Working Paper

# Production and marketing of leaf meal from fodder shrubs in Tanga, Tanzania

## A pro-poor enterprise for improving livestock productivity

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East Africa

World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

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**Abstract**

This study assesses the production and marketing of *Leucaena leucocephala* leaf meal in the Tanga area of Tanzania, the only location in sub-Saharan Africa where leaf meal is widely marketed. Among the 5400 dairy farmers in the Tanga area, about 61%, 3290, use leaf meal to feed their stall-fed dairy cows or chickens. The other main actors in the market chain are producers, who gather leucaena leaves from the wild or from their farms and dry and crush them into leaf meal, and traders, who buy leaf meal and transport it to the mostly urban and peri-urban consumers. Following a rapid reconnaissance survey, questionnaire surveys were conducted with 28 consumers, 11 traders, and 10 producers. Leaf meal is a key component of dairy rations, as it provides crude digestible protein and metabolic energy at low cost. Retail prices fluctuate considerably, primarily because supplies are reduced during the rainy season, when it is difficult to dry leaf meal and when many producers prefer to work on their farms. Marketing leaf meal is highly competitive, there are few barriers to entry, and returns appear to be relatively low. Proposals for expanding the industry and improving the livelihoods of producers, who are mostly poor women, and traders, who are mainly poor men, focus on improved technologies (improved drying and compressing techniques), institutional innovations (trader associations and expanded price information), and improved policies and extension strategies (exchanging information with Asian leaf meal producers and developing a cross-sectoral advocacy group to mobilize resources and support system improvements).

**Keywords:** Agricultural production, market chains, agricultural economics, marketing, dairy farming, fodder shrubs, leaf meal, *Leucaena leucocephala*, livestock productivity

# Contents

# Introduction

The marketing and processing of raw materials is an important means for increasing smallholder incomes and generating employment. Globally, leaf meal is probably the most widely traded product from fodder shrubs and is found in Indonesia, China, India, Thailand, and Philippines. Asian leaf meal is processed in several different ways, by hand or using simple machinery. It is ground into powder, transformed into pellets and mixed with other feeds in commercial concentrates and mineral supplements. In East Africa, the production and use of fodder shrubs has rapidly increased over the last 15 years but processing and marketing are rare, except around Tanga, Tanzania. There, in northeastern Tanzania near the Indian Ocean, leaf meal is widely processed and marketed and is used in the commercial production of a mineral supplement.

The overall objective of this study is to assess the production and marketing of leaf meal in the Tanga area so as to determine how to improve its performance for the benefit of smallholder producers. Specifically we

- characterize the market chain for leaf meal from collection/production to final use,
- assess the role of the main participants in the market − consumers (leaf meal users), traders, and producers[1] and identify the constraints and opportunities faced by each.
- assess the feasibility of using leaf meal in commercial feed manufacturing as a substitute for other protein sources.

The information generated is used to make recommendations for policy makers, research and extension providers on how fodder shrub leaf meal can be promoted to improve smallholder livelihoods and increase processing and trade of fodder shrub leaf meal. We also make recommendations on how the industry can be introduced to other areas.

[1] Farmers collect Leucaena leaves from their farms or from wild trees growing on public land and dry and crush the leaves at their homesteads to make leaf meal.

# Methods

## Conceptual framework

Sub-sector surveys can play an important role in identifying and solving marketing problems, assessing market opportunities, and improving overall market performance (Scott et al. 1995). Morris (1995) defined a sub-sector as an economic unit of analysis specific to a particular commodity or commodity group (e.g., maize or feed grains). Rapid surveys of sub-sectors examine vertically and horizontally linked economic market relationships such as production, assembly, transportation and storage. Vertically, assessment of the sub-sector extends from input markets, through the production of the product(s) to use by the final consumer. Horizontal relationships refer to the different actors involved at each stage of the production and marketing process.

The market chain (also called market channel) is another useful concept used in sub-sector analysis. Market chains highlight the vertical aspects of a subsector and the linking of each stage of the chain to other stages and to demand (Russell and Franzel 2004; Mendoza 1995). Holtzman (1986) and Abt Associates (1993) highlight the importance of interviewing participants in rural, agricultural markets to characterize the markets and propose technological, institutional, and policy innovations for improving market performance. Lecup and Nicholson (2000) adapt the subsector and market chain approach to the needs of smallholders marketing agroforestry products.

## Study area

The study area encompasses Tanga, Muheza and Pangani Districts in the northeastern corner of Tanzania, bordering Kenya to the north and the Indian Ocean to the east. Soils are deep sands, with more clayey subsoils, and are of low fertility. The landscape is fairly flat, with slopes up to 10% and altitudes are below 200 m. Rainfall averages 800-1400 mm, falling in 2 seasons, April-June, the main season, and October-December, the minor season (Ministry of Agriculture 2003). As in other areas of the East African coast, *Leucaena leucocephala* (‘leucaena’) has become a significant invasive, widespread in bush areas and in the extensive, abandoned sisal plantations of the area. Leucaena is an exotic leguminous shrub originally from Mexico but now pantropically naturalized. Despite its high palatability to many

herbivores, its precocious and prolific seed production makes it one of Africa's most invasive woody species.

The three districts had a population of 567,000 in 2002, of which about 209,000 (37%) live in the city of Tanga (Government of Tanzania 2003). Farm sizes average 3-5 ha and the main cash crop is coconuts. Cashew, citrus, vegetables, and pineapple are also important. The main food crops are cassava, maize, and banana.

