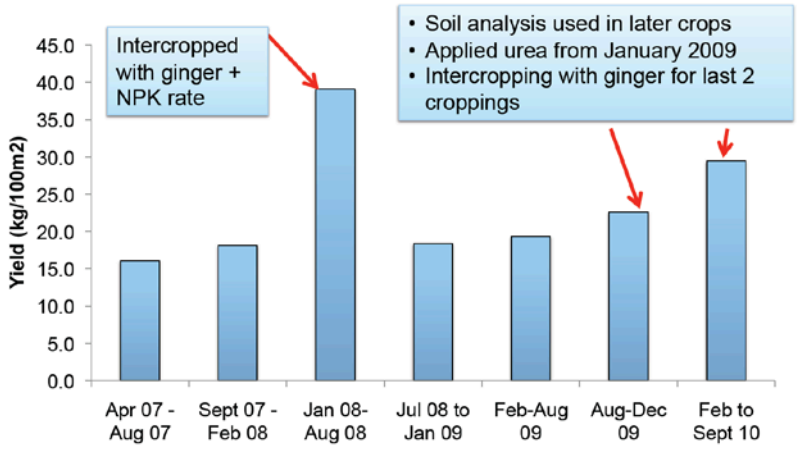

Figure 2: Corn yields on the Carmen site showing improvement over the life of the project.

The gross margins follow the same pattern as yield. The price of corn is relatively stable in the Region, so if growers can produce higher yields, they can also increase the financial return from the crops. The gross margin return shown in Figure 3 confirms that moderate increases in spending to supply adequate cropping inputs are more than compensated for by higher financial returns for the additional productivity.

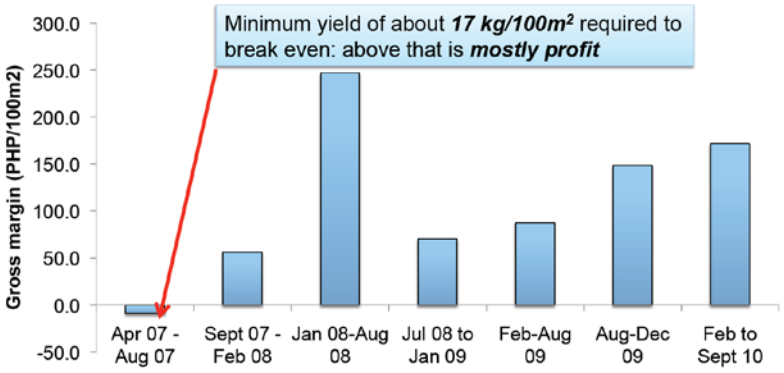

Figure 3: Corn gross margins from the Carmen site

The yield of other vegetable crops from the improved and control sites show a mixed result. Because the experiment could not be controlled to the point of directing precisely what farmers planted, direct comparisons between the same crops were often not possible (Figure 4). This should not be considered a major problem in the evaluation, and in fact is a characteristic of this type of *action research*. It is therefore more informative to look at gross margins of the whole farming operation than individual crop comparisons. This is the way farmers see it and how they judge the success or otherwise of their farming enterprise. For many of the following examples, the combined gross margin of the cropping mix is presented.

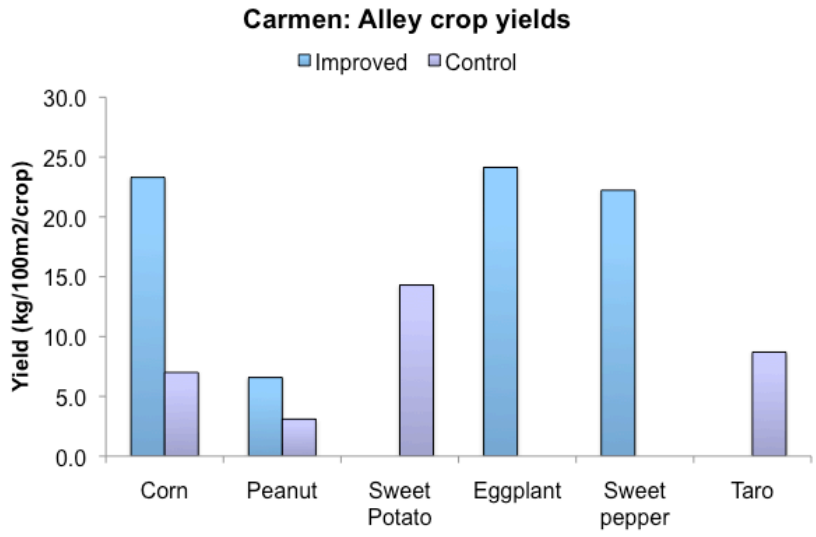

Figure 4: Yield of control and improved crops, Carmen Bohol

When vegetables were included in the cropping mix, in Carmen, gross margins increased again, over and above the results for corn alone. The mix of crops showed the same general increase in gross margin over the project as did corn alone, except that the maximum gross margin for corn was 171 PHP/100m^2 whereas adding vegetables into the

cropping mix increased the maximum gross margin achieved to 261 PHP/100m^2, an increase of 35% in gross margin (Figure 5).

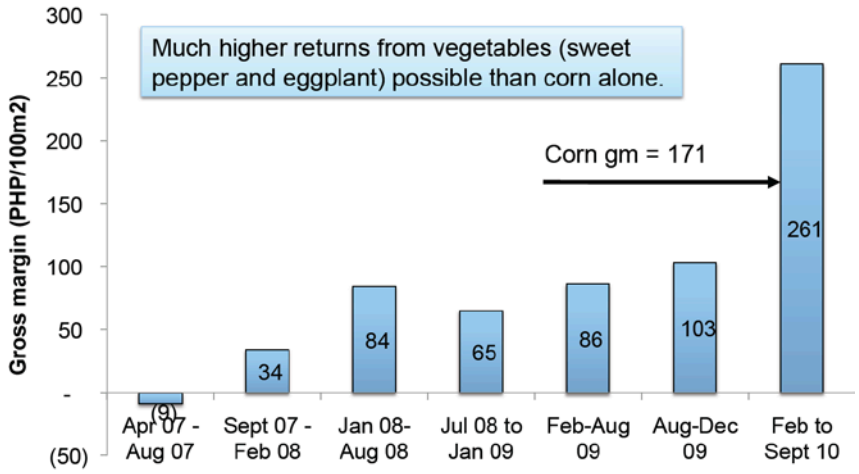

Figure 5: Alley crop (corn and vegetables) gross margins per cropping

When the various vegetable crops grown in alleys were compared for the average gross margins to the farmer, the most profitable crops were sweet pepper, ginger, eggplant, cassava and corn in that order (Figure 6) which is consistent with the idea that including vegetables in the cropping mix improves profitability. The average gross margin for sweet pepper, alone, was around double the return on a 100m2 block to the other vegetable crops.

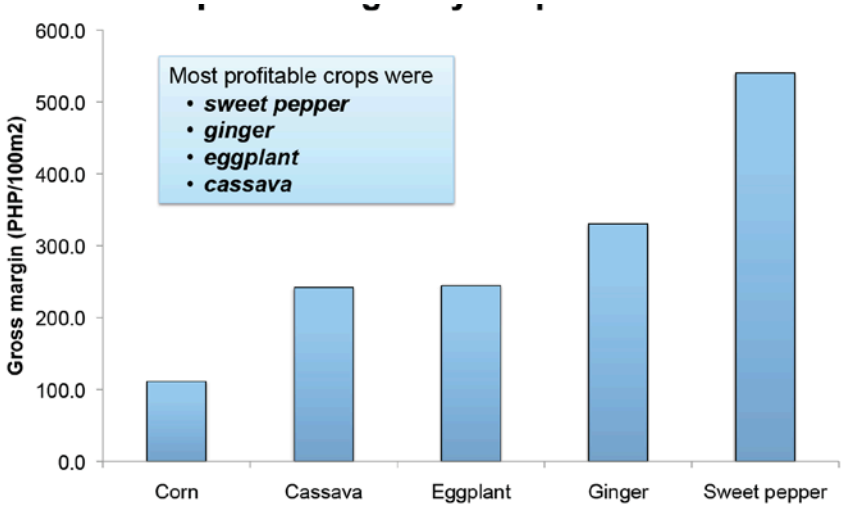

Figure 6: Best performing alley crops, Carmen Bohol

When the impact of improved farming techniques measured by comparing the gross margins at the start of the project before the farmer had received any agronomic training to after, an increase of 172 Pesos per m^2 was observed. When eggplant and sweet pepper were added to the mix, the gross margins of the combined cropping mix could be increased by a further 282 Pesos to 392 Pesos per m^2 (Figure 7).

