Smallholder Dairy Production in Malawi: Current Status and Future Solutions

Scoping Papers:
Optimising Smallholder Dairying project

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Smallholder Dairy production in Malawi: Current Status and Future Solutions

**Authors**

**Dr. Mizeck G.G. Chagunda**  
Senior researcher at SAC Dairy Research Centre. Mizeck’s background is in Animal Breeding and Genetics but concentrates on issues of genotype by environment interaction, dairy systems and of late, climate change. SAC Sustainable Livestock Group, SAC Research, King's Buildings, West Mains Road, Edinburgh, EH9 3JG, Scotland, UK

**Dr. Timothy N. Gondwe**  
Associate Professor of Animal Breeding and Head of Department, Department of Animal Science, Bunda College. His research interests are in the area of characterisation of local genotypes in low input – low output production systems. Animal Science Department, Bunda College P.O. Box 219 Lilongwe, Malawi

**Mrs. Liveness Banda**  
Senior Lecturer in Animal Physiology, Department of Animal Science, Bunda College. Her specialization is in the area of Animal Physiology and Farming Systems. Animal Science Department, Bunda College P.O. Box 219 Lilongwe, Malawi

**Mrs. Patritia Mayuni**  
Chief Animal Health and Livestock Development Officer, Blantyre Agricultural Development Division, Department of Animal Health and Livestock Development, Ministry of Agriculture, P.O. Box 2096, Lilongwe, Malawi

**Prof. Joshua P. Mtimuni**  
Professor of Animal Nutrition, Department of Animal Science, Bunda College. Specialty in Animal Nutrition-Ruminant. His major areas of research are in forage production systems, Pigs and Rabbits, Mineral Nutrition. Animal Science Department, Bunda College P.O. Box 219 Lilongwe, Malawi

**Mr. Thomas Chimbaza**  
Deputy Director, Department of Animal Health and Livestock Development, Ministry of Agriculture, P.O. Box 2096, Lilongwe, Malawi

**Mrs. Agnes Nkwanda**  
IGA coordinator, the International Committee for the Development of People (CISP), Blantyre, Malawi

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All correspondence concerning this document should be addressed to: Dr Mizeck Chagunda email: mizeck.chagunda@sac.ac.uk

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Market-oriented milk production in Malawi started as a result of an increasing demand for liquid milk in the southern region of Malawi. This was mainly around the major towns of Blantyre and Zomba. This led to some individual farmers to import high-yielding dairy cattle from South Africa and Zimbabwe by some farmers. For instance, between 1952 and 1954 more than 54 exotic dairy cattle were imported into the country (Malawi Government 1952, 1954) and the commercial farms marketed milk direct to consumers. A milk plant, which was the first to pasteurise and market fresh milk in Malawi, started operating in 1961, pasteurizing 2500 litres of milk per day (O'Keefe 1970). In 1979 the Malawi Government and the Canadian Government through the Canadian International Development agency (CIDA) approved a dairy development project: the Malawi Canada Dairy Development project. Consequently, over a period of 5 years, a foundation stock of 400 Canadian Holstein Friesian heifers was imported to the 5500 hectare Ndata farm in the southern region of Malawi and the 2250-hectare Katete farm in the central region. In 1988 the project was combined with Malawi Milk Marketing to form Malawi Dairy Industries Corporation (MDI), a statutory organization involved in producing, processing and marketing milk and milk products. At present, there is no institutionalized and countrywide recording system in Malawi, hence farmers keep on-farm records in various formats. Over the last few decades, dairy cattle management in Malawi has been oriented towards increasing milk yield per animal. One consequence of this process has been dependence of the breeding strategy on Holstein Friesian bull semen from temperate regions, Canada in particular. Selection of the bulls was based on Canadian published sire catalogues. However, there are some principal differences in the animal environment between Malawi and Canada. As described by Stanton et al. (1991) and Ron & Hillel (1993), in this respect the term environment not only comprises the physical and climatic factors but also production and health management, economic constraints, prevailing agricultural policies and/or a combination of these.

Smallholder Dairy Sector

Peri-urban smallholder dairy sector supplies about 60 % of the milk that is processed at the formal processing plants in Malawi every year (Banda, 1996). Recent information (Malawi Government, 1997) indicates that there are about 3600 smallholder farmers who use over 6000 Holstein Friesian x Malawi Zebu cows and about 1700 smallholder farmers who use an unknown number of Malawi Zebu cattle for commercial milk production in the peri-urban setting. In addition to the smallholder farmers, there are 15 private large-scale dairy farms accounting for about 2200 milking cows. The major differentiating features between smallholder and large-scale dairy farms are the holding size, the genotype of cattle raised and the level of management applied. The predominant genotype on the large-scale dairy farms is the Holstein Friesian although some of these farms also have few Arshire and Jersey cattle while smallholder farmers utilize Holstein Friesian x Malawi Zebu crosses of different grades. The total milk production from both the large scale and the smallholder sub-sectors as at the year 2001 was estimated at 35 000 metric tonnes per year (FAOSTAT, 2005). The smallholder dairy farmers are organised in three milk shed areas around the three major cities of Malawi and operate under corporate approach where at local level farmers belong to milk bulking group. Farmers from within a radius of 8 kilometres km bulk their milk at a cooling centre from where milk processors collect it. Buying of the milk by the processors is in bulk and a bonus is paid for higher bulk quantities. Malawi consumes about 42 000 metric tonnes of milk per year (FAOSTAT, 2005). With a population of about 11 million people, the estimated average milk consumption is 3.8 kg per capita. This average is very low even when compared with that for Sub-Saharan Africa, which is estimated at 30.8kg per capita (FAOSTAT, 2005). Coupled with the fact that Malawians get 7.46 calories, 1.18 grams, and 0.27 grams per day from milk compared to 52 calories, 2.7 grams, and 2.9 grams of energy, protein and fat for Sub-Saharan Africa, the need for improving milk production and the consequent milk consumption in Malawi is heavily pronounced.
Non Governmental Organization Initiatives in the Dairy Industry

During the last decade attempts have been made in Malawi by Non Governmental Organizations like Small Scale Livestock Promotion Programme (SSLPP) and Land ‘O’ Lakes (L’O’L) in dairy development to encourage the dissemination of improved technologies on credit (Chindime, 2007). This was done specifically to address the critical shortfalls the government was facing, hence stimulating the development of a commercially viable smallholder dairy sector that will result in significant increases in rural incomes, provide employment opportunities, and improve overall performance of dairy business that contributes to Malawi’s GNP. Some of the technologies include: Provision of extension messages on supplementary feeding and homemade dairy mash, pasture establishment and fodder conservation for stall-feeding, importation of improved dairy cattle breeds for dissemination to farmers on the heifer loan scheme, importation of dairy semen to improve milk production per cow, construction of appropriate housing and structures for dairy animals, improved veterinary services, encouraging zero grazing systems for dairy cattle and provision of training to dairy farmers (Chagunda, 2001).

The developed technologies were aimed at improving the reproduction and production performances of dairy cattle as most of these are negatively affected by poor management which includes insufficient feeding, lack of artificial insemination and lack of veterinary facilities. These technologies were packaged in a form of credit-in-kind by Land O’ Lakes Inc. / Malawi (Chindime, 2007).

The developed credit system by Land ‘O’ Lakes was based on the revolving fund principle, with four components.

- Heifer in-kind loan (for passing on the first pregnant heifer to another eligible farmer).
- Dead cow fund (for replacing a dead project cow),
- Veterinary drug fund (for increasing farmers access to priority veterinary drugs for disease control) and
- Supplemental feeds fund for increasing farmers access to supplemental feeds as dairy mash, concentrates, cane molasses, and mineral supplements, in order to increase milk yield.
The importance of Livestock sub sector in National Development

The Livestock industry in Malawi contributes about 8% to the total Gross Domestic Product (GDP) and about 36% the value of total agricultural products. Livestock provides food, income, manure, animal traction and social security. Taking of all these into consideration, livestock may contribute up to more than 11% of the GDP.

