Farmer demand for forages
Tropical forage research for the future — better use of research resources to deliver adoption and benefits to farmers

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Abstract

Successful adoption of forage technology is frequently associated with a need to increase production and income generation. Farmers might be expected to ‘demand’ new forages only when they can see a financial benefit in the short-medium term. Opportunities for farmers to generate income from livestock production are increasing dramatically as demand for animal products increases across Asia and Africa. Most of this increased demand will be met from mixed cropping-livestock enterprises, in which the majority of tropical livestock are currently raised and where production is usually dependent on low-quality crop residues. Forage research in the future will need to provide farmers with the means to meet the increased demand for livestock products. The challenge will be to develop research strategies that identify well adapted forages that can improve livestock production and can be grown within the spatial and temporal constraints of complex and resource-limited mixed cropping-livestock farming systems; in addition, it will be necessary to provide appropriate information on the management and economic benefits of these forages. This paper presents 2 possible approaches.

In a participatory action research program on the use of forage legumes in cropping systems in Zimbabwe, the keys to successful forage adoption in rural communities are seen as: the emerging market for livestock products; a motivated and educated extension service working with a range of research specialists; and the opportunities for beneficial synergies to be exploited from a mixed livestock-maize production system. Focused benchmarking of the communities identified farmers with sufficient resources and appropriate livestock systems to benefit from improved forage.

In a rice-based Indonesian farming system, simulation of forage growth and livestock production is being used to examine the possible whole-of-farm impacts of using planted forages prior to commencement of on-farm research. Identifying the most likely spatial and temporal opportunities for growing forages and incorporating them into the feed calendar can potentially avoid costly on-farm research on practices that have doubtful economic impact; moreover, this approach enables a wide range of options to be compared rapidly.

To avoid the mistakes of the past, researchers need to provide supporting evidence that investment in new forages makes a difference not only to livestock production but also to household income. They will need to focus on farming systems such as mixed crop-livestock systems where farmers have total control over the forage they produce and where adoption can be shown to be economically sustainable. They also need to identify and target those farmers within rural communities with the resource capacity to invest in new farming practices.

Introduction

Livestock production is an important component of many smallholder farming systems throughout the tropics. As well as providing food, such as fish, meat, milk and eggs, livestock are also critical in providing draft power and manure for fertiliser and/or fuel; moreover, livestock often have wider socio-economic roles within the...
community such as financial security. The feed sources for animals in smallholder farming systems are extremely variable but usually comprise a mixture of grazing on communally owned grasslands, cut-and-carry forages from off-farm and the feeding of crop residues.

Without substantial additions in the form of mineral, protein and energy supplements to the diet, both reproductive rates and animal production are almost universally poor within these systems. Despite this low level of animal production, dietary supplements including sown forages have seldom been used until recently because of farmers’ perceptions that they were not needed, the lack of capital or planting materials or the absence of a financial incentive to invest labour and capital in forage production. For many years, the lack of incentive for forage investment resulted in poor adoption of almost all new forage technologies in smallholder systems in tropical Africa and Asia. This is despite many decades of pasture and forage research, and development in these regions. As noted by Squires et al. (1992) and Thomas and Sumberg (1995), the adoption of planted forages by farmers in sub-Saharan Africa has, in the main, been limited. Before considering any further commitment to new tropical forage science in smallholder systems, researchers need to address the following 3 key questions:

• Given the history of forage adoption, why should an increase occur now in the use of improved forages in smallholder systems?
• If such an increase is to occur, what farmers are most likely to adopt forage technology and in what farming systems?
• What have been the constraints to forage adoption and utilisation by these farmers?

This paper attempts to answer these questions in the light of international and regional trends in livestock production and consumption, socio-economic constraints on farmers and the large body of information already available on forage species adaptation and forage management.

International demand for livestock products

The past 10 years have seen remarkable changes in demand for livestock products across the tropical world and the increased demand is predicted to become even more obvious in the future. It has been estimated that milk consumption across the tropics will increase by about 3.2% per annum until the year 2020 (Delgado et al. 1999). Similarly, beef and pork consumption is expected to double in developing countries between 1993 and 2020. This increase in demand is already having, and will continue to have, major impacts on household, farm and even regional economies throughout the tropics. The mixed crop-livestock farming systems of the tropics will be most affected by this increase in demand for livestock products. These systems already produce more than half the meat and most of the world’s milk supply (Blackburn 1998; CAST 1999); more than 85% of the world’s cattle, sheep and goats are held in these mixed systems in the tropics (Gardiner and Devendra 1995).