On the control site, traditional practices were maintained and overall farm returns were much lower than those on the improved site. The crops grown were relatively low value

crops, no fertilizer was used and no pesticides were applied; additionally, there was significant weevil damage in the mungbean cropping.

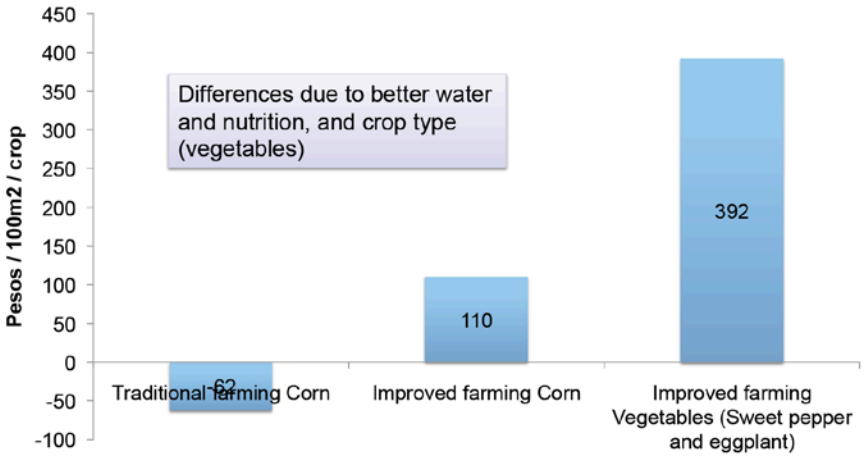

Figure 7: Farm gross margins per crop, Carmen Bohol

In interpretation of the results, it is important to be wary of directly extrapolating the data to larger areas to determine returns because of the possible impact increased production could have on the price received and overall returns. This potential impact and the importance of cooperative planning within the local farming communities were discussed during training sessions.

Case Study 2. Sierra Bullones: Plastic mulch, trickle irrigation, FFS.

Sierra Bullones, Upper Inabanga watershed, site description

There were three farmers on the improved site, growing a combination of vegetables, corn and cassava. There was also a control site on which the farmer grew only corn, and used traditional practices such as ploughing up and down the slope. The control site farmer did not receive any training to improve his crop management skills.

The site was characterised as having best practice cropping improvements:

The farmer at the improved site participated in a Farmer Field School (FFS) between January and April 2010 along with other selected farmers and LGU technicians from 3 municipalities, with a total of 46 participants (15 – Sierra Bullones, 13 – Pilar and 18 from Carmen).

This FFS trained farmers in best management practices including:

- plastic mulch
- trickle irrigation
- F1 hybrid vegetable varieties selected to suit the climatic and market requirements
- 16 week farmer field school in agronomy provided by East West seeds
- correct crop nutrition management

The control site did not receive any of the improvements provided to the improved site. The crops produced by cropping cycles for the improved and control sites are shown in tables 3 and 4, respectively. The Improved and Control sites were at an elevation of 170 – 200m and had slopes of 3 to 20%.

Photo 2: Improved project site at Sierra Bullones, Bohol showing NVS strips planted with bananas

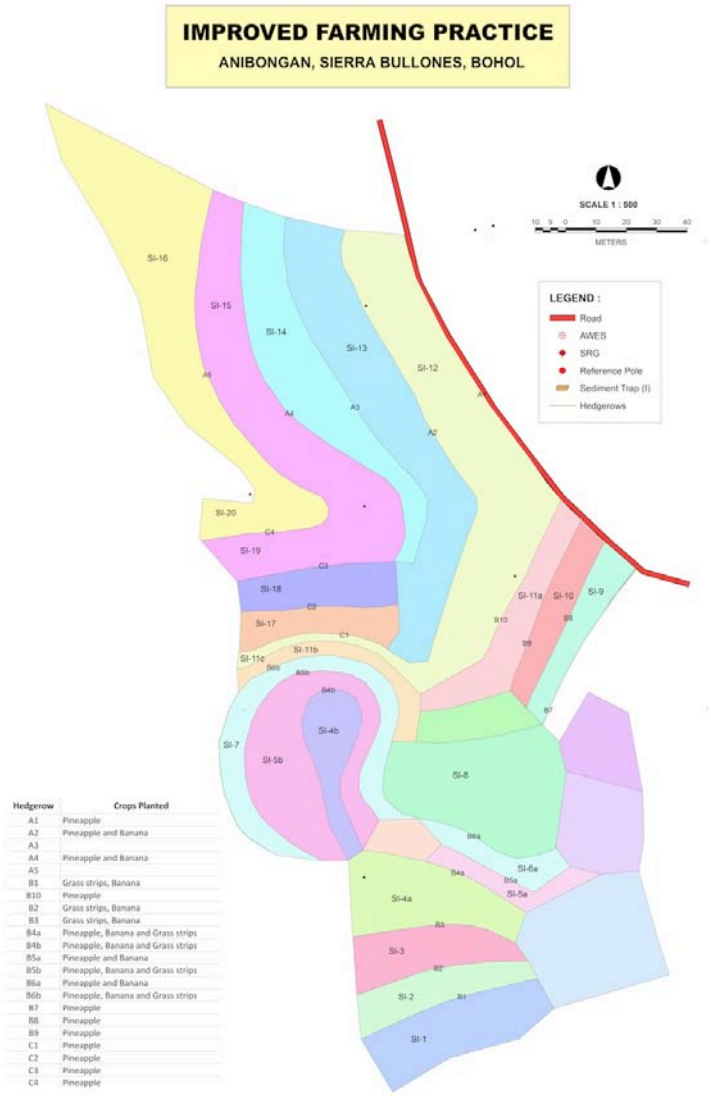

Figure 8: Layout of the Sierra Bullones improved site showing the cropping alleys and hedgerows

CROP / PLANTING	1	2	3	4	5	6
Sweet potato	■					
Squash	■	■	■	■		■
Eggplant	■	■		■		■
Sweet pepper	■	■	■	■	■	
Okra	■		■		■	■
Stringbeans	■		■	■		
Mungbean		■				
Bittergourd			■		■	
Tomato			■			■
Cucumber						■
Peanut			■			■

Table 3: Cropping schedule for the improved Sierra Bullones site over 6 croppings

CROP / PLANTING	1	2	3	4	5	6
Corn						

Table 4: Cropping schedule for the improved Sierra Bullones site over 6 croppings

Photo 3. Farmer field school graduation showing improved growing techniques used to produce sweet pepper crops Sierra Bullones, Bohol

The results at the Sierra Bullones farm were interesting and reflected a gradual increase in skill levels over the life of the project and especially after the three farmers at the improved site were trained in vegetable agronomy during an FFS provided jointly by East West Seeds and the project team.

Figure 9 clearly shows a dramatic improvement in crop yields after the FFS training was completed in April 2010.

