Forage Options for Fish and Pigs in Vietnam

Vu Thi Hai Yen[1] and Le Hoa Binh[2]

THE provinces of the northern midlands and mountains of Vietnam are generally considered to be the poorest areas in the country. The intermontane valleys of the north are intensively cultivated and heavily populated but the surrounding hills and mountains are mostly infertile and used for forestry and upland crops such as maize and cassava. Farmers in these areas have diverse agricultural systems, often comprising a mix of lowland and upland crops. Most farmers also keep a wide range of animals such as chickens, pigs, ducks, fish, buffalo and cattle to supplement their diets and incomes.

In 1997, the Forages for Smallholders Project was asked to work in the midlands of Tuyen Quang province (Figure 1) to start developing forage options with farmers to feed their buffalo and, to a smaller extent, other ruminants. The farmers had limited land areas for planting forages but were interested to test small areas for supplementing their animals when penned, especially in the dry season.

Discovering New Uses for Forages — Feeding Fish

By 1998, 53 farmers were testing forages in small plots but were also discovering new ways of using the forages. From 30–80% of farmers in the northern lowlands and intermontane valleys raise carp (grass carp, common carp and mud carp) in small ponds — fish that feed on plants (Figure 2). Some of these farmers, working with the FSP, discovered that several varieties of forage grasses appeared to be excellent fish feed. This proved to be an exciting discovery for them. As one explained: 'If we do not provide feed for our buffalo, they can still find feed somewhere, but if we do not feed our fish, they die!'

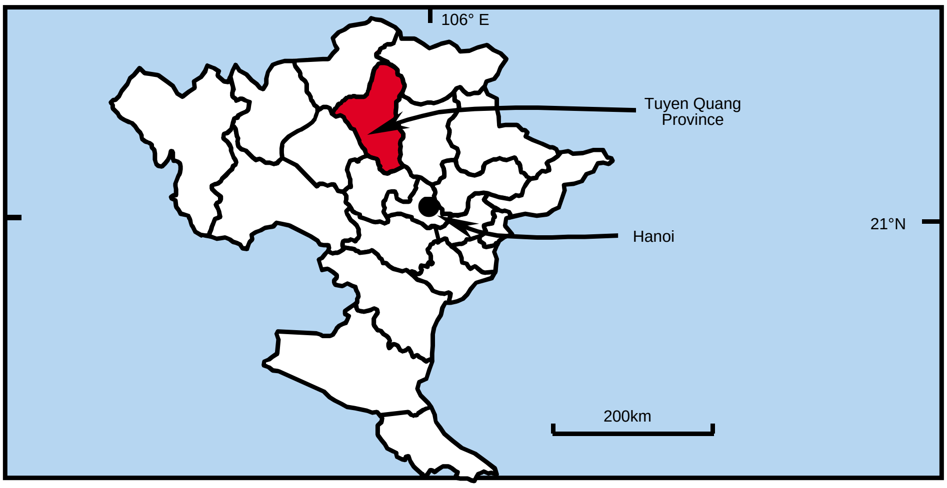

Figure 1. Location of Tuyen Quang.

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In the project area (Ham Yen district), fish ponds are commonly 600–900 m^2. To feed the fish in a pond of 800 m^2, a farmer would typically cut about 30–40 kg of plant material each day, consisting mainly of native grasses (such as *Eleusine indica.*, *Echinochloa* spp. and *Hymenachne* spp.), banana (leaves and stems), cassava (leaves and roots), fresh rice straw and maize leaves (after harvest). A well managed and fed pond of this size could yield the equivalent of 4 tons of fish per hectare per year, bringing the farmer 3–4 million Dong (US$250–300) per year which is equivalent to the income of two high-yielding rice crops from 2500 m^2 of irrigated paddy.

Traditional feed resources for fish are becoming increasingly scarce, so many of the farmers working with the FSP have started to expand their forages. They generally prefer the grasses *Panicum maximum* 'Simuang', *Paspalum atratum* 'Terenos' and *Setaria sphacelata* 'Solander', because they are high-yielding, easy to cut, persistent, and stay green into the cool dry season. Another important characteristic of good fish feed is that grasses need to have smooth, soft leaves and float on the surface of the water where the carp feed.

By July 1999, the project was working with 173 farmers. Most of these were planting between 400–1000 m^2 of forages around their ponds or near their houses. Rapid expansion of forage systems to new farmers (largely by vegetative propagation) is expected to continue because of intense local demand.

Discovering New Uses for Forages — Feeding Pigs

It is also common for smallholder farmers in Ham Yen to keep 1–3 sows, selling up to 10 pigs a year. The normal practice is to cut green feed for the pigs once or twice a day (including leaves of peanut, sweet potato banana and cassava). Many of the green feeds need to be chopped or cooked to make them palatable to the pigs and are not always available. A growing number of farmers are expanding their areas of *Stylosanthes guianensis* 'Stylo 184' as a pig feed, mainly because it is highly palatable, nutritious, persistent and productive.

Returning to Traditional Uses for Forages — Feeding Buffalo

In 1998, the provincial agriculture department banned the free grazing of livestock in order to reduce damage to crops. This has stimulated many farmers to reconsider planting forages suitable for buffalo, including *Brachiaria brizantha* 'Marandu', which farmers had earlier evaluated and rejected only because they could not use it to feed their pigs and fish.

Two Important Lessons…

1. **Developing forage 'solutions' has been a process, not a 'once off' transfer of technology** Initially, farmers evaluated forages for buffalo but very quickly developed different forage systems to solve more-important needs: the feeding of fish and pigs. As farmers gained experience with growing and using forages, they found new uses for them. Some farmers are now integrating forages into their farming system to control soil erosion (e.g. hedgerows) and improve soil fertility through the introduction of legumes. In 1999, other farmers diversified into either breeding or fattening local catttle and are planting *P. maximum* and other grasses and shrub legumes (e.g.

Figure 2. Floating grass for fish in Tuyen Quang, Vietnam (Cartoon – Dave Daniel)

Gliricidia sepium), along field edges for this purpose. The lesson we learned is that it is often impossible to predict the directions that on-farm technology development will take. Therefore, it is necessary to offer a broad range of technology options to farmers at the beginning, actively involve farmers in the development process and remain flexible in the way we respond to the innovations they develop.

2. A common major benefit of forages for farmers has been labour savings

Researchers tend to think of the benefits of forage in terms of improved productivity of animals and improved natural resource management. Farmers frequently have other equally important objectives. In Tuyen Quang, they have commented on the labour saving benefits of planting forages, not just the better feed supply.

Forage Options for Smallholders raising Sheep or Goats in Indonesia

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SHEEP and goats are managed differently from cattle and buffalo. In many areas, smallholder farmers keep small ruminants in barns for most of the time and only take them out for short periods for grazing. Most of the feed for small ruminants is cut-and-carry forage, and farmers have to spend considerable time gathering sufficient feed.

Although much of the feed consists of grasses and herbs (as for cattle), sheep and goats eat feeds such as tree leaves that are not always accepted by cattle. An example is the leaves of *Gliricidia sepium* which are always palatable to sheep and goats whereas cattle sometimes need to be trained to eat foliage of this species (Figure 1).

The Forages for Smallholders Project (FSP) has been working with smallholder farmers who raise sheep and goats in several locations in Southeast Asia. Two Indonesian sites are featured in this paper. These are Marenu (sheep) in North Sumatra and Makroman (goats) in East Kalimantan, Indonesia (Figure 2).

Site Descriptions

Both areas are in the humid tropics with only a short dry season in most years (Table 1). Soil fertility is poor and farmers are more dependent on income from livestock than similar farmers in more fertile upland areas.

Farmers in Makroman migrated to this area from Java in 1974 and the farming system is relatively stable, with food security ensured by lowland rice. Most farmers have been able to secure additional agricultural land to the originally allocated 2 ha. Marenu is a new transmigration area (first settlers

Figure 1. Sheep eating *Gliricidia sepium* in Marenu, Indonesia.

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arriving in 1995) which was designed with emphasis on sheep production. Farmers received 20 sheep and planting material of king grass (*Pennisetum* hybrid). While some farmers have concentrated on increasing animal numbers and income from animal sales, others are dependent mainly on off-farm income. Income from sheep sales is low, even in families with larger flocks, since they are in the process of building up their flocks.

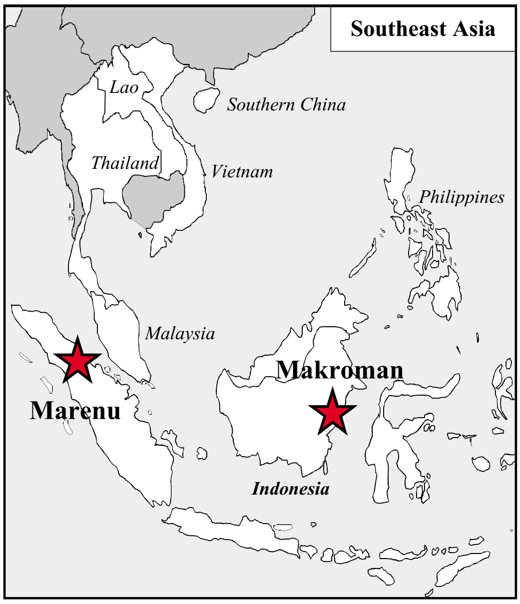

Figure 2. Location of Makroman and Marenu project sites.

In Makroman, goats are kept mainly in the barn and are fed cut-and-carry feed. In Marenu, farmers graze sheep for 3–4 hours per day and provide additional cut-and-carry feed. Before the FSP started working with farmers at these sites, the cut feed consisted mainly of naturally occurring grasses which were cut along roadsides, fields and other vacant areas by all family members. The time needed to cut sufficient feed varied with feed availability from 1–2 hours in the wet season and 2–4 hours in dry months. At both sites, farmers were growing king grass, but yields were low because of the low soil fertility, and many plants died during dry periods.

Developing Forage Options

The FSP has been working with farmers at Marenu for three years and Makroman for four years to develop forage technologies. The pattern of forage development has been similar at both sites:

- Initially, farmers evaluated a range of species in small plots near their house.
- After 1–2 years, most farmers started to plant grasses in cut-and-carry plots or rows, and tree legumes as living fences of along existing fences (Table 2).

Table 2. Proportion of farmers planting forages in different systems (based on a survey conducted in 1999).

	Marenu (n = 81)	Makroman (n = 51)
	(% of farmers)[1]	
Cut-and-carry plots or rows	90	94
Legume covers in annual crops	0	18
Ground covers for erosion control	5	0
Hedgerows	0	4
Living fences (tree legumes)	73	61

[1]Column totals exceed 100% since many farmers are using more than one forage system.

Table 1. Site characteristics.

	Makroman	Marenu
a) Physical		
Annual rainfall (mm)	2750	2350
Dry months (<50mm)	0–4	1–3
Soil fertility	moderately infertile	infertile
Soil pH (H_2O)	4.6–4.8	4.6–4.8
Aluminium saturation (%)	64	85
b) Agricultural system[1]		
Farm size (ha)	0.5–1 ha lowland plus 1–2 ha upland	1 ha upland
Main crops	rice, cassava, maize	vegetables, rice
Number of sheep or goats per family[2]	10	21
	(9–14)	(4–45)
Income from sheep and goats (% of family income)	26%	22%

[1]Means based on data from 40 farms in Makroman and 60 farms in Marenu.
[2]Mean and (range in parenthesis).