In several regions of Africa, Asia and the Americas, dairying has become an important and economically attractive enterprise for smallholder farmers. For example, by 1996, more than 400,000 smallholder dairy farmers in Kenya produced about 70% of the country’s market milk (Reynolds et al. 1996). In Thailand, dairy cattle numbers increased 4-fold during the 1990s to meet the increase in demand for milk; by 1999, there were >19,000 smallholder dairy farms in existence (Hare et al. 1999). Similar increases in demand for milk have been recorded in Colombia, South America (Rivas and Holmann 2000). With these rapid increases in livestock production comes demand for new sources of livestock feed.

The increase in demand for livestock products is also having major effects on regional economies and even government policy. The increase in demand for beef in Java, the most populous Indonesian island, has resulted in a rapid decline in local herd sizes on the Indonesian islands of Lombok and Sulawesi. High beef prices have encouraged farmers to market a significant portion of the breeding herd for slaughter. Consequently, beef cattle numbers in South Sulawesi have declined from 1.23 M in 1991 to only 0.84 M in 1997 (FAO 1999). The decline in herd size has had various effects. A number of provincial governments in Indonesia have embarked on research and development programs to improve reproduction and livestock production in Bali cattle with emphasis on developing a better forage basis for the industry. Some provincial governments have also imposed restrictions on livestock exports from their islands.
The rapid increase in demand for livestock products is providing opportunities for farmers to derive income from livestock production and improve the economic sustainability of their farming enterprises. However, it is also providing threats as farmers over-stretch their dependence on limited resources such as communally grazed grasslands, manure and their breeding herds. Improved planted forages have the capacity to provide better quality feed for livestock. How then should the research community prioritise the limited forage research budget to assist farmers to take full advantage of the changing marketplace?

Avenues available to improve livestock production

Smallholder livestock systems throughout the tropics have traditionally been based on low-quality roughage sources from communally owned grasslands and/or crop residues (Ranjhan 1986; Moog 1986; Dzwewela 1993). With both of these sources, total forage available and forage quality are usually limiting for considerable periods of the year. For example, crude protein concentrations in grass and maize stover can be as little as 3 and 6%, respectively (Ndlovu and Sibanda 1996; Makembe and Ndlovu 1996). Consequently, peak milk yields of indigenous animals in Zimbabwe can be as little as 3–5 kg/d (Mutukumira et al. 1996; Pedersen and Madsen 1998). Improving animal production will necessitate additional forage and/or some method of improving diet quality at strategic times throughout the year.

As potential economic benefits from improved animal nutrition become apparent, farmers are becoming far more interested in their feeding options and are making larger investments in animal feed. In Thailand, the purchase of animal feed constitutes almost 60% of a dairy farmer’s direct costs and still productivity is largely limited by feed supply (Hare et al. 1999). Farmers have a number of options for improving diet quality. Feeding concentrates such as urea, phosphorus and molasses can greatly improve overall diet quality and improve livestock production. Such technology has been widely adopted throughout much of the tropics where low quality crop residues are in abundance and form a significant part of the diet. In Zimbabwe, many livestock producers already feed concentrates, while in many parts of Asia, urea-molasses blocks are commonly used.

Over 40 years of research has clearly demonstrated that animal performance can also be improved by providing better nutrition via higher quality grasses, such as fertilised cut-and-carry grasses or by the inclusion of legumes in the diet, (e.g. Humphreys 1991). Despite the well known benefits of improved forages, adoption in smallholder systems, and indeed in extensive production systems in developed countries, has frequently been poor. However, a number of success stories do exist.

In formulating policy on where forage research might be directed, it is important to consider factors that might affect adoption and at least attempt to characterise the farmers most likely to adopt new forage technologies and their farming systems.