There are about 1.2 million farm families who own one or more of various livestock types. Fifteen percent of all the livestock owners are commercial and the rest are subsistence.

Livestock provides potential food security among the vulnerable groups, such as female-, juvenile- and elderly-headed households, and orphans. Livestock provide regular cash and earnings for approximately 15% of families in Malawi that can be classified as commercial producers. Being a small country with high population density, livestock in Malawi provides an efficient way of transforming crop residues e.g. straws, groundnut haulms and crop by products into food or cash and using areas of grazing land unsuited for arable farming. (Malawi Government, 2006).

References


Dairy Cattle Breeding in Malawi

Timothy Gondwe

Background to livestock, cattle and dairy production in Malawi

Table 1 shows distribution of major livestock species in Malawi and their relative annual increase. The cattle population is under one million and has the least rate of increase per annum. Cattle are, however, distributed countrywide as shown in Table 2. National figures show that dairy cattle constitute only 3.27% of the cattle population. Of this, majority are crossbred dairy cattle, at various grades. The representation of dairy farmers in the different ADDs is as follows:

- Shire Milk Producers Association (2,900 dairy farmers with cows)
- Central Region Milk Producers Association (2,255 dairy farmers with cows)
- Mpoto Dairy Farmers Association (684 dairy farmers with cows)

Table 1. Current status (2007 / 2008) of cattle and other livestock species by number and annual increase (%) over years

<table>
<thead>
<tr>
<th>Species</th>
<th>Number</th>
<th>Average annual increase</th>
<th>Number of years</th>
<th>% increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>919,799</td>
<td></td>
<td>8</td>
<td>2.66</td>
</tr>
<tr>
<td>Goats</td>
<td>3,106,271</td>
<td></td>
<td>8</td>
<td>8.32</td>
</tr>
<tr>
<td>Sheep</td>
<td>188,520</td>
<td></td>
<td>8</td>
<td>12.49</td>
</tr>
<tr>
<td>Pigs</td>
<td>1,227,468</td>
<td></td>
<td>8</td>
<td>14.28</td>
</tr>
<tr>
<td>Rabbits</td>
<td>609,319</td>
<td></td>
<td>5</td>
<td>28.88</td>
</tr>
<tr>
<td>Poultry</td>
<td>46,606,440</td>
<td></td>
<td>8</td>
<td>30.01</td>
</tr>
</tbody>
</table>

Source: DAHLD Census (2008)

Some of the milk produced is utilized within households or sold within the smallholder informal sector of markets. This means less milk goes through the formal marketing and processing sector.

The national distribution gives opportunity for potential milk production in all areas in Malawi. The current production is below the national demand, leading to milk imports. Land O’Lakes (LoL) dairy fact sheet (2005) reported that 24% of milk comes from imports (Figure 1).

Despite low numbers of dairy cattle, there is noticeable increase in milk production. Figure 2 shows that increase in milk production is largest of all products from livestock. These increases are due to among other, the following factors:

- Increase in number of cattle
- Increase in number of farmers taking dairy cattle as business
- Increase in number of support agencies in the dairy sector
- Government policy on the dairy sector support

According to LoL (2005), key support agencies in the dairy sector are:

- Department of Animal Health and Livestock Development (DAHLD)
  - supporting with import permits, backstopping, policy and legislation, multiplying breeding stock for sale, coordination; guiding stakeholder committees on heifer loan schemes
- USAID (Land O’Lakes project)
  - Promoting dairy extension, management and marketing, including heifer loan scheme
  - Currently promoting contract support in stud-breeding, feeding and processing, health and drug services, among others
- EU & Oxfam
  - supporting Shire Highlands Milk Producers Association dairy project
- MASAF and WVI
  - supporting dairy projects for CBOs looking after orphans
- Plan Malawi
  - supporting pilot dairy project in Kasungu
- Bothar (Ireland) & Heifer International
  - supporting dairy project run by Small Scale Livestock Promotion Programme
- British VSO
  - supporting VSO dairy adviser placements to central and northern milk shed dairy associations

Table 1. Current status (2007 / 2008) of cattle and other livestock species by number and annual increase (%) over years

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<tr>
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<td>46,606,440</td>
<td></td>
<td>8</td>
<td>30.01</td>
</tr>
</tbody>
</table>

Source: DAHLD Census (2008)
• JICA
  - supporting Artificial Insemination activities
• SARRNET/IITA
  - supporting production of cassava and technology transfer on cassava silage making.

From the above, it is clear that majority agencies provide support in areas of
  • Dairy extension
  • Animal health
  • Artificial insemination

Breeding of dairy cattle is rarely covered although it is featured as one of the core functions of DAHLD.

Table 2. Distribution of dairy cattle numbers and milk production with respect to total cattle population in Malawi, by ADD in 2007 / 2008

<table>
<thead>
<tr>
<th></th>
<th>KRADD</th>
<th>MZADD</th>
<th>KADD</th>
<th>LADD</th>
<th>SLADD</th>
<th>MADD</th>
<th>BLADD</th>
<th>SVADD</th>
<th>Total estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle numbers</td>
<td>130201</td>
<td>184257</td>
<td>166964</td>
<td>153181</td>
<td>23319</td>
<td>54956</td>
<td>92899</td>
<td>114022</td>
<td>919799</td>
</tr>
<tr>
<td>Pure dairy breeds</td>
<td>66</td>
<td>1416</td>
<td>388</td>
<td>803</td>
<td>91</td>
<td>2448</td>
<td>2</td>
<td>5214</td>
<td></td>
</tr>
<tr>
<td>Cross bred dairy</td>
<td>81</td>
<td>1912</td>
<td>713</td>
<td>1713</td>
<td>194</td>
<td>854</td>
<td>19358</td>
<td>53</td>
<td>24878</td>
</tr>
<tr>
<td>% Pure</td>
<td>0.05</td>
<td>0.77</td>
<td>0.23</td>
<td>0.52</td>
<td>0.00</td>
<td>0.17</td>
<td>2.64</td>
<td>0.00</td>
<td>0.57</td>
</tr>
<tr>
<td>% Crosses</td>
<td>0.06</td>
<td>1.04</td>
<td>0.43</td>
<td>1.12</td>
<td>0.83</td>
<td>1.55</td>
<td>20.84</td>
<td>0.05</td>
<td>2.70</td>
</tr>
<tr>
<td>Milk production (tones)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pure dairy breeds</td>
<td>80</td>
<td>1708</td>
<td>468</td>
<td>969</td>
<td>110</td>
<td>2953</td>
<td>2</td>
<td>6290</td>
<td></td>
</tr>
<tr>
<td>Cross bred dairy</td>
<td>56</td>
<td>1321</td>
<td>493</td>
<td>1184</td>
<td>134</td>
<td>590</td>
<td>13380</td>
<td>37</td>
<td>17195</td>
</tr>
<tr>
<td>Milk from local Zebu cattle</td>
<td>1677</td>
<td>2333</td>
<td>2140</td>
<td>1943</td>
<td>301</td>
<td>697</td>
<td>917</td>
<td>29076</td>
<td>39084</td>
</tr>
<tr>
<td>Total Milk</td>
<td>1813</td>
<td>5362</td>
<td>3101</td>
<td>4096</td>
<td>435</td>
<td>1397</td>
<td>17250</td>
<td>29115</td>
<td>62569</td>
</tr>
</tbody>
</table>

ADD = Agricultural Development Devisio; KRAD = Karonga ADD; MZADD = Mzuzu ADD; KADD = Kasungu ADD; LADD = Lilongwe ADD; MADD = Machinga ADD; BLADD = Blantyre ADD; SVADD = Shire Valley ADD

**Government policy on dairy and recent initiatives**

The Ministry of Agriculture, through DAHLD, developed a policy document on Livestock in Malawi (MoA, 2005). The Goal and objective of the dairy sub-sector policy include

**Goal:** adequate supply and consumption of milk and milk products

**Objective:** to increase dietary intake of milk and milk products and household income

- Livestock multiplication
- Artificial insemination (AI)
Dairy breeding initiatives and current status

The DAHLD has three main farms whose purpose is to breed and multiply breeding stock for dairy and beef cattle for farmers in Malawi. Table 3 shows the three stations and their livestock numbers over three years.

