FRUIT PRODUCTION AND THE MANAGEMENT OF SLOPELANDS IN THE PHILIPPINES

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ABSTRACT

The effective management of slopeland combines soil conservation measures and food production. High-value foodcrops such as fruit trees have become an integral feature in sustainable upland farming. Several soil conservation measures have been developed over long years of farming, some of which have been modified through research. Various efforts have been made to promote conservation farming in slopelands using different approaches.

INTRODUCTION

Fruit production is a profitable enterprise and a promising way of raising the incomes of slopeland farmers. Existing food production and environment conservation programs in the Philippines tend to integrate fruit trees into the existing cropping system. The rapid conversion of lowland arable areas to various industrial uses will eventually push agricultural production, including fruit crops, into the uplands, where soil erosion is a major problem.

EXTENT AND EFFECT OF SOIL EROSION

More than half of the Philippines' total land area of 30 million hectares has slopes steeper than 18%. Furthermore, 63% of the total land area is classified as too steep and eroded, too dry, or with soils that are too shallow, for cultivation.

Out of the total of 8 million hectares of arable land in the Philippines, 58% is eroded to some degree. Reports indicate that 41% of farming activity is carried out on steep hilly land. At present, an estimated 4 million hectares are under cultivation, with grain crops, mainly corn, planted on 2.3 million hectares of slopeland with a gradient of more than 30% (Maglinao 1996, Concepcion 1995, Paningbatan 1992).

The productivity of slopelands in the Philippines is declining alarmingly, due to increased population pressure and soil erosion (Pava *et al.* 1993, Paningbatan 1992, Calanog and Calderon 1990). Soil erosion results in the loss of soil nutrients, causing low fertility, flooding and environmental degradation. The rate of soil erosion on slopelands can be high, with annual soil losses ranging from 23 - 218 mt/ha from bare plots on gradients of 27-29%, to 36-200 mt/ha on plots cultivated up and down the slope (Paningbatan 1993 and Sajise 1983).

FRUIT PRODUCTION

From 1991 to 1995, the average area planted in fruit in the Philippines was 810,000 ha, representing 6.4% of the total land devoted to agricultural crops (AGRICOM and APRAAP 1996). Banana occupied the largest area with 320,900 ha, followed by pineapple (64,780 ha), mango (60,180 ha), and citrus (29,300 ha), the rest being planted in other fruits. The area planted in mango trees increased the most rapidly, with an average annual growth rate of 6.13%. The area planted in fruit crops is expected to increase dramatically over the next five years in response to various government programs designed to increase food production and raise farm incomes. Already, fruit production areas have expanded from flat or rolling land onto hilly and marginal slopelands.

Keywords: Agroforestry, alley cropping, conservation farming, fruit, orchards, slopeland, uplands

Table 1. Socio-demographic characteristics of Philippine upland farmers

Indicator	Characteristics
• Sex	Mostly male
• Age	30 to 70 years old
• Status	Married
• Educational attainment	Completed either elementary or secondary schooling
• Number of children	3 to 9 per household
• Farming experience	10 to 50 years
• Tenure status	Land owners/claimants (Visayas) Tenants (Luzon)
• Farm size	1 to 5 ha (Mindanao) 0.5 to 1 ha (Luzon)
• Net farm income per year	$20-40 (Luzon) $20-400 (Mindanao)
• Others	Holders of Certificate of Stewardship Contracts

Source: Floresca 1995, Baggayan 1994, Balmocena 1994, Pava *et al.* 1993, and Calanog and Calderon 1990

While there are large commercial orchards of mango, citrus, durian (*Durio Zibethinus* Murray), lanzones* (*Lansium domesticum* Correa), pili* (*Canarium ovatum* Engl.), and rambutan* (*Nephelium lappaceum* L.), the majority of fruit trees in the Philippines are raised in backyards or grown in small clusters. Unlike the monocropping practiced in orchards, backyard fruit production combines the growing of fruit trees with other crops, along with the raising of poultry or livestock and small-scale fish farming. Most commercial orchards are owned or managed by people with a good education and sufficient financial resources, and are located on flat to gently rolling land. It is the smallholder fruit production that is found on steeper gradients.

There are thirteen provinces in the Philippines where more than half of the total land area is severely eroded and degraded (Paningbatan 1992). This is a grave concern because a sizable area of fruit production is found in seven of these provinces.