Farming systems and control of utilisation

Given their restricted resources, smallholder farmers are necessarily cautious about new investments; they would probably invest in new forages only when they have control over the resultant utilisation. Consequently, investment in new forages for communally grazed grasslands is unlikely until pastoral communities develop strategies for grazing management (Squires et al. 1992). Rather, improved forages are more likely to be planted in mixed cropping-livestock systems where grazing control is usually practised, at least for part of the year. In these farming systems, the challenge for farmers, extension specialists and forage scientists is to identify suitable forage species/cultivars, and to identify the spatial and temporal opportunities to grow those forages.

Which farmers might invest in forage technology?

The availability of well adapted species and sound scientific evidence that improved forages improve livestock production has been insufficient to encourage farmers to make significant investment in forages. Thomas and Sumberg (1995) attributed some part of this reluctance to grow forages to producers being unfamiliar with the concept of investing labour and capital in forages rather than staple crops. Farmers have not
been accustomed to considering forage production as a part of subsistence agriculture. Horne and Stür (1997) argued that, in Asia, the lack of adoption of what are clearly well adapted pasture plants was, in the main, the result of researchers not addressing farmers’ requirements. They stressed the need for farmers to be partners in forage research and development so that researchers can understand better the complexities and forage priorities within farming systems.

Over the last decade, there have been 2 significant changes that affect these views. The first was the already described development of smallholder livestock enterprises that have income-generation, rather than wealth, social status or food security as a cornerstone. The second has been the use of a participatory process in agricultural research, particularly in agricultural research targeting smallholders in developing countries. In fact, participatory action research (PAR) has become commonplace and almost a prerequisite of research programs. Appropriately applied PAR is, by definition, inclusive of the farming community and enables all research partners to be part of the process of developing project aims. Farmers can then see first hand the impact of various experimental treatments on the production of their own crops and livestock.

Despite the increase in income-generating livestock enterprises and the use of PAR, investment in forage technology would not be appropriate for all smallholder livestock farmers. To adopt forage technology, it might be expected that farmers would meet at least the majority of the following criteria:

- They would already have a relatively stable food source. Farmers who struggle to support their families’ needs for rice or maize or other staple food would almost certainly see investment in forage as a high-risk strategy. If these subsistence farmers had available capital for on-farm investment, it would most likely be targeted at improving food production through the purchase of fertiliser, labour for weeding etc.
- They would already have expertise in livestock production and would be in the position to recognise the potential benefits of increased animal production.
- They would have capital available for the investment.
- They would have land available for growing the forage and could envisage a management system that could fit the forages into a cropping cycle. Farmers who perceive that they already have insufficient land for crop production would not be in a position to consider using valuable land for new forages, unless totally new scenarios of land use became available.

- They would already have an established or emerging market system for livestock products available to them.

Forage research for smallholders — where to from here?

Identifying new well adapted forages?

Farmers can produce higher-quality forage through the use of improved grass species, such as napier grass, in conjunction with fertiliser or manure use, or provide high-quality forage through the incorporation of legumes into animal diets. Both strategies have a role and are being used in a range of environments throughout the tropics.

For instance, in Kenya, rapid advancement in the dairy industry has been largely based on the use of napier grass (Pennisetum purpureum) or other Pennisetum spp. Throughout Asia and the Americas, Pennisetum hybrids also form a major component of improved forages but several other species such as Paspalum atratum, Panicum maximum and Brachiaria spp. are also used in various farming systems in the tropics (Horne and Stür 1999).

Legumes to supplement crop residues and grasses are also being adopted much more widely; again, a range of species is already being used. In west Africa, Stylosanthes scabra has been adopted as a supplementary feed and S. guianensis is being used widely in south-east Asia. In sub-Saharan Africa, velvet bean (Mucuna pruriens) and lablab (Lablab purpureus) are being used, while in the Americas, Arachis pintoi and Desmodium ovalifolium have been adopted by smallholder farmers. Horne and Stür (1999) list a range of other legume species that are being used or have potential as forage in smallholder systems in south-east Asia.

In general, the large number of well adapted species identified over many years of research and the range of planted forages being used in some way in diverse environments suggest that finding new forage species and cultivars is not a priority research activity, at least for now.
If the knowledge base for forage adoption can be considered at least adequate, what approaches might the research community take to enhance adoption?

