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The Uptake of Fodder Shrubs among Smallholders in East Africa: Key Elements that Facilitate Widespread Adoption

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Abstract

Fodder shrubs are highly attractive to farmers as protein supplements for their dairy cows because they require little or no cash. Nor do they require land as they are grown along boundaries, pathways, and across the contour to curb soil erosion. But like many agroforestry and natural resource management practices, fodder shrubs are "knowledge intensive", that is, they require considerable skills that most farmers do not have such as raising seedlings in a nursery, pruning trees, and feeding the leaves to livestock. Because of the difficulty in acquiring knowledge and skills and at times, seed, the technology does not spread easily. Nevertheless, over the past 10 years, about 200,000 farmers in Kenya, Uganda, Rwanda, and northern Tanzania have planted fodder shrubs, mostly to feed dairy cows.

This paper highlights 5 key dissemination pathways that have facilitated widespread adoption: (1) large NGOs that promote fodder shrubs, (2) dissemination facilitators who train trainers and provide support to extension providers, (3) farmer-to-farmer dissemination led by a relatively few 'master disseminators', (4) private seed vendors, and (5) civil society campaigns that bring together a range of different stakeholders to sensitize and train farmers.

With formal extension systems in decline throughout Africa, research is needed to better understand how to make these dissemination pathways more efficient and effective for ensuring the sustained uptake of new knowledge intensive practices such as fodder shrubs.

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Introduction

The low quality and quantity of feed resources is the greatest constraint to improving the productivity of livestock in sub-Saharan Africa (Winrock International 1992). Milk demand is concentrated in towns and cities and dairy production has grown rapidly around these, to take advantage of low marketing costs. But farm sizes are also generally small in these peri-urban areas, exacerbating feed constraints. Dairy production is increasing rapidly in the highlands of East Africa, which hosts roughly three million dairy farmers, including some two million in Kenya alone (SDP 2006). Zero-grazing systems are the most common smallholder dairy system; farmers cut and carry feed to their confined dairy cows. Napier grass is the basal feed of choice but its protein content is too low to sustain adequate milk yields. Fodder legumes have been tested in East Africa since the early 1900s as protein supplements but there are few cases of widespread adoption, especially in the smallholder sector (Thomas and Sumberg 1995; Sumberg 2001).

The objective of this paper is to describe and explain the recent rapid and widespread adoption of fodder shrubs in East Africa as protein supplements for dairy cows. First we describe the study area and review research results on fodder shrubs. Next we assess the economic impact of fodder shrubs and dissemination pathways used to promote the practice, highlighting 5 key factors which facilitated rapid adoption. Finally, future challenges are examined.

Study area description

The highlands of East Africa extend across central and western Kenya, westward to Uganda and Rwanda, and to the south in parts of Northern Tanzania. Altitudes range from 1000 m to 2200 m. Rainfall occurs in two seasons, March–June and October–December, and averages 1200 mm to 1500 mm annually. Soils, primarily Nitosols, are deep and of moderate to high fertility. Population density is high, ranging from 300 to over 1,000 persons/km^2. In central Kenya, which has the region's highest numbers and density of dairy cows, farm size averages one to two

hectares. Most farmers have title to their land, and thus their tenure is relatively secure. The main crops are coffee, produced for cash, and maize and beans, produced for food. Most farmers also grow napier grass *(Pennisetum purpureum)* for feeding their dairy cows and they crop their fields continuously because of the shortage of land. About 80% have improved dairy cows, 1.7 cows per family, kept in zero- or minimum-grazing systems. Milk yields average about 8 kg/cow/day and production is for both home consumption and sale. Dairy goats, which are particularly suited to poorer households, are a rapidly growing enterprise (Minae and Nyamai 1988; Murithi 1998; Staal *et al.* 2002).