Dairy farming increased rapidly during the 1990s. Several Dutch-funded dairy projects, most notably the Tanzania Dairy Development Programme (TDDP) which started in 1985, have promoted the industry and facilitated the distribution of cross-bred heifers for poor and women farmers. Tanga Fresh, Tanga's only milk company, began processing milk in 1995 and buys from about 2,500 farmers. Most of the milk is sold in Dar es Salaam. Munster (1997) reported that women accounted for 45% of the farmers receiving heifers through the TDDP and 26% of farmers purchasing dairy cows. Chicken layers and broilers are also becoming important enterprises in urban and peri-urban Tanga, with poultry farmers each owning several hundred chickens.

## Survey methods

The study began with a rapid reconnaissance survey of the leaf meal subsector at various periods: December 2004, and July and September 2005. The survey was used to broadly characterize the subsector, develop hypotheses, and draw up questionnaires to collect qualitative and quantitative data. Survey team members included 3 economists, 2 animal nutritionists, and 1 agroforester. Those interviewed included producers, traders, consumers (defined as persons feeding leaf meal to their animals), stockists, extension staff, and representatives of dairy companies.

The team returned to the study area in November 2005, to organize and start the formal questionnaire survey. Team members designed 3 different questionnaires, 1 for each of the main actors in the subsector: producers, traders, and consumers. Sample frames were unavailable for the 3 groups; instead, quota sampling was used to interview 28 consumers, 11 traders, and 15 producers. Stockists, extension staff, and interviewees themselves assisted in identifying other persons to be interviewed.

# Results

## Overview of the market chain

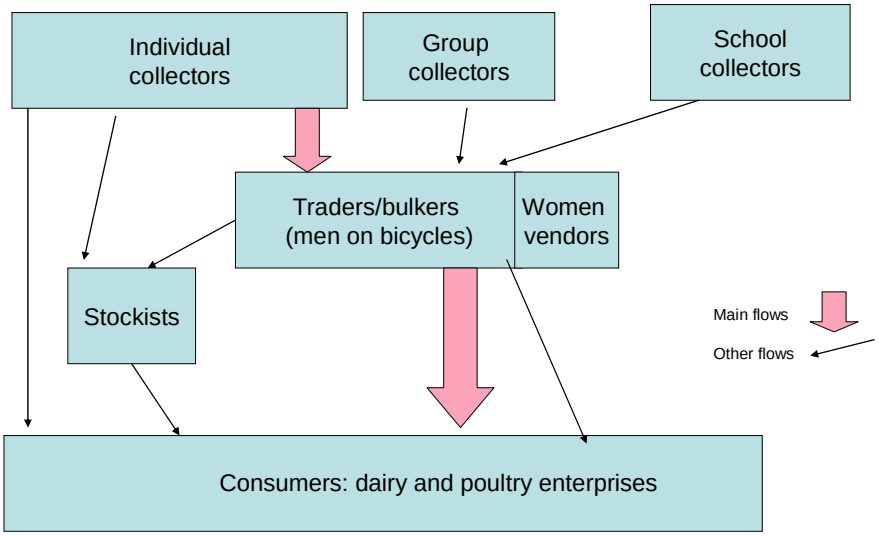
Extensive use of leucaena as a feed began with the TDDP in the late 1980s. The project first worked with primary schools in Maramba, teaching staff and students to dry and crush Leucaena leaves, which they sold to the project to support school activities. Activities later shifted to Pangani, where the project trained women and children to harvest and process leaf meal. The project bought leaf meal by the truckload, subsidizing the cost so that producers could benefit and prices could be kept low for dairy farmers. The big problem faced was the bulkiness of leaf meal, making it expensive to transport. The project tested various ways to reduce bulkiness. For example, a simple machine for making pellets was introduced but a binding agent was needed, such as molasses, and none was locally available. By the late 1990s, project activities supporting leaf meal production and marketing were abandoned.

Around the same time, in the late 1990s, a few traders began organizing farmers to collect leucaena leaves and to dry and crush them into leaf meal. The traders transported the leaf meal by bicycle to Tanga to sell to the many emerging smallholder dairy farmers in the city. The main components of the chain are (Figure 1):

(a) producers, mostly women, who collect leucaena leaves from the wild and dry and crush the leaves into leaf meal,
(b) traders, mostly men, who transport the leaf meal to the towns of Tanga and Muheza, and
(c) consumers: owners of stall-fed dairy and poultry enterprises who buy leaf meal to feed their livestock. These are mostly men but large numbers of women also own dairy cows (Munster 1997).

Several other actors also participate in the chain. In addition to individual producers, some farmer groups and schools also collect and process leaf meal. Where distances between sources and consumers were not great, women vendors transport leaf meal by the headload and sell it in small quantities. Six agro-vet stockists in Tanga also sell leaf meal in their shops. Though only a few consumers use them as their primary source, many appreciate being able to buy leaf meal should their primary supplier fail to deliver to their homes.

Figure 1. Market chain for Leucaena leaf meal, Tanga area, Tanzania




Extension services of the Ministry of Agriculture recommend formulating a supplement for dairy cows by mixing maize bran, cottonseed cake, and leucaena leaf meal in a 3-2-1 ratio. In Muheza the recommended ratio is 3-2-2, perhaps because leaf meal is cheaper and more available there than in Tanga. In fact, the 3 main components are highly complementary, particularly because price fluctuations frequently change their relative profitability (Table 1). The prices of leucaena leaf meal and cottonseed cake fluctuated considerably during 2005; cottonseed cake declined 50% in price from January to September, and leucaena, 34% between April and August. Cottonseed cake has the highest levels of metabolic energy, digestibility, and crude protein, but is also the most expensive feed on a per-kilogramme basis. Maize bran was the cheapest source of metabolic energy in April and August but in November, leucaena leaf meal was equally inexpensive. Cottonseed cake and leucaena provided digestible crude protein at the same cost in April but in August, leucaena was much cheaper while in November, cottonseed cake was cheaper. Given the acute price fluctuations and the complementary nature of the 2 feeds, it is best to use both of them, as the extension service recommends.