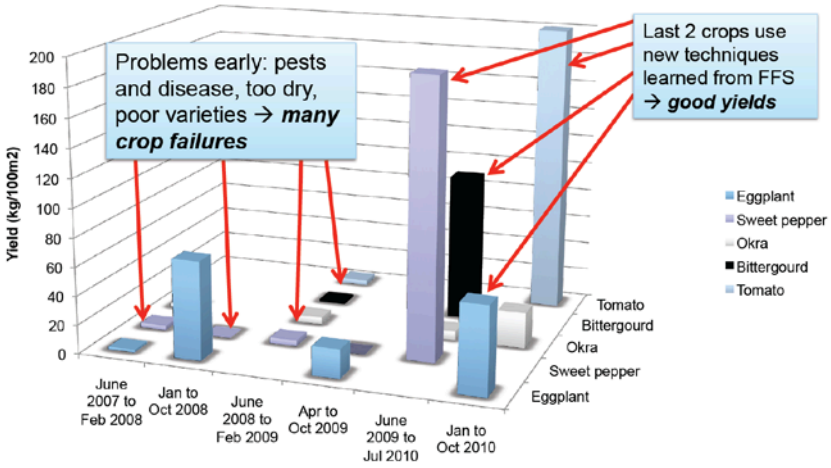

Figure 9. Sierra Bullones (Albert Tado) crop yields over time

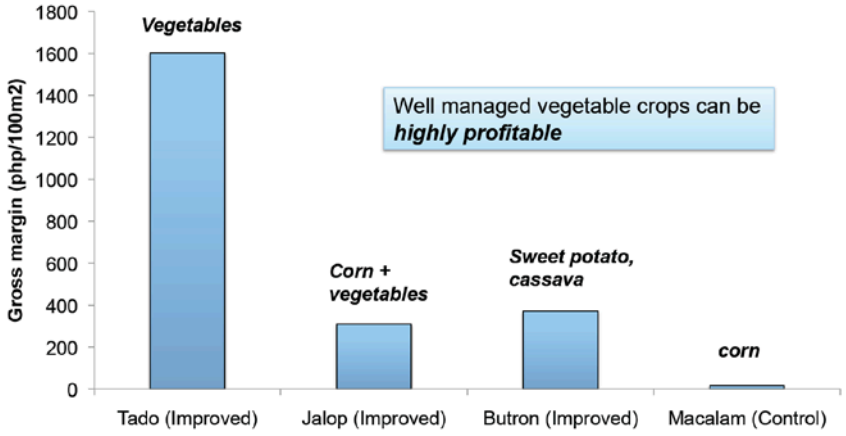

Figure 10. Average alley crop gross margin after FFS training had been provided to the Sierra Bullones project site, Bohol

There were three farmers at the improved Sierra Bullones site and one farmer in the control group. Farmer Tado was growing only vegetables, farmer Jalop used a mixture of vegetables and corn while farmer Butron grew a combination of sweet potato and cassava. These results clearly show the role vegetables can play in increasing farmer incomes, especially when combined with appropriate training in agronomic techniques. The farmer on the control site (Melcam) was growing only corn using traditional techniques and his gross margins were close to zero (Figure 10).

Farmer Tado has been the most successful of all four farmers at the Sierra Bullones site, and his achievements include:

- built an extension onto his house from the increased profits;
- bought two new motorbikes. Tado can be seen riding one of these in Photo 4;
- became an accredited farmer-teacher by the Sierra Bullones LGU and has been of one of 5 Farmer-Trainers providing training to other farmers in the 3rd FFS run in Pilar.

Photo 4: Alberto Tado, farmer at the Sierra Bullones improved site was able buy this motor bike from the profits from his farm.

Case Study 3. San Isidro Site

San Isidro site, Upper Abatan watershed, description

This site focussed on improvements including contour ploughing, NVS and improved agronomy provided by a farmer field school, conducted with farmer cooperators on the improved site. This was a long-term site and had been initially established as part of a previous Spanish funded project. The NVS and contour ploughing improvements had been in place for 5 years prior to the start of this project. The improved site was compared to a control site, approximately 200 m from the improved site. On the control site, traditional practices of ploughing up-down the slope and allowing patches of bare soil were evident throughout the study. The improved and control sites were at elevations of 60 – 110m and had slopes of 3 to 30%.

The improvements which had been established at the project site were specifically:

- contour farming and NVS planted with bananas, coconuts and various tree crops;
- 16 week farmer field school in agronomy provided by East West seeds;
- improved agronomy in the alley cropping areas.

The control site did not receive any of the improvement treatments provided to the improved site. The crops produced by cropping cycles for the improved and control sites are shown in Tables 5 and 6, respectively.

Photo 5: Arthur (Arturo) Sinanggote standing in his tomato crop at San Isidro. Arturo was a great supporter of the project, an enthusiast and a skilled farmer

Vale Arthur (Arturo) Sinanggote. Tragically, Arturo died during the project. He was a great enthusiast and supporter of the project and was always ready to help and the first to try any new innovations. The project team in Australia and the Philippines extend our condolences to Arturo's family.

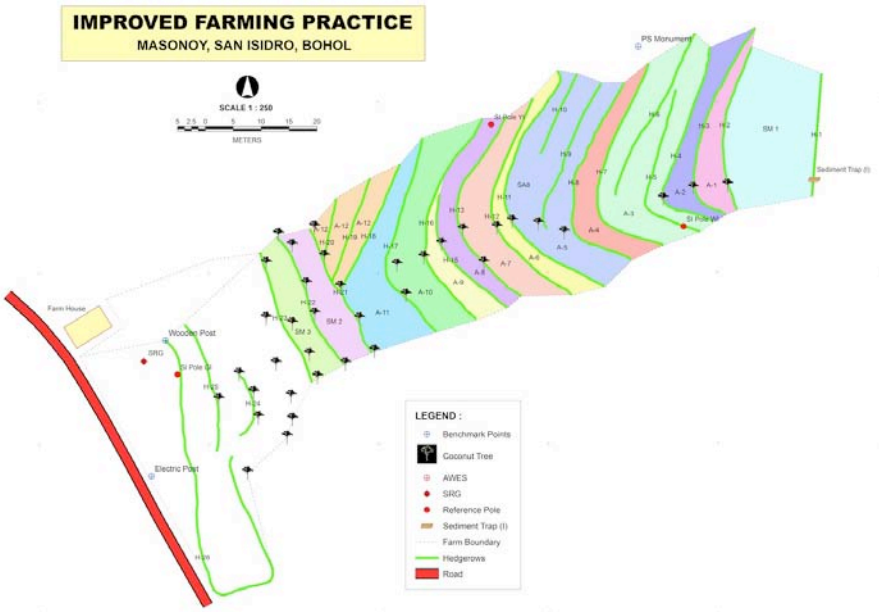

Figure 11: Layout of the San Isidro improved site showing the cropping alleys and hedgerows

CROPS / PLANTINGS	1	2	3	4	5	6	7	8	9
Sponge gourd			■						
Squash				■		■		■	
Pole sitao				■					
Onion bulb				■					
Eggplant					■			■	
Pechay					■				
Okra					■				■
Bittergourd					■				■
Bottlegourd							■	■	■
Tomato							■	■	
Sweet pepper							■	■	
Black pepper						■	■	■	■

Table 5: Cropping schedule for the improved San Isidro site over 9 croppings

CROPS / PLANTINGS	1	2	3	4	5	6	7	8	9
Corn	■						■		
Bitter gourd		■	■	■		■	■	■	■
Sweet pepper			■						
Tomato			■						
Beans				■	■			■	
Bottle gourd						■	■		
Pole sitao									■
Eggplant									■
Sweet potato									■

Table 6: Cropping schedule for the control San Isidro site over 9 croppings

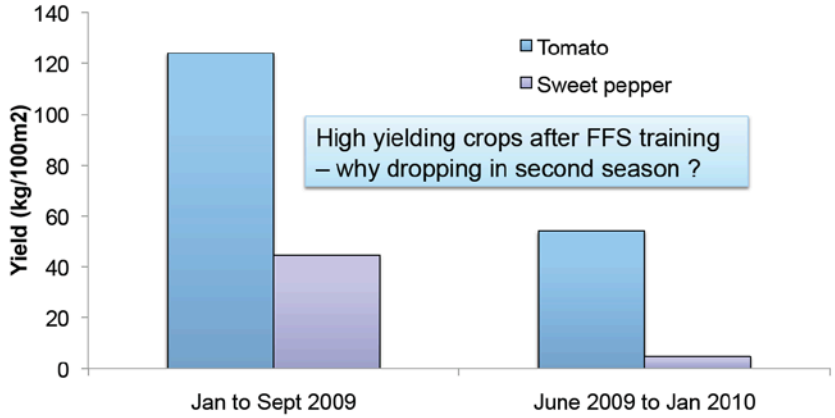

Figure 12: Vegetable yields (tomato and sweet pepper) at the improved site showing high yields in the January to September 2009 period but falling in the following cropping period on the same farms

Farmers from the improved sites (Celeste, Navarette and Sinanggote) participated in the first FFS run by East West Seeds and the project team. Their average yields of tomato and sweet pepper were much greater than previous seasons but declined significantly in the following season (June 2009 – Jan 2010) Figure 12. The reasons for this decline are not clear, however two explanations are are hypothesised. First, it is possible that cropping inputs such as fertilizer and F1 hybrid seed, which were provided for the first crop after the training, were not available for the second crop. A second possibility is that disease started to have an impact after the second consecutive Solanaceae Family crop in the same soil. There was a significant amount of bacterial wilt observed in the second crop, for both tomatoes and sweet pepper.