**Forage research — approaches to encourage adoption**

Low adoption rates over the past 40 years indicate that many farmers do not see investment in forages as a priority. If farmers are to take advantage of forage technology to meet livestock market demands, new approaches need to be applied to targeting, designing and conducting research, and providing outcomes to farmers. These approaches include: better identification of those farmers for whom forage planting is a sustainable practice to enhance livestock production and farm income; and better delivery of information on which judgments on planted forages and changes in practice can be made. Two contrasting research projects, which address these approaches in southern Africa and Indonesia, are outlined below.

**Forage research using teams, participatory research and a systems approach: an example from southern Africa**

This model of research has been widely used over the past 10 years (e.g. Horne and Stür 1997; Thorpe 1999) and so cannot be considered novel. Its key elements are its truly participatory approach and the use of a team of scientists and extension specialists who can evaluate the role, management, biological and economic benefits and costs of new planted forages within the whole farm enterprise.

In 1999, a project was initiated to develop forage technology for mixed cropping-livestock systems in southern Africa. Aims of the project, funded by the Australian Centre for International Agricultural Research (ACIAR), included:

- The identification of well adapted legumes for use in rotations with cropping;
- The development of strategies for feeding legumes to supplement maize stover and other low-quality forage; and
- The development of strategies to make the best use of soil nitrogen accumulated during the forage legume phase of the rotation.

Although the project operates in the Limpopo Province of South Africa and near Wedza in Zimbabwe, only the results from Zimbabwe will be discussed here. Farmers have been partners in most aspects of the research program, all of which is taking place on-farm. Most importantly, the project team restricted their research program to groups of farmers who were perceived to have the capacity to change. Communities which might participate in the project were selected according to a number of criteria, the most important of which were:

- Farmers were already producing livestock or milk for marketing;
- It was believed that some members of the community had sufficient capital to consider including inputs in their farming systems;
- At least some farmers had sufficient land to enable them to fallow an area of cropping land each year; and
- The community had access to experienced extension officers who understood their farming practices.

Two communities in close proximity to each other are participating in the project. The Zana II community is a ‘resettlement’ community and has been farming its land, over which the community has tenure, for >20 years. The Dendenyore community is on communal land with none of the farmers having tenure over the land.

Experienced, local extension officers who had a detailed knowledge of the local community undertook initial benchmarking of these communities at the commencement of the project. The aim of the benchmarking was to determine farming practices, production levels, and the consumption and/or sale of agricultural outputs. Several groups of farmers (about 5 farmers/group) were interviewed in each of the communities. Farmers on the communal area of Dendenyore produced maize and some other crops but also produced beef cattle for market. In contrast, farmers from Zana II produced a greater array of crops, were investing in cash crops (such as paprika) and were involved in livestock production that focused on milk production.

The farmers perceived their communities to consist of 3 distinct groups based on wealth. They were able to describe in detail how they saw measures of wealth, based on capital and farming equipment. For instance, farmers in Wealth Group 1 had cultivators, harrows and carts while the poorest households (Wealth Group 3) had no farming implements. Crop yields varied across ‘wealth’ groups. Most of the wealthy farmers had...
up to 1.2 ha of fallow land per year (see Tables 1 and 2). In Zana II, the number of cows/farmer ranged from 2 to 4, while milk yields ranged from 3 to 6 L/day. Off-farm labour was used in the resettlement community of Zana II but not in Dendenyore. In Dendenyore, there was a vast range in the age of finished bullocks (3–10 years) and sale price (Zim$2000–8000/animal).

The benchmarking provided a detailed overview of wealth and farming practice and the relationships between these 2 factors. It also enabled the identification of smallholder farmers in each community who might be best situated to adopt new practices because of their greater wealth and access to inputs. It also provided baseline criteria such as level of animal production, cropped area and grain yields. These baseline data are essential to assessment of project impact in terms of productivity changes; impact assessment will be made at the project’s completion in 2003.