- The area of king grass declined over the last two years to less than 25% of the original area planted, being replaced by better-adapted forage species.
- Farmers experimented with many varieties but some species are becoming more popular than others (Table 3). *Paspalum atratum* 'Terenos' is used extensively by many farmers at both sites. Open-ended evaluation showed that farmers liked 'Terenos' since it has a high leaf yield, is easy to cut, regrows fast following cutting, and is liked by sheep and goats. *Setaria sphacelata* 'Lampung' is also a preferred variety by many farmers in Makroman where it is adapted. Following initial reluctance because of a concern about poor palatability, farmers at both sites have 'discovered' the usefulness of *Gliricidia sepium* varieties and many farmers are now planting this species in rows as fence lines, and around fields and houses. Small ruminants tend to prefer legumes to grasses and, in response, farmers growing forages for small ruminants tend to plant more legumes than do farmers growing forages for cattle and buffalo.
- Many farmers prefer to feed a mix of forage varieties to their animals rather than feeding only one or two varieties.
- Several novel forage options have been emerging. In Makroman, some farmers are using *Centrosema pubescens* 'Barinas' as a cover crop in annual crops such as maize and cassava to suppress weeds and provide feed for their animals. Others are growing *Stylosanthes guianensis* 'Stylo 184' to improve egg production of local chickens. In Marenu, some farmers are using king grass as a dense fence around chicken yards. In many instances, farmers grow forages inter-cropped with upland crops such as cassava and maize, or along field boundaries and home gardens.

The FSP has been working directly with more than 100 farmers at Makroman and 85 at Marenu who each plant up to 5000 m^2 of forage for their sheep and goats. The areas planted with forages and the number of farmers adopting forages for use on their farms are both increasing at both sites.

Lessons Learned

Farmers raising sheep and goats are:

- dependent on cut-and-carry feed, and are very interested in growing forages that reduce the time required to cut feed for their animals;
- adopting tree legumes to a much larger extent than farmers raising cattle and buffalo since their animals particularly like leaves from tree legumes.

Table 3. Forage varieties used by many farmers in Marenu and Makroman for feeding small ruminants (based on a survey conducted in 1999).

	Marenu[1]	Makroman
Albizia falcataria	•	
Andropogon gayanus 'Gamba'		•
Brachiaria brizantha 'Marandu' and CIAT 16337	•	••
Brachiaria humidicola 'Tully' and 'Yanero'	•	
Centrosema pubescens 'Barinas'		•
Gliricidia sepium 'local', 'Retalhuleu', 'Belen Rivas', 'Monterrico'	••	••
Leucaena leucocephala 'local' and 'K636'	•	•
Paspalum atratum 'Terenos'	•••	•••
Paspalum guenoarum 'Bela Vista'	••	
Pennisetum purpureum and *Pennisetum* hybrids	••	••
Setaria sphacelata 'Lampung'		•••
Stylosanthes guianensis 'Stylo 184'	•	

[1] • = few farmers, ••• = many farmers.

Forage Options for Smallholder Farmers in Shifting Cultivation Farming Systems of Lao PDR

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Figure 1. The mosaic of shifting cultivation in northern Laos.

SHIFTING cultivation is the dominant land-use in the northern uplands of Laos and occupies up to 80% of the cultivated land in the whole country (Figure 1). Typically, secondary vegetation in steep upland fields is slashed and burned, and the fields are sown to annual crops such as upland rice, maize or a cash crop. These are grown for one to three years and the field is then left fallow for 3–15 years.

In the past, the traditional system of long rotations (>15 years fallow) resulted in forest fallows, which supported efficient nutrient cycling and sustainable land use. With increasing populations, however, fallow periods are becoming very short in most areas (often no more than 3–5 years) and the resulting fallow vegetation is shrubby. When the fallow is slashed and burned, little of the organic matter is returned to the soil and consequently soil fertility is declining (Roder et al. 1997). The shrubby fallows produce huge quantities of seed which increases the weed problems in the subsequent crops. As a result, at least two rounds of weeding are necessary to grow upland rice, which can take from 140–190 person-days/ha, amounting to >50% of the total labour input into these crops (Roder et al. 1995). Furthermore, farm sizes are declining, with each family now only cropping 0.5–2 ha each year.

Often the area cultivated by a family is limited by the amount of labour available to provide the huge inputs required to maintain the crop. Pressure on land resources also forces farmers to cultivate steeper and more marginal lands leading to increasing soil erosion and associated downstream siltation. The combined pressures on land and human resources have led to declining crop yields and greater susceptibility of upland communities to risk (Figure 2).

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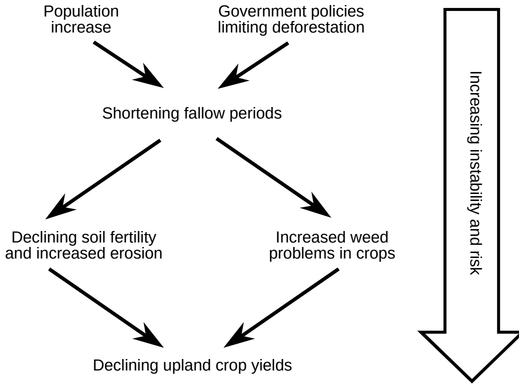

Figure 2. Shifting cultivation is becoming environmentally and socially unsustainable.

Weeds, rodents, insufficient rainfall and the interlinked problems of land availability and shortening fallows are the main problems identified by farmers in the shifting cultivation areas of northern Laos.

Rural communities and government/development organisations in Laos are looking at a range of strategies that together will help stabilise shifting cultivation. These include:

- intensifying lowland rice production;
- encouraging sedentary agriculture in the uplands, where possible;
- promoting cash crops, fruit trees and farm forestry;
- developing infrastructure, access to markets and social services;
- improving land use planning and land tenure;
- developing better livestock systems.

The Role of Livestock in Shifting Cultivation

Most farmers in the uplands of Laos keep small numbers of cattle, buffalo and small animals such as pigs for one or more of the following reasons:

- there is a constant market demand at relatively stable prices (livestock commonly provide 50–70% of all household income);
- large livestock can walk long distances to market;
- manure can be used to fertilise crops and home gardens (especially as farmers try to intensify production from their small areas of good land);
- livestock give a high profit per unit of labour;
- ruminant livestock utilise an otherwise unused feed resources.

Traditional management systems tend to be low input, being mainly free grazing with cattle returning to the village only occasionally, or limited grazing where cattle return to the village each night. Long-cycle rotational grazing systems are common, with communities designating whole areas to remain fallow for one or several years and be used for grazing.

As shifting cultivation systems intensify livestock numbers are increasing, since many farmers see livestock raising as a 'stepping stone' out of poverty and out of reliance on labour-intensive and unproductive farming systems. As this happens, however, farmers are increasingly experiencing some of the following problems:

- Livestock destroying crops, which is a common cause of conflict in villages. In some places, free-grazing is banned or limited to particular areas, and commonly farmers devote a lot of labour to building fences each year.

Table 1. Expected (●) and emerging (✔) forage options for shifting cultivation systems.

Forage species currently being evaluated by farmers	Forage options					
	Cut-and-carry plots	Grazed plots	Living fences	Hedgerows	Improved fallows	Erosion control
a) Grasses						
Andropogon gayanus 'Gamba'	● ✔	—	—	✔	—	—
Brachiaria brizantha 'Marandu'	● ✔	—	—	✔	—	✔
Brachiaria decumbens 'Basilisk'	● ✔	—	—	✔	—	—
Panicum maximum 'Simuang'	● ✔	—	—	✔	—	—
Setaria sphacelata 'Solander'	● ✔	—	—	—	—	—
b) Legumes						
Stylosanthes guianensis 'Stylo 184'	● ✔	—	—	—	●	—
Calliandra calothyrsus 'Besakih'	●	—	●	—	—	—
Gliricidia sepium 'Retalhuleu'	● ✔	—	●	—	—	—
Leucaena leucocephala 'K636'	●	—	●	—	—	—

● = In 1997, the FSP expected these options to be of interest to farmers.
✔ = Options that are actually emerging on-farms in 1999.

- Loss of traditional grazing land to protected/planted forests or cropping resulting in feed shortages in the wet season (when this land is normally used for grazing).
- Insufficient feed in the dry season. It is common to meet farmers who spend 1–3 hours each day cutting grass for their animals.

These problems are motivating many farmers to experiment with better management of their livestock, including the use of planted forages as a supplement to the diminishing traditional feed resources.

Forage Options for Shifting Cultivation

Since 1997, the Forages for Smallholders Project has been working with farmers in shifting cultivation areas of Laos to help them integrate forages on their farms. Initially, we expected particular forage systems, such as the use of legumes for fallow improvement, to emerge but farmers invariably started testing forage species in small plots before moving on to evaluate forage systems (Table 1).

By the end of the 1999 wet season, 395 farmers were evaluating forages with 204 new farmers having joined in the 1999 wet season. Of the farmers who had been evaluating for two or more years, 85% had started to expand their areas, mostly for providing cut feed. No farmers have shown interest in large areas of planted forages for grazing (Table 1). Instead, farmers addressed specific feeding problems such as saving labour on cutting or providing forage for sick animals by planting forages for cut-and-carry as a supplement to their traditional feed resources.

The Future

Across all countries and farming systems where the Forages for Smallholders project has been operating in Southeast Asia, we have found that farmers do not immediately adopt integrated forage systems, but experiment first with forage varieties. Only once they have confidence in the varieties will they begin to experiment with integrating them into their farming systems. This has certainly been the case in northern Laos, but many farmers are now beginning to experiment with forage integration.

The challenge now is to work with farmers to develop integrated forage systems that not only provide benefits for feeding livestock but capitalise on the potential benefits for natural resource management (in particular, soil fertility improvement and weed control).

A new project (the Forage and Livestock Systems Project; FLSP) funded by AusAID and managed by CIAT (Centro Internacional de Agricultura Tropical) has been designed partly to focus on this goal in northern Laos from 2000–2005. In particular, the FLSP will use participatory approaches to technology development to integrate forage and improved livestock management strategies into upland farming systems that will:

- increase income by improving the productivity of small and large livestock;
- increase labour efficiency and reduce workloads of both men and women farmers in the livestock production systems;
- enhance sustainable cropping systems by increasing soil fertility and reducing soil erosion; and,
- sustain livestock production within the national policy of stabilising shifting cultivation.

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Integration of Sheep and Utilisation of Fodder Trees in Rice-based Cropping System in Tarlac Province, the Philippines

E.E. Victorio[1] and F.A. Moog[1]

"OUR problem in the village is purely religious; technicians come and preach like gods!" (Adapted from a T.R.E.E.S. editorial cartoon). Farmers live on experience; they learn by doing. Researchers and extensionists, on the other hand, are concerned with delivering services and aim to augment the farmers' incomes.