Characteristics of Upland Agriculture

The term 'upland', as defined by the Philippine government, includes marginal land with a slope of 18% or more; lands within identified mountain zones, including tableland and high plateaux; and lands with terrain classified as hilly to mountainous.

Generally, upland farming systems are based on production for subsistence, and include extensive shifting cultivation, intensive shifting cultivation, permanent cultivation, home gardens, grazing, and any combination of these. Over time, there has been a tendency towards intensification of land use and permanent upland cultivation. Most farms are not accessible by road, lying at least one kilometer away from the "barangay" road (which links villages). The major crops grown are coffee, cacao, corn, banana, upland rice, root crops, abaca, fruit trees, and coconut (Balmocena 1994, Baggayan Jr. 1994, Pava *et al.* 1993, Garrity *et al.* 1992 and Kummer 1992).

Various surveys (Floresca 1995, Balmocena 1994, Pava *et al.* 1993 and Calanog and Calderon 1990) have been conducted to characterize upland farmers (Table 1).

SOME FRUIT TREE PRODUCTION, AND SOIL AND WATER CONSERVATION PROGRAMS

High-value fruit trees are the banner commodities of the key Commercial Crop Development Program (KCCDP) of the Department of Agriculture. This program supports the production of a wide range of fruit trees, including mango, durian,

* Lanzones : Belongs to same species (*Lansium domesticum*) as duku and langsat. Trees bear clusters of fruit with sweet-sour translucent flesh, leathery skin.
Pili : Purple-black fruit which contains edible nut.
Rambutan : Fruit are borne in clusters. They are red when ripe, and covered with soft spines.

citrus, lanzones, pili, Guayabano (*Annona muricata* L.), jackfruit (*Artocarpus heterophyllus Lamk*), guava (*Psidium guajava* L.), mangosteen (*Garcinia mangostana* L.), and cashew (*Anacardium occidentale* L.). The S&T Agenda for National Development (STAND) of the Department of Science and Technology (DOST) has identified five priority fruit crops i.e., banana, pineapple, papaya, mango, and durian. These are supported by a number of national research and development programs.

Past experience in programs to reverse land degradation and deforestration has taught the importance of tying these projects to food production for them to be sustainable. Thus, upland development projects for soil and water conservation always include fruit trees and other food crops.

SOME CONSERVATION TECHNOLOGIES FOR SLOPELANDS

Conservation Practices of Upland Farmers

Surveys have shown that some conservation measures are already practiced by upland farmers (Concepcion 1995, Floresca 1995, Baggayan 1994, Balmocena 1994 and Villanueva et al. 1993 and PCARRD 1990). Knowledge of these has been passed on to them by their parents and elders. Some of the technologies are traditional, fine-tuned by many years of experience, while others have been generated by research. The main practices are fallowing, construction of terraces, mulching, contour plowing, and contour farming using hedgerows and rockwalls (Table 2).

Indigenous Conservation Technology

Indigenous technologies developed over long years of farming include the Ifugao Rice Terraces, Palawan's home garden agroforestry program, and the Naalad System in Cebu (Concepcion 1995 and Kung'u 1997).

In Palawan, swidden farms are established near farmers' homes. Farms are planted in a variety of tree and food crops such as mango, jackfruit, coconut, banana and medicinal herbs.

In the Naalad System, basically a fallow system, plantations of leucaena (ipil-ipil, *Leucaena leucocephala*) are planted closely in strips. Cut leucaena trees and branches are piled along the contours, forming a fascine-like structure called a "balabag" or "bagbag". The dead branches (instead of live hedgerows as in alleycropping) decay easily and need little maintenance. At least two parcels of land are needed for each farmer, since the fallow and cultivation period each last for five to six years.

Sloping Agricultural Land Technology (*SALT*)

The SALT technology has already been described in detail in a previous FFTC Bulletin (Extension Bulletin No. 400, *The Development of Sloping Agricultural and Technology (SALT) in the Philippines)*. Developed in 1971 at the Mindanao Baptist Rural Life Center (MBRLC), Southern Philippines, SALT is a simple and effective way of farming hillylands without losing the topsoil. Briefly, the four SALT models are:

- SALT 1: Alleycropping using leguminous tree or shrub species planted closely in a belt along contour lines. Annual and perennial crops are planted between the rows. These are a mixture of food and cash crops.
- SALT 2: Known as "simple agro-livestock technology", this recommends a land use of 40% for agriculture, 20% for forestry, and 40% for livestock, particularly goats. The cropping mix includes forage crops as well as cash and food crops.
- SALT 3: Known as "sustainable agroforest land technology", this promotes food-wood intercropping where forest trees are planted in slopes of more than 50%. Tree species are a mixture of fruit and timber crops.
- SALT 4: This is "small aØrofruit livelihood technology", and recommends the planting of fruit trees on the upper two-thirds portion of a SALT farm.