The main feed source for dairy cows in Kenya is napier grass, supplemented during the dry season with crop residues, such as maize and bean stover, banana leaves and pseudostems, and indigenous fodder shrubs. Commercial dairy meal (composed mainly of maize bran, wheat bran, cotton seed cake, soybean meal and fish meal, and nominally 16% crude protein) is purchased by only a few farmers. Dairy meal use has declined in recent years as farmers complain that the price ratio between dairy meal and milk is unfavourable, that they lack cash to buy the meal, and that it is difficult for them to transport it from the market to their homesteads. Many also suspect its nutritive value, in part because of scandals concerning fraudulent maize seed and agrochemicals sold to farmers (Murithi 1998; Staal *et al*. 2002; Franzel *et al*. 2003).

Smallholder dairy systems in Uganda, northern Tanzania and Rwanda are similar to those in Kenya but the density of dairy farmers and cows is generally lower, as is government extension support and private sector marketing infrastructure.

Research on fodder shrubs

The International Livestock Research Institute and the Kenya Agricultural Research Institute initiated research on fodder shrubs in the late 1980s along the Kenya coast. The first research trials in the highlands, where the vast majority of dairy cows are, were initiated by scientists of KARI, the Kenya Forestry Research

Institute, and ICRAF in the Embu area and were managed by farmers. The trials assessed three promising species: C*alliandra calothyrsus*, *Sesbania sesban*, and *Leucaena leucocephala* to assess performance and to find out where on the farm farmers preferred to plant the shrubs. Because of the limited size of the farms, farmers and researchers focused on integrating the shrubs into the existing cropping systems rather than planting them in pure-stand fodder banks. Two of the species, sesbania *and L. leucocephala* performed poorly. Sesbania did not withstand frequent pruning and *L. leucocephala* was attacked by psyllids (*Heteropsylla cubana).* But calliandra performed well and farmers preferred the following locations and planting arrangements for it:

- Planting in hedges around the farm compound. Hedges are a common feature of homesteads in central Kenya, and have traditionally been planted to relatively unproductive, non-browse species, to prevent free-ranging livestock from eliminating them. But livestock are now confined and there is great potential for replacing unproductive hedges with fodder hedges (Thijssen *et al*. 1993).
- Planting in hedges along contour bunds and terrace edges on sloping land. The shrubs thus help conserve soil and, when kept well pruned, have little effect on adjacent crops.
- Intercropped in lines with Napier grass. Results from intercropping experiments show that introducing calliandra into Napier grass has little effect on the grass yields (Nyaata *et al*. 1998).
- Planting in lines between upper-storey trees. Many farmers plant *Grevillea robusta,* a tree useful for timber and firewood along their boundaries. Fodder shrubs may be planted between the trees in the same line (NARP 1993).

Planting and pruning management have also been examined, especially for calliandra, the best performing and most widely planted species. Seeds are planted in nurseries and then transplanted on the farm at the onset of the rains, after about 3 months in the nursery. Experiments on seedling production have confirmed that the seedlings may be grown ‘bare-root’, that is, raised in seedbeds rather than by

the more expensive, laborious method of raising them in polythene pots (O'Neill *et al*. 1997). Bare-root seedlings are cheaper to produce but sometimes have lower survival rates after transplanting (Wambugu *et al*. 2006).

The shrubs are first pruned for fodder nine to 12 months after transplanting, and pruning is carried out four or five times per year (Roothaert *et al*. 1998). Leafy biomass yields per year rise as pruning frequency decreases and cutting height increases but adjacent crop yields are negatively affected (ICRAF 1992). The most productive compromise is probably in the range of four to six prunings per year at 0.6 to 1 m cutting height, which yields roughly 1.5 kg dry matter (4.5 kg fresh biomass) per tree per year planted at two to three trees per metre in hedges under farmers' conditions. Thus a farmer would need about 500 shrubs to feed a cow throughout the year at a rate of 2 kg dry matter per day, providing about 0.6 kg crude protein. This amount would provide an effective protein supplement to the basal feed of Napier grass and crop residues for increased milk production. A typical farm of 1.5 ha could easily accommodate 500 shrubs without replacing any existing crops. For example, the farm would have available about 500 m of perimeter and several hundred metres in each of three other niches: along terrace edges or bunds, along internal field and homestead boundaries, and in Napier grass plots. As shrubs are planted at a spacing of 50 cm, only 250 m would be needed to plant 500 of them (Paterson *et al*. 1998).