So, how do we introduce to the farmer an animal he or she knows only from the Bible? Worse, in addition to the animal, is the task of persuading the farmer to grow fodder tree species and to cut-and-carry the foliage. At the same time, we need to show that one technology is better than another technology including putting the technology to test!

Objectives

The project aimed to promote the integration of sheep-raising in rice-based cropping systems. It sought to highlight the acceptability and economic viability of sheep-raising in these systems as a means of augmenting farm income. The study also sought to demonstrate the advantage of involvement of farmers in research.

Methodology

Sheep distribution

The study area is a rain-fed lowland rice village in Tarlac, the Philippines, and the study was conducted from 1994 to 1998. An account of the early stages of this study was published by Victorio and Moog (1995). Thirteen farmer-cooperators were selected, based on expressed willingness to raise sheep under a repayment-in-kind arrangement, whereby two female lambs had to be repaid for each ewe received. Each farmer was provided with the number of ewes he or she wanted to raise.

To prevent inbreeding, a ram was provided by the Bureau of Animal Industry (BAI), the custody of which was rotated annually among cooperators, while repayment sheep were extended to new cooperators.

Feeding practices

Fodder tree supplementation practices were introduced among farmer cooperators. Pre-identified fodder tree species were *Leucaena leucocephala*, *Gliricidia sepium*, *Bauhinia sp.*, *Samanea saman* and *Pithecellobium dulce*. The farmer cooperators were left to make their own decisions regarding feeding, provided that records covering their daily activities were kept for monitoring by researchers. Sheep were weighed monthly by the research team and the liveweight gain (LWG) and average daily gain (ADG) were calculated.

Data analysis

Farmer records were regularly monitored through field visits made by the researchers. These records were organised, assessed and analysed.

Observations

Farmers' records showed that sheep were tethered like local ruminants on rice straw and weeds associated with rice during the rice growing period and supplemented with rice stubbles, standing legumes and crop residues after the rice harvest. Fodder tree species were used for supplementary fodder.

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Results and Discussion

Sheep integration

Raising sheep in this lowland rainfed farming system required at least two hours labour per day during the rice-growing period for cut-and-carry, and one hour per day after the rice harvest for tethering and watering.

The project started in the second quarter of 1994 with four cooperators, increasing to ten in 1995, 12 in 1996 and 13 in 1997 and 1998. Eleven of the farmers treated the sheep like any other ruminants, except for keeping them in semi-confinement. Weeds included in the sheep's diet were predominantly *Echinochloa* spp. and *Cyperus rotundus.*

Benefits

Without raising sheep, farmers would have had to spend much time weeding paddy bunds and fields. Over a four-year period, farmers involved in the project saved a total of 2640 man-days (Table 1).

Table 1. Labour-saving generated from raising sheep.

Year	Number of cooperators	Number of man-days
1994 (Jul–Dec)	4	76
1995	10	647
1996	12	777
1997	13	842
1998	13	298
Total	13	2640

Average daily gain of the supplemented sheep was higher than that for those provided with traditional feed (Table 2). However, overall weight gains of the sheep were lower than those obtained from sheep grazed under coconuts with ADG ranging from 27 to 67 g at different times of the year (Moog 1994). The low ADG obtained from the sheep with the fodder tree supplement was likely owing to inadequate quantity of fodder tree leaves provided to the sheep, averaging only 190 g of fresh leaves per animal per day.

Table 2. Mean liveweight gain of sheep in rice-based farming system (October 1994 to December 1995).

Treatment	Initial weight (kg)	LWG (kg)	ADG (g)
Traditional feeds	11.5	13.2	28
Traditional feeds plus fodder tree supplements	14.1	16.9	36

To demonstrate further the benefits of a fodder tree supplement, an on-site study was conducted during the dry season. Only two farmers volunteered to participate in the five-month trial. Sheep were provided with larger amounts of tree leave supplements, and gained weight at 2.5 to 3 times the rate of the sheep fed with smaller amounts in the earlier trial (Table 3).

Table 3. Average daily gain of sheep supplemented with tree leaves.

Farmer	Supplement	Fresh tree leaves provided (g/hd/day)	ADG (g)
Farmer A (17 sheep)	*Leucaena, S. saman, P. dulce*	230	81
Farmer B (1 ram)	*Leucaena, Bauhinia, Gliricidia*	515	111

Table 4. Benefits to farmers from sheep raised.

Farmer-cooperator	Disposal	Use
M. Valdez	sold (3 sheep)	bought food for the family; bought 4 pieces GI sheets for cow shed
A. Estavillo	sold (3 sheep)	bought food and clothes
W. Manzano	sold (2 sheep)	bought school supplies and food
R. Fabros	slaughtered (1 sheep)	for son's wedding
F. Ganapin	sold (3 sheep)	bought food, fuel oil and fertiliser
	slaughtered (1 sheep)	for brother's death
J. Fabros	sold (1 sheep)	to finance new animal shed
	slaughtered (2 sheep)	birthday and son's graduation
L. Valdez	sold (2 sheep)	bought dining set; domestic expenses
	slaughtered (1 sheep)	brother's visit
C. Salonga	exchanged 1 sheep for 2 goats	bought additional animals to raise
T. Castro	sold (1 sheep)	bought rice
J. Micu	slaughtered (5 sheep)	for special occasions

Development of a Market

Mutton is becoming popular in the village and apparently substitutes for other meat on special occasions (Table 4). It provides an additional source of income for smallholder farming families. In the town market, price has been pegged at PhP 90/kg.

Problems encountered

A farmers field day was conducted to demonstrate opportunities to supplement sheep with fodder trees. All farmers who attended the field day expressed interest in fattening sheep after the rice harvest, from October to June, to take advantage of the available forage biomass in the area.

When farmers were reluctant to adopt supplementary feeding with tree forage it was often due to conflict of use. Some farmers in the village use fodder trees for fuel wood. Some farmers hesitated to feed *Leucaena* for fear that psyllid insects on the foliage might cause death to their animals.

Conclusions

Sheep-raising has good potential for expansion in rice-based cropping system. Mutton is an acceptable and growing alternative to traditional meats and local markets develop quickly.

In small farms, a flock of two or three ewes and a ram is manageable, considering the scarcity of fodder during the rice-growing season. In rice-based systems, the availability of tree fodder can be improved by promoting the planting of tree legumes as living fences. Fattening of sheep during the dry season can be practiced and sheep should be ready for marketing before planting the rice crop.

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An On-Farm Trial on Integration of Cattle under Coconuts in Albay, the Philippines

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COCONUT land in the Philippines is potentially available for the expansion of the livestock industry. With a low national average production of 49 nuts/tree/year, one of the options to increase land productivity is to integrate livestock, particularly cattle, under coconuts. Earlier studies of the Bureau of Animal Industry (BAI) showed that cattle on improved grass pastures like signal grass (*Brachiaria decumbens*) and humidicola (*B. humidicola*) can produce liveweight gains of 300 to 400 kg/ha/year at stocking rates of 2–3 beasts/ha. The majority of coconut farms are small, and these results should be extended to the farm situation.Objectives in this study were to demonstrate the value of integrating cattle under coconuts and to determine the benefits that could be derived by farmers from cattle-coconut integration.

Methodology

Six farmer-cooperators were selected in Barangay Baligang, Camalig, Albay. Farmers' meetings and seminars were conducted. Responsibilities of farmer-cooperators to establish pasture, including land preparation and planting, were emphasised. Planting materials of napier grass (*Pennisetum purpureum*), humidicola and signal grass, and technical assistance, were provided. The forages were planted at staggered intervals from March 1995 to September 1997, with areas ranging from 0.12 to 2.0 ha per farmer. Eleven head of American Brahman cross cattle (five heifers and six steers) were delivered and randomly distributed by drawing lots. Cattle were weighed on 6 December 1996 and at 3-month intervals thereafter, until the final weighing on 10 December 1997.

Results

Liveweight gains ranged from 22–142 kg/head/year, with an average daily gain of 0.06–0.38 kg/head. From an average of 183.3 kg/head, cattle liveweight soared to 266.5 kg (mean ADG – 0.23 kg) (Table 1).

Liveweight gain of the cattle was directly related to the improved feeding regimes carried out by the farmers. The animals of farmers 1 and 5 performed best as they were provided with supplements such as molasses, corn starch and fodder trees such as *Leucaena leucocephala* and *Gliricidia sepium*. To ensure sufficiency of feed during the dry season, Farmer 5 resorted to gathering rice straw and treating with sugar dissolved in water, to increase palatability. Animals of Farmer 6 performed well as they were supplemented with fodder trees during the dry season. Poor performance of cattle owned by Farmers 3 and 4 was associated with lack of supplementation.

The average annual income of farmers from coconuts is P58 561. Depending on individual farming activities and size of landholding, farmers' incomes range from P17 880 to P104 625 per annum.

The relative income contribution of cattle in integrated livestock systems with coconuts ranged from 1.8–26.3%, depending on farm size, for farmers with two head of cattle. The highest proportion of income from cattle (26.3%) was obtained by Farmer 5, with 1.5 ha of coconut (Table 2). Supplementary income from cattle can increase average family income by 15.1%, from P58 651 to P67 176.

Conclusion

Raising cattle under coconuts provides farmers with additional income and increases the overall productivity of the coconut land. It generates employment for members of the farming family, including women. Development of coconut areas for livestock production will increase the local supply and availability of meat, which will eventually reduce import of meat from overseas.

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Table 1. Liveweight gain (LWG) of cattle distributed to farmer-cooperators.

Farmer	Animal no. and sex	Initial weight (kg) 12/6/96	Final weight (kg) 12/10/97	Total LWG (kg)	ADG (kg)
1	1 (M)	165	307	142	0.38
	2 (F)	194	266[1]	72[1]	0.31
2	3 (M)	192	264	72	0.19
	4 (F)	195	272	77	0.20
3	5 (M)	156	211	55	0.15
	6 (F)	187	209	22	0.06
4	7 (F)	163	215	52	0.14
5	8 (M)	164	306	142	0.38
	9 (F)	203	280[2]	77[2]	0.33
6	10 (M)	195	313	118	0.32
		208	289	81	0.22

[1]Until July 31, 1997, animal bred July 1, 1997.
[2]Until July 31, 1997, animal bred July 10, 1997.

Table 2. Income (pesos) of farmers from coconut and cattle in Baligang, Camalig, Albay (December 6, 1996 to December 10, 1997).