Table 3. Cattle population at the three Government farms

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mikolongwe</td>
<td>BLADD, MADD and SVADD</td>
<td>929</td>
<td>1320</td>
<td>1183</td>
</tr>
<tr>
<td>Likasi</td>
<td>LADD and KADD</td>
<td>491</td>
<td>821</td>
<td>973</td>
</tr>
<tr>
<td>Dwambazi</td>
<td>MZADD and KRADD</td>
<td>495</td>
<td>806</td>
<td>752</td>
</tr>
</tbody>
</table>

At these farms, the government maintains pure Malawi Zebu as dams to crossbreed with Holstein / Friesian (for dairy) or Brahman (for beef) sires. Dairy crossbred at ½, ¾ or higher grades are produced and sold to smallholder farmers.

Since the numbers at the farms were low, Government embarked on a restocking process by buying Malawi Zebu heifers from local farmers throughout the country. The increase over years is therefore, through the restocking process. This follows one of the strategies in the Livestock Policy. At the moment, the breeding strategy is not clear. To maintain pure Malawi Zebu population, seasonal breeding (February, March, April) is used with pure Zebu bulls. Crossbreeding is through bulls or through AI. Other than seasonal breeding, no breeding strategies, designed mating and recording for genetic evaluation and selection takes place.

Importation of dairy breeds

Low numbers of pure dairy breeds and the long duration it takes to multiply any existing stock to required numbers prompted the Malawi Government to import dairy heifers and to intensify use of AI and other technologies. This has been done in a 10 year Dairy Development Project funded by Government that started in 2006 / 2007 and is to end in 2016 / 2017. The project is worth MK396,000,000 (1 US$ = MK140.00). The project identified 100 lead farmers in Blantyre, Lilongwe and Mzuzu Milkshed areas to be multiplying the pure dairy breeds. These are to emerge into stud breeding farmers. Parallel to breed importation, 5000 Malawi Zebu cows in the three milkshed areas have been ear-marked for upgrading through the AI programme.

In recent years (2006/2008), 214 Holstein Friesian heifers have been procured from South Africa and sold to farmers. It is through the same program that in 2007/2008, had 137 breeding Friesian bulls and 274 Malawi Zebu cows were bought from local farms and distributed to government farms including Diamphwili.

To date, it shows that the Government has stock to embark on a breeding program for dairy development in Malawi. What is missing is clear strategy on how to breed and follow-up on improved breeding stock. The distribution of imported heifers from Government Farms goes without proper tracking. Recording for genetic evaluation and progeny testing of the bulls is not taking place. Activities of the 100 lead farmers to emerge into stud-breeders are not followed, and empowering them through training in breeding and back-up services seems to be lagging behind. The current import did not come with records although the Government aimed at importing registered approved breeding stock.

Use of AI to enhance breeding

The Government set up a National Artificial Insemination Centre (NAIC) at Mikolongwe (within Blantyre Milkshed area). At NAIC, the government aimed at getting and preserving semen from approved bulls. By so doing, stud-breeders and Government farms would benefit from pure bred bulls during their breeding and multiplication process. NAIC also acts as training centre for AI, PD and general dairy husbandry.

To date, the NAIC is operating and distributing semen throughout the country. The four bulls that provide semen are however, not genetically evaluated. They were just physically selected. In addition, there are no mechanisms for replacing the bulls. LoL dairy fact sheet (2005) documented cases of one identifying a bull and bringing it to NAIC for collecting semen from it. The semen propagated from NAIC is therefore, not from proven bulls.

NAIC would also include activities of progeny testing, so that selection for bulls to replace existing ones takes place. This is not taking place.

Other service providers in dairy cattle breeding

A few new small and medium scale breeding businesses are emerging. In addition, other NGOs such as Small Scale Livestock Promotion Program (SSLPP) import direct pure dairy breeds and distribute to farmers under heifer loan scheme. SSLPP also imports semen for use in these farms through trained AI technicians.

The problem with all breeding units, public or private, is the lack of skills and capacity to manage the breeding units. This is especially in areas to genetically evaluate breeding stock, select and make designed mating. As such, what is currently happening is mere multiplication and not breeding.

Conclusion

Dairy breeding in Malawi is still ad hoc and not coherent. The existing materials and structures exist to breed and multiply improved breeding dairy stock for commercial and smallholder farmers. Both Government and private institutions exist, but currently do more of multiplication than breeding. On the other hand, limited number of dairy cattle requires enhancing breeding to sustain and increase current stock, and reduce costly imports. Without breeding plans, what we see is wastage of genetically potential material that deciper into the farming system without tracking. Opportunities exists, government farms are undergoing rehabilitation to allow designed mating, breeding bulls are borne among farmers to provide material worth progeny testing, and demand for dairy breeds goes beyond existing milkshed areas.

References


Dairy Cow Fertility in Malawi

Liveness Banda, Timothy Gondwe and Mizeck Chagunda

Introduction

Fertility is the ability of animals to produce healthy offspring in abundance and on regular interval. Fertility in cattle is affected by environmental, genetic, disease and management factors. These influence the different stages of the reproductive process (Mukasa-Mugerwa, 1989). Fertility is one of the reproductive traits important for the expansion of any herd of animals. However, with the increase in milk yield that has been achieved in many dairy cattle herds, a decline in fertility rates has been noticed (Dobson et al, 2007; Berglund 2008; Leroy 2008). Berglund (2008) attributes the decline in reproductive performance in many countries partly to an unfavourable genetic relationship between milk yield and fertility while Leroy et al (2008) points at conflicting metabolic and reproductive needs. Lovendahl et al (2009) points to yet another important factor which is recording of fertility with lower accuracy than milk yield recording. In Malawi, the problem of low fertility in smallholder dairy farming is complicated by inadequate management skills and limited access to extension, health and other important technical services.

A practical estimate of fertility in smallholder farming would be the percentage of inseminated cows that become pregnant (pregnancy rate) or finally calve (calving rate). For this measure to be accurate, proper recording is a prerequisite. However, in Malawi, recording is one of those areas that is lagging behind among smallholder farming. It is, therefore, difficult in the first place to present the exact status of fertility in smallholder dairy production. Irrespective of this challenge, the production trends of dairy cattle among smallholder farmers still give an indication of the status of cow fertility. Hence this paper presents the apparent status of the dairy cow fertility which would be used as a basis for interventions to improve dairy cattle productivity among smallholder farmers in Malawi.

Dairy cattle production background

Dairy cattle production is said to be the flag carrier of the Department of Animal Health and Livestock Development (DAHLD). This is because the sector has proved to be sustainable and lucrative as a business venture. Dairy production in Malawi started way in the 60s and has continued to grow over the past decades. The Holstein-Friesian is the main dairy breed available in Malawi. This breed is usually crossed with local Malawi Zebu cows through artificial insemination or use of bulls. As such crosses between the two breeds are the most dominant dairy cattle breeds among smallholder farmers (Table 4). Semen for AI is either obtained from the National Artificial Insemination Centre (NAIC) in Mikolongwe or imported through organizations such as the World Wide Sires and Semex.