Essentially, the SALT Package consists of:

- Laying out the contour lines along slopes, using an A-frame;
- Plowing and harrowing along the marked contours in lines 1m apart, then laying 2 furrows 0.5 apart;
- Planting leguminous shrub or tree species as hedgerows in the furrows;
- Planting annual and perennial crops in the alleys between the hedgerows;
- Trimming the hedgerows to provide green mulch from the clippings;
- Rotation of annual crops;

Table 2. Soil and water conservation practices in the Philippines

Type	Practice
Vegetative measures	Fascines Wattling Brushwood (bench) Hedgerows Sodding Mulching Cluster planting Windbreaks/shelterbelts/boundary planting
Mechanical/Structural measures	Checkdams (Brushwood, Rock, Pole, Bagion) Terracing Riprapping Contour levee Contour ditches Contour rockwalling Bangkal (log laying) Grassed waterways Stream channeling
Tillage practices	Zero Minimum Sub-soiling Stubble-mulching Fallow
Crop rotation/patterns Engineering measures Gen-gen (Trenching plus sweet potato) Checkdam with Tree Planting	

Source: PCARRD 1990

- Building of green terraces.

Alleycropping

As the SALT program gained momentum, hedgerows or alleycropping became popular. Alleycropping is a system whereby hedgerows of trees, shrubs or grasses are established across slopes, along the contour lines. Agricultural crops are grown in the alleys. Field trials of intercropped woody species, fruit trees or cash perennials, and pasture grasses showed that this system can provide increasing and sustained productivity (PCARRD 1996).

Several alleycropping systems were evaluated, in terms of their ability to improve soil productivity. In Bukidnon, a fruit production area for mango and citrus in the Southern Philippines, contour hedgerows using giant leucaena were found to be most appropriate for soil conservation (Table 3). They minimized surface runoff and sedimentation (Manubag 1991). A combination of acacia (*Acacia auriculiformis*) and mango in Ilocos Norte, a province in the Northern Philippines, also gave promising results. Soil carbon content increased by 26% after ten years of the system, while organic nitrogen followed a similar trend (Malab 1993). However, contour strip planting could not be followed on land with a gradient of more than 25%, or in fields with irregular topography (Cambel and Descuatan 1991).

Experience from several programs in the Philippines carried out in cooperation with the International Board for Soil Research and Management (IBSRAM) has shown the beneficial effects of alley cropping.

Soil Loss Reduction

Soil loss in runoff became negligible three years after hedgerows were established in Batangas, Southern Luzon. Meanwhile, the farmers' practice of plowing up-and-down the slope caused soil losses amounting to 425 mt/ha over seven years (Table 4). Similar trends were observed in several other sites in different parts of the Philippines (Maglinao *et al.* 1996, PCARRD 1996).

Reduction of Nutrient Losses and Depletion of Soil Organic Matter

After four and a half years of cropping following farmers' practices, about 6 mt of soil organic matter, 296 kg N and 266 kg K per hectare had been lost. Negligible amounts had been lost from fields using alleycropping. The recycling of 9.8 mt/ha of dry crop stover and hedgegrow trimmings returned about 200 kg N, 20 kg P, and 180 kg K to the soil (Table 5). It also increased soil organic matter by 0.5 - 1% after five years of cropping (PCARRD 1996).

Terrace Formation

Landsteps were formed by the establishment of hedgerows after two years of cultivation and cropping. These bench terraces resulted from the mass movement of runoff sediments within the alley-way which accumulated in the hedgerows during cultivation and erosion. Five years later, however, no drastic changes in the terraces were seen. This means that the formation of terraces occurs rapidly in the earlier years of establishment of hedgerows, and then gradually slow down (Maglinao *et al.* 1996).