Farmer #	Income from Coconut (P) and area (ha)	Income from cattle (P) and no. of head	Total (P)	% Contribution of coconut	% Contribution of cattle
1	51 596 (3.2)	11 532 (2)	63 131	81.7	18.3
2	104 625 (7)	8875 (2)	113 500	92.2	7.8
3	17 880 (2)	5065 (2)	22 945	79.8	20.2
4	77 469 (4)	2635 (1)	80 104	96.7	3.3
5	3377 (1.5)	12 245 (2)	46 622	73.7	26.3
6	65 421 (3)	11 335 (2)	76 756	85.2	14.8

Assessing the Impact of Agricultural Technologies in Smallholder Farming Systems — Results from a Participatory Monitoring and Evaluation Study on Forages in Malitbog, Northern Mindanao, Philippines

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Abstract

In this paper, a participatory approach is used to assess impact of forage technologies recently introduced to Malitbog, the Philippines. Despite the fact that participatory approaches to technology development are designed to ensure that new technologies meet farmers' needs, extent of adoption and the impacts on farm productivity and natural resources have rarely been assessed. Participatory methodologies applied to impact assessment enabled stakeholders to identify, elucidate and rank indicators of potential impact according to their perceived importance by those stakeholder groups. Simple in-field and statistical analysis highlighted important impacts and their relationships to each other. Comparing the two approaches, statistical analysis confirmed the in-field results and indicated that the field technicians could apply in-field analysis with confidence. The results indicated that smallholder farmers are aware of potential benefits of forage technologies to livestock as well as benefits to crops and the environment. Forage technologies were shown to have the potential for significant positive impacts on farming systems provided that they are tailored to individual requirements. In general, cut and carry species had greater appeal (than species for grazing) to farmers from Malitbog since they complement rather than substitute existing pasture and they enable the tethering of livestock closer to home, with a concomitant increase in animal safety.

THERE have been many projects aimed at reducing rural poverty by increasing productivity and maintaining the natural resource base. Despite the fact that participatory approaches to technology development are designed to ensure that new technologies meet farmers' needs, extent of adoption and the impacts on farm productivity and natural resources have rarely been assessed.

Studies of impact have generally focused on key productivity increases at the regional level, but at the farm level there are few 'user-friendly' methods that assess environmental and economic impact during early stages of adoption. Any framework for monitoring progress or assessing impacts of new technologies must be related both to the problems and needs expressed by farmers as well as expected outcomes at different scales (farm, community, region). With this capability, farmers and researchers can modify technology development better to target both local and regional needs.

This monitoring and evaluation project aims to develop a framework to monitor and assess the ongoing and ex-post impacts of new forage technologies developed through farmer participatory research. Specifically, this paper reports on a series of impact indicator assessment workshops held with stakeholders in the Forages for Smallholders Project.

The Forages for Smallholders Project (FSP) has been working with smallholder farmers in Southeast Asia developing suitable forage technologies to help boost livestock productivity. A major question for the FSP was whether the availability and adoption of

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new forage technologies was providing significant positive impact for the smallholder farmers in its project sites.

Two sites where the FSP has been active and where smallholders have adopted improved forage technologies, Malitbog in Bukidnon Province, Philippines, and M'Drak in Dac Lac Province, Vietnam, were chosen to develop this framework of participatory monitoring and evaluation. The basic approach was to work with the stakeholders to identify, order, rank and finally measure indicators of impacts within the context of the overall farming system. The workshops aimed to use participatory techniques to develop and rank indicators of the impact arising from the on-farm development of forage technologies.

In this paper, we present preliminary results from the monitoring and evaluation study of the Malitbog site.

Stakeholder views on impact of new technologies

In developing impact indicators for a particular project, the views of the stakeholders involved in the project are important in defining the potential indicators of impacts. Stakeholders do not necessarily comprise only those people whom the project is designed to help, for example farmers, but all those groups who potentially are going to be affected by the project outcomes (Figure 1). A full assessment of project impacts can only be achieved by identifying all the stakeholders and eliciting their views regarding the potential impacts of the project.

Success can mean different things to different stakeholders. For example, some stakeholders may be interested in increasing aggregate or national production, while other stakeholders may be interested in gender, equity and environmental aspects of the project. Still others may be interested in increasing income and reducing risk. All of these criteria are valid to the particular stakeholder concerned and success therefore depends on the views of the stakeholders involved with the project.

The question of interest to a particular stakeholder is the manner in which the new technology impacts on the system. That system may be an aggregate farming system, or a sub-system like a livestock or cropping system. A new technology impacts on each stakeholder in a different way. At the macro level, a new forage technology might mean that aggregate or national livestock production might increase, or there might be a noticeable improvement in crop yield due to soil erosion control. At a micro level, other stakeholders might be interested in the labour saving aspects of the new technology.

At any one-system level, a new technology will have multiple impacts (Figure 2), which may be immediate, intermediate and long-term in nature. For example, the availability of forages may mean that seasonal shortfalls in feed quality and availability may be alleviated (an immediate impact). This may result in increases in liveweight gain for livestock,

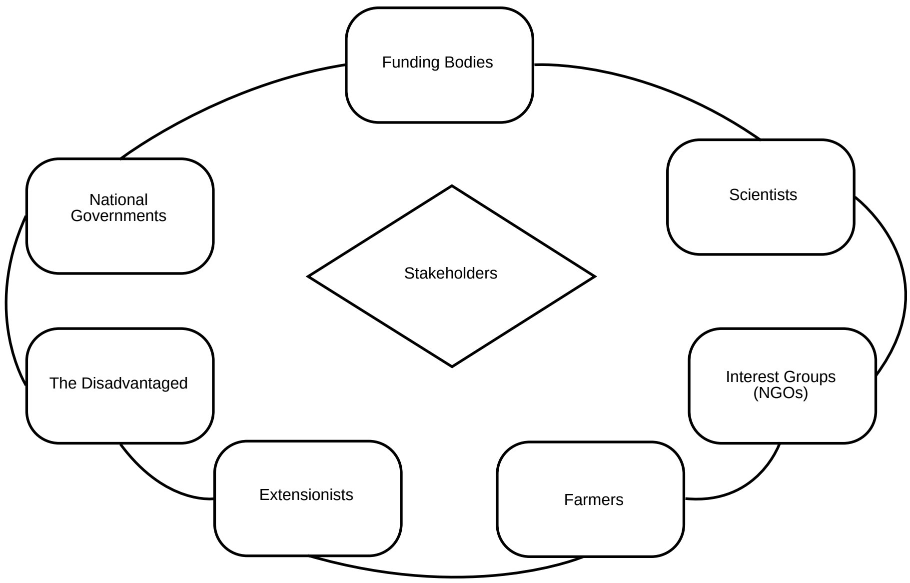

Figure 1. Project stakeholders.

with a resultant improvement in productivity of draught animals and a higher sale price for fattened livestock (a sequence of intermediate impacts). Ultimately these changes may result in higher incomes and improved farmer welfare.

At the same time, the establishment of forages on sloping land may reduce soil erosion (an immediate impact) with consequent benefits for soil fertility and crop yield (intermediate impacts) and, ultimately, beneficial consequences for farmer welfare and downstream resource users (Figure 2).

The multiple effects of a technology may include both positive and negative impacts. For example, while the planting of forage species may result in the reduction of soil erosion from sloping land, as noted above, it may have the adverse effect of reducing the area under cropping, thereby reducing farmer income.

Although a new technology may impact on stakeholders in different ways depending on their relationships to the system in question, impact also depends on the views of the stakeholders. While this topic will be elucidated later, in essence these views can be broadly classified into stakeholders' perceptions, expectations, knowledge and experience of the new technology. For example, stakeholders differing in age or gender may have different perceptions as to how the new technology impacts on their system. In addition, these perceptions are contingent on their own expectations of what this new technology has to offer. Knowledge and experience also changes stakeholders' views, enabling a broader and deeper understanding of the benefits and limitations of the new technology.

Identification of Impact Indicators

Workshops were held with stakeholder groups to elicit indicators of impacts (especially intermediate impacts) that could result from adoption of forage technologies. Workshops were held with the FSP collaborators, comprising representatives from funding bodies, the respective national governments and forage scientists, at the 4th Annual Forages for Smallholders Project Meeting in Nha Trang, Vietnam in January 1999. Further workshops were held with the Malitbog Municipal Agricultural Office personnel, and with seven of the target *sitios* (villages) in the Malitbog Municipality. These were Bilayong, Paitan, Kaluluwayan, San Migara, Santa Inez, Silo-o and Tagmaray.

Each workshop was a two-stage affair. In the first stage, the participants were asked to identify the indicators of impacts, both the positive and negative 'benefits', that they foresaw as likely outcomes from forage adoption. In the second stage, the participants were asked to weight each indicator of impact in order of importance. At all of the sites except Silo-o both the impact assessment and weighting exercises were conducted. The weighting exercise was not carried out at Silo-o due to its remoteness, which meant that it could only be visited once.

In the first stage of the process the participants in the focus groups were asked to identify the likely outcomes of forage adoption on their farming systems and livelihoods. These indicators of impacts were developed by the facilitator and the participants as a flowchart leading from 'forage adoption' to 'well-being' of the stakeholder (see, for example, Figure 3).

The indicators of impacts were differentiated by gender, in that it was noted whether a male or female participant had made that particular comment. It should be noted that this does not mean that the identification of that indicator only applies to one gender, merely that they were the first to mention it; it may well be that other participants (irrespective of gender) agreed with them.

The number and nature of impact indicators differed across focus groups. Groups with a greater (and longer) exposure to forage technologies were able to identify a larger number of indicators, a greater number of multi-stage intermediate and final indicators, and a more complex interaction of indicators in the farming system.

As an example, all focus groups mentioned that forages could fatten livestock and therefore increase their sale price, but only the FSP national coordinators mentioned the reproduction aspect of improved nutrition.

Concentrating on the indicators of impact identified by the farmer focus groups, the groups identified intermediate and final indicators associated with both livestock and non-livestock activities.

Most groups indicated that forages could be used to increase the number of livestock cared for and to fatten livestock already held. These animals could then be sold at a higher price. Some groups indicated that an increase in manure could result from the increase in the number of animals and the change in feeding regime (from an extensive tethering to an intensive cut-and-carry system). The manure subsequently could be collected and either sold or used as fertiliser on-farm. Most groups readily identified linkages between forages and other aspects of their farming systems. For example, forages could be used for soil erosion control.

As mentioned above, stakeholder views on forages were contingent upon their perceptions, expectations, knowledge and experience of how the new forage technology was going to impact on the farming system. As an example, different genders and ages

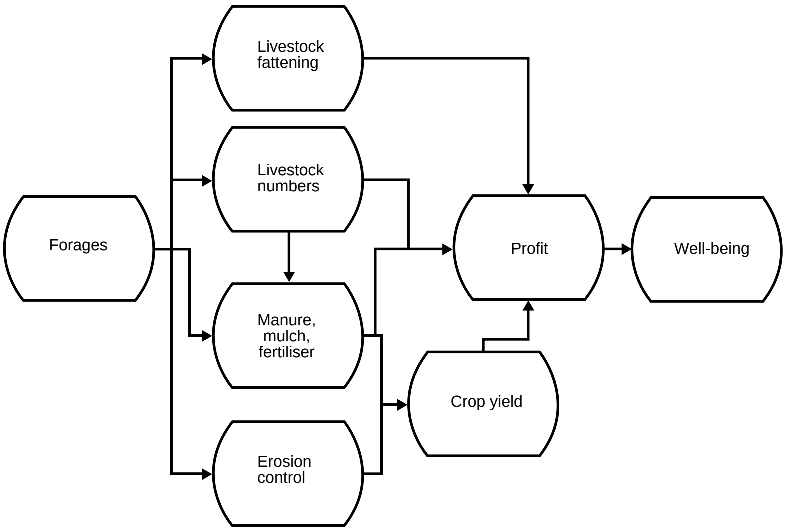

Figure 2. Possible sequences of farm-level impacts arising from introduction of forages.