On-farm feeding trials have confirmed the effectiveness of calliandra as a supplement to the basal diet. One kg of dried calliandra (24% crude protein and digestibility of 60% when fed fresh) has about the same amount of digestible protein as 1 kg dairy meal (16% crude protein and 80% digestibility) (Paterson *et al*. 1998); each increases milk production by about 0.75 kg under farm conditions, but the response is variable, depending on such factors as the health of the cow and the quantity and quality of the basal feed (Paterson *et al*. 1998). Koech (2005) found that a sample of 20 farmers in the Embu area, Kenya, reported an average response of 0.8 kg milk from feeding one kilogramme (dry weight) of calliandra. Patterson reported that the effects of calliandra and dairy meal were additive, suggesting that the two feeds are nutritionally interchangeable. Unfortunately, data

are not available for constructing a response curve to show the effect of varying quantities of calliandra on milk production. Calliandra was also found to increase the milk production of dairy goats (Kiruiro *et al.* 1998).

Since calliandra was introduced in the mid-1990s, several other species have also been tested and disseminated. In Kenya, *Leucaena trichandra*, an exotic species, *Morus alba* (mulberry, a naturalized species), and sesbania *(*an indigenous species) are widely grown but are not as common as calliandra. In Rwanda, calliandra and *Leucaena diversifolia*, also exotic, are the most common species. In Uganda, these same two species, and sesbania, are widely grown. In Tanzania, calliandra and *L.leucocephala* are the most widely used species. *Desmodium intortum,* a herbaceous legume, has also been introduced to farmers in Kenya with some success (Sinja *et al*. 2004).

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Economic impact of fodder shrubs

This section presents an analysis of the profitability of *Calliandra calothyrsus*, the most common fodder shrub planted by farmers. First, two different scenarios are presented that can be used to calculate the profitability of calliandra for increasing milk production. Next, other costs and benefits that were not quantified are discussed. Finally, we present the profitability of calliandra under different scenarios and at different locations.

Scenario 1—Calliandra used as a substitute for dairy meal Some farmers use calliandra instead of dairy meal; they thus perceive the benefits of calliandra to be the money they save from not having to buy dairy meal. In the economic analysis, the costs and benefits of feeding a cow 6 kg of fresh calliandra (equivalent to 2 kg of dried calliandra) per day are compared with the costs and benefits of feeding 2 kg of dairy meal, which has about the same quantity of digestible protein and gives roughly the same milk output. Assuming this substitution rate, we compare:

- the benefits of using calliandra, that is, the money saved by not purchasing and transporting the equivalent quantity of dairy meal for protein, with

- the cost of using calliandra, that is, planting, cutting and feeding it—planting costs (including the costs of raising bare-root seedlings) are modest-about $US 6 to $US 8 per 500 shrubs.

Beginning in the 2nd year after planting 500 calliandra shrubs, a farmer's net income increases by about $US 101 to $US 122 a year by using calliandra as a substitute for dairy meal. The increases in income vary by site because of differences in prices and other coefficients by site (Tables 1-2).

Table 1. Selected coefficients and prices used in the economic analysis.