Table 4. Population of dairy breeds in Blantyre ADD

<table>
<thead>
<tr>
<th>Category</th>
<th>Cross breeds</th>
<th>Pure breeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows</td>
<td>9,271</td>
<td>1,051</td>
</tr>
<tr>
<td>Bulls</td>
<td>895</td>
<td>48</td>
</tr>
<tr>
<td>Heifers</td>
<td>4,172</td>
<td>449</td>
</tr>
<tr>
<td>Bull calves</td>
<td>3,207</td>
<td>324</td>
</tr>
<tr>
<td>Heifer calves</td>
<td>3,001</td>
<td>228</td>
</tr>
<tr>
<td>Steers</td>
<td>385</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>20,931</td>
<td>2,135</td>
</tr>
</tbody>
</table>

Source: BLADD Annual Report 2008

Smallholder farmers are the main players in dairy cattle production. The other players are tea estates and a few commercial farms. The estate sector has a participation of about 10 estates that mainly target tea as their primary production. Hence their contribution to dairy production has remained generally low. The smallholder sector has a total of about 7000 dairy farmers with technical support from government and some NGOs. The general trend is that there is an increase in the dairy cattle population and this can be attributed mainly to new entries in the sector with support from NGOs and government projects. The average milk production per cow per day is 6-10 litres.

Blantyre Agricultural Development Division (ADD) is the largest and oldest milk shed area with 23 milk bulking groups (MBGs). The daily and monthly milk yield per cow is 7-15 and 361 litres, respectively. The ADD reported a total of 4,258 dairy farmers in the year 2008.

Current status of dairy fertility in smallholder dairy farms in Malawi

Fertility rates of dairy cattle in Malawi are generally low across the breeds available. This is evidenced by long calving intervals, slow growth rate of dairy herds and continuous importation of breeding stock. There may be other factors other than fertility that would contribute to the factors listed. However, fertility may still have a significant contribution. There are no concrete figures available as data is not readily available due to lack of records and/or a dairy production database. Based on scanty data obtained from BLADD the calving rate in 2007 was 30% (Table 5). The local Malawi Zebu under traditional systems has higher calving rates reported ranging from 52 to 69% (Butterworth and McNitt,1984).
Livestock production has a relatively low number of extension workers. This is partly because in the past, livestock extension services concentrated on animal health services. The health services were treated as a specialist subject matter and had only one specialist per extension planning area (EPA). This led to livestock extension workers (called Assistant Veterinary Officers, AVO) having to cover a large number of farmers and in most cases the demand for their services could not be met. The general extension workers (Area Extension Development Officers, AEDOs) tend to concentrate more on crop production than livestock. An EPA may have six sections, one AEDO per section, but with one AVO for all the sections. The policy on livestock extension has since changed and AEDOs also ought to cover livestock husbandry. However the challenge has been that the extension worker to farmer ratio is still very high. The extension workers also rarely undergo refresher courses. Worse still long periods elapse without recruiting and/or replacing extension workers.

**Disease control**

Livestock health services in each EPA depend on one AVO. With the increase in the number of farmers involved in livestock production, it is almost impossible for the AVOs to meet the demand for their services. The AVO also faces similar challenges related to transport and multiple requests as explained for AI technician above. However some AVOs are better off as they have access to motor bikes although fuel availability to some sections may be the limiting factors. These are poor competency due to inconsistent practice, poor heat detection by farmers coupled with problems in storage and transportation of semen. Even where heat is accurately detected, AI technicians are faced with the challenge of transport and a large AI technician to farmer ratio. The technicians have to travel long distances to provide services to farmers. They often get requests to service animals from several farmers at the same time. In most cases the mode of transport used is a push bike. This results in some animals being served too late or not at all. There is also lack of incentives as the price paid for each insemination is relatively low. There is also lack of refresher courses, proper record keeping and follow up on performance of the AI technicians.

**Heat detection**

Many farmers that are involved in dairy cattle production have not been formerly trained on heat detection. Hence heat is often reported late. In some cases heat is properly detected but communication and transport may be the limiting factors as stated above.

**Inadequate extension services**

Livestock health services in each EPA depend on one AVO. With the increase in the number of farmers involved in livestock production, it is almost impossible for the AVOs to meet the demand for their services. The AVO also faces similar challenges related to transport and multiple requests as explained for AI technician above. However some AVOs are better off as they have access to motor bikes although fuel availability to some sections may be the limiting factors. These are poor competency due to inconsistent practice, poor heat detection by farmers coupled with problems in storage and transportation of semen. Even where heat is accurately detected, AI technicians are faced with the challenge of transport and a large AI technician to farmer ratio. The technicians have to travel long distances to provide services to farmers. They often get requests to service animals from several farmers at the same time. In most cases the mode of transport used is a push bike. This results in some animals being served too late or not at all. There is also lack of incentives as the price paid for each insemination is relatively low. There is also lack of refresher courses, proper record keeping and follow up on performance of the AI technicians.

**Semen storage and transportation**

The semen used for AI is obtained from Mikolongwe National Artificial Insemination Centre (NAIC) which is based in the Southern Region. The semen has to be transported for long distances particularly for farmers in the Central and Northern Regions. Some of the liquid nitrogen tanks that are used are too old and cannot keep the liquid nitrogen for longer periods. As such the semen has to be used in a limited period otherwise sperm viability is reduced.

**Capacity of AI technicians**

Dairy cattle farmers depend on trained AI technicians to provide AI services whenever their animals are on heat. However, operation of the AI technicians meets with several limitations. These are poor competency due to inconsistent practice, poor heat detection by farmers coupled with problems in storage and transportation of semen. Even where heat is accurately detected, AI technicians are faced with the challenge of transport and a large AI technician to farmer ratio. The technicians have to travel long distances to provide services to farmers. They often get requests to service animals from several farmers at the same time. In most cases the mode of transport used is a push bike. This results in some animals being served too late or not at all. There is also lack of incentives as the price paid for each insemination is relatively low. There is also lack of refresher courses, proper record keeping and follow up on performance of the AI technicians.

**Challenges**

The causes of low fertility in Malawian dairy cows raised under smallholder farming systems are numerous and quite complex. Lack of records and a proper recording system makes it further difficult to isolate a particular cause of low fertility in the animals. The following are some of the factors that constrain fertility of dairy cattle production under smallholder farming:

**The production environment**

The major challenge is that the management system that is mostly used is not ideal for optimum production. Chagunda (2002) reported that the production environment under smallholder farming is a major limitation to improved dairy production. The production environment is characterized by poor housing, nutrition and disease control. This is further complicated by seasonal availability of feed and the traditional perception of the farmers regarding livestock feeding. Most farmers do not have established pastures, instead they rely on natural pastures. Natural pastureland areas are gradually decreasing with increasing population and subsequent demand for land. Where the natural pastures are available, the feed is not efficiently utilized as feed conservation practices such as hay making are rarely practiced. Livestock production is often secondary to crop production. As such livestock production may not be receiving adequate attention.

**Table 5. Fertility of dairy cattle served through artificial insemination in Blantyre ADD.**

<table>
<thead>
<tr>
<th>Performance indicator</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of cows on heat</td>
<td>4,401</td>
<td>-</td>
</tr>
<tr>
<td>1st inseminations</td>
<td>3,057</td>
<td>69.5</td>
</tr>
<tr>
<td>Repeat inseminations</td>
<td>1,129</td>
<td>25.7</td>
</tr>
<tr>
<td>Total inseminations</td>
<td>4,186</td>
<td>95.1</td>
</tr>
<tr>
<td>No of calves born</td>
<td>1,247</td>
<td>29.8</td>
</tr>
<tr>
<td>No of calves dead</td>
<td>51</td>
<td>4.1</td>
</tr>
</tbody>
</table>


Interpretation of Table 5 above may not be straightforward as some other important details were not available. For instance, it is not clear how many repeat inseminations were done on individual animals. Conception rates and abortions, if any, are also not reported. However, this information suffices to confirm that indeed fertility of dairy animals is low.
for the farmers and the animals are either under-dosed or left untreated. Proper disease control measures are also not in place and hence diseases are easily transmitted from one animal to another as well as from one farm to another.