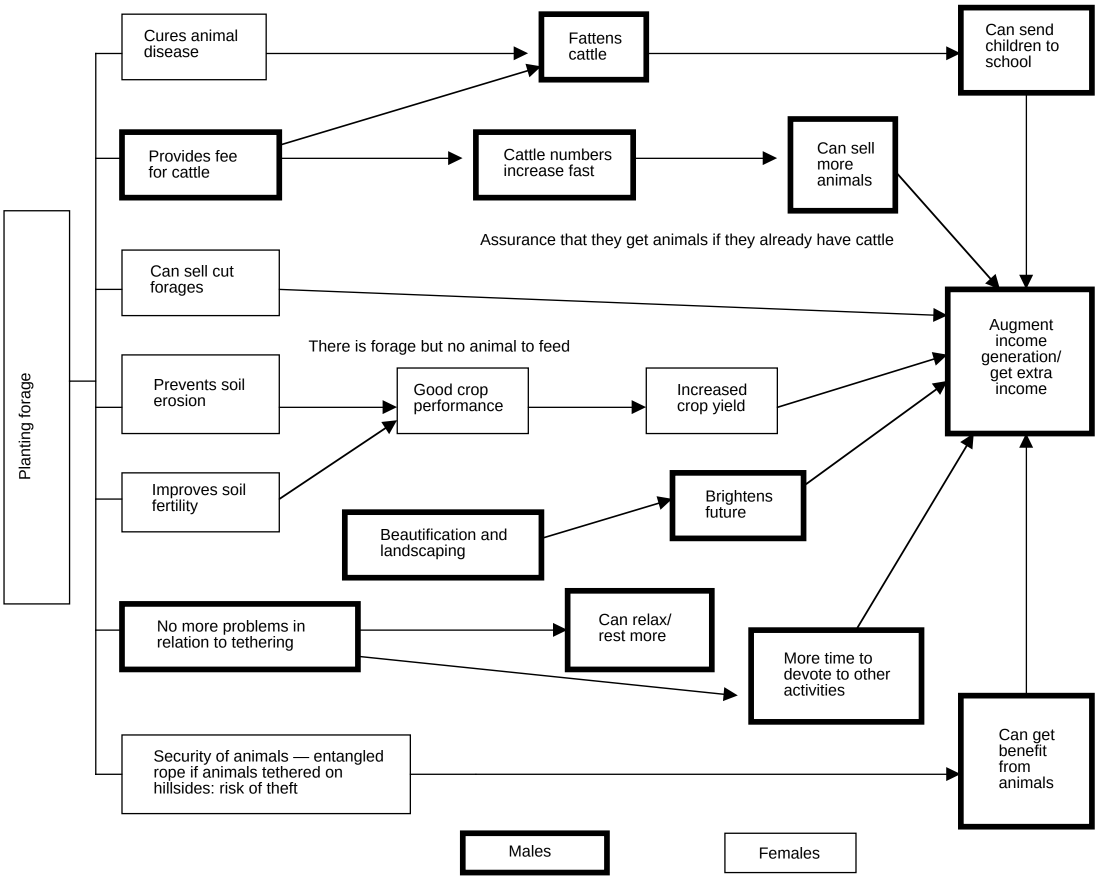

Figure 3. Impact assessment — Sitio Tagmaray.

had different perceptions as to the impact of forages on labour. While some farmers saw that time saved by feeding livestock cut-and-carry forages, rather than tending grazing animals, could be used for rest and relaxation, other farmers saw that the time saved could be used for other farm activities. Some farmers identified the role younger members of the household played in caring for livestock ('even small children can now feed the animals'). The children themselves appreciated the savings in their time which resulted from moving from a purely grazing system to a combined grazing and cut-and-carry system ('Before we had forages it was laborious to feed the animals. Now it is not so laborious').

The expectations of what benefits forage technologies were going to bring to the farming household also played a role. For example, there was a high level of interest shown in forages in some of the villages in the Malitbog area. It transpired that a livestock dispersal program operating in parallel to the Forages for Smallholders Project was requiring qualifying farmers to plant forages. Thus, there was an incentive for non-dispersal recipient farmers to plant forages in order to increase their chances of qualifying for the dispersal program.

Stakeholders with a higher level of knowledge, such as forage scientists and government extension workers, were able to identify likely indicators of impacts such as improved reproduction rates due to improved nutritional status of the animals. Farmers themselves might not have been able to elucidate such concepts, but were well aware of their consequences — increased numbers of livestock.

The amount of experience stakeholders had with forages was directly correlated with the number and range of potential impact indicators identified. Farmers experienced with forage production indicated that they needed forages that could withstand drought and that sometimes the livestock preferred grazing a species in preference to being offered that species as 'cut-and-carry', because they liked to be able to select the palatable leaves and pull the grass from the ground. Experienced farmers also indicated that they now had extra time available for other activities, because they had a readily available source of feed for their livestock.

After all workshops were held, the results were collated into a list of around 70 different indicators of impacts. These were grouped and condensed down to 37 (Table 1).

Weighting of Indicators

The second stage of the process involved collating indicators from each of the stakeholder focus groups and selecting the 24 most mentioned indicators. These were selected under the assumption that the more times it was mentioned the greater was the probable importance. The indicators were written down on a large sheet of paper, which was then used as the weighting board to weight the indicators. Each of the farmer groups was then asked to weight the indicators according to importance.

The farmers were given 10 cards, numbered 1 to 10 and asked to place them upside down (to preserve anonymity) against the impact indicators written on the board in order of importance to them, with 1 being most important and 10 being least important. The remaining 14 indicators were thus classified as 'not important'. This is not to say that the farmers considered them to be totally irrelevant, as they were important enough to mention during the first stage of the impact assessment exercise.

In this stage of the exercise, no differentiation was made between gender responses. In future research it may be necessary to collect information on within-site variability (such as gender and wealth) during the weighting exercise in order to account for the very large variation in responses not attributed to site differences alone.

There was a wide distribution of responses from each site, but several impacts stood out as being most important to all the farmers:

- the ability of forages to fatten animals,
- the ability to provide feed to counter seasonal and overall shortfalls,
- the potential of forages to control soil erosion, and
- the opportunity to ensure the safety of animals against theft and accidents or sickness by tethering closer to home.

In addition, there were indicators of impacts that were considered to be of secondary importance:

- the ability of forages to increase soil fertility by providing fertiliser and manure;
- the time savings generated by a reduction in animal management effort;
- the reduction in social tensions by limiting the need to graze in communal areas and the associated danger of stray animals damaging other peoples' crops[1]; and
- the increased price obtained for fatter livestock.

[1]A system of fines has been introduced in some of the villages which puts pressure on farmers to control movement and grazing of livestock. A P50 fine is levied against farmers who allow their cattle or buffalo to roam free and a P5/damaged plant (typically maize) is levied against farmers who allow their animals to graze on other peoples' plots. Due to the dispersed nature of farm plots in the area the probability of getting *caught in flagrante delicto* is low and hence the continuing social tensions and the interest in new forage technologies.

Interestingly, the livestock dispersal programs operating in the municipality (cattle, carabao and goats) were considered to be less important that the other factors. This was despite informal discussions with the farmer *alayons* (groups) indicating that the dispersal programs were a common factor in decisions to adopt forage technologies. In a subsequent survey, 61% of the 120 farmers growing forages indicated that the dispersal programs played a role in their decision to plant forages. The results indicate that, although the dispersal program did have some importance in farmer decisions to adopt forages, there were also other, more important factors influencing their decisions to adopt.

One of the indicators of impact highlighted by some of the focus groups was the potential for labour savings for women and children in animal management. This was not generally seen by stakeholders as an important enough indicator to mention. In fact, only the national level research scientists identified labour savings by women and children as a likely impact to arise out of forage technology adoption. One of the farmer focus groups actually highlighted that a perceived benefit of forage adoption was that children could now participate more in animal management under a cut-and-carry system than they could with the traditional grazing and tethering systems. Interviews with stakeholders revealed that little importance was attached to the contribution of child labour to the farm household and that the opportunity cost of such labour was considered to be marginal to zero. The contribution of women's labour to

Table 1. Impact indicators identified by stakeholder workshops.

Indicators of impact	Malitbog Agricultural Office	FSP Country Coordinators	All male farmers	All female farmers	TOTAL
Forage little eaten as cut-and-carry but eaten if animals tethered				X	1
Expand establishment of species for grazing			X		1
Planting forage			X		1
Was instructed to plant/given information				X	1
Less drudgery for working animal			X		1
So we could get assistance from MAO				X	1
Livestock dispersal				X	1
Security of animals — preventing theft				X	1
Don't fully own land or animals, so cannot plant forages			X		1
Planting materials were available	X			X	2
Progress for farmers and livestock			X	X	2
Increased sale price		X	X		2
Less work for women and children		X	X		2
Increased work capacity		X	X		2
Have forages but no cattle			X	X	2
Meat quality	X	X			2
No damage to other peoples crops			X	X	2
Send children to school			XX		2
Improve family health/feed animals even if sick	X		X	X	3
Selling feed	X	X		X	3
Relax/rest more	X	X	X		3
Less drudgery for farmer		X	XX		3
Other land uses	X	X		X	3
Helps us with our hardship/financial problems				XXX	3
Fertiliser/manure	X	X		XX	4
Crop yield	X	X		XX	4
More time to devote to other activities	X	X	XX		4
No need to tether far from household			XX	XX	4
Landscaping/clean & green	X	X	XX	X	5
Animals will be healthy	X		XX	XX	5
Improves soil fertility	X	X		XXX	5
Increased number of cattle	X	X	X	XX	5
Additional farm/non-farm income source	X	X	XXX	X	6
To save on labour for caring of animals		X	XX	XXX	6
Soil erosion control	X	X	XX	XX	6
Can fatten their cattle	X	X	XX	XXXX	8
Feed for animals	X	X	XXXX	XXX	9

the farm (as opposed to the household) was likewise considered to be low, by both men and women. This was contrary to observed activities and may reflect a cultural attitude towards female farm labour. When asked how important women's and children's labour savings were, most farmer focus groups attached little to no importance to such an impact. Even one farmer focus group comprised only of women indicated that most thought such labour saving was not important at all. Those that did consider it to be important (compared with 'not important') only ranked it as 'important', rather than 'very important'.

Analysis of Indicator Weightings

An in-field approach to the analysis of indicators

With such a wide range of responses from farmers, it was important to be able to identify patterns and trends within the data. More importantly, it is necessary to be able to develop a methodology that could be applied in the field by extension workers without access to computers or advanced statistical analysis techniques.

Simple bar-charts of farmer responses to each impact indicator at each site were developed (See, for example, Figures 4, 5 and 6). These charts grouped responses into 'very important' (scores 1–3), 'important' (scores 4–6), 'less important' (scores 7–9) and 'least important' (scores 10+).

An ad-hoc ranking scheme was applied, where indicators of impact were ranked by number of responses in the 'very important' class, followed by 'important', 'less important' and 'least important' classes. This is not a very satisfactory ranking scheme, in that indicators with a low score for 'very important' but a high score for 'important' are ranked lower than what casual observation suggests (e.g. the 'fertiliser and manure' indicator compared with the 'crop yield' indicator in Figure 6). However, as part of the study is to compare the-field analysis with rigorous statistical analysis, such *ad hoc* ranking schemes are important benchmarks.