Increased Crop Yields and Returns

Corn yields using farmers' practice were consistently lower, while peanut yields were comparable to yields obtained from the alley cropping system. However, the yields of both crops followed a downward trend over time. The falling corn yield could have been due to the shading effect of the hedgerows of banana and chico (*Manilkara zapota* (L.) P. van Royen). The decrease in peanut yields was attributed to the apparent incompatibility of grain legumes with tree-legume hedgerows (Maglinao *et al.* 1996). Using discounted rates, banana + chico as hedgerows seemed to be the most profitable farm management system (de Guzman 1996).

TECHNOLOGY ADOPTION

SALT

The practice of SALT spread to different provinces in the Philippines, with modifications to suit local conditions (Cumpio 1995, Cambel and Descuatan 1991 and PCARRD 1986). In Isabela, Northern Luzon, SALT 2 was easily duplicated but farmers found that it was labor-intensive and needed water during the summer (dry season) months for forage crops (Reyes and Lasuden 1993). SALT has also been adopted in a number of social forestry programs, and slopeland SALT demonstration farms have been established in selected agricultural schools and universities. To hasten technology adoption, MBRLC conducts training and extension programs, and also produces simple manuals. The model farm in Davao del Sur accepts local and international visitors, representing various interest groups such as farmers, tribal groups, foresters, agriculturists, and school teachers.

The Philippine Congress is now being asked

Table 3. Data on different conservation measures, Philippines

Conservation measure	Surface runoff m^3/ha	Sedimentation kg/ha	Establishment cost (US$/ha/yr)	Maintenance cost (US$/ha/yr)
Bench terrace	12.59	188.00	1,411.72	141.16
Contour canal	23.15	601.33	352.92	282.32
Contour hedgerow	30.48	919.22	181.72	141.2
Contour levee	32.07	1,205.83	282.32	
Wattling structure	43.58	2,647.13	494.08	494.08
Fascine	45.04	2,127.53	847.04	847.04

Source: Manubag 1991
1US$ = 25 Philippine pesos

Table 4. Annual rainfall and soil loss in Mabini, Batangas, Southern Luzon, 1989-1995

Year	Rainfall (mm)	Soil loss (mt/ha)			
		T1	T2	T3	T4
1989*	453	20	24	14	17
1990	1093	97	2	1	2
1991	1932	18	0.2	0.1	0.1
1992	1413	41	0	0	0
1993	1861	124	0	0	0
1994	1327	61	0	0	0
1995	648	30	0	0	0
1996	995	34	0	0	0
Total		425	26.2	15.1	19.1

*September to December 1989
Source: Maglinao *et al.* 1996

T1 - Farmers' practice (plowing up and down the slope)
T2 - Alley crops: Corn-peanut; hedgerows: *Gliricidia* + Napier grass (low-input technology)
T3 - Alley crops: Corn-peanut; hedgerows: Gliricidia + Napier grass (high-input technology)
T4 - Alley crops: Corn-peanut; hedgerows: banana + sapodilla* (high-input technology)

* *Achras sapota*: Evergreen tree native to tropical America, with sweet, brown fruit (Ed.).

Table 5. Total dry matter weight and nutrient content of crop residues recycled back into the alleyway

Method used	Dry matter weight (kg/ha)	Nutrient content N (kg)	P (kg)	K (kg)
Farmers' practice	3077	61	8	55
Alley cropping	9829	212	20	179

Source: Paningbatan *et al.* 1994

to fund the SALT farming program on a national basis. The bill being considered by Congress advocates the adoption of SALT on all public and private lands, including ancestral lands devoted to agriculture, with a slope of at least 5%, regardless of the agricultural products being produced there.

Manresa Integrated Diversified and Sustainable Farm (MIDAS)

This 1.7 ha demonstration farm in Manresa, Cagayan de Oro, Mindanao, features profitable small-scale technologies for slopeland areas. It produces fruit, vegetables, rice, corn, pigs, goats, chickens, ducks, fuelwood, feed and fish. It also promotes organic farming, integrated pest management, and renewable energy utilization. The farm was established in 1989 by the Xavier University Appropriate Technology Center (Polestico 1995).