Items	Values
Coefficients	
Calliandra quantity fed per cow per day (equiv. to 2 kg dry)	6 kg fresh
Dairy meal quantity fed per cow per day	2 kg
Milk output per day from 1 kg dry calliandra	0.62 litre
Calliandra leafy biomass yield per tree in year 1	None
Calliandra tree biomass yield per tree per year, year 2–5	1.5 kg (dry)
Shrubs required to feed 1 cow per year	500
Labour in planting calliandra	20-28 shrubs per hour
Labour in cutting and feeding calliandra	15-30 minutes per day
Prices ($ US)	
Dairy meal	$ 0.16-0.18/kg
Seedling cost of production (bare-rooted)	$ 0.50-0.96/100 shrubs
Labour wage rate	$ 0.51-0.79/ day
Milk price (farm gate)	$ 0.13-0.33/litre

Because coefficients and prices often vary by site, values are presented as ranges

2003 Exchange rates: 1 $ US = 1881 Uganda Shillings ;1 $ US = 76 Kenya Shillings

Table 2. Net returns per year earned by fodder shrub farmers at different locations, using different strategies.

Location	Strategy	Net returns ($US per year) for full adopter (farmer with 500 shrubs)	Mean no. of shrubs/ farmer in sample	Net returns ($US per year) for farmer with mean no. of shrubs
Embu, Kenya, 2003	Substitution	101	358	72
	Supplementation	62	358	44
Kisumu, Kenya, 2004	Substitution	122	130	32
	Supplementation	115	130	30
Makono, Uganda, 2003	Substitution	112	280	63
	Supplementation	93	280	52
Kabale, Uganda, 2003	Substitution	102	560	114
	Supplementation	72	560	81
Mean	Substitution	109	332	72
	Supplementation	85	332	56
Grand mean		97	332	64

Notes:
Net returns per year are returns earned beginning in the second year after planting, when farmers start feeding fodder shrubs to their dairy cows.
In some of the areas, the samples were random (e.g., Kisumu) whereas in others, farmers with large numbers of trees were purposively selected (e.g., Kabale and Embu)

Scenario 2-Calliandra used as a supplement to basal diet Here, calliandra is fed in addition to the existing basal diet which may or may not include dairy meal. The cow's diet thus remains the same except that calliandra is added. The farmer does not view calliandra as a substitute for dairy meal or for any other component of the cow's diet, rather it is viewed as a supplement. We compare:

- the benefits of using calliandra, that is, the value of the extra milk produced, with
- the costs of planting, cutting and feeding calliandra

Beginning in the second year after planting 500 calliandra shrubs, a farmer's net income increases by about $US 62 to $US 115 a year by using

calliandra as a supplement for dairy meal (Tables 1-2). As above, the increases in income vary by site and are particularly sensitive to differences in milk prices.

Other benefits and costs

The above analysis does not take into account several other benefits of calliandra, as cited by farmers (Table 3):

- It increases the butterfat content of milk and therefore its 'creaminess' (Patterson *et al.* 1998)
- if used as a supplement, it may improve the cow's health and shorten the calving interval
- it provides firewood, fencing, boundary marking, and erosion control

Nor, does the analysis include the slightly negative impact that a calliandra hedge may have on adjacent crops by shading them or competing with them for moisture and nutrients. It is also important to realise that calliandra may sometimes need to be fed at a higher level to substitute for the same amount of dairy meal, and this will reduce its profitability.

Table 3. Benefits of fodder shrubs according to farmers.

	% of farmers mentioning in	
Type of benefit	Embu area, Kenya	Kabale area, Uganda
Firewood	50	72
Soil fertility improvement	48	72
Improvement in animal health	38	5
Soil erosion control	18	20
Improved creaminess of milk (increase in butter fat)	18	6
Fencing	18	76
Revenue from sale of seedlings	13	9
Stakes	9	70

Percentages sum to greater than 100 because most farmers mentioned several benefits

Economic returns

The analysis thus shows that farmers with 500 calliandra shrubs increase their net income by between $US 62 to $US 122 depending on whether they use it as a substitute or a supplement and depending on where they are located (Table 2). Among the four areas studied, the Kisumu area had the highest profitability, largely because of high milk prices. Returns were lowest in the Embu area, primarily because of low milk prices. The study also assessed the profitability of calliandra according to the actual number of shrubs farmers had. Mean numbers of shrubs were highest in the Kabale sample and lowest in the Kisumu sample. Actual profitability followed the same pattern, highest in Kabale and lowest in Kisumu. The low numbers of shrubs per farmer in the Kisumu area is because fodder shrubs were introduced there only recently, relative to the other three sites. Tree numbers there are likely to increase significantly, due to their high profitability.