After 3 years of project implementation, research indicates that: velvet bean and lablab are amongst the best-adapted legumes for use in rotation with maize on the acid, light-textured cropping soils; there are large benefits to subsequent maize crops when legumes have been included in a rotation; and both beef and milk production are increased by including legumes in feeds. While none of these results is new, importantly, they have been obtained on-farm, with farmers participating in most aspects of the work. Farmer response to these research results is promising; farmers, who have been part of the project since the beginning, and their neighbours, are sowing lablab or velvet bean in their fallow land at their own expense and initiative, i.e., in addition to planting as part of the research program (see Table 3). They are investing considerable labour into making and storing hay from these legumes in early autumn, and are feeding it to lactating

### Table 1. Resources, crop yields and number of animals for each of 3 wealth groups within the Dendenyore communal farming community (n = 49 households). (US$1 = Zim$60, May 2001).

<table>
<thead>
<tr>
<th>Resource or crop</th>
<th>Wealth group 1 (wealthiest)</th>
<th>Wealth group 2</th>
<th>Wealth group 3 (poorest)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank account</td>
<td>&gt;Zim$5000</td>
<td>Zim$1–4000</td>
<td>&lt;Zim$3000</td>
</tr>
<tr>
<td>Arable land</td>
<td>3–5 ha</td>
<td>2–4 ha</td>
<td>&lt;2 ha</td>
</tr>
<tr>
<td>Maize yields</td>
<td>2 t/ha</td>
<td>1.5 t/ha</td>
<td>0.8 t/ha</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>75 bags/ha</td>
<td>25 bags/ha</td>
<td>12 bags/ha</td>
</tr>
<tr>
<td>Oxen</td>
<td>4</td>
<td>2</td>
<td>Nil</td>
</tr>
<tr>
<td>Cattle</td>
<td>&gt;10</td>
<td>5–9</td>
<td>&lt;5</td>
</tr>
</tbody>
</table>

### Table 2. Resources, crop yields and number of animals for each of 3 wealth groups within the Zana II re-settlement farming community (n = 75 households). (US$1 = Zim$60, May 2001).

<table>
<thead>
<tr>
<th>Resource or crop</th>
<th>Wealth group 1 (wealthiest)</th>
<th>Wealth group 2</th>
<th>Wealth group 3 (poorest)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank account</td>
<td>Zim$10 000–100 000</td>
<td>Zim$1000–9000</td>
<td>&lt;Zim$1000</td>
</tr>
<tr>
<td>Maize yields</td>
<td>3 t/ha</td>
<td>2 t/ha</td>
<td>2 t/ha</td>
</tr>
<tr>
<td>Tobacco</td>
<td>2 t/ha</td>
<td>1.5 t/ha</td>
<td>Nil</td>
</tr>
<tr>
<td>Paprika</td>
<td>2 t/ha</td>
<td>1.25 t/ha</td>
<td>1.0 t/ha</td>
</tr>
<tr>
<td>Farm labour</td>
<td>Up to 3 employed</td>
<td>Occasional</td>
<td>Nil</td>
</tr>
<tr>
<td>Oxen</td>
<td>&gt;4</td>
<td>2</td>
<td>Nil</td>
</tr>
<tr>
<td>Dairy cows</td>
<td>&gt;3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

### Table 3. Changes in the number of farmers using lablab, velvet bean or bana grass and making legume hay for dairy or beef production in Zana II and Dendenyore communities in Zimbabwe since the commencement of the project in 1999.

<table>
<thead>
<tr>
<th>Forage/practice</th>
<th>Zana II community</th>
<th>Dendenyore community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lablab</td>
<td>Nil</td>
<td>4</td>
</tr>
<tr>
<td>Velvet bean</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Bana/napier grass</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Hay making</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>
cows and penned beef animals during the dry season. Supplementing maize stover with lablab hay has increased milk yields (measured by the farmers) significantly from 4–6 to 6–17 L/day. Similar improvements in liveweight gains have been recorded when low-quality forage has been supplemented with lablab hay. Changes in farmer practices, not directly associated with the forage research results per se, have also occurred because of farmers’ perceptions of what can be achieved through better practice (see Table 4). These changes in practice are possibly more important than the research results themselves since farmers are demonstrating that they are willing to make significant investment to achieve change and improve production.