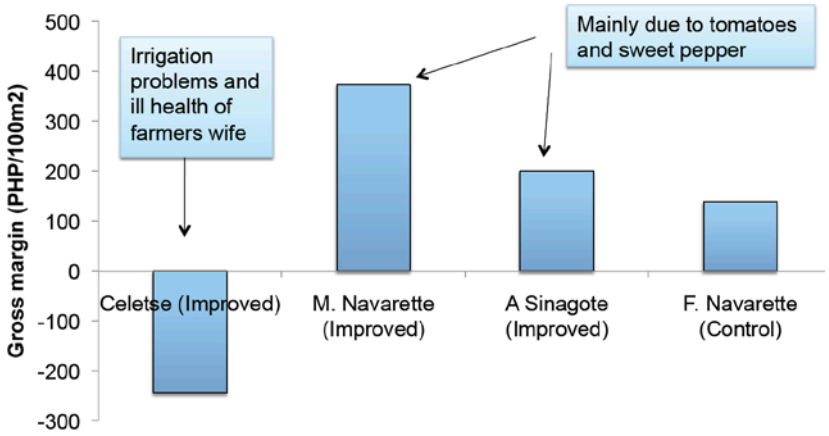

Figure 13. Gross margins from alley crops during the last two croppings of the San Isidro site, after the farmers had been trained in improved production techniques

When the gross margins of the last two cropping at the improved site (farmers trained in vegetable agronomy) are compared to the control site (no training), the results clearly show an increase in gross margin due to a combination of training and improved cropping practices (Figure 13). Farmer Celeste had a negative gross margin for the last two croppings, but this could be attributed to his wife being ill and, as a consequence, he was not able to work the farm effectively during this time.

Case Study 4. Pilar Site

Pilar site, Upper Inabanga watershed, description

This site focused on improvements including contour ploughing and NVS and was set up as an "organic site" which focussed on the production of vermicompost and its use on the farm to supply nutrients to the crops.

The farmer co-operator on the Pilar improved site attended the FFS training, between January and April 2010 along with other selected farmers and LGU technicians from 3 municipalities, with a total of 46 participants (15 – Sierra Bullones, 13 – Pilar and 18 from Carmen). The farmer, Celeres, in fact, became one of the Farmer-Trainers from that program, but did not implement plastic mulch and inorganic fertilisers on the farm used for the project.

The FFS trained farmer used best management practices including:

- plastic mulch
- trickle irrigation
- F1 hybrid vegetable varieties selected to suit the climatic and market requirements
- 16 week farmer field school in agronomy provided by East West seeds
- correct crop nutrition management

The improvements which had been established at the project site were specifically:

- contour farming and NVS planted with bananas, coconuts and various tree crops;
- 16 week farmer field school in agronomy provided by East West seeds;
- nutrients supplied by vermicompost only.

The control site did not receive any of the improvements provided to the improved site. The crops produced grown on the improved site were corn, cassava, sweet potato, ginger, mungbean, peanut, eggplant, sweet pepper, bitter gourd, okra and string beans. Whereas, the control site only produced corn and cassava in the same areas each season.

Photo 6. Pilar farmer Raymondo Celeres and his farm at Pilar, Bohol

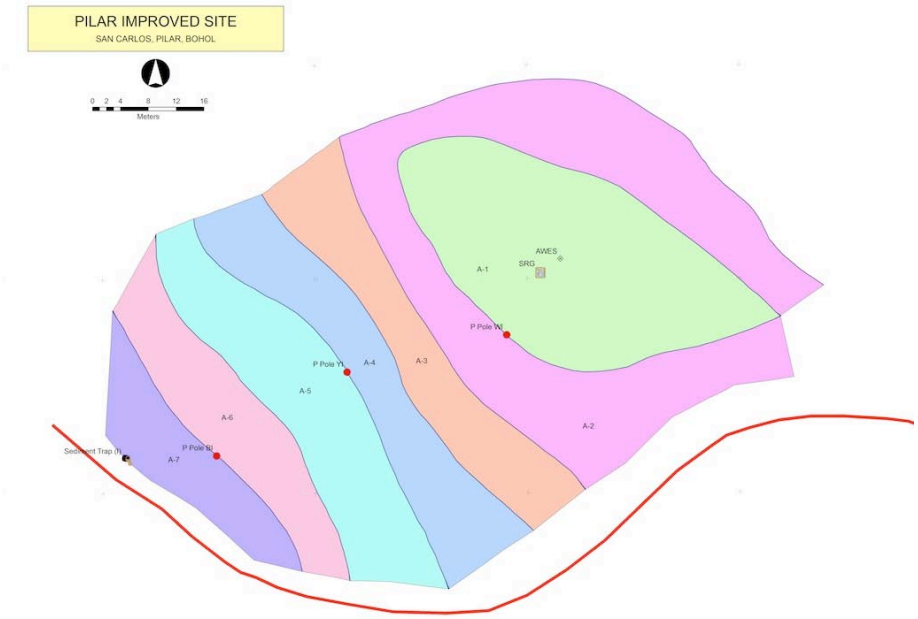

Figure 14: Layout of the Pilar improved site showing the cropping alleys and hedgerows

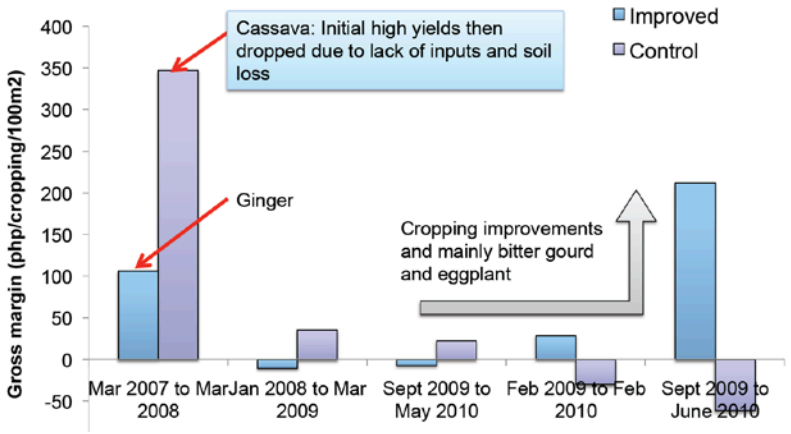

Figure 15: Gross margin returns from various alley crops grown over 5 cropping seasons on the improved site

The gross margins of the control site were initially higher than for the improved site and this was most likely because the site had not been cultivated for some time. There were also high levels of residual nutrients available following a cassava crop. After the first crop, yields and gross margins on the control site dropped so that by the Feb 2009 cropping, the gross margins were negative and became more negative by the final cropping in 2010 (Figure 15). The gross margins of vegetable crops in the improved site, mainly bitter gourd and eggplant, improved over this period and by the last cropping in 20102 were 200 Pesos/m^2/crop which was significantly better than the control crop which lost about 75 Pesos/m^2/crop.

Farmer Led Farmer Field School

The third FFS was organised by Geramil Cordero of ICRAF and BSWM staff in Bohol between January and April 2010 in partnership with Pilar LGU. Farmers and LGU technicians were selected from 3 municipalities, with a total of 46 participants (15 – Sierra Bullones, 13 – Pilar and 18 from Carmen)

The aim of the FFS was to build the capacity of outstanding farmers to train co-farmers in improved their farming techniques. The training was conducted by 5 farmers: Aurea Sumagang, Alberto Tado, Ponciano Valentos, Justiniano 'Tano' Celeres and James Peligro, Snr. A total of 21 farmers were trained in this third FFS.

The sites were revisited by Australian team members in February and May 2012 and most of these are still functioning at a high level. Farmer-trainers Ponciano Valentos, Justiniano 'Tano' Celeres are still growing excellent crops. Photo 7 shows successful bitter gourd crops at Carmen and Photo 8 shows a successful eggplant crop at Pilar.

Photo 7: Sweet pepper growing successfully in organic mulch on the farm of Ponciano Valentos, May 2012

Photo 8: Eggplant growing successfully on plastic mulch in Pilar after 2 years. The farmer (Cipriano) was trained by the farmer-teachers in 2010 and the area is still highly productive in May 2012

General Discussion

Main problems and opportunities identified:

The main issue which limited productivity was the skill level of the farmers. In particular, factors such as inappropriate varieties, incorrect crop establishment, inappropriate planting density, incorrect use of fertiliser, poor pest and disease management and inadequate irrigation were responsible.