The bar-chart rankings indicate that, for all sites, the top indicators of impact were feed for animals, the safety of the animals and fattening cattle. The bar-chart also indicates that the ad-hoc ranking scheme places the fertiliser and manure and the higher animal price impact indicators lower down the ranking than their 'important' score would suggest is appropriate.

What is interesting to note is that. although farmers were able to identify the indicators which ranked highly, middle ranked indicators were very closely ranked, suggesting that farmers have difficulty in differentiating between these indicators. This can be observed in Figure 7, in which the relative rankings of each impact indicator by each assessment workshop are plotted together. While the indicators which attracted a high ranking are clustered together quite closely, indicators which attracted a middle ranking are spread further apart. This is indicative of participants' difficulty in being able to distinguish between indicators of impact which had little intrinsic difference in outcome.

The bar-charts constructed for each of the sites individually generally coincide with the rankings for all the sites combined. The 'time savings' impact appears out of expected ranking due to the construction of that impact. This impact was a combination of four separate 'time' impact indicators and thus has a higher ranking.

The charts indicate that individual sites have some differences in ranking, due to their particular circumstances. For instance, Tagmaray, a site that is steeply sloping, ranked soil erosion control as the most important impact of forage technology adoption. This can be compared with a site like Paitan, which ranked it as seventeenth out of twenty (Figure 7). Unlike most sites, the farmers at Tagmaray considered the ability of forages to provide feed for animals as very minor, ranking it sixteenth out of twenty. This is due to the relative abundance of grazing land available in a place that has been newly opened for development, compared with other sites with higher population densities.

A Statistical Verification of the In-Field Analysis

While *ad hoc* ranking using bar-charts can give an indication of the relative importance of indicators of impact in assessment exercises, there is always the question of the statistical significance of any perceived difference.

An analysis of variance was carried out on the indicators of impact and the results indicate that there was a highly significant difference ($p<0.01$) between the impact indicators and that there was no significant difference in participants' responses between village of origin. The results are tempered by a low R^2 of 0.18, indicating that only 18% of the variability in rankings can be attributed to either the impact indicator itself or to the site variable. While low R^2s are a common feature of human responses in experimental studies (values of 0.3 are considered to be quite reasonable), an R^2 of 0.18 is probably too low for one to have much faith in the predictive power of the model. A low R^2 combined with a highly significant F-statistic indicates that the problem with the model is under specification and that factors explaining the difference in responses by individuals (in addition to the site variable) need to be incorporated.

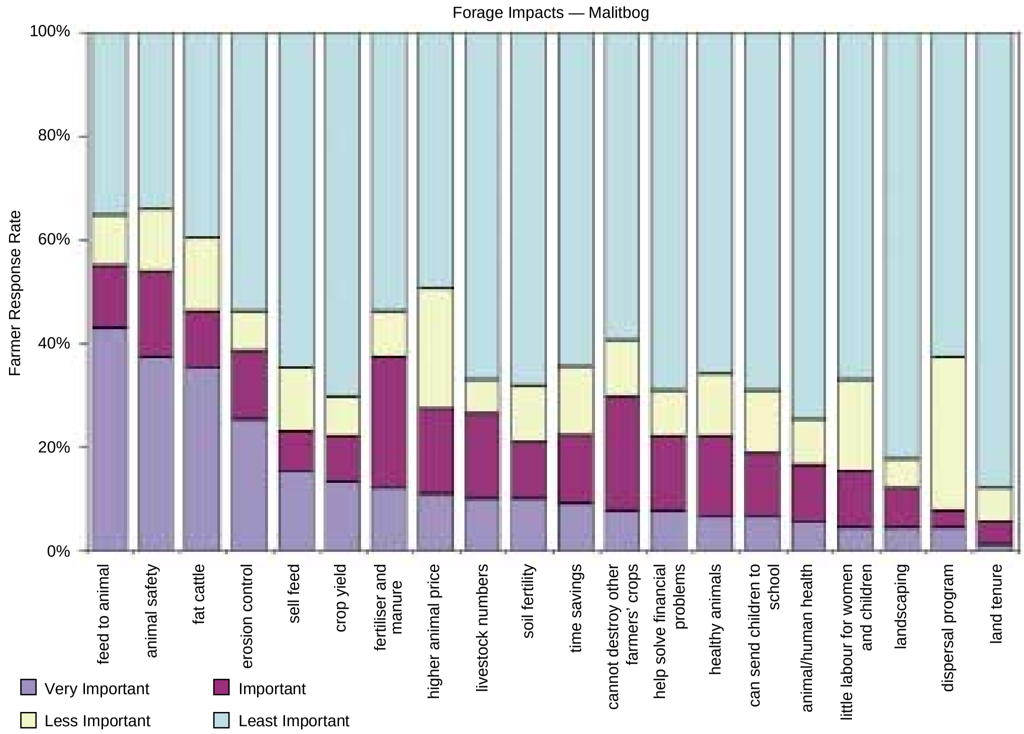

Figure 4. *Ad hoc* ranking schemes — Malitbog (all sites combined).

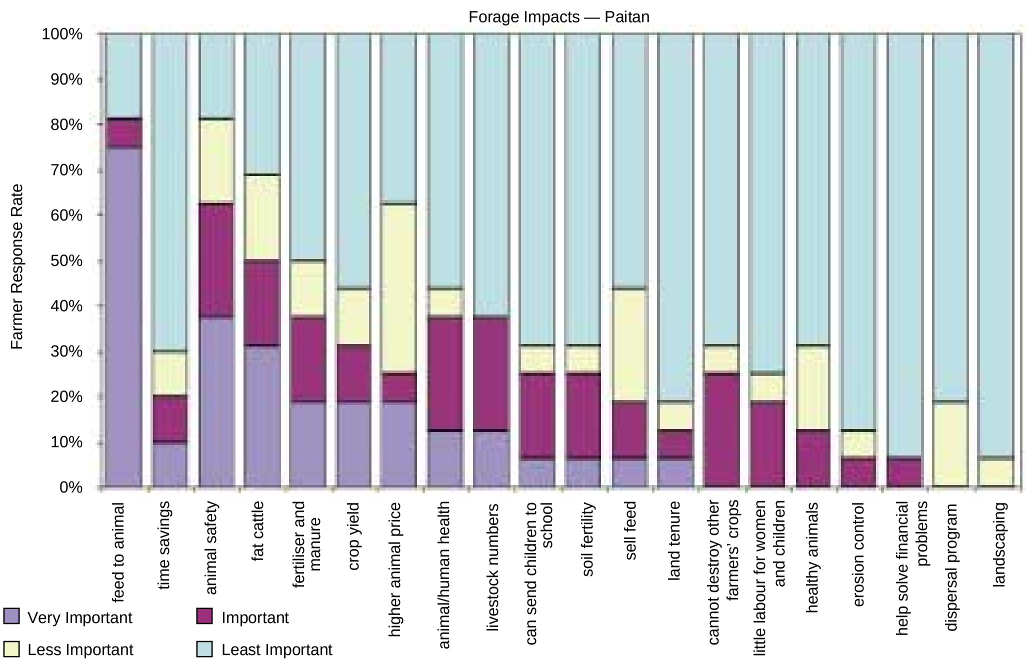

Figure 5. *Ad hoc* ranking schemes — Sitio Paitan.

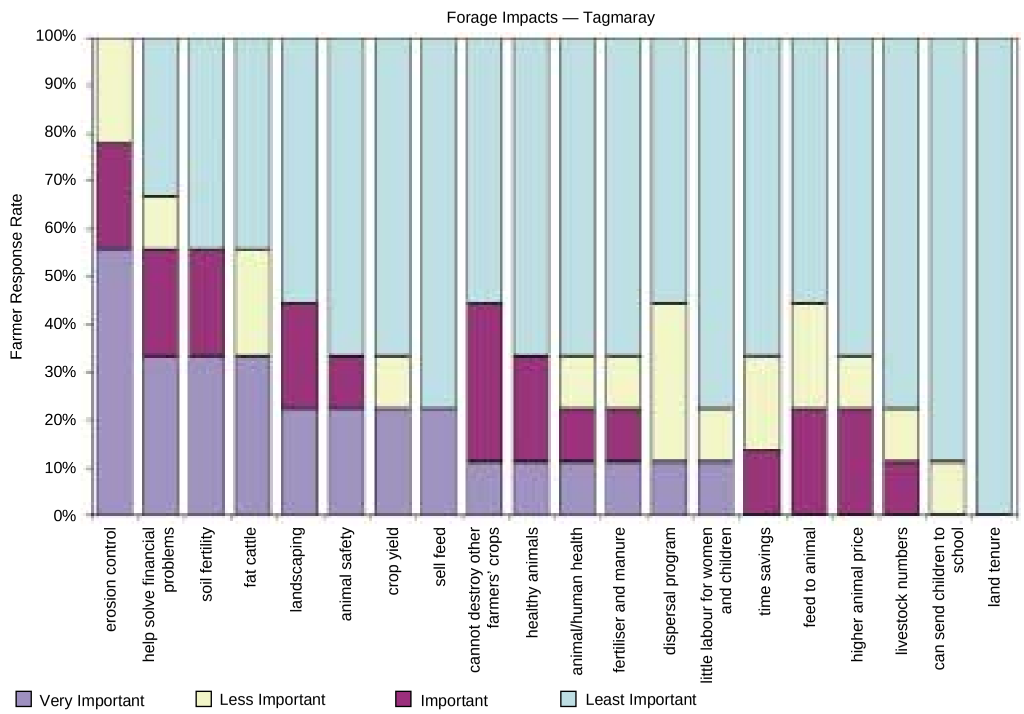

Figure 6. *Ad hoc* ranking schemes — Sitio Tagmaray.

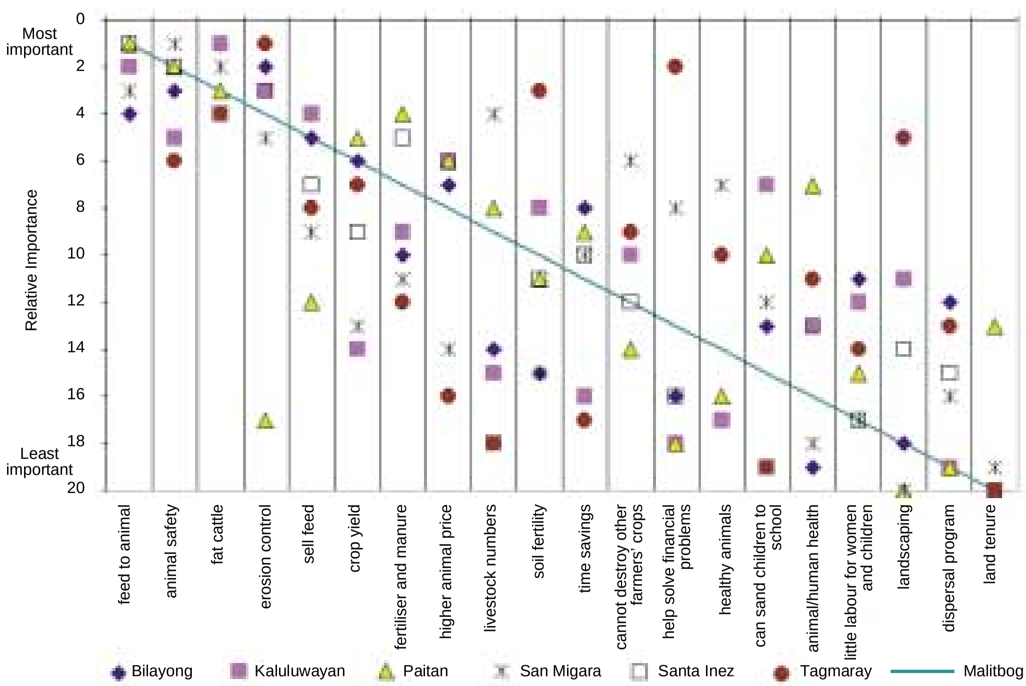

Figure 7. *Ad hoc* ranking scheme — relative rankings of each assessment site.