We consider that several factors have been important in achieving the enthusiastic partnership with the farmers in this project and achieving change in practice. These include: the use of a participatory approach; the success of well adapted forages; and a focus on the more wealthy farmers who were exposed to existing dairy and beef marketing practices. Primarily, it is these farmers who have increased the areas sown to legumes outlined in Table 3. However, the teamwork of researchers and extension specialists has been equally important. The team of researchers with expertise in plant adaptation, soil nutrition, crop agronomy and livestock nutrition has enabled a range of issues to be addressed. The role of the extension specialists in the project has enabled researchers to identify better farmers’ needs and priorities. Most importantly, the researchers and extension specialists have worked with farmers to transform research results into on-farm practice.

At this early stage, there is still some doubt as to whether this initial adoption will be sustained; however, evidence of new practice and farmer investment suggests that some of the changes will be sustained.

**Evaluation of forage value in farming systems prior to on-farm research: a project in Sulawesi, Indonesia**

The previously outlined decline in cattle numbers in Sulawesi will inevitably mean that this region will be unable to maintain its role as an exporter of cattle. This outcome will impact on the agricultural and overall economy in a region that is already one of the poorest of the 26 provinces of Indonesia. Based on cattle prices of about 3–4 M rupiah (Rp)/animal (US$ 1 = Rp11 200 at June 2001), the export industry has a gross worth of about US$ 75 M. For individual farmers, cattle sales are extremely important as they provide a means of obtaining a significant cash income, in addition to their income from crop production.

**Table 4.** Descriptive changes in practice as indicators of adoption of legume technology in the Zana II and Dendenyore farming communities in Zimbabwe.

<table>
<thead>
<tr>
<th>Change in practice from 1999 to 2001</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thirty-eight farmers in the community now hold ‘dairy production’ certificates</td>
<td>The demand for dairy certificates has been farmer-driven and was not envisaged in the initial project design</td>
</tr>
<tr>
<td>Three farmers from within the project have attended ‘train the trainers’ courses</td>
<td>This development has been encouraged by both the farmers and the extension specialists</td>
</tr>
<tr>
<td>Fourteen fact sheets have been produced in relation to legumes in the cropping system — four of these have been produced by farmers in partnership with AGRITEX</td>
<td>Some key farmers are recognising their own expertise in certain areas of legume production and use, and have willingly provided key information for these fact sheets</td>
</tr>
<tr>
<td>Some farmers are purchasing additional dairy animals as production increases</td>
<td>This is a strong indication of adoption — with substantial investment being required to purchase these animals</td>
</tr>
<tr>
<td>Farmers are replacing high-cost dairy concentrates with legume hay</td>
<td>Initially the project aimed to improve production of dairy and beef animals by supplementing animals that produced milk primarily from veld grazing. However, more affluent dairy producers have taken the opportunity to reduce costs by replacing concentrates with legume hay while maintaining or increasing milk production</td>
</tr>
<tr>
<td>Farmers in adjacent communities are adopting forage options without the project having any on-farm study in those communities</td>
<td>This is another strong indicator of adoption as the project has had no on-site research here; the on-farm results are being communicated by farmers themselves</td>
</tr>
</tbody>
</table>
that is often limited to subsistence production levels.

Previous research has provided considerable understanding of the complexities of forage and livestock production in rice-based farming systems in south-east Asia (Perkins et al. 1986; Ranjhan 1986), particularly in Sulawesi (Rachmat et al. 1992). However, there has been no quantitative evaluation of the economic costs, benefits and risks of using improved forages to increase livestock production.

In this project, a farming systems analysis approach is being adopted to evaluate the potential impact of improved forages on production of cattle. A simulation modelling approach is being used to provide estimates of forage production, its impact on livestock production, and the possible biophysical interactions between livestock and crop production. Finally, a whole-of-farm economic analysis will be used to evaluate the economic benefits and risks of forage adoption. This combination of simulation and economic analysis provides information to the farmer on the possible on-farm consequences of forage adoption and also provides researchers and funding agencies with evidence on which to base decisions about research investment.

The project focuses on smallholder farmers operating mixed farming systems of: (a) rice, maize, groundnut and cattle; and (b) estate crops, rice and cattle. To date, farmers in these systems rely almost exclusively on cut-and-carry forage, and communal grazing of naturally occurring vegetation and crop residues, as feed for their animals. This is largely because of intensive cropping in the farming systems and hence, the limited opportunity for spatial and temporal placement of improved forages within the farming systems.