Fertiliser recommendations supplied by project staff and BSWM were not being applied by the farmers in every case, mainly because the inputs farmers needed were not supplied consistently by BSWM project staff. The Australian team reviewed each of the project sites and cropping situation in detail during the project and supplied reports to BSWM staff in an attempt to correct this problem. The strategy was partially successful, but it was not until additional funds from the Australian budget were used to directly purchase cropping inputs, such as fertilizer, which had been identified as limiting production.

Pest and disease management was an important issue for farmers throughout the project. The farmer field school provided by East West seeds and the project staff significantly improved the pest and disease diagnostic skills of farmers working on the improved project sites. In all cases, after the farmer field school was completed the level of pest and disease control improved significantly.

Inadequate soil moisture was a common problem on the control sites. In Bohol there is a distinct dry season and farmers cannot rely upon rainfall to satisfy crop water requirements. In some cases inadequate irrigation was due to an insufficient supply of water but in other cases simply due to the farmers lacking simple requirements such as a hose. The project was always intended to supply these simple items so that farmers could irrigate their crops. In the assessment prior to the final year of the project farms at Sierra

Bullones, San Isidro and Pilar were identified as requiring a hose and this was supplied directly to farmers and paid for from the Australian budget..

Varieties. F1 hybrid vegetable seed supplied during the FFS was being saved as second-generation (F2) seed which is not true-to-type. This is a common problem among poor farmers who cannot afford to buy expensive F1 hybrid seed. After the farmer field schools the farmers understanding of the correct use of F1 hybrid seed improved. There is however an ongoing issue with the correct use of F1 hybrid seed and there is also a place for the use of good quality inbred varieties such as those bred by AVRDC (Asian Vegetable Research and Development Center) World Vegetable Centre in Taiwan.

Technical Skills Lacking. There were large improvements in yield and gross margins after the Farmer Field School and this has been discussed in previous sections of this report. One of the most effective means of improving the income of poor smallholder farmers used to provide effective training for them in crop production techniques.

Subsidy mentality. Another critical factor was the lack of finance to purchase basic cropping inputs and this project was unable to address that important issue. Farmers expect subsidies rather than funding inputs from expected profits. There is a need to build in some sort of sustainable long-term solution to the subsidy mentality when it comes to farmers expecting their cropping inputs to be provided by someone else. If local organisations such as the LGUs could organise some sort of financing system it would be of great benefit to the farmers. Some of the LGUs have initiated a version of "Micro-Financing" in which the LGU advances basic planting and maintenance funding and recoups the advance from the farmers' subsequent crop earnings. This is an important initiative and should be developed more fully to achieve sustainability. Another potential option in developing such a system could be to involve the private sector, such as East West Seeds and Harbest Agribusiness, with these types of projects and attempt to form effective public-private partnerships between the private sector, the LGUs and other organisations.

Summary of cropping findings

In summary, the key findings of the agronomic aspect of the project included:

1. Improvements in the growing of traditional crops such as corn and cassava can improve farm incomes. The returns available for farmers can be significantly increased by improving crop production techniques and soil management practices. The most effective improvements in soil management were the use of natural vegetative strips and contour ploughing, better soil nutrient management, irrigation and correct crop establishment.

2. Inclusion of high-value vegetables such as sweet pepper, eggplant, ampalaya and ginger were effective in raising farmer gross margins. When these crops were added to traditional cropping mixes such as corn or cassava the farmers' gross margin invariably increased. When vegetable crops were grown alone, without the other traditional crops, this again further increased farmer gross margin.

3. Farmer field school training was critically important in making the improvements effective. Farmer Field schools were shown to be highly effective in training

farmers. They were able to increase this skill levels from "backyard" or non-professionals vegetable farmers to skilled farmers within one cropping season through the use of Farmer Field schools. The first two Farmer Field schools were run by East West seeds and these could then be run by farmers themselves.

4. Farmer-led Farmer Field Schools were just as effective as the school run by East-West seeds. This is an important innovation in the farmer field school model because it can be a sustainable system. The farmer teachers selected from the East West seeds Farmer Field Schools were effective trainers and were also able to gain accreditation is Farmer teachers from the local LGUs. Farmers accredited in this way are able to qualify for subsidy payments from the LGUs to provide training to new adopters and this helps with the financial stability of the system. Also, accreditation allows a rational and sustainable mechanism for financially compensating farmers for providing training. In the long-term, perhaps some of the funds should come from the farmers who are receiving the training. This would require a change in mindset but nevertheless is an important goal.

5. The video ***The Next Crop*** was launched at the project review in November 2010 and copies of the DVD were distributed to farmers, LGU staff, BSWM staff and the Visayas State University. The video is also available on *YouTube* where to date there have been 515 views of this video. There is a need to produce more copies of this video and distribute it more widely to LGUs and other organisations in the Visayas.

6. Sustainability strategy. Thought should be given to improving the sustainability of improvements that have been made as a result of this project. These could involve further engagement of local government organisations such as LGUs, Department of Agriculture, the Department of Environment and Natural Resources and, of course, the private sector.

7. Financial feedback to farmers (FBS). The financial information collected and analysed as part of this project has been discussed with the participants over the term of the study. The final overview in this report should be presented back to the farmers and other staff who participated in this project.

Impact of NVS on soil and nutrient movement across alleys and down the slope

Introduction

Contour ploughing and NVS are aimed at stabilising soils on steeply sloping lands when those soils are used for cultivation. The techniques work by slowing the movement of water down the slope during rainfall events which reduces the capacity of the moving water to carry soil particles down the slope, thereby reducing erosion.

Contour ploughing works on a localised level whereas NVS strips work at a somewhat broader level. NVS works by catching soil at each strip, and forcing it to build up on the uphill side of the strip. This means the soil should be deeper on the downhill side of the alley. It was hypothesised that the soil which builds up on the lower edge of the alley will carry with it organic matter and nutrients which could have an impact on its fertility across the alley. Over time this accumulation of soil on the lower side of the alley, combined with the practice of plough uphill, results in a levelling of the soil across the alleys, further improving the effectiveness of NVS strips in controlling erosion.

Methods

To test this idea, on the improved site the project team collected soil samples from the top, centre and lower edge of alleys located at four locations down the slope as shown in Figure 15. At each sampling point a soil core was taken using a soil auger. The depth of each change in horizon was recorded and soil sample collected from each horizon an replicated 3 times (n=3). The control site had no alleys so this was sampled at three points down the slope: top, middle and bottom.

The soil samples were then transported to the BSWM laboratory in Manila where the following measurements were made: pH, EC, organic carbon, exchangeable K, CEC, total N, total P (Olsen), Zn, Cu, Fe and Mn. Soil organic matter levels were calculated from soil organic carbon measurements.

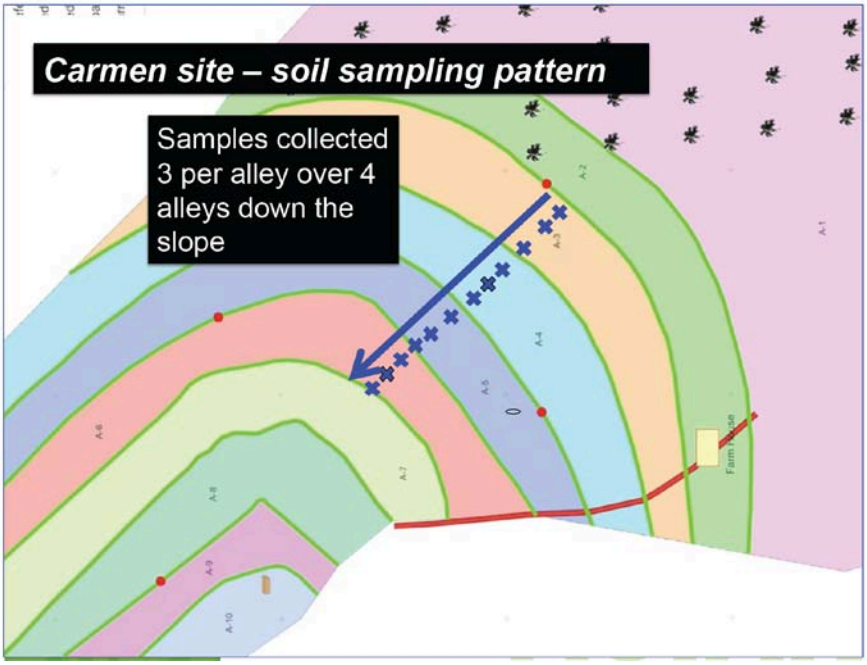

Figure 15: Sampling pattern used at the Carmen site to collect soil samples.