**Possibility of inbreeding**

As stated above, proper record keeping is not in place. Hence low fertility could also be as a result of inbreeding both through use of natural mating and AI. The bulls used at NAIS have not been replaced for quite some time. With no records in place, there are high chances that some heifers and cows being served are daughters to the bulls. The bulls have also not been progeny tested and therefore their progeny performance in terms of fertility and other traits is not guaranteed.

**Other management related problems**

Where bulls are used, inadequate nutrition, inbreeding, diseases and other management related problems are the major causes for low fertility. Pertaining to diseases, reproductive diseases such as brucellosis and other sexually transmitted diseases are a major challenge. It is recommended to exploit the most effective management practices in order to circumvent the environmental constraints on genetic expression of yield in Malawi.

The other challenge is that fertility commonly decreases with age Mukasa-Mugerwa (1989). Several cows calve for the first time after the third, fourth or even fifth breeding opportunity. Ideally such cows would have been culled in a commercial livestock enterprise, but traditional smallholders cannot afford to cull animals as most of them have only one or a few cows. In some cases, failure to calve is because infertility is due to other complications such as reproductive diseases. However, in most cases farmers are not able to deduce such problems. Many farmers in such situations keep their animals for long periods in the hope of eventually getting a calf. This practice is costly to the farmer who already is constrained in terms of access to feed resources, drugs and labour.

Low fertility is not only a problem to smallholder farmers. Even where management is ideal, low fertility still remains as a challenge. For instance, Heersche (2005) reported that the modern high producing Holstein is not highly fertile, and the conception rate in many high producing herds is 40% (2.5 services/conception). He reported that the expected conception rate in many high producing herds is 40% (2.5 services/conception). He reported that the expected conception rates are 50-55% (1.9 to 2.0 services/conception) with milking cows. This shows that the causes of low fertility in cattle are quite complex and in the absence of concrete data one can only speculate.

**Possible solutions**

There are several challenges that affect fertility and this would require a multidisciplinary approach to solve. Primary issues such as improvement of the production environment need to be addressed first. There is need for intensive efforts to create awareness in relating performance of dairy animals to their production environment. The perception of the farmers could be changed through use of demonstrations and exchange visits with other successful farmers. Capacity building of extension workers and AI technicians with scheduled refresher courses is required to complement the other interventions. AI kits and storage equipment should be made available to improve on the AI services. Proper record keeping should be in place for both farmers and the service providers. The service providers include NAIC, Department of Animal Health and Livestock Development (DAHLD), NGOs and other stakeholders. There has to be some proper mechanisms to monitor and evaluate the performance of AI technicians and provision of incentives. Records should also be accessible for proper monitoring, evaluation and appropriate analyses. This could be done through establishment of a database manned by DAHLD and accessible to all stakeholders. Some aspects of the challenges such as animal health and nutrition may need further research for appropriate and specific interventions to be put in place. Where the production environment is ideal, Dobson et al, (2007) suggested making genetic and management changes to increase the persistency of lactations to reduce the number and intensity of clinical risk periods throughout a cow's life without compromising milk output.

**Conclusion**

There are many challenges that affect fertility rates of dairy cows in Malawi. These need to be addressed in order to improve the productivity of dairy animals. The actual status of fertility rates also needs further investigation for appropriate and specific interventions to be put in place. This requires proper record keeping by farmers as well as all other stakeholders.

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Dairy Herd Recording

Patricia Mayuni, Agnes Nkwanda and Mizeck Chagunda

Introduction

Record keeping for day to day activities in dairy production as in any other farm enterprise is an integral component for production success and provides a good management tool. For the dairy farmer the most important records are those relating to the production performance of his dairy cows, and also those relating to the reproductive performance. Records kept should also include costs and returns made on operations. Dairy farms and milk shed areas in general need to come up with simple and practical methods of collecting, collating and analyzing basic dairy records. This information when available to the farmer and the extension worker is important for use as a management tool to improve management efficiency. Furthermore dairy recording provides information for genetic improvement and may also provide a basis on which the progress of the dairy industry as a whole can be judged. In order to maintain records, all animals must be identified using an agreed identification method. The common identification method is the use of ear tags. (MOA Small Holder Dairy Scheme, Land ‘O Lakes (LoL) Dairy production Manual).

This paper focuses on the various aspects of dairy cattle recording systems in Malawi aimed at improving the management of herds and subsequent genetic improvement and to build upon these systems to promote a sustainable, cost effective, efficient and simple recording system that provides an adequate degree of coverage and accuracy.

Records at a dairy farm

To maintain proper records in any type of dairy farming there are areas and functions that need to be considered and in most cases the following types of records are maintained:

- Individual cow records
- Milk Production records
- Reproduction records
- Costs and returns

Individual cow records

These would include:
- Farmer identification
- Cows identification name, number, use of pictures, markings
- Cows pedigree etc
- Cows performance
- Vaccinations
- Disease diagnosis and treatments
- Feeds and feed use
- Other materials
- Disposal records
- Breeding records

Milk Production Records

- Daily weekly and monthly partitioning
- Daily weekly monthly milk yields

Reproduction Records

- Dates of heat period
- Dates of breeding/services
- Pregnancy checks
- Breeds of sire/male used

Costs and Returns

- For each input, quantity and unit costs at intervals are recorded
- For the outputs, the sales are recorded e.g. milk sales, milk prices, income received; milk used at home, milk fed to calves i.e. if calves are bucket fed.

Examples of dairy record collection ever practiced in Malawi

This example is taken from the Dairy Smallholder scheme in the late 80s and early 90s under the Ministry of Agriculture.

The collection of records from the dairy farms was being carried out by the section Extension worker, who had access to a scale with which he could weigh the milk. Farms were visited on one day in a month at both morning and evening milking times and the individual production of each cow recorded. At these visits the recording officer also recorded up to date information concerning recent calvings, heat periods, services, completed lactations and deaths.

The recording visits were arranged for the same time each month. This was to ensure that the records of milk production were taken at evenly spaced time intervals.

These records were then quickly forwarded to the central registry.

Analysis of Records

All records from the field were transferred to the master card maintained for individual cows.

From the production data recorded at the visit a total monthly yield of each cow was calculated which made it possible to complete a record of complete lactation.

All the information with regard to breeding performance was also recorded on the master cards from which it was possible to determine expected calving dates, times for drying off, etc.

A complete register of all calves born was also registered and maintained. Each year all the records from those cows which completed a full lactation during the year were analyzed, the various efficiency indicators calculated i.e. mean 305 day yield, lactation length, calving intervals, no. of inseminations per conception, age at first calving etc.
Use of records

Accurate recording of information is very essential in order to obtain maximum benefits.

Records have the following functions:

- Monitor the day to day activities of the dairy farm
- Used as management tool to offer on the spot advice at farm level e.g. whether feeding is adequate, whether the animal should be bred or should be dried off
- Calculate the profitability of the dairy and other enterprises
- Provide efficiency indicators of the dairy business enterprises
- Secondary use of records, in particular the efficiency indicators as at policy making level where information obtained can be used to monitor the progress of dairy development and determine possible areas of weakness, which require more attention

The current situation on record keeping in smallholder farms in Malawi

The dairy set up in Malawi is that farmers are organized in what are called milk bulking groups (MBGs). These Bulking groups are run and managed by farmers themselves with a few that are private owned and managed. Each bulking group has at least one cooling tank of capacities ranging from 500l to 6000 litres depending on milk quantities. Farmers deliver milk to these bulking groups twice a day i.e. in the morning and afternoons. Following milk testing on specific gravity and Alcohol test (70%) for acidity milk is bulked in a cooling tank. After similar tests by the processors milk is transferred to dairy processing plants at a set interval once every two days by tankers which are owned by the processors. These processors buy milk in bulk and payment is done to the bulking group on monthly basis.

Dairy Farmers in the milkshed areas of Malawi especially smallholder farmers do practice limited record keeping. There are those who maintain records of different kinds while others only manage to maintain milk sales record mainly because they want to be sure they are getting a correct pay at the end of the month. Most farmers also maintain visitors books for general visits by extension workers (AI Technicians and Veterinary assistants) and these also are used to record treatments and breeding services. Treatments will usually show type of drug used and the charges paid while for AI the details will include date of service and the Technician’s name.