Extension records show that there are about 5400 dairy farmers in Tanga, Muheza and Pangani Districts and about 34,000 dairy cows (Table 2). About 61% of the farmers, 3,290, use leucaena leaf meal. About half of these farmers are in the cities of Tanga and Muheza and buy leaf meal to meet their feed needs.

Table 1. Costs of obtaining crude digestible protein and metabolic energy from different sources, 2005

| | Maize bran | Cottonseed cake | Leucaena leaf meal |
|---|---|---|---|
| **Physical coefficients** | | | |
| Dry matter (%) | 85 | 90 | 90 |
| Metabolic energy (Mcal/kg) | 2.32 | 2.81 | 2.19 |
| Digestibility(%) | 65.1 | 78.9 | 61.5 |
| Crude protein (%) | 9.19 | 42.5 | 26.12 |
| Digestible crude protein (%) | 5.09 | 30.18 | 14.46 |
| **Prices and costs** | | | |
| Price/kg April retail (rainy season) | 100 | 300 | 143 |
| Price/kg digestible.crude protein April | 1966 | 994 | 989 |
| Price/kg August retail (dry season) | 100 | 230 | 94 |
| Price/kg digestible.crude protein August | 1966 | 762 | 650 |
| Price/kg November retail | 100 | 200 | 129 |
| Price/kg digestible.crude protein Nov. | 1966 | 663 | 892 |
| Price/kg digestible.crude protein November | 1966 | 364 | 892 |
| Price/kg digestible metabolic energy Apr. | 78 | 150 | 118 |
| Price/kg digestible metabolic energy Aug. | 78 | 115 | 78 |
| Price/kg digestible metabolic energy Nov. | 78 | 100 | 106 |

Table 2. Numbers of dairy farmers and dairy cows in Tanga and Muheza using Leucaena leaf meal

| Area | No. Dairy farmers | No. of dairy cows/farmer | No. of cows | Percentage of dairy farmers using leaf meal | No. dairy farmers using leaf meal |
|---|---|---|---|---|---|
| Muheza town | 200 | 5 | 1000 | 80 | 170 |
| Muheza rural areas | 1800 | 3.5 | 6300 | 60 | 1200 |
| Tanga District | 2400 | 4.6 | 11040 | 60 | 1440 |
| Pangani District | 800 | 20.1 | 16080 | 60 | 640 |
| Total | 5400 | 6.4 | 34420 | 61 | 3290 |

Source: Extension staff. Estimates of the proportion of farmers using leaf meal were not available from Pangani but were assumed to be as high as in Tanga and Muheza, because of the wide availability of leucaena there.

Most of the remainder are in rural areas and usually grow or collect leucaena themselves for their animals. Some of the growers do not actually plant leucaena; rather they allow it to grow once it establishes itself as a weed. No estimates were available on the numbers of traders and producers. Our rough estimate is that the number of traders probably exceeds 100 and that there are over 1.500 producers. While dairy production in the Tanga area is increasing, there appears to be a shift from small-scale (1-2 cows) to medium-scale production (3-6 cows).

### Consumers

Our survey of 28 consumers included 25 dairy farmers and seven poultry producers; four had both enterprises. About 80% of the surveyed households were male-headed; 20% were female-headed. Dairy was the most important enterprise for about half of the households; 4 rely primarily on poultry, and most of the rest on off-farm enterprises. Half of the males had attended secondary school and half, only primary school. Women had much less education; only 1 of 21 had entered secondary school. The dairy and poultry enterprises are associated with relatively high-income farms. Twelve of the households had high levels of well-being (as indicated by house-type and other assets), twelve had middle levels, and only 2 could be considered to be poor.

Twenty-five of the farmers had lactating dairy cows, averaging 3.7 per household. On average, they had 4.6 other cows. Milk yields averaged about 6 litres per lactating cow. Chicken farmers had on average 480 broilers and 312 layers.

Nearly all farmers (25) used maize bran and leaf meal in their dairy rations. Eleven used cottonseed cake, eight used sunflower meal, and 1 used copra. Among farmers using the recommended components, maize bran, cottonseed cake, and leaf meal, the median ratio of the three in their rations was 11-5-3. This ratio is similar to the recommended 3-2-1 ratio but uses slightly more bran and less cake. Few farmers had ever experimented with changing their rations to assess the effect on productivity. Rather, they said that they always tried to follow the recommendations. Some modified their recommendation in response to changes in prices. For example, many farmers reduce or eliminate leaf meal during the rainy season, when it is expensive or not available.

Poultry farmers fed leaf meal at between 2% and 4% of their ration. Their main reason for using leaf meal was that it improves the color of the yolk, changing it from white to a deep orange, making the eggs easier to sell. Farmers also said that leaf meal was nutritious for their chickens.

Two methods were used to determine the amount of leaf meal used by dairy farmers. In the first method, the proportion of leaf meal in the ration was calculated and the quantity fed was derived from the number of kilogrammes of ration fed per day. In the second method, we asked the amount of leaf meal last purchased, the number of days it would last, and the number of cows that were fed. Both methods gave very similar results: a mean of 0.66 (median of 0.52) kg/lactating cow/day for the first method and 0.7 (median of 0.58) kg/lactating cow/day, for the second method (Table 3). Two-thirds of the farmers said that they had varied their use of leaf meal over the past year; most had reduced their use of it during the rainy season because prices were high and quality was poor. At the time of the survey, farmers used an average of 4.3 kg day of leaf meal or about 1300 kg/year/household, assuming that farmers reduced their their use of leaf meal to 2.1 kg/day during the wet months.