Results and Discussion

Movement of soil nutrients across the alleys

Soil moved across the alleys from the upper edge to the lower edge and this was quantified by measurements of soil depth (data not shown). In addition to the soil accumulating on the lower edge of the alleys, soil organic matter and nutrients follow the same pattern. Organic matter levels measured across the alley were higher on the lower edge compared to the centre or upper edge (figure 16). The soil macronutrients nitrogen, phosphorus and potassium followed a similar pattern (figures 17 to 19). This finding was consistent with the observation that crop growth appeared to be more vigorous on the lower edge of the alleys compared to the centre or upper edge.

Accumulation of soil organic matter and nutrients on the lower edge of the alleys was not simply due to the mass movement of soil but due to movement of components within the soil. This could have been clay particles or soil organic matter (or both) moving across the profile and taking adsorbed nutrients with it. The means by which the soil accumulated on the lower side of the early was not specifically investigated however it

was likely this occurred through ploughing/cultivation consistently moving soil towards the downhill side or by the natural vegetated strips catching rain displaced moving soil.

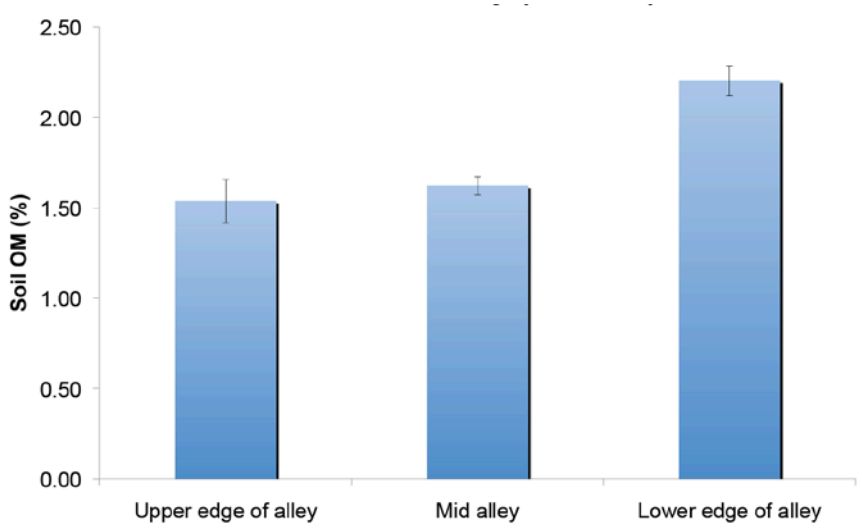

Figure 16: Levels of soil organic matter across individual alleys (average over the whole slope). Vertical bars indicate standard errors (P<0.05)

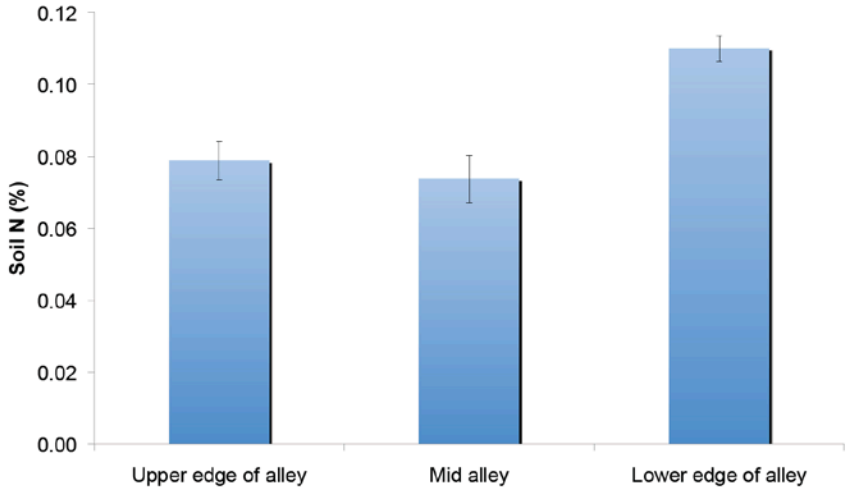

Figure 17: Levels of soil nitrogen across individual alleys (average over the whole slope). Vertical bars indicate standard errors (P<0.05)

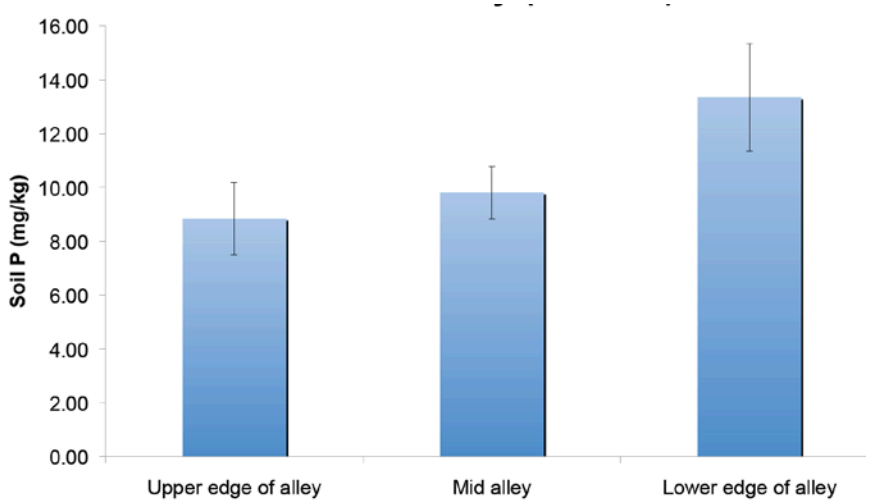

Figure 18: Levels of soil phosphorus across individual alleys (average over the whole slope). Vertical bars indicate standard errors (P<0.05)

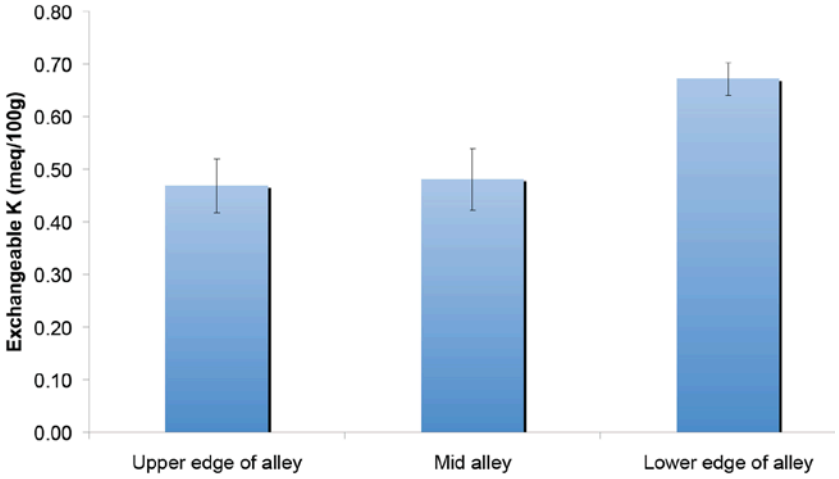

Figure 19: Levels of soil potassium across individual alleys (average over the whole slope). Vertical bars indicate standard errors (P<0.05)

Movement of soil nutrients down the slope

The second question was whether the natural vegetative strips were effective in reducing the movement of soil components from the top to the bottom of the slope. If one considers soil phosphorus levels as an indicator of soil and/or nutrient movement down the slope, then Figure 20 suggests that while there was some movement of phosphorus down the slope its movement was inhibited by the presence of natural vegetative strips. Phosphorus levels at the top, upper middle and lower middle regions of the slope were relatively constant but with an accumulation of phosphorus at the base of the slope. Comparing this to the control site which did not have natural vegetative strips and where the farmer ploughed up and down the slope, the results indicate that there was an increase in soil phosphorus levels down the slope, and the overall levels of phosphorus were higher at the control site (Figure 21).