Regardless of the low R^2, the model results are still valid estimates of the differences between impact indicators in the absence of additional information about individual workshop participants. Multiple range tests were conducted to test for response differences between impact indicators. Fisher's least-significant-difference (LSD) test and the Ryan-Einot-Gabriel-Welsch multiple-range test (REGW) were calculated[2] and the results presented in Table 2.

The multiple range tests give additional information about the significant differences between indicators and suggest that, like the ad hoc ranking scheme results, the ability of forages to provide feed, safety and increased liveweight gain are more important impacts than the other indicators that were suggested. Unlike the ad hoc ranking scheme, the statistical results have the advantage that they are not biased in their ranking of indicators by the allocation of lower 'Very Important' scored but higher 'Important' scored indicators to lower rankings.

The statistical results confirm the ad hoc ranking scheme presented in the bar-charts in that the ranking of impact indicators is qualitatively the same (See Figure 8). There are some minor differences in ranking but these do not appear to be statistically different given the associated increase in variance for indicators of impact scored 'Important'. For most of the indicators of impact the difference between the statistical and the ad hoc ranking schemes was only ± 3 ranks and even the biggest outlier (a difference of 10 rankings for the 'Healthy Animals' indicator of impact for Sitio Kaluluwayan) was within the statistical limits of the multiple range tests. A χ^2 test of independence was carried out and indicated that there was no statistical difference between the ad hoc and the statistical ranking schemes overall.

The multiple range tests also confirm the perception given in the bar-charts of impact indicator rankings that, while the first and last few ranked indicators were statistically different from the rest, there was no statistical difference between the middle ranked indicators. This lack of statistical difference can be attributed to, firstly, the possibility that workshop participants found it difficult to distinguish between indicators that may have held little intrinsic difference. Secondly, the lack of information about the individual participants in the workshops (which led to a low R^2 in the first place) means that variances around the individual estimates are very large, and thus the t-tests of differences between means will reject the null hypothesis of no difference less often.

[2]Fisher's LSD test controls the Type I comparisonwise error rate whereas the Ryan-Einot-Gabriel-Welsch test controls the Type I experimentwise error rate.

Table 2. Analysis of importance of impacts of forages in smallholder farming systems.

Impact indicator	Mean importance (1=Important, 10=Least Important, >11= Not Important)	REGW Multiple Range test (p>0.05)				Fisher's LSD test (p>0.05)			
Provides feed for livestock	5.79	X				X			
Animal safety (theft, accident)	6.15	X				X	X		
Fattens livestock	6.68	X		X			X		
Soil erosion control	7.64		X	X		X			
Provides manure and fertiliser	8.12	X	X			X	X		
Increased livestock price	8.33	X	X			X	X	X	
Cut&carry prevents straying	8.67	X	X	X			X	X	X
Sell feed	8.69	X	X	X			X	X	X
Livestock numbers	8.85	X	X	X		X	X	X	X
Soil fertility	8.97	X	X	X	X	X	X	X	X
Time savings	8.97	X	X	X	X	X	X	X	X
Help with finances	9.09	X	X	X	X	X		X	X
Crop yield	9.11	X	X	X	X	X		X	X
Healthy animals	9.12	X	X	X	X	X	X	X	X
Education and tuition fees	9.29	X		X	X	X	X		X
Labour reduction for women and children	9.37	X		X	X	X	X		X
Livestock dispersal program	9.62	X		X	X	X	X	X	
Animal/human health	9.63	X		X	X	X	X	X	
Landscaping	9.99			X	X		X	X	
Land tenure	10.42				X			X	

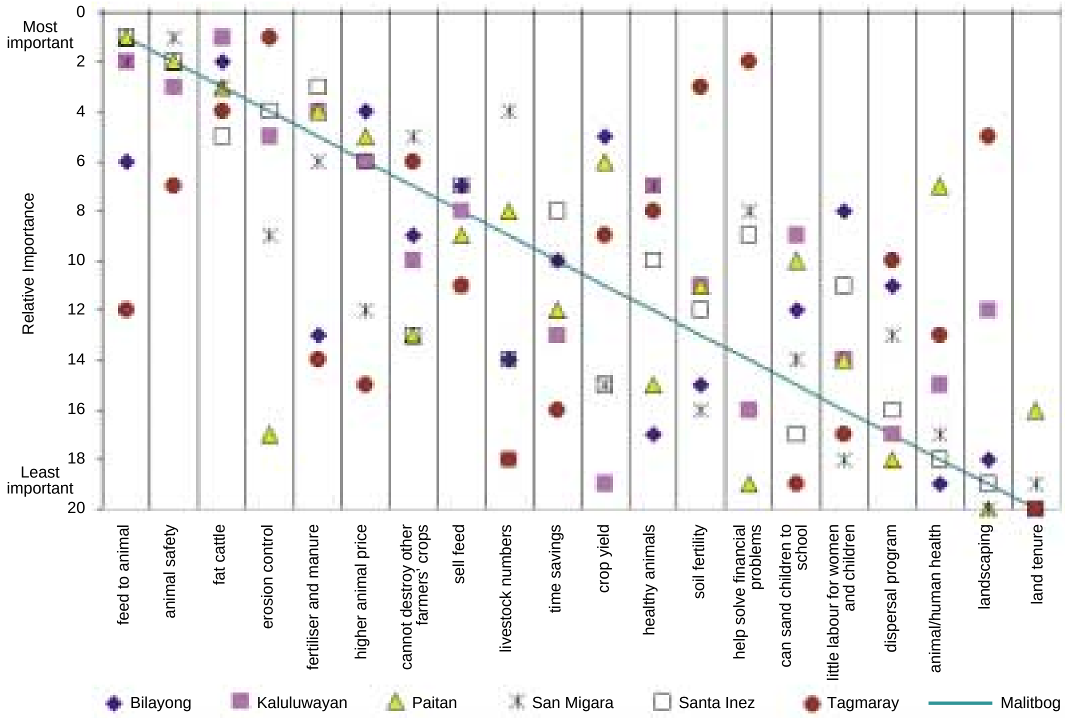

Figure 8. Statistical ranking — relative rankings of each assessment.

Given the results of the ad hoc ranking in the bar-charts, which suggest that there are differences between sites, there is the question of how the results of the statistical analysis (which shows no significant differences between sites) can be reconciled with the results of the ad-hoc ranking scheme.

The number of participants in each of the workshops weights the statistical results, thus differences in rankings in sites with smaller number of participants are diluted by sites with a larger number of participants. This has important implications for policy decisions in reconciling a macro view of rural development with the minutiae of individuals' development in a smallholder farming system. A more detailed dataset, with information on individuals' responses, and their associated demographics, may go part way to identifying critical factors determining how agricultural technologies impact on smallholder farming systems.

Conclusions

Introducing a new agricultural technology into a smallholder farming system can be problematic when trying to reconcile competing interests of the various stakeholder groups. One of the fundamental questions that has to be answered is whether the new technology being introduced has an impact on the farming system and which stakeholder groups benefit (or lose) from that impact. Participatory methodologies applied to impact assessment enable stakeholders to identify, elucidate and rank indicators of potential impact according to their perceived importance by those stakeholder groups.

Not only is it important to have a participatory approach to impact assessment in eliciting the views of all stakeholder groups but it is important to be able to include stakeholder groups in any subsequent analysis of impact. Simple in-field and statistical analysis highlight important impacts and their relationships to each other. Comparing the two approaches, statistical analysis confirms in-field results and indicates that field technicians can apply in-field analysis with confidence.

The results indicate that smallholder farmers are aware of potential benefits of forage technologies to livestock (fattening, feed availability, higher prices) as well as benefits to crops and the environment (fertilizer and manure, soil fertility and reducing erosion). The results also highlight the importance of an inclusive approach to rural development in that the smallholder stakeholders identified benefits not foreseen by scientists and other stakeholder groups (animal safety due to tethering closer to home with a cut-and-carry system, and a reduction in crop damage and associated social tensions).

For Malitbog as a whole the indicators of impact which were perceived to be most important were the ability of forages to provide feed for livestock fattening, and the safety of livestock. In addition, soil erosion control, fertilizer and manure collection, and a higher livestock price were seen as important attributes and outcomes of new forage technologies. The analysis indicates that important impact indicators vary by site; for example, erosion control may not be important for flat areas but is important for steep ones. The analysis also indicates that individual sites and individual farmers have their own characteristics, needs and expectations, and that it is important to get views of all stakeholders.

In conclusion, forage technologies have the potential to have significant positive impacts on farming systems provided that they are tailored to individual requirements. In general, cut and carry species may have greater appeal to farmers from Malitbog since they complement rather than substitute existing pasture and they enable the tethering of livestock closer to home with a concomitant increase in animal safety.

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Monitoring Forage Technology Development – The Adoption Tree

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THE Forages for Smallholders Project (FSP) followed a process of developing forage technologies with smallholder farmers that was based on the principle: 'start small, encourage farmers to innovate and then expand'. During the early stages of this process, when there were only a few farmers testing forages, it was easy to monitor forage development simply by maintaining contact with every farmer (see Figure 1). Very quickly, however, the process became complicated. Each year, new farmers began to evaluate forages for the first time and each year others expanded, maintained or abandoned areas of forages (Figure 2).

This process was made even more complex by the immense diversity that exists between individual households within upland communities, let alone between communities. The opportunities for forages varied greatly between individual households. In the example shown in Figure 2, some farmers planted very large forage areas in the first year and did not need to expand after that. In other cases, they expanded, but only planting small areas each year. Some farmers planted and maintained many forage varieties for different uses, whereas others quickly selected two or three preferred varieties.

Some farmers experimented with new ways of growing the forages and others discovered new uses for forages that they had not initially imagined. The FSP needed to be able not only to monitor these changes but also to try to understand why they were happening and what impacts they were having on farmers' livelihoods.