Most farmers had first heard about leaf meal from their extension agents; the rest from friends, neighbors, relatives, or research staff. Most consumers purchased leaf meal from traders, who deliver it to their homes by bicycle (Table 4). Others bought from vendors, women who carry leaf meal in basins on their heads. Some in Tanga and Muheza town bought from stockists, but only if they could not procure the amounts they needed from traders and vendors. Stockists' prices were higher than traders and vendors, reflecting their higher costs.

Table 3. Numbers of farmers feeding different quantities of leaf meal per day

| Kg/lactating cow/day | No. farmers estimated from ration fed | No. farmers estimated from quantity purchased |
|---|---|---|
| 0.1-0.5 | 10 | 8 |
| 0.51-1.0 | 8 | 11 |
| 1.1-2 | 3 | 1 |
| Estimate not possible | 4 | 5 |
| Total number of farmers | 25 | 25 |

Table 4. Consumers' sources of leaf meal

| Source | No. of farmers using | Ranked 1st | Ranked 2nd | Ranked 3rd |
|---|---|---|---|---|
| Bicycle traders | 23 | 18 | 4 | 1 |
| Stockists | 15 | 6 | 6 | 1 |
| Vendors | 7 | 7 | | |
| Collect from bush | 6 | 2 | 3 | 1 |
| Own farm | 2 | 0 | 2 | |
| Total | 28 | 33[a] | 15 | 3 |

[a]. Sums total to greater than the size of the sample because some farmers ranked two sources as first

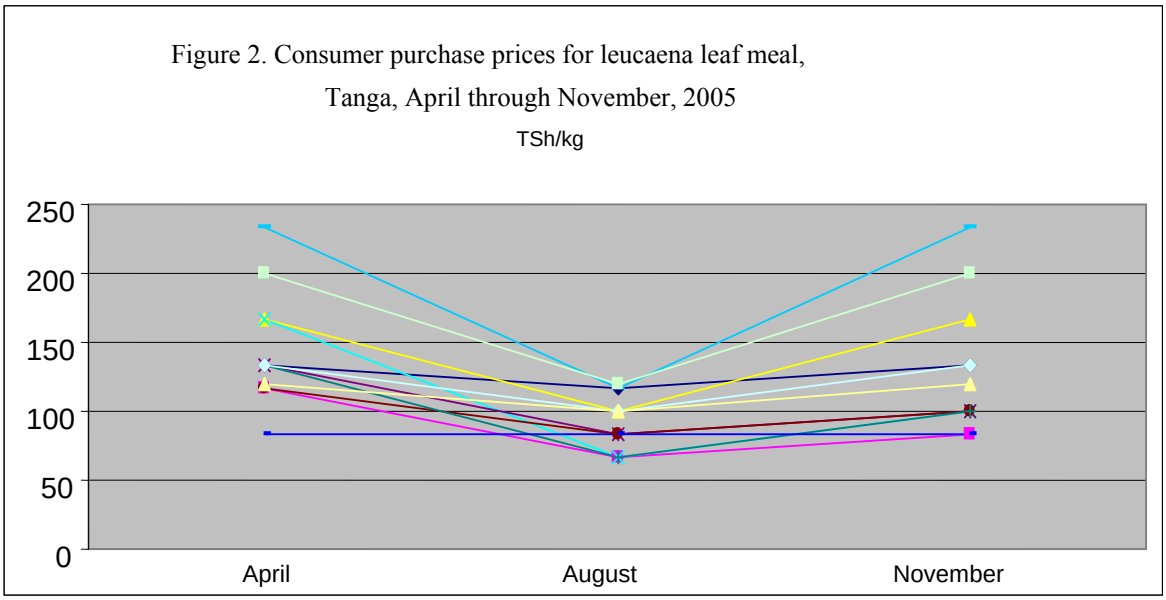
Most farmers (59%) bought quantities sufficient to last them for 1-2 months; only 18% bought a week's supply or less.

Eight farmers (28%) occasionally fed fresh leucaena, picked from their farms or common areas. Feeding of fresh leaves was evenly divided between the wet and dry seasons. Eight had also planted leucaena, either in plots or as live fences.

Farmers' reasons for using leaf meal were primarily to increase milk production (15 farmers), improve milk quality (three farmers), improve animal health (three farmers) and to save money, because they considered it to be a cheaper source of nutrients than other supplements (three farmers). Leaf meal's main disadvantages were its poor quality and high price during rainy seasons. At times it is not even available. Two farmers noted that leaf meal is sometimes sandy or dirty, reducing its feed quality.

Consumers in Tanga reported that they purchased leaf meal during October-November 2005 at an average price of 129 TSh1/kg ($US 1.00 = 1160 Tanzania Shilling(TSh) in November 2005). Prices ranged from 83 to 233 Tsh/kg (Coefficient of variation = 0.36) (Figure 2).

Figure 2. Consumer purchase prices for leucaena leaf meal, Tanga, April through November, 2005




Ten consumers purchased leafmeal by the "debe" (a kerosene tin or its equivalent), 3 by the kilogramme, and 2 by the gunia bag. The weight of leaf meal may vary for a given volume measure but when traders sell to consumers, a debe weighs about 3kg and a bag, about 18 kg. In contrast, when traders transport leaf meal to town, they pack it more tightly, getting 30 kg (10 debes) into a bag. Prices are highest during the rainy season in April, when they averaged 143 TSh/kg and lowest during the dry

season in August, when they declined to 94 TSh/kg. The percentage increase from the lowest price to the highest is only 52%, well within the range of other agricultural produce. In fact, prices cannot rise very high, because farmers will substitute other protein supplements for leaf meal. Nor can they drop very low, because producers will refuse to collect leaf meal at very low prices. Price variation during a single month is also fairly low, coefficients of variation ranged from 22% during the dry season to 28% during the wet season. Price variation was highest during October-November, the minor wet season, which in fact was fairly dry in 2005. The coefficient of variation was 36%.