Dissemination pathways

Fodder shrubs are highly attractive to farmers because they require little or no cash, nor do they require farmers to take land out of food or other crops. They only inputs required are seed and minimal amounts of labor, which farmers are usually willing to provide. But like many agroforestry and natural resource management practices, fodder shrubs are “knowledge intensive”, that is, they require considerable skills that most farmers do not have such as raising seedlings in a nursery, pruning trees, and feeding the leaves to livestock. Because of the difficulty in acquiring knowledge and skills and at times, seed, the technology does not spread easily.

Nevertheless, the spread of fodder shrubs has been substantial. By 2006, about 10 years after dissemination began in earnest, we found that 224 organizations across Kenya, Uganda, Rwanda, and northern Tanzania were promoting fodder shrubs and that over 200,000 farmers had planted them (Table 4). Numbers of shrubs average 71 to 236 per farmer depending on the country. This is still well below the number needed to feed a single dairy cow: 500. Numbers are

low because (1) many farmers adopt incrementally, they have recently planted and want to see how the shrubs perform before adding more, and (2) many farmers "partially adopt", that is they apply several different strategies for providing protein supplements (herbaceous legumes, dairy meal, etc.) in order to better manage risks of relying on a single strategy.

Table 4. Estimates of numbers of farmers planting fodder shrubs in Kenya, Uganda, Rwanda, and northern Tanzania

Country	Numbers of organizations promoting fodder shrubs	Numbers of farmers planting according to our records	Rough estimate of additional farmers planting	Total
Kenya	60	51,645	30,000	81,645
Uganda	80	77,369	5,000	82,369
Northern Tanzania	15	17,519	10,000	27,519
Rwanda	69	9,590	4,400	13,990
Total	224	156,123	49,400	205,523

Notes and sources

Kenya	Data in records column are from 4 random sample surveys and reports from 23 organizations, mostly from 2004-05. Data in "rough estimates" column include numbers in areas with fodder shrubs for which we have no data (e.g., Coast, Kisii, and Machakos) and increases in Central and Eastern Provinces since 2003 surveys.
Uganda	Data in records column are from surveys in 2003 and 2005 in which 44 organizations reported on numbers of farmers planting fodder shrubs. Data in "rough estimates" column includes numbers in areas we did not include in the survey and 16 organizations who were unable to report on numbers of farmers. Many of the organizations were promoting fodder shrubs primarily for soil conservation.
Northern Tanzania	Data in records column are from 14 organizations in Arusha and Kilimanjaro and estimates of numbers of collectors, planters, processors, and users in Tanga. Data in :"rough estimates" is for farmers in Mbeya, Mwanza, Shinyanga, Tabora and other parts of the country where fodder shrubs are promoted.
Rwanda	Data in records column are from 11 of the organizations that promoted fodder shrubs 2000-2005. In "rough estimate" column, we estimate that each of the other 44 organizations that bought seed helped 100 farmers to plant. Many of the organizations were promoting fodder shrubs primarily for soil conservation.
Total	92 organizations

* Average of all organizations responding, not weighted by the number of farmers reached by each organization

Representatives of 70 organizations promoting fodder shrubs were interviewed and asked to name the most important factor explaining their

achievements in disseminating fodder shrubs. The most important factor, with a mean score of 4.1 on a scale of 0 to 5, was that fodder shrubs met the needs of farmers (Table 5). Other key factors were that the fodder shrubs were profitable, that effective extension approaches were used, and that partnerships with other organizations facilitated success. Less important factors included long-term commitment by key players, farmers' commercial orientation, farmer skill levels, availability of training materials and backstopping from research. That training materials and research support were less important is very telling; the findings suggest that they are not necessary to succeed in helping farmers to plant fodder shrubs. Many of the reasons for the spread have to do with the technology itself, its attractiveness to farmers, and with the socio-economic environment and, in particular, the rapid growth of the smallholder dairy industry in the region.