A simple random interview had these results

<table>
<thead>
<tr>
<th>Farmers’ Name</th>
<th>COW ID</th>
<th>History</th>
<th>Total Milk Production</th>
<th>Milk sales</th>
<th>Production costs</th>
<th>Insemination dates</th>
<th>Trtmnt record</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miss Chikaonda</td>
<td>Naming &amp; Tagging</td>
<td>X ü ü ü X ü ü ü</td>
<td>The farmer knows average feed cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Mbewe</td>
<td>X X X ü X ü ü ü</td>
<td>Stores own maize bran</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christopher Mosiwa</td>
<td>Naming</td>
<td>ü X ü ü X ü ü ü</td>
<td>Knows feed cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr Wusuman</td>
<td>Naming</td>
<td>ü X ü ü X ü ü ü</td>
<td>Doesn’t buy feed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr Lleyton Gondwe</td>
<td>Naming &amp; Tagging</td>
<td>X ü X ü X ü ü ü</td>
<td>Farmer uses milk recording cards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr P Kapinji</td>
<td>Naming</td>
<td>X ü ü ü ü ü ü</td>
<td>These are maintained in one book</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alex Kumwenda</td>
<td>Naming</td>
<td>X X X X X X X</td>
<td>Substandard performance of the animal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dr P Sibale</td>
<td>Tagging</td>
<td>X X X X X X</td>
<td>No primary business</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duncan Nundwe</td>
<td>Naming &amp; Tagging</td>
<td>ü ü ü ü X ü ü</td>
<td>Lead farmer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ü = Records maintained  X = records not maintained
Farmers have notebooks where they keep scanty records for general issues that they find worthy recording and the most consistently maintained is milk sales. The treatments and the Breeding records are maintained as part of registering service payment. For example the Veterinary assistant has to sign in this notebook as one who has visited the farm and also indicate the purpose of his visit. At the same time if the farmer has made any payments, signing in this visitors book serves as a receipt. The same is done for AI service where the visitor book is signed showing purpose and also payment made on a specified date. Farmers do not seem to care much about recording production costs, Cows history and production levels of their animals. This may mean that they don’t really appreciate the running costs of their business and may not really be able to tell whether they are making profits which are normal or extra ordinary. Perhaps one can conclude that as long as the cow is surviving and being bred the farmer is comfortable. However this can also limit farmers in making further investment decisions in dairy production.

**Challenges**

*How to develop a milk recording scheme that is user friendly*

Since previous attempts at recording have to some extent failed, there is a need to look at socio-economic and biophysical factors in any farming system factors which might influence recording especially at smallholder level. In a study by Chagunda et al., 2003, a number of factors which could influence recording adoption were analysed in Lilongwe milk shed area at smallholder level. The study indicated that farmers who are likely to participate in milk recording have to be able to take the responsibility of the recording task themselves as it reflects the seriousness over the task. In addition, level of participation increases with farmers using calibrated containers since it is simple; as well as farmers having an optimal number of animals which are economically viable to keep and record for in the different recording systems. Therefore it is critical to focus on the factors that show a positive relationship in order to promote a sustainable and simple recording system.

*How to motivate farmers to appreciate the importance of systematic record keeping*

Efforts to create and maintain a conducive environment for record keeping would include provision of guaranteed milk markets and attractive and stable milk prices. Currently the milk markets in the country are private owned and very few, creating little competition. As indicated by Diwyanto et al., 1995, it is difficult to convince smallholder farmers to keep consistent records in a situation where they are getting little returns. The organization and stable prices offered for milk volumes sold at dairy processors would in turn motivate farmers to participate in recording. This can also be backed by a well stipulated policy specifically put in place for milk recording.

*How to ensure accurate recording of dairy information by smallholder farms*

Milk recording should become an integral part of any dairy farming. As reported by Chagunda (2000), dairy farmers in Malawi keep records in the format and at the intensity that they consider reliable and convenient. In a study, to investigate accuracy, milk weights were sampled using different frequencies, (daily, weekly, and monthly) - (Chagunda et al., (2003)). The results can be inferred that a weekly recording interval provided a closer estimate to the daily recording interval without much loss of precision and gives acceptable estimates of total milk yield, which apart from breeding purposes could be used as a tool to advise farmers on appropriate feeding and management practices. Therefore, recording all the relevant traits at intervals of not more than one week should be a starting point. And considering the apparently low standards of management practiced and the many activities farmers are involved in, this is the practical an appropriate recording interval.

*How to assess performance of Farmer and Government AI technicians*

Frequent monitoring and sustainable feedback mechanisms towards the smallholder farmers, completed by informative technical and statistical information should be instituted. Dairy technical support staff should be trained on utilization of such information.

*How to define the grading levels of the dairy stock and development of a registered dairy herd for Malawi*

Currently the dairy herd in Malawi comprises crosses of different grades and breeds. These include Friesian/Malawi Zebu crosses, Brahman/Friesian crosses, Brahman/Malawi zebu/Friesian crosses, Jersey/Malawi Zebu crosses etc. The breeding systems are very mixed ranging from natural means, artificial means, controlled and random mating, making it very difficult to categorize the herd.

*Way forward*

It is proposed that the processing and storage unit be located at a university institution (e.g. Bunda College) since it has already functioning machinery for such. An additional channel would be the involvement of NAIS through which farmers would be encouraged to use AI and therefore be motivated to keep records.

These will be a national central data recording and processing unit which will be assigned overall management of the scheme. This unit will among other functions be responsible for providing a good base for extension services, compiling data from farmers, production of publicity materials and will be a source of database for research and development. Data could be stored in D-base, a computer programme which is easy to use and access. The institution in consultation with other local institutions, farmer organizations and other stakeholders viz a viz; Dairy associations, Veterinary services providers, Milk buyers and Processors and Dairy cattle breeders.
Government machinery can act as a technical backstopping in a facilitating role and regulating the animal production process in liaison with NGOs. The sources of funding may be from government, various NGOs and International agencies. Farmers and their organizations should be assigned a part of financing animal recording from the beginning. Government should also provide baseline funding or be responsible for maintaining funding from other external sources for the sustainability of the scheme. Base funding for the recording scheme should be part of the nation’s development budget though donor funds may be necessary to provide key supplemental funding.

The recording scheme should be tested as a pilot scheme and any feedback from the various stakeholders be incorporated into modifications ready for general use. The recording can be done in local language and farmers will be using relatively cheaper calibrated cups which could be provided at MBG as loan. The recording sheets will also be readily available at the MBGs.

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Forage and Feed Resources

J.P. Mtumuni

Introduction

The major feed for ruminants which includes dairy cattle is forage. Levels of milk production of about 10 to 15 liters per day can be supported on forage alone depending on the quality of the forage. On higher levels of production, inclusions of concentrates are required to balance the ration. High milk-producing cows may require 40 to 80% concentrates in the ration. Even then the amount of concentrate may be reduced if the quality of the forage is fairly high especially in legume forage.

Current Status

Currently in Malawi, most ruminant animals are raised on natural grasslands on hydromorphic areas called “dambos” or upland areas which are invariably owned by the communities surrounding the area. If the smallholder farmer is close to a dambo, the major source of the feed for the animals will be the dambo even though the animals may be confined. Forages on the upland areas tend to dry quickly after the rainy season and remain dry for most of the long dry season which lasts about six to seven months beginning about April to about October.

Tropical grasslands, the savanna, have little or practically no legume component. Natural grasslands or pastures have low feeding value especially during the dry season; whereas legumes have high feeding value for most part of the dry season and even then legumes have much higher feeding value at the same stage of maturity as grasses.