Mindanao Upland Stabilization and Utilization Through Proper Agroforestry Networking (MUSUAN)

The Central Mindanao University, with support from the FORD Foundation, implemented the project MUSUAN at Bukidnon from 1989 to 1993. The four project sites have slopes ranging from 10 - 55%. MUSUAN is an integrated social forestry program which uses a participatory, community-level approach. Farmers' cooperatives serve as a conduit for technology transfer, marketing, and the delivery of inputs. Farmers were trained in soil conservation measures and agroforestry, particularly SALT 2. They themselves decided which were the best combinations of crops and livestock, and also decided which of their own indigenous practices to incorporate. However, when the program was implemented, the livestock component did not expand successfully because it required more capital to purchase the animals than the farmers had. Instead, fruit trees and *Gmelinas* were planted along contours, with rockwalls to retain soil and water, and using wild sunflower as hedgerow plants.

The technology was promoted by means of meetings, farm visits, training workshops, and dissemination of information through newsletters and radio broadcasts. Leading farmers became trainers. To enhance their skills, they were also given seminars on organization management, capability building and leadership. A total area of 190.3 ha belonging to 186 farmers was laid out under this program. The National Power Corporation also hired farmer-trainers to teach farmers in nearby villages to plant trees along land adjoining the Pulangi river.

PCARRD-IBSRAM Project on "Management and Rehabilitation of Degraded Hillylands"

This on-farm research project began in 1995, aimed at extending alleycropping technology to a wider group of farmers. The new project site in Ma. Paz, Batangas, is a slopeland area with gradients ranging from slightly rolling to steep. Fruit crops planted in these areas include banana, mango, jackfruit, papaya, custard apple (*Annona cherimola* L.), avocado (*Persea americana* Miller), and kamias* (*Averrhoa bilimbi* L.).

Farmers decided to change the crop used for hedgerows, from *Gliricidia* to pigeon pea. Plant density and spacing of annual crops were later adjusted following a positive response from farmers who applied the recommended spacing.

Exchange of experiences among farmers, researchers, and extension workers is facilitated through training courses, field visits, meetings, and promotional activities such as the publication of information materials and participation in fairs as well as radio and TV programs. Inquiries regarding the technology have been received from farmers seeking to establish alleycropping in other parts of the Philippines.

Although conservation technology is available, the rate of adoption remains low outside the context of development projects. Many farmers revert to their earlier practices once the project has been terminated and there is no more outside support. Factors leading to this low rate of adoption include the inappropriate nature of some recommended technologies, marketing difficulties, and institutional constraints. Farmers' perception of the soil erosion problem influences the extent to which conservation technology is adopted. Whether farmers adopt conservation technology also depends on family income, liquidity of assets, debt-asset ratio, farm size, land tenure, the age of the farmers, farming experience, land productivity, and gradient of the slopeland. High-input technology is unlikely to gain wide acceptance because it is beyond the scope of the small farmer who needs credit, marketing assistance, and delivery of inputs to his farm (Maglinao *et al.* 1996, Maligalig 1993 and Villanueva *et al.* 1992).

SUMMARY AND RECOMMENDATIONS

The management of slopelands is an important concern in the Philippines, both to sustain food production growth and to arrest degradation of the environment. Perennial fruit trees are an integral component in the sustainable management of hillylands, and play a significant role in reducing soil loss and increasing farmers' incomes. With proper assistance, fruit production can provide a viable way of satisfying the twin goals of conserving the environment and improving the quality of life of upland farmers.

The adoption of conservation practices is affected by a number of technical, socioeconomic, policy, and institutional constraints, which must be properly understood and adequately addressed. Benchmark information on orchard management on lands with gradient over 5% must also be generated.

* Kamias : Same genus as the star-fruit or carambola, *Averrhoa carambola*. (Ed.).
Santol : (*Sandoricum koetjape*). Fruit with thick, velvety skin, either red or yellow when ripe. Flesh is translucent and aromatic, with a sweet-sour taste.

REFERENCES

Baggayan, R.L.; J.L. Baggayan and R.L. Lanuza. 1994. Documentation and assessment of agroforestry farms and farm practices in Central Visayas. In: *Highlights '94.* Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Los Baños, Laguna. 190 pp.

Balmocena, B.J. 1994. Socio-economic and bio-physical characterization of upland farms in Region XI. In: *Highlights '94.* PCARRD, Los Baños, Laguna. 190 pp.

Cambel, T.L. and W.A. Descuatan Jr.. 1991. Soil conservation practices in hilly areas for cassava production. In: *Highlights '90.* PCARRD, Los Baños, Laguna. 167 pp.