Table 5. Main factors that have contributed to extension providers' achievements in promoting fodder shrubs.

Factors	Mean Score	Standard deviation
1. Fodder shrubs met a need of farmers	4.1	1.25
2. Use of the fodder shrubs was profitable	3.8	1.30
3. Effective extension approaches were used	3.8	1.45
4. Partnerships with other stakeholders	3.6	1.62
5. Strong and long term commitment by key persons	3.1	1.65
6. Farmers' commercial orientation and openness to new ways	2.8	1.67
7. Availability of written training materials	2.7	1.55
9. Fodder shrubs matched farmer skills	2.5	1.5
8. Backstopping from research	2.2	1.66

Note: 5 means "contributed a lot" and 0 means "did not contribute at all".
The sample size was 70 and included organizations in Kenya, Uganda, Rwanda, and northern Tanzania

Concerning the effective extension approaches mentioned by the extension providers, we feel that five elements were critical for the successful dissemination of the practice:

1*. Large non-governmental organization (NGO) promoters.* In Uganda and Rwanda, a few large, international NGOs facilitated the dissemination of fodder shrubs to many thousands of farmers, accounting for over half of farmers planting in the two countries. Large NGOs were also important in facilitating the spread of the practice in Kenya and Tanzania. Some of the NGOs employed hundreds of extension staff and thus had significant reach. Many were promoting dairy production and wanted to ensure that their farmers had sufficient feed for their cows. Others were primarily promoting agroforestry and were interested in helping farmers plant more trees for a range of purposes, fodder, soil erosion control, and fuel wood.

2. *Dissemination facilitators.* Dissemination facilitators are extension specialists who are knowledgeable about fodder shrubs and whose principal function is to promote their use among extension providers and to support them with training, information and gaining access to seed. Dissemination facilitators are employed by international organizations such as ICRAF or national agricultural research institutes such as the National Agricultural Research Organization of Uganda or Selian Agricultural Research Institute in Arusha, Tanzania. With few exceptions, they were employed through donor financed projects designed to promote fodder shrub adoption. The dissemination facilitators proved to be highly effective. In central Kenya, for example, over a two-year period, a dissemination facilitator assisted 22 organizations and 150 farmer groups comprising 2,600 farmers to establish 250 nurseries and plant over 1,000,000 fodder shrubs (Wambugu *et al.* 2001)

3. *Farmer to farmer dissemination*. Survey results showed that farmers played a critical role in disseminating seed and information to other farmers. A survey of 94 farmers in central Kenya, randomly selected from farmers who had planted fodder shrubs three years before, revealed that 57% had given out planting material (seeds or seedlings) and information to other farmers. On average, those giving out planting material gave to 6.3 other farmers. But what was most astounding was that 5% of the farmers accounted for 66% of all dissemination. These ‘master disseminators’ did not differ from other farmers in any appreciable

way – they included both males and females, and had a range of different ages, levels of education, and farm size. Farmers receiving planting material from other farmers had fairly high rates of success in planting; about 75% were found to have fodder shrubs. One disturbing trend was that while women accounted for 43% of adopters and 37% of farmers disseminating to others, they accounted for only 25% of farmers receiving planting material (Table 6). Nevertheless, farmer disseminators play a key role in promoting fodder shrubs and policy makers need to explore how they can promote them, to substitute for or complement formal extension services.