Tropical grasses tend to dwarf tropical legumes; because, the grasses grow very fast under the tropical sun. Legume component increases the feeding value of a pasture. Therefore tropical grasslands have low feeding value. The major constraint to ruminant production in tropical climate including Malawi is the occurrence of little or no legume component in the natural pasture or grassland. The problem was realized in Malawi in the sixties (Savory and Thomas, 1971) and large number of improved forages were screened and tested in most of ecological zones of Malawi (Pasture Handbook, 1983). Practically the technology has not been adopted by the smallholder farmers and yet it has be demonstrated that increased animal production results from such technology. The technology is fast disappearing as in some circles; they are regarding the technology of pasture production as new, i.e. re-inventing the wheel. Varieties that once existed in Malawi are being lost. This chapter examines the current situation in the forage resources and outlines the solutions for the existing problems.

Natural Pasture

Most animals in Malawi are raised on natural grasslands, Dambos or upland areas which are invariably communally owned. Grasslands have low feeding value for the following reasons:

a) Natural pastures are dominated by grasses. Tropical grasses easily dwarf legumes because tropical grasses are C4 plants which are much more efficient in photosynthesis under the tropical sun than the tropical legumes which are C3 plants (Wolfson and Tainton, 2000). In temperate areas, grass/legumes mixtures can be controlled by the proportion of seed mixture at planting time; but, not with tropical grasses and legumes. It is practically not possible to find compatible tropical grass and legume species. Very few successful tropical grass legume mixtures have been observed in Malawi. The best example may be that of the mixture of Panicum coloratum (Bushman mine) and Stylosanthes guianensis cv Cook stylo, or Desmodium uncinatum Silverleaf or Desmodium intortum Greenleaf in natural pastures which cannot readily be duplicated. Tropical legumes have to be grown in pure stand to derive the maximum benefit.

b) The little component of legume present is too low to supply the one percent nitrogen (Hungate, 1966) or 6.25 % Crude Protein (CP) approximately 7 % CP required for the normal growth of the rumen microbes. The CP content of grasslands for the most part of the dry season is much lower than 7% CP. It has been demonstrated (Savory and Thomas, 1971) that legume forage even though dry contains CP levels above 7%. The legume is quite crucial for maintaining high levels of animal production on pasture only if legume component can be introduced in the pasture or supplemented from a pure stand as hay or foggage.

c) Natural grasses grow, mature and lignify too quickly in the short wet season and are of low digestibility. The materials remain in the digestive tract for along time because the forage contain less than 1% nitrogen required for normal microbial activity in the rumen (Hungate,1966) and therefore there is little room in the rumen for the forage in the next meal. The voluntary feed intake of the low quality dry forages during the dry season is low and animals invariably lose weight (Stobbs, 1975). Animals gain weight during the rainy season only to lose it again during the dry season (Stobbs, 1975 ). This cyclic gain and loss of weight makes an animal to reach mature weight much longer than it would otherwise take. Most animals on natural pasture take 5 to 6 years to reach 350 kg. For dairy animals, it means low milk production during the dry season. Unfortunately, no variation is made in milk prices considering that milk is produced at a higher price during the dry season than during the rainy season.

d) Natural grasses have lower digestibility and overall feeding value than improved pastures. This is not surprising. Indigenous plants or animals adapt to the local conditions by reducing stressful conditions such as lack of water or feed, respectively. Thus an increase in yield can only be obtained when stress is introduced in the system by genetic application or manipulation so that in the attempt of removing the stress such as providing extra water in case of a plant or increasing the required nutrients for the plant or animal, now an improved one, can produce more than it would otherwise produce. Therefore one cannot expect indigenous plants or animals to produce significant yields without putting on stress on the plant or the animal through genetics. It is in trying to remove the water or fertility stresses that we get an improvement in yield or quality of a plant or animal in improved varieties or breeds. Improved tropical
grasses and legumes have significantly much higher yields than natural.

e) There is little or practically no legume component in the grasslands. Legumes have much higher nutritive value than grasses at the same stage of maturity.

**Improved pastures**

Pasture improvement is the most economical method of ensuring that stock have access to adequate supplies of nutrients. Like any successful enterprise, improved pasture must be planned for so that one knows how much one can reasonably spend on pasture to make it worthwhile. It would be useful to know how much is spent to establish a pasture in Malawi and how much returns one can realize from a unit area. Establishing a pasture with a companion crop the first year invariably cuts down the cost. A list of some improved legumes which have been recommended for various soil-climate-management-environmental conditions in Malawi is presented in Appendix 1.

The advantages of improved pastures are as follows:

a) Animal production: Pasture herbage is the cheapest form of animal feed available, and concentrates are only required at very high levels of animal production. Animal production is increased on improved pastures. One should be aware of the role improved legumes and grasses play in improving animal production.

b) DM yield is higher on improved pastures.

c) Legumes can fix atmospheric N to useful nitrogen for grasses to use.

d) Build up of soil fertility. Shedding of leaves increases organic matter in the soil although this is a disadvantage for the animals. Macroptilium atropurpureum (Siratro), is perhaps the best example.

e) Control of pests and diseases - Many grasses and legumes are resistant to or are unaffected by the pests and diseases which attack arable crops. A period under pasture will reduce the incidence of disease or pests. The best example in Malawi is growing of tobacco results in an increase in the population of eel-worm in the soil. Leys based on Panicum, Eragrostis curvula (Love grass), or Chloris gayana (Katambora Rhodes grass), have given effective control of the eel-worm.

**Dambo (Hydromorphic area) as a source of forage**

Dambos remain the major source of feed for most cattle, sheep and goats in Malawi. Dambo or most of grazing areas are invariably owned by the communities surrounding the area. Practically all dambos are owned by many people and several chiefs. No single individual or chief can claim sole ownership or can have exclusive rights to a dambo or any grazing area in Malawi.

This is a major setback to cattle, sheep and goat production. No single factor can make tremendous improvement in ruminant production than improvement of the dambo or upland grazing area fencing would have to be an integral part of this. A fenced dambo or grazing area would allow one to practice all known animal husbandry techniques such as fodder conservation, controlled breeding, controlled grazing and disease control. Yet not much attention is paid to this great resource.

In 1971 (Russel, 1971) a survey was conducted to evaluate dambos in Lilongwe District. The survey concluded that there was no limitation to the number of livestock grazed by individual villagers implying that there was no grazing control of the area. Majority of cattle owners still regarded cattle in a traditional light, as a sign of prestige and above all as an insurance against hardships, a “walking bank”. Forty-two per cent of village headmen thought that improvements to the dambo were impossible or were unsure. A significant number of cattle owners from heavily overgrazed dambos were not aware that their dambos offered poor grazing. Twenty-five per cent of the cattle owners had no desire to improve the quality of their herds or saw any benefit from improvements to dambo grazing and 50% wanted to improve the quality of their herds; but, could not make any constructive suggestions as to how they would implement their ideas. Although about 20-25% of cattle owners and chiefs saw no benefit to improvements to the dambos, the programme was still initiated and it worked for sometime during the project life. After project was stopped, there is no single trace in dambos which were fenced and had improved pastures planted.

Recent evidence (Kumwenda and Ngwira, 2003), indicates that this attitude of livestock farmers still exists in hindering the adoption of pasture or forage technology in Malawi. It was reported by the authors that farmers consider pasture or forage as weeds rather than crops and tend to consider weeds and pasture species as one and the same thing. Many livestock farmers do not consider forage as a valuable crop and do not see why they have to plant a pasture or forage. Yet they keep dairy cattle. Such farmers present a huge challenge for improving the pasture let alone see the value of planting legume forage and the role it plays in increasing milk.

**Forage seed**

One of the major constraints to adoption of pasture technologies as is true to all other crops is the availability of seed to the farmer. The issue of seed availability (lack of inputs) ranks number one in priorities of 13 issues which if addressed can improve food security in Malawi.