Calanog, L. and Calderon. 1990. The Philippine upland communities: socio-demographic update. In: *Highlights '95.* PCARRD, Los Baños, Laguna. 167 pp.

Concepcion, R.N. 1995. Policies concerning conservation farming in the Philippines: a national viewpoint. In: *Proceedings of the International Workshop on Conservation Farming for Sloping Uplands in Southeast Asia: Challenges, Opportunities, and Prospects*, Manila, 20-26 November 1994. IBSRAM, Bangkok, Thailand - (IBSRAM Proceedings No. 14).

Congressional Commission on Agricultural Modernization (AGRICOM) and Agricultural Policy Research and Advocacy Assistance Program (APRAAP). 1996. Commercial crops subsector: Fruits, vegetables and ornamentals. Philippines. (Unpublished mimeograph).

Cumpio, J. 1994. Economics of goat production in SALT-2, Agno, Pansasinan. In: *Highlights '95.* PCARRD, Los Baños, Laguna. 192 pp.

de Guzman, T.L. 1996. Economic assessment of soil-conservation practices: case study from the Philippines. In: *The Management of Sloping Lands in Asia (IBSRAM/ASIALAND).* Network Document No. 20. IBSRAM, Bangkok, Thailand. (Unpublished mimeograph).

Floresca, O.E. 1995. Communication Network of Farmers in the Sloping Lands of Barangay ïaria Paz, Tanauan, Batangas and their Adoption Behavior toward Soil Conservation. Unpub. M.Sc. Thesis. University of the Philippines at Los Baños, College, Laguna, Philippines.

Garcia, J.N.M., R.V. Gerrits, R.A. Cramb, G.C. Saguiguit Jr., J.J. Conchada, R.T. Yao, R.G. Bernardo and A.S. Perez. 1995. Soil conservation in an upland farming system in Davao de Sur: a socio-economic survey. SEARCA, Los Banños, Laguna - (SEARCA-UQ Uplands Research Project, Survey Report No. 2). (Unpublished mimeograph).

Garrity, D.P., D.M. Kummer and E.S. Guiang. 1992. *The Upland Ecosystem in the Philippines: Approaches to Sustainable Farming and Forestry.* International Rice Research Institute, Manila, Philippines.

House Bill No. 9820. 1997. An act establishing the sloping agricultural land technology farming program and appropriating funds therefor. House of Representatives, Quezon City, Metro Manila.

Kummer, D.M. 1992. Upland agriculture, the land frontier and forest decline in the Philippines. *Agroforestry Systems* 18: 31-46.

Kung'u, J.B. 1997. Biomass production and some soil properties under a *Leucaena leucocephala* fallow system in Cebu, Philippines. In: *Developments in Agroforestry Research.* PCARRD, Los Baños, Laguna. (Book Series No. 160/1997).

Laquihon, W.A., H.R. Watson and G.A. Laquihon Jr. 1995. Soil conservation-based upland farming system with high value crops: The case of sustainable agroforest land technology (SALT-3). Paper presented at the Fourth Central Mindanao Techno-commercialization Fora and Training-Workshop on High Value Crops, University of Southern Mindanao, Kabacan, North Cotabato; 6-8 July 1995. (Unpublished mimeograph).

Maglinao, A.R., G.M. Huelgas, P.P. Evangelista and T.Q. Correa Jr. 1996. Management and rehabilitation of degraded hillylands in the Philippines (Phase III). Paper presented at the Eighth Annual Meeting of the IBSRAM-ASIALAND Network on the Management of Sloping Lands. Vientiane, Lao, PDR; 23-27 September 1996. (Unpublished mimeograph).

Maglinao, A.R., G.M. Huelgas, P.P. Evangelista and T.Q. Correa Jr. 1996.

Management of sloping lands for sustainable agriculture in the Philippines. In: The Management of Sloping Lands in Asia (IBSRAM/ASIALAND). Network Document No. 20. IBSRAM, Bangkok, Thailand. (Unpublished mimeograph).

Manubag, J. 1991. Evaluation of different soil and water conservation structures in Bukidnon. In: *Highlights '91*. PCARRD, Los Baños, Laguna. 159 pp.

MBRLC Eitorial Staff. 1997. *Small Agrofruit Livelihood Technology (SALT 4): A Guide on how to Integrate Fruit Trees into the SALT System*. Mindanao Baptist Rural Life Center, Kinuskusan, Bansalan, Davao del Sur, Philippines. (How-to-series No. 8).