Table 6. Farmers receiving planting material from other farmers

Source of planting material	Recipients of planting material		
	No. of men	No. of women	Total no. and % of recipients
Individual group members			
-Seedlings from group nursery	45 (75)	15 (25)	60 (100)
-Seedlings from farmers' own nurseries	33 (80)	8 (20)	41 (100)
-Seed from farmers' own shrubs	26 (87)	4 (13)	30 (100)
-Wildings	7 (87)	1 (13)	8 (100)
-Seed from farmers who got seed from group	9 (64)	5 (36)	14 (100)
Groups			
Seed or seedlings from group nurseries	39 (68)	21 (32)	60 (100)
Total	159 (75)	54 (25)	213 (100)

4. *Facilitating seed flows.* Seed availability was a key constraint in many areas. Calliandra, the main species, produces relatively little seed and farmers need to be trained to collect, maintain and treat it before planting. An assessment of the seed market chain found that private seed vendors in western Kenya were effective in providing seed to big institutional suppliers, such as NGOs, but were ineffective in reaching farmers, particularly in central Kenya where the greatest number of potential adopters were (Figure 1). Following the study, ICRAF and its partners assisted seed vendors in central Kenya to form an association, to forge links with seed providers in western Kenya, and to package seeds in small packets for sale to

farmers in central Kenya. Over an eight month period in 2006, 43 seed vendors sold over 1 tonne of seed, a quantity much greater than they had sold previously. A thriving private seed market is a key to sustainable growth in the adoption of fodder shrubs.

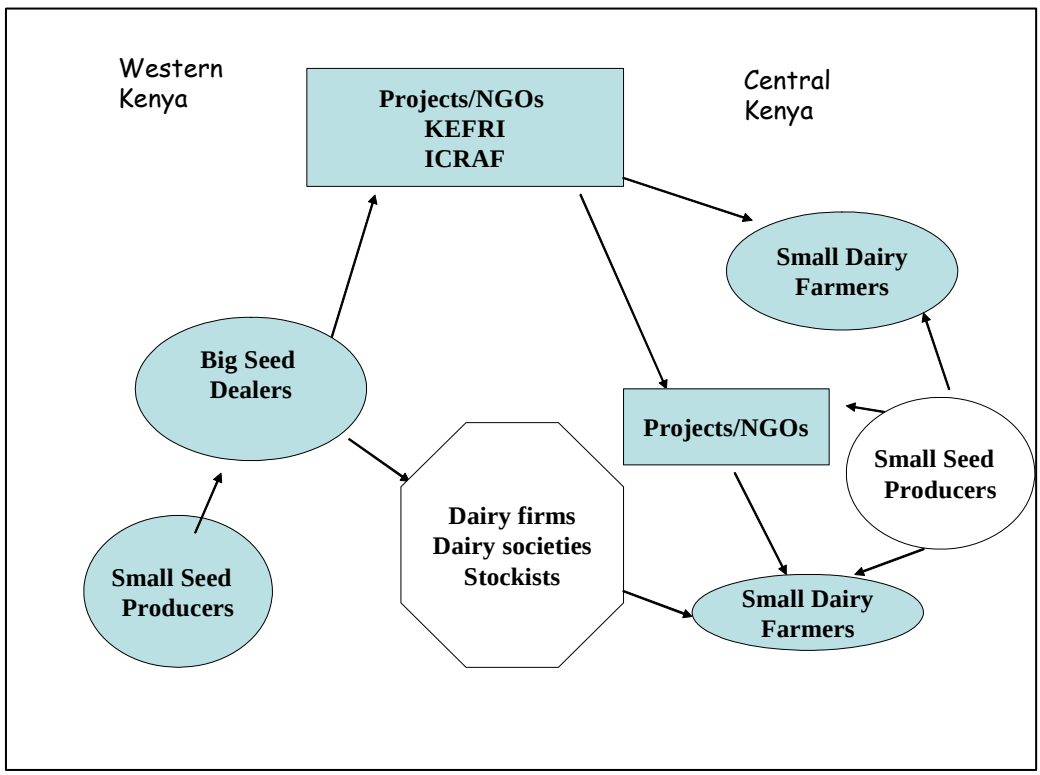

Figure 1. Market chain for calliandra seed.
(Shaded shapes show current status; unshaded shapes show interventions we are supporting)