Prices in Muheza and Pangani were considerably lower than in Tanga, reflecting the more widespread supply of leucaena in those areas and lower demand, as the cattle population was more rural than in Tanga. In Muheza, prices averaged 87 TSh/kg during the main rainy season, 67 TSh/kg during the dry season, and were at 83 TSh/kg during the survey. Pangani prices were even lower: 52 TSh/kg during the rainy season, 42 during the dry season, and 42 during Ocober-November.

**Traders**

Our survey of eleven traders included five in Pangani, five in Muheza, and one in Tanga. Eight of ten had started between 1998 and 2001; the other two had started earlier. Their reasons for starting in the leaf meal trade involved their interest in generating income without a large capital investment, as well as requests from livestock owners in Tanga to find leaf meal for them. Ten traders were male and one was female. Average age was 42 and only 3 of 11 had more than a primary school education. All were farmers with no other source of off-farm income other than selling leaf meal. Maize was the most important cash source for 4 traders, cassava for 3, and leaf meal for 2. Leaf meal was the second most important cash source for 8 of the traders.

All of the traders bought leaf meal from farmers within their own villages; only 1 bought from farmers outside. On average, they each bought from 23 other farmers (median = 13). Six of ten said they had trouble at times getting the supplies they needed; five cited problems during the wet season and 1 during the dry season. Traders had trouble procuring leaf meal during the wet season because producers find it difficult to dry the leaves during rainy periods. Furthermore, producers are busy cultivating their own farms and do not have time to collect leucaena. Flexible financial arrangements with their suppliers permitted them to offer incentives when supplies were low. Thus, five occasionally paid producers in advance in order to ensure a steady supply of leaf meal. Three occasionally paid their suppliers after collection, because they were selling on credit.

Traders made about two trips per week during the rainy season to their selling destination (primarily Tanga) and five during the dry season, when leaf meal is more abundant and both producers and traders have fewer farm activities. A single trip generally takes a full day, including assembling, transporting, and delivering. Bicycles are the main means of transport and traders carried roughly 70 kg per trip in the rainy season and 90 kg per trip during the dry season. A few women transport leaf meal by bus from Muheza to Tanga.

Purchase prices, sale prices, and gross margins for traders buying leaf meal in Muheza and selling it in Tanga are shown in Table 5. Prices are highest during the wet season, reflecting the scarcity of leaf meal. But quantities transported and gross margins per trip are higher during the dry season. Thus a trader earns about, 4200 TSh per trip during the dry season as compared to 2700 TShs during the rainy season.

Main costs, assuming 250 trips to Tanga are:

(1) the cost of capital as cash must be available for paying suppliers daily, 5,000 TSh tied up for 1 year at 50% interest /250 trips = **10 TSh/trip**
(2) maintenance of the bicycle = 10,000 TSh/yr, 250 trips per year = **40 TSh/trip**
(3) tires cost 8400 TSh/2 yrs/250 trips = **17 TSh/trip**
(4) depreciation of the bicycle = 75,000 TSh/5 years/250 trips = **60 Tsh/trip**
(5) bags 300 TSh/bag x 10/2 yrs/250 trips = **6 TSh/trip**
**Subtotal = 133 TSh/trip**

Table 5. Average trader purchase prices, sale prices, and gross margins, rainy season and dry season, 2005

| | Rainy season | Dry season |
|---|---|---|
| Purchase price, TSh/kg, Muheza | 72 | 50 |
| Sale price TSh/kg, Tanga | 113 | 100 |
| Margin TSh/kg | 41 | 50 |
| Average quantity transported kg/trip | 66 | 84 |
| Gross margin TSh/trip | 2706 | 4200 |

Average figures for 5 traders buying in Muheza and selling in Tanga.

Costs are fairly low, only 133 TSh/trip, plus the value of the trader's labour, estimated at 1,000 TSh/day, the average wage for casual labor in rural areas. Net returns per day of leaf meal trading thus earn a trader 2.5-4 times the daily wage rate. These returns appear to be reasonable, that is, they are probably not much higher or lower than other similar trading enterprises in the area that have low capital costs. The high degree of competition among leaf meal traders and the ease with which new persons can enter the trade ensure that returns are kept at relatively low levels.

Eight of nine traders sold leaf meal mainly to livestock owners, 1 sold mainly to stockists and 3 others sold to stockists in addition to livestock owners. Seven of eleven traders sold throughout the year, while 4 did not sell during the rainy season, due to the low availability of leaf meal.

Traders have two main criteria for assessing quality of leaf meal: nine mentioned that it has to be well sorted and clean and eight noted that a deep green color is associated with high quality. Two stated that they do not buy leaf meal if the quality is low, five mentioned that they may buy but at a low price. One stated that his buying price was constant regardless of quality. Traders appeared to be less concerned about quality when they sold their leaf meal, probably because their customers were less concerned. Thus, only two mentioned that they have to reduce their price if selling low quality leaf meal and three said that their prices were constant regardless of quality. Two mentioned that if they received low quality leaf meal, they were sure to hide it by mixing it with higher quality leaf meal.