Nevertheless, there are various possible opportunities for placement of forages into these farming systems including: placement of forages in communally grazed areas; placement of forages in estate cropping systems; use of herbaceous forages with field cropping (such as relay cropping); and even the placement of forages on bunds. Improving forages in communally grazed areas is notoriously difficult due to the absence of grazing or harvesting management; moreover, sowing forages on bunds in rice paddies offers little potential to provide substantial amounts of forage. The best opportunities for substantially increasing forage production are likely to be the use of herbaceous legumes and grasses in relay cropping (especially in those areas where only one or two crops of rice, peanuts, maize or soybean are grown annually) or in estate crops (especially newly established orchards). The project is concentrating on these two options.

The key questions being addressed are:

- What benefits, if any, to animal production and whole-farm income might be realised from the adoption of high-quality forages?
- What are the related costs and constraints to that adoption?
- Is the use of planted forages ever a viable economic option, and, if so, when and where in the cropping systems might they be produced?
- If planted forages are a viable option, do farmers find the provision of information relating to adoption, in terms of potential economic costs and benefits, useful in decision making?

Providing answers to these questions should move the research and development of tropical forages in smallholder farming systems forward. The topic needs to progress from species evaluations and the description of farming systems, to a consideration of the broader issue of technology adoption by smallholders. In particular, it needs to concentrate on the potential use and impact of high-quality forages on livestock production and whole-farm income in rainfed cropping systems.

Conclusions

Despite almost 50 years of investment in forage research in the tropics, forage adoption has been relatively poor across all tropical farming systems. Yet, there is overwhelming evidence that planted forages can make a substantial impact on livestock production. When considered together, these two facts suggest serious flaws in the research community’s understanding of smallholder farming systems and of how farmers perceive forages. The lack of adoption of well adapted plants also demands that researchers and extension specialists must themselves adopt a new paradigm — one that ‘recognises’ the socio-economic factors affecting adoption and is also dominated by socio-economic considerations. Forages are not a commodity in themselves but a means to providing livestock products. As such, they are not usually high on a farmer’s list of
priorities. It is now time that forage researchers place more emphasis on providing evidence to farmers of the economic benefits and costs of forages.

As most livestock in the tropics are in mixed crop-livestock systems, research and development (R&D) providers must prioritise these systems. Of course, this is not a new approach and undoubtedly the majority of forage research being conducted today is aimed at these farming systems. It is here that forages potentially play a large role in supplementing the crop residues that form the bulk of feed resources in many production systems. The major question is how much, if any, resources should be aimed at open grazing/communal land situations where, in the developing world at least, there is rarely any control over grazing. In such circumstances, any judicious farmer would be unwilling to invest resources, as the return on that investment would be shared with others. In these situations, until control of grazing can be implemented, further research and development on new forage plants or other management practices cannot be justified. Instead, investment to demonstrate to decision makers the benefits of implementing change, especially in grazing control, within the socio-economic constraints of the community would be a potentially better use of R&D resources.

Given past difficulties in achieving adoption, R&D providers may need to relinquish their often-desired aim of introducing forage development amongst the most resource-poor farmers. These farmers, by definition, are the most sensitive to risk and are most unlikely to adopt new forage technologies. In most smallholder systems, these poorest farmers have little or no land in addition to their cropping land; thus, they do not have land on which to grow forages and seldom have the cash reserves necessary for new initiatives. Instead, more receptive targets for adoption might be farmers who have access to resources for investment and who are more able to take risks.

The forage research environment has changed considerably over the past decade. Research funding for forage genetic resources, species evaluation and forage management has decreased greatly. At the same time, new R&D forage programs that consider socio-economic factors are becoming more prevalent as evidenced by several papers in these proceedings. An even more recent research theme has been the use of simulation modelling of forage and animal production. The judicious combination of research on socio-economic factors, simulation modelling and economic analysis appears to offer the best hope in helping farmers to develop farming practices which enable them to take advantage of the rapid increase in consumption of livestock products and improved market conditions.

References