Paningbatan, E.P. 1993. Management of soil erosion for sloping uplands in the Philippines. Paper presented at the Third International Forum on Soil Taxonomy and Sustainable Land Management. Diliman, Quezon City, Philippines; 17-28 May 1993. (Unpublished mimeograph).

Paningbatan, E.P., A.R. Maglinao, C.B. Alcalde, G.M. Huelgas, E. Roderos, G. Penaranda, D. Cortiguerra. 1994. Management and Rehabilitation of degraded hillylands, Phase II. Terminal Report - (UPLB-DAIV-RSC-BSWM-BPI-PCARRD Project). (Unpublished mimeograph).

Paningbatan, E.P., A.R. Maglinao and R.B. Alamban. 1996. Alley cropping system in sloping lands. *Technology!* 18,2 (PCARRD, Los Baños, Laguna, Philippines).

Paningbatan, E.P., A.R. Maglinao, L.A. Calanog and G.M. Huelgas. 1992. Management of sloping lands for sustainable agriculture in the Philippines. In: Technical Report on the Management of Sloping Lands for Sustainable Agriculture in Asia, Phase 1, 1988-1991 (IBSRAM/ ASIALAND). Network Document No. 2. IBSRAM, Bangkok, Thailand. (Unpublished mimeograph).

Pava, H.M., J.B. Arances, J.M. Magallanes, I.O. Mugot, I.S. Sealza, J.M. Manubag and L.A. Chua. 1993. Mindanao upland stabilization and utilization through proper agroforestry networking program (MUSUAN), Phase III. Terminal Report - (CMU-FORD Foundation Project). (Unpublished mimeograph).

Philippine Council for Agriculture, Forestry and Natural Resources Research and Development. 1990. Soil and Water Conservation Measures and Agroforestry: *Proceedings of the Workshop on Soil and Water Conservation Measures and Agroforestry*. Los Baños, Laguna, 9-16 July 1989. PCARRD Book Series No. 103.

Polestico, M. 1995. Manresa integrated diversified and sustainable farm. In: *Highlights '95*. PCARRD, Los Baños, Laguna. 192 pp.

Reyes, T.C. and H. Lasuden. 1993. Evaluation of different soil and water conservation structures in Isabela with peanut under cultivation. In: *Highlights '93*. PCARRD, Los Baños, Laguna. 168 pp.

Sajise, P.E. 1983. Effects of Intercropping and Tillage Practices on Crop Productivity and Soil Conservation Unpub. M.Sc. Thesis, UPLB, College, Laguna, Philippines.

Serrano, R.C. 1986. Sloping agricultural land technology. *Technology!* 8,5 PCARRD, Los Baños, Laguna, Philippines.

Villanueva, C.D., L.S. Parilla and S.B. Gisulga. 1992. Socioeconomic constraints to the adoption of cropping methods for soil conservation by upland farmers in Leyte, Philippines. In: *Highlights '93*. PCARRD, Los Baños, Laguna. 168p.

DISCUSSION

One participant was interested in Dr. Escaño's comment that the small size of land holdings is a major constraint to the adoption of conservation technology. He asked whether it might be possible to amalgamate the land holdings of a community, and use that as the basic resource. Dr. Escano agreed that the community has to be the basic unit. It needs to be provided with basic services, and organized into an agricultural cooperative of some kind. He pointed out that most people in upland areas are economically depressed and in great need of help. Unless the government provides roads and other infrastructure, and helps establish small enterprises, the outlook is not promising. He emphasized that the main problem in slopeland development is almost always marketing, because of the poor transport network and the distance from markets.

A participant pointed out that provided enough water is available, rice is nearly always the first choice of slopeland farmers in Asia. Dr. Escano was also asked if there is a strategy on how to modify the SALT technology according to local needs. He answered that the choice of crops differs according to the location. Given that rice is the major crop, it is always the first choice on terraces. Soils of rice terraces must retain their moisture for the terraces to be stable: if the soils dry out, the terraces may collapse. Farmers on rice terraces have their own traditional technology, and generally government agencies have no wish to interfere. Such farmers do not even want to adopt new varieties, since their own native varieties have other characteristics not found in improved varieties. For example, they may be suitable for processing into traditional foods.