Traders claimed that poor transport was the main constraint limiting their business. The amount they could pack on their bicycle was the maximum amount they could trade in a day. Other problems included lack of capital and unstable prices and supplies, especially during the rainy season. Nevertheless, 7 of 11 traders had plans to expand their business. Specific plans included to hire an assistant, buy a second bicycle, store leaf meal for sale during the rainy season, and supply leaf meal to other urban centers, such as Dar es Salaam and Mombasa.

### Stockists

The six agro-vet stockists in Tanga all sell leaf meal. Most started selling it in 1998-2000, following its promotion by the Tanzania Dairy Development Project. The stockists purchase from traders who bring the leaf meal to their shops. Most customers are from Tanga; they purchase quantities of 10 kg to 50 kg. There are also a few large-scale buyers from Lushoto and Dar es Salaam, who buy 500 kg at a time.

Like the consumers and traders, the stockists did not have information on the nutrient content of leaf meal or other feeds. They do, however, know the extension recommendations for feed rations and suggest these to farmers. Some even employ an extension agent who advises farmers on livestock management.

The numbers of customers buying leaf meal ranged from about 20 to 50 per week. Sale prices of leaf meal in August, during the dry season, ranged from 130 TSh/kg to 167 TSh/kg, with an average of 150 TSh/kg. A stockist we visited kept his prices constant throughout the year, even though the price at which he bought leaf meal was 21% higher than the dry season price. During the first ten months of 2005, 55% of his

sales were during the rainy months of April, May, and June, when leaf meal is most scarce. The stockist said that he often ran out of leaf meal during the rainy season because supplies were limited and demand was high. In fact, it appeared that some consumers were unable to get leaf meal during the rainy season from their usual suppliers so they came to the stockist looking for it.

Stockists' retail prices were roughly 48%-67% higher than traders' retail prices, depending on the season. But there were three main reasons why some consumers would prefer to buy from stockists in some instances. First, stockists appeared to pay more attention to providing high quality leaf meal than other traders. Second, if a customer's regular supplier failed to bring leaf meal to his or her home, the consumer would have to buy from a stockist. Third, stockists sell by the kilogramme whereas traders sell by volume measures. Some consumers prefer to buy by the kilogramme since volume measures may vary considerably in weight.

### Producers

Of the 15 persons interviewed collecting leucaena leaves and producing leaf meal, eight were based in Pangani, five in Muheza, and two in Tanga. Nine out of thirteen had stared producing leaf meal between 1997 and 2003 (data were missing for two cases). Eleven out of seventeen adults involved in collecting were female. The average age was 62 for men and 50 for women, considerably higher than for traders. All were primarily farmers; two also had off-farm enterprises selling cooked food. Producing leaf meal was the most important cash-earning enterprise for four farmers, and was the second most important for four others. Twelve out of thirteen producers we interviewed were categorized as poor farmers (data were missing for two cases).

All 15 collected leucaena leaves and made leaf meal during the dry season, only nine collected during the wet season. Farmers' main reasons for not collecting during the rainy season were that (1) rain interfered with collecting and drying, and (2) farmers preferred to work on their crop fields, to ensure sufficient food for their families. Those collecting during the rainy season collected four days per week, spending about three hours per day. The average trip involved one woman accompanied by one child; men were less frequently involved. Some were able to combine a trip to work on their crop fields with the collection of leucaena leaves. Farmers made about the same number of trips during the dry season as the wet season but were able to make more leaf meal, 17kg vs. 9 kg, during the rainy season. Returns to labor from leaf meal were low, only 558 TSh per 6-hour day during the rainy season, when farmers can often earn 1,000 TSh working as a casual laborer. Returns to labor from collecting

leaf meal were about 47% higher during the dry season, 821 TSh/day, than during the rainy season (Table 6). Farmers were particularly appreciative of their earnings from leaf meal during the dry season because there were few other opportunities to earn money.

The use of leucaena for other products is not common; only 2 of 15 used leucaena for fire wood and only 2 used the leaves for green manure. Only 1 had ever planted leucaena although 2 others mentioned the planting of leucaena as a possible solution to the problem of the tediousness of collecting it from the wild.

Table 6. Costs and returns for collecting leaf meal, Muheza

| | Rainy season | Dry season |
|---|---|---|
| **Work hours/trip** | | |
| -Travel to source | 2 | 2.8 |
| -Collecting leaves | 1 | 2.8 |
| -Drying[1] | 2.5 | 1.4 |
| -Beating/sorting | 0.6 | 0.7 |
| -Total work hours | 6.1 | 7.7 |
| | | |
| No. adults participating | 1 | 1 |
| No. children participating[2] | 0.8 | 1.4 |
| Total no. workdays per trip[2] | 7.6 | 11.6 |
| **Net returns/trip** | | |
| Quantity leafmeal sold | 9 | 17 |
| Leafmeal price | 63 | 62 |
| Value of sales | 567 | 1054 |
| Returns to labor (per 6 hour day) | 558 | 821 |

1 Since farmers can perform other tasks while drying, we costed drying at only 1/4 of the actual hours spent

2. Children participate in travel and collection but we did not include their labor in the analysis.

In addition to the dry season income leaf meal provided, producers also appreciated that the enterprise required no cash investment and, when supplies were close by, little labor. The main problem with the enterprise was that it was tedious, especially when supplies were not close by, and the market was poor, especially during the rainy season.

Farmers reported that there were virtually no controls over the harvesting of leucaena, it was collected from common areas or abandoned sisal plantations. There were also no reports of conflicts among producers over access to leucaena. A few farmers near Tanga reported that supplies were limited during the dry season in areas they collected from, because tree growth was slow during dry periods. Leaves were plentiful during the rainy season but many farmers did not collect because drying the

leaves was difficult and they had other farm activities that received higher priority. Some key informants expressed concern over whether new policies to sell off abandoned sisal plantations to private entrepreneurs may result in producers having less access to leucaena supplies. Apparently, sisal prices are more favorable than previously and entrepreneurs are interested in restarting the plantations.