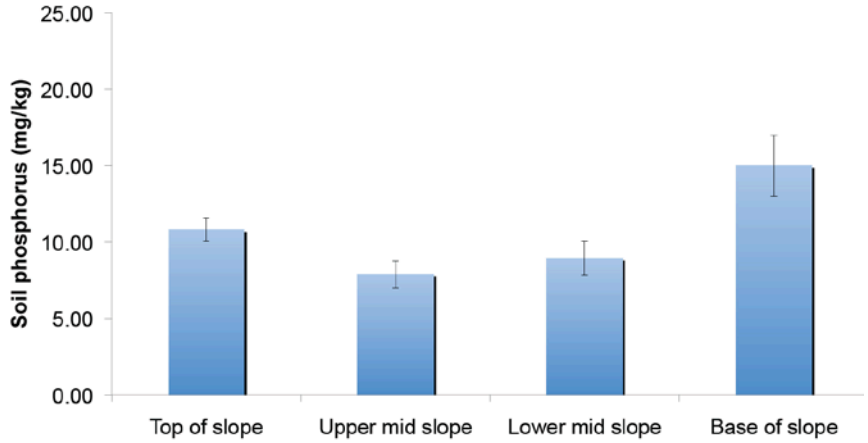

Figure 20: Levels of soil phosphorus from the top to the bottom of the slope on the improved site. Vertical bars indicate standard errors (P<0.05)

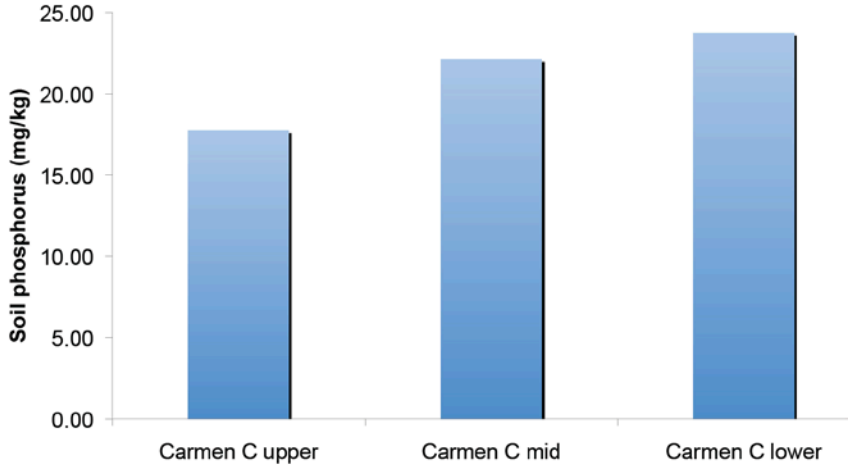

Figure 21: Levels of soil phosphorus from the top to the bottom of the slope on the control site

Conclusions

From these results, it is concluded that natural vegetative strips are effective at reducing the movement of soil and nutrients down the slope, validating their application for sloping, fragile soil profiles.

There is some movement of soil components, including both clay and humus particles from one side of the alley to the other. The translocation resulted in an accumulation of soil organic matter and major plant nutrients on the lower side of the alley. This accumulation of nutrients can supply the hedgerow crops with the additional nutrients and is a bonus of the system.

8 Impacts

8.1 Scientific impacts – now and in 5 years

A number of scientific impacts have resulted as a consequence of experimental protocols and practices developed as part of this work. More detailed soil survey strategies are now being implemented as a consequence of identification of low pH soils in what had been considered as hi pH calcareous-soil farming areas. Liming has now been proposed for some of the project study areas to improve the soil profile. Linking of geophysical characteristics, farming practices and crop yields is now feasible using the GIS techniques and imagery provided through the project. In addition, importantly, the project enables critical testing of Landcare promoted practices for cropping, linking it with ACIAR Project ASEM/2002/051. Findings such as the propensity for rill erosion occurrences on cultivated slope areas between vegetated strips, for example, are leading to development of strategies to prevent or moderate the problem.

8.2 Capacity impacts – now and in 5 years

A significant impact of the project is the development of a collaborative partnership with Local Government Units (LGU), through the municipal agriculture office, BSWM, ICRAF and East –West Seed Company for the implementation of Farmer Field School (FFS) on high value crops vegetable production using improved technologies. The LGUs have provided some initials inputs through a loan and the East-West company have provided appropriate production technology strategies and basic farming accounting to assist farmers determine if the technology is a positive or negative contributor to their income.

The project has facilitated the drafting and approval, with the assistance of the municipal agriculture office, of an ordinance that designates the project research sites as official Municipal Learning Centres for soil and water conservation and improved farming practices. The drafted ordinance will help encourage more farmers, agricultural technicians, students, politicians and other interested groups to visit the area and learn about different dynamics for the improvement of their respective farms and also for the development of long term planning options for sustainable agricultural development at municipal and provincial levels.

The Project team is developing strengthened skills in using new tools to monitor and collect needed data. A new technique that has been introduced is the use of specialised capacitance based soil moisture array systems. Analysis of the soil moisture data enables the evaluation of crop water use, infiltration and on-site time series monitoring to assess the impact down slopes and in the soil profile of vegetated strip and other water conservation techniques.

8.3 Community impacts – now and in 5 years

The Project has engaged local farmers and community groups in the development of the FMD Sites. The LGUs have formally recognised the importance and value of the project and are providing both in-kind assistance, planting materials, fertiliser and financial support to participating farmers.

Project staff undertook Farm Journal validation and updating on a cropping seasonal basis. The validations were carried out with the Farmer-cooperators and their families to review and check recording of farming activity details and costs for the preceding cropping

periods. The activity had considerable strengthening impact on capability enhancement in farm journal recording and ownership of the cropping-planning process for the farmers and their families. This impact is further noted in 8.3.2, below.

8.3.1 Economic impacts

The preliminary data and analyses have indicated mixed results in terms of economic benefits of "improved practice" farmer co-operators. To date, six farmer co-operators (of which 4 are improved sites) have realised positive gross margins while the remaining six (of which 4 are improved sites) have yet to recover investment and cost of production inputs from a number of crops during the entire period. Given the preliminary nature of the data, however, it is not possible at this stage to make definitive comments about the economic impacts of the improved land management practices. However, the initial results are being used to make adjustments to the ongoing farm plans in terms of cropping mixes for the improved sites.

The procedures that have been implemented for collection of agronomic and economic data and the training that has been provided to co-operators in doing this will provide economic benefits into the future because of the skills that have been learnt by farmers in comparing the economic returns of different cropping and management options.

8.3.2 Social impacts

As part of the cropping planning and marketing initiatives introduced through the project, farmers wives and children are included in training sessions and have contributed to evaluation of market demand for specific crops and also to the planning of cooperative local sales stalls. LGUs have also been active in offering to provide market-stall venues for the farmer cooperatives. Additionally, as a gender and age related impact, farmer's families have been drawn into farm journal and record keeping activities. This has led to whole-family/community ownership and ongoing interest in the Project outcomes.

8.3.3 Environmental impacts

The project is leading to an understanding by farmers of the direct relationship between land practices, soil loss and loss of productivity. Thus, environmental sustainability is clearly linked to farming sustainability, a new concept for many of the farmers. Sustainable practices that have been demonstrated include ploughing-in of cover crop residues, vermicomposting and compost making. These practices are seen by the farmers as achievable means to improve soil fertility and crop yields.

8.4 Communication and dissemination activities

Train-the-trainer and Farmer Field School training for Inabanga and San Isidro farmers. (2008 – 2011)

Activity included trainer-training for BSWM, ICRAF and LGU staff and development of training materials, followed by training of Farmer Trainers. The development included conversion of training materials into the local Visayan dialect.

Farmer Field School - TRAINING MODULE VEGETABLE PRODUCTION

(BSWM/ACIAR/ICRAF/ EAST-WEST COMPANY/DAR)

Field Schools presented:

Sep-Oct 08 (Balilihan)

Feb-Jun 09 (San Isidro)

As a component of the above two FFSs, project staff conducted two Farmer Cross Site Visits to Catigbian and Balilihan, Bohol for the FFS participants, aimed to learn from the practices and advice of experienced 'Good Agricultural Practices' farmers in the municipalities. For the San Isidro group, the visit focussed on pest management, for the Sierra Bullones group the visit focussed on vegetable production.