5. ***Civil society campaigns.*** The dissemination approaches mentioned above involve extension providers, seed vendors and farmers but a much broader set of partners can add significant value in promoting a new technology such as fodder shrubs. The SCALE (System-wide Collaborative Action for Livelihoods and the Environment) methodology brings civil society stakeholders together to plan and implement campaigns to promote new practices (AED 2006). By engaging with a

wide range of stakeholders, representing all aspects of a given system (in this case, dairy production), SCALE generates change across many levels and sectors of society, using a combination of different social change methodologies including advocacy, mass communication and social mobilisation. Our experience with the SCALE approach in central Kenya highlights the effectiveness of civil society campaigns as complements to more conventional extension programs. Religious leaders, the media (radio, TV, the press), private input suppliers, local government administrators, and dairy companies each have a critical role to play in sensitizing and training farmers about new practices such as fodder shrubs. The SCALE approach brings these various actors together into a unitary planning process, enhancing the synergy of their individual efforts.

Future challenges

This paper documents the substantial progress that has been made in promoting fodder shrubs in East Africa. But the 200,000 farmers planting them represent only about 10% of dairy farmers in the region. Because of the information-intensive nature of the technology, it will not spread easily on its own and thus requires outside facilitation. Considerable investments are still required to reach the other dairy farmers and sustain the uptake process. With formal extension systems in decline throughout Africa, more efforts are needed to develop other approaches for spreading the use of fodder shrubs. This paper documented three dissemination approaches that are particularly effective and where greater investment and more research is needed:

- dissemination facilitators to support organizations promoting fodder shrubs offer a high return to investment. These facilitators do not train farmers; rather they train trainers and therefore have a high multiplicative effect in promoting new practices.
- more effort is needed to identify ‘master disseminators’ and support their efforts to extend new practices. Research is needed to determine how best to select them and how to support them. “Contact farmer”

programs focus on expert farmers but these may not be the best disseminators. A critical research activity would be to assess the performance of different 'master disseminators' selected using different criteria, that is, because their colleagues have selected them, because of their past alleged performance in disseminating new practices, or because of other factors. Finally, research is needed on how best to support master disseminators. Is it worthwhile to assist them with transportation (e.g., bicycles) or train them in the use of fodder shrub technologies or extension methods? Can they be assisted to earn cash from providing extension services, either in exchange for the information they provide or through selling inputs such as fodder shrub seeds and seedlings?

- Seed vendors face an array of constraints: NGOs giving out free seed and undercutting their business, government seed centers selling seed to institutional buyers at subsidized prices, and government services demanding licensing fees. Efforts in Kenya have been successful in helping seed vendors to organize themselves and greatly increase their sales and reach. More efforts are needed to support them, by linking them with institutional buyers and lobbying governments for policy reforms to provide them with a level playing field. Efforts are also needed to help seed vendors in other countries to emerge and to organize themselves.
- Civil society campaigns offer great promise for both sensitizing communities about new practices and training farmers in their use. Key questions that research could address concern the scope of the campaign (e.g., fodder shrubs, enriched feeds, or dairy production), the balance between sensitization and training, and the relative importance and effectiveness of involving different types of stakeholders, e.g., the media, religious leaders, and dairy companies.

Finally, investments are needed in two other key areas to sustain progress in fodder shrub adoption and impact:

- Improved species diversification: The range of species currently available to farmers should be expanded to include more indigenous shrubs, in order to reduce the risk of pests and diseases and promote local biodiversity. The most widely planted shrub, calliandra, has numerous qualities that make it attractive: it is easily propagated, it grows fast and withstands frequent pruning, and it does not compete much with adjacent crops. But it is not among the most nutritious of feeds (Hess *et al* 2006); greater efforts are needed to find shrubs that have calliandra's favorable features and are higher in nutritive quality.
- Improved species for marginal environments: Fodder shrub species are currently available for the highlands (1,200 m to 2,000 m) but few are available for higher altitudes or for semi-arid areas.

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