One curious finding was that, in contrast to consumers and traders, producers faced the same prices in the dry season as in the wet season (Tables 6 and 7). Retail prices in Tanga, as cited by consumers themselves, were on average 52% higher during the rainy season than during the dry season. For traders buying leaf meal in Muheza and Tanga, rainy season prices exceeded dry season prices by 44%; traders' sale prices were 13% higher during the rainy season.[2] But the mean prices at which producers sold their leaf meal was exactly the same during the two seasons. This is odd as leaf meal is clearly in deficit in Tanga during the rainy season; a higher offer price to producers could help reduce scarcity.

Table 7. Leucaena leaf meal prices faced by different market participants, Tanga and Muheza, 2005

| | April (rainy season) | August (dry season) | % difference |
|---|---|---|---|
| Consumers' purchase price | 143 | 94 | 52 |
| Traders' sale price | 113 | 100 | 13 |
| Stockists' sale price | 167 | 167 | 0 |
| Traders' purchase price | 72 | 50 | 44 |
| Stockists' purchase price | 105 | 87 | 21 |
| Producers' sale price | 63 | 62 | 1 |
| | | | |

## Feasibility of using leaf meal in commercial feed manufacturing

No commercial feeds are produced in Tanga, the nearest feed producers are in Dar es Salaam and Arusha, 390 km and 465 km away, respectively. Whereas leucaena leaf meal provides protein and energy in Tanga at similar prices to cottonseed cake (Table 1), leaf meal would be much more expensive if transported to Arusha and Dar es Salaam. The problem is that leaf meal is very bulky, a well packed gunia bag weighs only 30 kg so transportation costs might be 15 TSh/kg or more, raising leaf meal costs

[2] The price at which traders bought and producers sold could be different for several reasons. Some producers sell to stockists and not traders. Moreover the producers interviewed did not necessarily sell to the traders interviewed, nor did the traders interviewed necessarily buy from the producers interviewed.

by about 15-30%. In contrast, cottonseed cake prices in Arusha and Dar es Salaam are lower than in Tanga. Thus, with current leaf meal technology, leaf meal can compete as a feed only in the Tanga area.

Several possibilities exist for increasing the use of leucaena if leaf meal technology can be improved. First, enterprising farmers may find that they can produce leucaena leaf meal at a lower cost if they produce it as a crop rather than collecting it or paying producers to gather it. Mureithi et al. (1994) reported leucaena yields near Mombasa, just across the border from Tanga, at 8 to 13 t/ha/year of dry matter. Even at the lower end of this yield range, assuming labor costs of 1,500/day and 50 workdays per hectare per year after the first year for harvesting and drying, a farmer could produce leaf meal at about 10 TSh/kg instead of 50 TSh/kg, which traders currently pay producers. Moreover, growing Leucaena for leaf meal appears to be much more profitable than growing maize, one of the area's main cash crops. Assuming a yield of 8 t/ha/year, a leaf meal producer would earn 400,000 TSh/ha/year after the first year. Assuming maize yields of 2 t/ha and a maize price of 100 TSh/kg, maize would earn a farmer only 200,000 TSh/ha/year. Moreover, production costs would be greater as maize, unlike leucaena, needs to be planted, weeded, and fertilized every year.

Another important means for improving leaf meal technology would be to compress it in order to reduce its bulkiness. Such an innovation would reduce the cost of transporting it, making leaf meal more competitive in other dairy areas of Tanzania, such as Arusha, Kilimanjaro, and Dar es Salaam.

A third technological change for improving productivity would be to introduce improved drying methods, especially for use during the rainy season. The Dutch-financed dairy development projects introduced plastic sheets for improved drying. The sheets were also important for producing cleaner leaf meal, because most farmers produce and dry their leaf meal on the ground. .

Finally, while there is no commercial feed manufacturing in Tanga, there is a manufactured mineral supplement and it contains leaf meal. The product, Bayslick, is reported to be Tanzania's third highest-selling mineral supplement and is also exported to Rwanda.

# Conclusions and recommendations

The leaf meal industry in the Tanga area provides employment and economic benefits to several thousand producers, traders, and livestock owners. Traders and producers are among the poorest residents of rural Tanga and producers are mostly women, who have no other sources of income during the dry season. Improvements in the leaf meal industry can increase benefits to the poorest members of rural communities as well as improving productivity the dairy industry. The proposals for improvements noted below involve new technologies, institutional innovations, and policies.

## Technology development and dissemination

**Leucaena plots for producing leaf meal**. As mentioned above, leucaena appears to have high potential as a cash crop for farmers; producing leucaena as a crop has higher returns than maize and provides leaf meal at lower costs than collecting it from the wild. Extension staff could begin assisting farmers to implement on-farm trials to assess the benefits of leucaena production relative to two alternatives: collecting it from the wild or producing other cash crops such as maize. Leucaena could be grown on a plot in a pure stand or along a field boundary as a live fence, depending on farmers' preferences. Researchers and farmers need to ensure that the trees not grow big enough to bear seed as leucaena could become a huge weed problem. Farmers targeted for the on-farm trials should be those already collecting leucaena to ensure that the same poor households that benefit from collecting also benefit from production. Increased supply will put downward pressure on prices but should also result in increased use of leucaena as feed.