Jan-Apr 10 (Carmen)

Jun-Nov 10 (Pilar)

Training Modules Presented, included:

Module 1: Off-Season Risks and Opportunities
Module 2: Basic Record Keeping
Module 3: Cultural Management (Field Layout and Bed Preparation)
Module 4: Cultural Management (Seed to Seeding Management)
Module 5: Soil and Water Conservation and Soil Analysis
Module 6: Organic Composting
Module 7: Fertilizer and Irrigation Management
Module 8: Transplanting
Module 9: Trellising, Pruning and Vine Clipping
Module 10: Basic Concept of Pest Management
Module 11: Plant Diseases – Identification and Management
Module 12: Insect Pest – Identification and Management
Module 13: Harvesting and Post - Harvest Handling
Module 14: Introduction to Good Agricultural Practices (GAP)
Module 15: Standardization of Costs of Production

Bohol-Leyte exchange visits (Aug and Oct, 2010) to promote Visayan Regional awareness of the Farmer Field School initiative for the Project improved farming practices and the successful outcomes from adopting the practices.

Bohol to Leyte: 12 farmers and LGU staff from Bohol visited Leyte and Southern, Leyte on August 9-11, 2010, and were shown project sites at VSU, Ormoc, Bontoc, and Maasin.

Leyte to Bohol: 10 Leyte protected vegetable cropping farmers and MAOs from Ormoc and Massin LGUs visited vegetable growing areas in Bohol on Oct. 27 – 30, 2010, and viewed FFS sites and project sites showing the outcomes of soil erosion control practices in Carmen, Sierra Bullones, Pilar and San Isidro. Additional funding was provided by ACIAR for the exchange visits.

Farm evaluation workshop (Nov-Dec,2011) was conducted. The farmer trainers were evaluated, by LGU, MAO and Project staff. The evaluators visited each farm with the Farmer Trainers, questioning the farmers on their soil and water management knowledge, production techniques knowledge and technical skills. Following the evaluation, successful Trainers were formally accredited by the LGU and evaluators.

Publications / Presentations:

Conference Paper: I. C. Genson, 2007. Geographic information system and erosion model applications in watershed management: The Bohol watershed, Philippines. International Conference on Hydrology and Water Resources Management for Hazard Reduction and Sustainable Development(HRSD 2007), Philippine National Committee for the UNESCO International Hydrological Programme (PNC-UNESCO-IHP), 19-23 November, Manila, Philippines.

Conference Paper: H. J. Bavor and I. C. Genson. 2008. Challenges in GIS and erosion model application in watershed management: The Bohol Watershed, Philippines. In Proceedings: Watershed & River Basin Management, Ed. M. Zessner, Budapest, Hungary.

Taylor, R., (2009). Harvestable hedgerows encourage erosion change, Partners Magazine, ACIAR. Mar-Jun 2009. pp12-15.

Margate, D., Mangara, J. and Bavor, H. J. (2010) Soil erosion as an indicator of agricultural sustainability in tropical watersheds. Proc. 19th World Congress of Soil Science, Brisbane, QLD.P0-0144.

Video Productions

Bohol Farmer Field School, 2009.(2010) Farmer Field School, Australian ACIAR-funded project showing achievements in modern crop production techniques at Sierra Bullones, Bohol, Philippines. Producer and Editor - G. Cordero. J & JC Digital Photo/Video & Multimedia Services, Tagbilaran, Bohol, Philippines. Language - Cebuano.

The Next Crop. (2010). Shows the economic, social and financial benefits of Natural Vegetative Strips (NVS) and improved cropping practices on the island of Bohol in the Philippines. Presenter - J. Bavor, Producer - S. Olivier, Editor - D. Blin. Anvil Media Pty. Ltd. Sydney. Language - Cebuano and English.

Protected Vegetable Cropping Leyte, Philippines. (2010). Showcasing low cost protected vegetable cropping in the Visayas, Philippines. Presenter - G. Rogers, Producer - S. Olivier, Editor - D. Blin. Anvil Media Pty. Ltd. Sydney. Language - Cebuano and English.

Farmer Field School Training Videos (2011) produced and provided, along with manual flip-chart versions, to LGUs and Farmer Trainers (Language – Cebuano):

- Natural Vegetated Strip (NVS) and Contour Ploughing Techniques video
- Vermicompost Production video
- Plastic Mulch, Preparation and Application Techniques video
- Plant Seedling Preparation video

9 Conclusions and recommendations

9.1 Conclusions

The Project demonstrated that improvements in the growing of traditional crops such as corn and cassava can improve farm incomes. However, the returns available for farmers can be significantly increased by both improving crop production techniques and soil management practices. The most effective improvements in soil management were the use of natural vegetative strips and contour ploughing, better soil nutrient management, irrigation and appropriate crop establishment.

Inclusion of high-value vegetables such as sweet pepper, eggplant, ampalaya and ginger were effective in raising farmer gross margins. When these crops were added to traditional cropping mixes such as corn or cassava the farmers' gross margin invariably increased. When vegetable crops were grown alone, without the other traditional crops, this again further increased farmer gross margin.

Farmer Field School training was critically important in making the improvements effective. Farmer Field Schools were shown to be highly effective in training farmers, individually, and in enhancing family and LGU understanding of the potential of improved farming practices. The Schools were able to increase skill levels from "backyard" or novice vegetable farmers to skilled farmers within one cropping season through the use of the Field Schools approach. The first two Farmer Field schools were run by East West seeds and, subsequently were organised and run locally by the LGUs and Farmer-Trainers.

Monitoring results from the Project demonstrated that natural vegetative strips are effective at reducing the movement of soil and nutrients down the slope, validating their application in managing sloping, fragile soil profiles. Additionally, incorporation of hedgerow crops such as pineapple, banana or coconut into the vegetative strip can assist in strengthening the NVS and also contribute to gross margins.

There is some movement of soil components, including both clay and humus particles from one side of the alley to the other. The translocation resulted in an accumulation of soil organic matter and major plant nutrients on the lower side of the alley. This accumulation of nutrients can supply the hedgerow crops with the additional nutrients and is a bonus of the system.

9.2 Recommendations

Farmer-led Farmer Field Schools were found to be just as effective as or more effective than the schools run by East-West seeds. This is an important innovation in the farmer field school model because it can lead to a sustainable system. The farmer teachers selected from the East West seeds Farmer Field Schools were effective trainers and were also able to gain accreditation as Farmer teachers, accredited by the local LGUs. Farmers accredited in this way are able to qualify for subsidy payments from the LGUs to provide training to new adopters and this helps with the financial stability of the system. Also, accreditation allows a rational and sustainable mechanism for financially compensating farmers for providing training. In the long-term, perhaps some of the funds should come from the farmers who are receiving the training. This would require a change in mindset but nevertheless is an important goal. Further introduction and

assistance in developing micro-financing practices through the Regional LGUs is recommended.

The video *The Next Crop* was launched at the Project Review in November 2010 and copies of the DVD were distributed to farmers, LGU staff, BSWM staff and the Visayas State University. The video is also available on YouTube where to date there have been 515 views of this video. There is a need to produce more copies of this video and distribute it more widely to LGUs and other organisations in the Visayas, to be used as a valuable promotion and communications tool.

Sustainability strategy: Consideration should be given to improving the sustainability of improvements that have been made as a result of this project. These could involve further engagement of local government organisations such as LGUs, Department of Agriculture, Department of Agrarian Reform, the Department of Environment and Natural Resources and, of course, the private sector.

Financial feedback to farmers: The financial information collected and analysed as part of this project has been discussed with the participants over the term of the study. The financial overview in this report should be presented back to the farmers and other staff who participated in this project.

A program for “Empowering Subsistence Farmers in the Visayan Region: Farmer Field School Techniques” should be considered to build upon the successes of the Farmer-Trainer initiatives used in this Project. With appropriate guidance, the established core group of LGUs, MAOs and Farmer-Trainers represent a significant building block for the Regional adoption of techniques for improved land management, cropping system planning and marketing capability.

10 References

10.1 List of publications produced by project

Genson, I. C.. (2007). Geographic information system and erosion model applications in watershed management: The Bohol watershed, Philippines. International Conference on Hydrology and Water Resources Management for Hazard Reduction and Sustainable Development(HRSD 2007), Philippine National Committee for UNESCO International Hydrological Programme (PNC-UNESCO-IHP), 19-23 November, Manila, Philippines.

Bavor, H. J. and Genson, I. C.. (2008). Challenges in GIS and erosion model application in watershed management: The Bohol Watershed, Philippines. In Proceedings: Watershed & River Basin Management, Ed. M. Zessner, Budapest, Hungary.

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