Simply recording the total numbers of farmers evaluating forages can be very deceiving. The example in Table 1 shows the changes in the total number of farmers working with the FSP in slash-and-burn farming systems. These numbers apparently show an expansion, but it is essential to know how many of the farmers in each year are new farmers and how many dropped out. If the majority of farmers starting to evaluate forages each year were dropping out and being replaced by new farmers, the prospects for forage development would be poor. In this case, 49% of the farmers in 1997 dropped out but only 19% dropped out in 1998. This did not tell us, however, whether any of the farmers whyo were continuing to evaluate forages were planting significant areas. Just measuring the average areas of forage planted, however, can be equally misleading. Often, the variation between farmers was enormous and it was common for a site to have a few farmers growing very large areas while the majority grew forages in small plots.

Table 1. Number of farmers evaluating forages in slash-and-burn farming systems.

Year	Numbers of farmers evaluating forages	Percent of farmers continuing to the next year
1997	83	51%
1998	169	81%
1999	395	–

To be able to offer advice for expanding locally successful forage technologies to new areas, we need a much better understanding of the process of forage technology development, adaptation and adoption in the field so we could answer questions such as:

- what problems was each farmer trying to solve with forages?

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Figure 1. Monitoring forage development in Indonesia by maintaining contact with farmers.

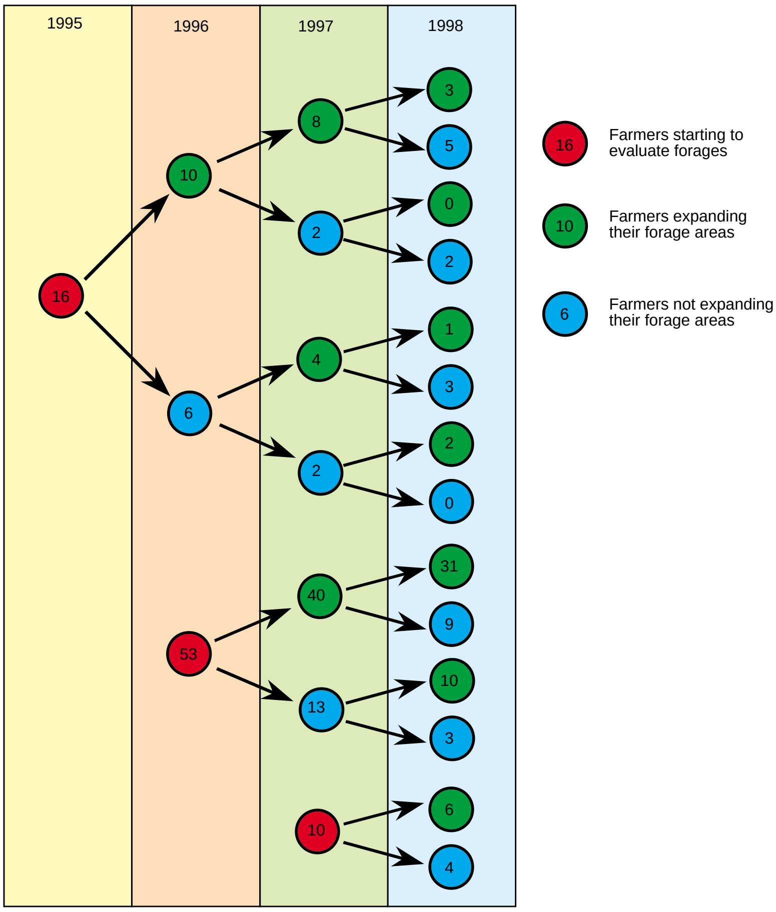

Figure 2. Number of farmers starting to evaluate forages, expanding their areas of forage or maintaining their areas, at Sepaku, East Kalimantan, Indonesia in each of 1995, 1996, 1997 and 1998.

- which forage varieties did each farmer prefer and why?
- which ways of growing and using forages were proving successful and why?
- which farmers were gaining the most benefits from forages and what were these benefits?
- why did some farmers abandon or not expand their forage plots?
- will new farmers more-rapidly adopt integrated forage systems once other farmers in the same area have been using these systems for some time?

What is the 'Adoption Tree'

The 'Adoption Tree' is a survey tool that was developed by the FSP to monitor the changes that occur in forage development for each individual farmer every year. A separate evaluation tool for evaluating farmers' perceptions of forage varieties (participatory evaluation) was often conducted at the same time (for details see Tuhuele et al. 2000). The 'Adoption Tree' is a mixture of survey questions and interactive evaluation tools that gave us information on:

1. Farmers' livelihood activities and forage development:
   - farmers' perceptions on the current and potential future impact of forages;
   - their livelihood (e.g. family members, people working on the farm);
   - their livelihood (e.g. agricultural income, off-farm income, and own consumption);
   - their crop and livestock systems (e.g. farm size, cropping system, livestock types, numbers and purpose, access to grazing land);
   - how important livestock are to them and their major problems with raising livestock;
   - which forages they are developing and how they are being integrated on farms (e.g. varieties, areas, forage system, and utilisation).
2. Impact of forage technologies:
   - farmers' perceptions on the current and potential future impact of forages;
   - how forages are spreading to new farmers in each location;
   - how farmers would like to develop their forage systems (helping the development worker decide what information and planting materials might be required).

The time needed for conducting the 'Adoption Tree' varied from 15 minutes to 1.5 hours depending on the complexity of the farming system and the experience of the recorder. In 1999, the 'Adoption Tree' was conducted with more than 800 farmers at 13 sites in four countries (Table 2).

Table 2. Implementation of the Adoption Tree in 1999.

Systems	Countries	Number of sites	Farmers
Grasslands	Indonesia, Vietnam	2	109
Slash-and-burn	Laos	3	178
Mixed upland cropping	Philippines, Indonesia, Vietnam	6	265
Extensive upland cropping	Indonesia	2	307

The 'Adoption Tree' will be repeated annually (with a sub-sample of farmers representing different wealth, gender and ethnic groups, where necessary) to follow the changes in forage technology development and farmers' perceptions of technologies and impacts.

Conventional economic impact assessment is normally based on collecting detailed economic and farm production data for partial farm budget analysis and other economic indicators. This requires substantial time, highly-skilled staff and is sensitive to the huge variability in basic economic variables that characterise upland farming systems. A separate study has been conducted in collaboration with the FSP to assess alternative approaches to measuring impact on smallholder farms, with the goal of producing a framework for impact assessment that can be implemented by development workers (Purcell et al. 2000).

Understanding the Process of Forage Technology Development

The 'Adoption Tree' has helped us better understand the process of forage development in different farming systems and countries. Apart from monitoring technology development, it has helped quantify the 'intermediate outcomes' (such as adoption and spread of the technologies) that lead towards impacts.

Often these impacts (such as improved household income) are not easy to measure or attribute to particular technological improvements. This is especially the case in smallholder livestock systems where one of the main reasons for keeping livestock is to provide livelihood security. Other impacts are easier to measure, such as where farmers develop forage technologies to reduce the amount of time they spend each day cutting grass for their penned animals.

The results of the 'Adoption Tree' are not presented here, as they have been the basis of many of the papers reporting the experiences of the FSP in these Proceedings (e.g. Nacalaban et al. 2000; Ibrahim et al. 2000). However, several common lessons emerged from the data, across all farming systems and countries. Two of the most important lessons are:

- Regardless of their farming system, almost all farmers started by evaluating forage varieties in small plots. They wanted answers to questions like 'how well do these plants grow in the dry season?', 'how easy are they to manage?' and 'will my animals eat them?'. Only when they were confident with the varieties did farmers experiment with different ways of integrating them on their farms. This may explain why attempts to 'photocopy' technologies from one location to another (for example, hedgerows of tree legumes for erosion control in sloping lands) often fail. That is, the technologies cannot be separated from the process of active farmers' involvement in education, adaptation and adoption.
- Although forages can provide some substantial benefits for natural resource management (e.g. improving soil fertility, controlling erosion and controlling weeds), livestock feeding is normally the entry point for forages into farming systems. The most successful forage developments have occurred at sites where livestock are important to household livelihoods and where feed resources are severely limited.

Some Lessons Learned . . .

The 'Adoption Tree' is being modified from many lessons learned during the first year of field implementation. These include:

- The same people should be involved in field recording, data entry and analysis. Separating these tasks resulted in difficulties in interpreting field recording forms and a feeling among the recorders that data collection was 'just another job' in a process they did not own and which did not provide them any benefits.
- Hands-on training of field recorders is critical to ensure that information collected clearly addresses the question and is an accurate record of farmers' comments. Difficulties often arose from different concepts of what 'accuracy' is required in the answers to the questions. Some field recorders found it difficult to judge the amount of information needed to adequately answer the questions. Active involvement of field recorders in data encoding, inputting and analysis can overcome these problems.
- Different stakeholders (e.g. farmers, extension workers, donors, local government) have different needs for information arising from the project. While some stakeholders are interested mainly in 'intermediate outcomes', others need a clear understanding of the process of technology development and others may not have a need for recording at all. Finding a compromise to address all needs adequately is important in ensuring a feeling of ownership of the results and the process by all stakeholders. Alternatively, different monitoring tools may need to be developed for different needs.
- Monitoring all farmers at the same level of detail was both impossible and unnecessary. In future, all farmers will be monitored at a very basic level and some (based on stratifying farmers according to wealth, gender and ethnic group) will be monitored in more detail.
- Farmers responded very well to active evaluation needs, especially those based on weighting techniques. With weighting, farmers allocate a number of counters to answers which then give not only a ranking but also their relative importance. Farmers had little difficulty in allocating counters in quite complex matrices.
- Qualitative responses from farmers are valuable but must be categorised for entry into the database to be useful.

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Future Directions

Presentations at this meeting clearly demonstrated that improved forage technologies can contribute significantly to improving smallholder farming systems by increasing animal production, reducing labour requirements for feeding ruminants and reducing soil erosion in sloping agricultural lands. The participatory approach to technology development has been embraced enthusiastically by development workers involved in the FSP and resulted in adoption of forage technologies by poor upland farmers. Involving farmers in technology development is clearly one way forward in helping them to improve their livelihoods and contribute to better management of the natural resources in these areas.

To sustain and accelerate the progress made with participatory approaches, support is needed on several fronts. There are two groups of people who require further nurturing:

- farmers who are still in early stages of developing well-integrated forage technologies into their farming systems; and
- research and extension workers who are adopting participatory approaches in their work but do not have the full support of their organisations which often still follow a conventional supply-driven approach.

We also need to develop practical methodologies for:

- participatory monitoring and impact assessment to provide continuous feedback to researchers and development workers, and
- participatory approaches to scaling-up. There is a danger that extension services and development projects take technologies developed using participatory approaches and try to 'extend' these technologies to other farmers in a conventional supply-driven process. This is doomed to fail as technologies need to be adapted to suit local needs and conditions, and new participatory approaches to extension are needed to scale-up local successes.

These are some of the challenges lying ahead and we invite readers to join the search for lasting solutions to these problems. Two projects have recently been approved to address some of these challenges. The Asian Development Bank (ADB) is funding a 3-year Southeast Asia regional project 'Developing Sustainable Forage Technologies for Resource-Poor Upland Farmers in Asia' which builds on the outcomes of the Forages for Smallholders Project, and AusAID is funding a 5-year bilateral development project, the 'Forages and Livestock Systems Project', with the Lao PDR.

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