**Technologies for compressing leaf meal.** Low-cost methods are needed to compress leaf meal, so as to reduce transport costs. Two different types of technologies could prove useful. One would be a very low cost tool that traders could use to compress leaf meal so as to increase the quantity they could carry to town on their bicycles. The second might be a more sophisticated tool for compressing large quantities of leaf meal so that it could be transported over longer distances, from Pangani to Tanga or out of the Tanga area, for use elsewhere. TDDP did some testing of such tools in the

1990s but were unable to find suitable ones. Transportation of leaf meal is currently limited by its bulkiness, which makes per-kilogramme transport costs very high.

**Improved drying practices.** Simple, low cost methods are needed for improved drying of leaf meal, especially during the rainy season. Such practices include the use of plastic sheeting, for both drying leaf meal and keeping it clean, and drying under shade and not in the sun, to maintain nutritive quality.

The Livestock Research Centre, Tanga, could lead research and extension efforts in the above areas, in close collaboration with Mlingano Agricultural Research Institute, farmers, producers, and traders.

**Assessment of lessons.** Any attempts to introduce methods for compressing leaf meal or improved drying need to be based on the lessons learned from past attempts. The Dutch-financed dairy projects in the 1980s and 1990s also developed and disseminated methods for improved drying and compressing but they were not widely adopted. It is not clear why the previous attempts failed and whether the same methods can be reintroduced or whether new methods are needed. A brief assessment of past efforts is thus needed, based on interviews with participating farmers and key informants (e.g., former staff of the TDDP).

## Policies and extension strategies

**Providing information to farmers for educated decision making.** Extension recommendations for feeding dairy cows call for a 3-2-1 ratio between maize bran, cottonseed cake, and leucaena leaf meal. We found that though farmers were familiar with the extension recommendations, they were unaware of the nutrient composition of the feeds and their costs per unit nutrient. Given the high degree of price fluctuations in the component feeds, dairy farmer need to be given the information they require to optimize feed rations on their own, and modify them when prices change. There are actually two recommendations being made here. First, farmers need information on the components of rations so that they can modify their rations in response to prices or other circumstances, such as the non-availability of particular feeds. Second, farmers do not just need "blanket" recommendations; they need to learn about the processes whereby improved feeds generate increased milk production. Such information can help them to experiment with different feeds to find the combinations that give them optimal economic performance.

**Promoting leaf meal quality.** Extension staff need to train stakeholders how to assess the quality of leaf meal and train producers on how to produce high quality leaf meal. In fact, the most important stakeholders to train are consumers because if

consumers demand high-quality leaf meal than producers and traders will be forced to supply it.

**Assessing the potential of leaf meal in other areas of East Africa.** Research is also needed to assess the potential of leaf meal production and marketing in other areas of East Africa. First, assessments should be made in Dar es Salaam and Mombasa, where wild leucaena stands reportedly exist but there is little if any leaf meal production and marketing. The studies should assess whether leaf meal industries can be started in these areas and what measures might help facilitate them to start (e.g., helping interested entrepreneurs, farmers, and policy makers from Dar es Salaam and Mombasa to visit Tanga).

Next, the economic potential of leaf meal should be assessed in areas of East Africa where fodder shrubs are grown. Our preliminary view based on the visits of stakeholders from central Kenya to Tanga is that leaf meal cannot be widely marketed as the cost of producing and transporting it are too high. But it has two potential niches which the stakeholders who visited Tanga are testing. First, it can be widely used by farmers as a dry season feed, prepared at the end of the rainy season and fed throughout the dry season. Second, farmers in peri-urban areas may be able to produce and sell it to their neighbors who need protein supplements for their livestock. A few farmers in central Kenya have started producing and selling leaf meal from *Calliandra calothyrsus*, the most widely grown fodder shrubs in that area, around their homes.

**Exchanging information with Asian leaf meal producers.** We have learned of the existence of leaf meal producers in Asia (India, China, Indonesia Thailand, and Philippines) and innovations there to improve leaf meal processing (e.g., pellets and bricks). But virtually no information is available in the literature or on the internet about these industries and processes. Participants in the leaf meal industry in Tanga, particularly enterprising entrepreneurs, could gain a lot from visiting Asian stakeholders (farmers, entrepreneurs, and policy makers) involved in leaf meal production and marketing.

## Institutional innovation

**Trader associations.** Traders could benefit from forming an association and such an entity could benefit the industry as a whole. First, traders have a strong interest in maintaining and improving the quality of their product so it can compete with other protein supplements, such as cottonseed cake and sunflower meal. Meeting together could help them to exchange information on quality control and how to improve it. A second reason for having an association could be to exchange ideas on how to

promote their product. A third reason could be to lobby policy makers for support. Since most traders market their leaf meal in Tanga, it would be fairly easy for them to meet together on occasion.

**Price information system.** In order to reduce leaf meal deficits in the rainy season traders need to offer higher prices to producers to encourage more production. How to get them to do so is a difficult issue as their returns are low during the rainy season and raising prices could reduce their margins further. The production of higher quality leaf meal during the rainy season, through improved drying methods, will help traders to get higher prices for the leaf meal. If producers could get more information on the prices being offered in Tanga during the rainy season, this would help them to negotiate higher leaf meal prices in their communities. Extension staff could test this hypthesis by informing selected groups of producers in a particular area to see if they can use the information to negotiate higher prices.

**Developing a cross-sectoral advocacy group**. Finally, the above proposals cannot be implemented without a core group of stakeholders to mobilize resources and facilitate implementation. A cross-sectoral advocacy group is needed composed of representatives of policy makers, dairy farmers, traders, entrepreneurs, researchers and extensionists. Such a group could help develop the leaf meal industry for improving dairy production and improving the livelihoods of the poor.

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