Forage can be cultivated only if sufficient and viable seed or planting material is available. Both annual and perennial plants can be grown from seeds. Vegetative propagation makes sense only with perennials. In the tropics, the production of seed of perennial grasses and legumes meets considerable difficulties. The yields of tropical pastures are quite low and compare much poorer with the temperate pastures (Table 6).

<table>
<thead>
<tr>
<th>Species</th>
<th>Yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachiaria</td>
<td>30 – 60</td>
</tr>
<tr>
<td>Hyparrhenia</td>
<td>30 – 60</td>
</tr>
<tr>
<td>Chloris gayana</td>
<td>200 -250</td>
</tr>
<tr>
<td>Panicum maximum</td>
<td>200 - 250</td>
</tr>
<tr>
<td>Paspalum dilatatum</td>
<td>200 - 250</td>
</tr>
</tbody>
</table>

The seed yields are quite low indeed in many tropical grasses (Table 7)
Yields of pure geminating seed (PGS) are usually in the order of 10 – 50kg/ha.

In some experiments in Kenya, the yields were quite low (Table 7) depending on the variety.

<table>
<thead>
<tr>
<th>Species</th>
<th>Yield (PGS/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setaria anceps</td>
<td>15 to 32</td>
</tr>
<tr>
<td>Chloris gayana</td>
<td>24 to 44</td>
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<tr>
<td>Panicum maximum</td>
<td>25</td>
</tr>
<tr>
<td>Brachiaria ruzinensis</td>
<td>23</td>
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</table>

Seed yields are low because seed is often poorly formed and large proportion of spikeletes can be empty. Further, ripening seeds shed easily often before maturation. Birds eat well-developed seeds, spikelets can be infested with smut or are burnt. Fertile shoots appear gradually and while shoots have ripe seed, others only begin to appear and flower; and some even shed their seed. The pods of some species burst vigorously, sending their seed to considerable distances from the plants on which they were formed. As a result of uneven ripening and seed shedding, only a relatively small proportion of seed that were formed and ripened can be harvested, e.g. Centrosema pubescens (Centro) and Macroptilium atropurpureum (siratro). All these factors reduce potentially high yields to a fraction of their potential. The low seed yield of tropical grasses and legumes explains why the seed of tropical grasses and legumes are expensive. The cost of seed in tropics including Malawi constitutes a large proportion of the total cost of establishing of pasture.

Imported seed

Currently, forage seed must be imported. In most cases, seed has to be imported from elsewhere; traditionally Malawi used to import seed from Australia and now from Ethiopia and possibly from Kenya. However, experience with imported forage seed has often been disappointing for the following reasons:

1) The seed can easily be damaged in transit.
2) Viability is greatly reduced if the seed is kept in hot warehouses and if it is poorly protected especially grass seed.
3) A cultivar of a forage species selected in one country may not fit well into the existing vegetation of farming system of another country, even if it has a similar climate.

Forage seed production can be considered under the following five broad areas:

1) Field multiplication
2) Post-harvest seed conditioning
3) Seed quality control
4) Seed marketing
5) Economics of forage seed production

Here, we will concentrate on field multiplication and touch on post-harvest seed conditioning since the other topics are dealt with elsewhere.

Field Multiplication

The major objective of forage seed production is to provide quality seed or vegetative material that is suited to the needs of farmers for livestock production. Livestock production in sub Saharan Africa is hampered by feed shortages and the poorer quality of available feeds.

Apart from specialized forage seed plants in Ethiopia and Kenya, there is no common system of producing forage seed in sub-Saharan Africa. Seed production is in the hands of opportunists who take an advantage of the situation rather than a planned venture. Forage seed is not grown on specialized fields. Rather the farmer makes a decision not to cut certain portion of the pasture. The seed is harvested in stock exclusion areas. Usually grazing is continued late into the second half of the rainy season thereby leaving no chance for the forage to set seed. The seed yields are quite low in this system. Large scale mechanized system does not exist in sub-Saharan Africa even in South Africa.

Crop establishment

Establishment requires conditions favorable for germination, emergence and growth of seed; for vegetative material, favorable conditions to initiate new roots and shoots are required. The land should be cleared of trees and stumps, ploughed, and disc harrowed. Efforts should be made to break all lumps on the seedbed. Lines are drawn on the prepared seedbed 30 – 45cm using a wooden stick with a prominent branch. The lines should not be too deep but should be up to 1cm depth. This is achieved by ensuring a sharp cutting edge on the stick. The spacing of 30 to 45cm is regarded as the most convenient compromise between seed yield and practical distance for weeding. Increasing the spacing to 90 cm reduces seed yield by as much as 30%. One of the commonest causes of failure in establishment of small seeded forage species is sowing them too deep. The seeds fail to come out of the ground. Planting forage seed in rows enables one to use a hoe to weed in between the rows. Broadcasting the seed is faster and quicker to sow; but, weeding cannot be done with a hoe. It takes along time to weed the field and is labour intensive and is therefore likely to be expensive where labour is scarce.

Sowing in rows is recommended for tussock grasses and vigorous sprawling legumes; but, may be regarded as serving little or no useful purpose to stoloniferous grasses and weakly competitive and or creeping legumes. For stoloniferous grasses or weakly competitive creeping legumes, broadcasting may be considered preferable. However, this may not be true when cost of establishment is considered.

Companion crop

Broadcasting of seed may not be a preferred method of choice when one considers the cost of establishment of a pasture. To cut down the cost of establishment of pasture, it is recommended that a companion crop be planted in the first year. For example, maize is planted two or three weeks later in alternate rows 90cm apart. The companion crop uses the maize as stake for climbing. If the maize is planted at a right time, one often gets a good harvest of maize. This system has worked well for us, for establishment of Centrosema pubescens (Centrosema) and Lablab. We have used maize as companion crop. We have had high yields of maize but without applying fertilizer. At the end of the growing season, maize ears are harvested first and the maize stover with legumes are cut and fed to the animals as hay or as cut- and-carry. Factors affecting
the weeding of the pasture should be considered seriously as a pasture can readily be established but fail to yield anything since it would be overtaken by weeds. One should remember that clean seed comes from clean fields. Weed control measures taken on seedbed planning and preparation ensure successful establishment.

**Seed**

Good quality seed (well matured and perhaps certified) must be used, seed of appropriate status or seed with known germination percentage would be preferred. One can conduct own seed germination test if this is not known. Although not taken as seed in the normal sense, rhizomes, stolons, stem pieces and cuttings (splits) may be used. Such materials are genetically identical to the parent plant. Some seeds can be sown directly especially grasses; but, some legume seeds require scarification such as Centrosema and Stylo seeds. The scarified seed after drying is inoculated with the appropriate rhizobium if the field never grew these species. Failure to inoculate such seeds before sowing could lead to poor nodulation and subsequent poor plant growth. Inoculation is a cheap precaution against failure especially where legumes have not been sown before. Care should be taken not to mix fertilizer with seed at the time of sowing; because, it has been observed that the fertilizer interacts with inoculum and the seed, which reduces germination and inoculant effectiveness.

The seeding rate for forage seed crops should be at least twice the rate recommended for normal pasture sowing.

The seed should be sown early at the beginning of the rainy season to enable a first harvest at the end of the year. However, weeding will be done more than twice if the pasture is planted at the beginning of the rainy season. Sowing at or close to end of the rainy season, risks poor growth and the chances of the plant not surviving the dry season.

**Fertilizer application**

If a grass is being established, nitrogenous fertilizer must be applied at a rate of 100 kg N per hectare equivalent to 220 kg urea/ha applied at the beginning of the rainy season applied twice during the growing season. Such as rate has been reported to increase seed yields a 100% from a low rate of only 60 kg N/ha (Bogdan, 1977).

Seed may fail to germinate because of several factors such as:

1) Seeds may be eaten or removed by predators such as ants. This is a physical loss of seed.

2) Environmental stress may reduce or be the cause of loss of seed viability.

3) Failure of germinated seed to emerge from the soil may be due to environmental stress or mechanical impediment in the soil e.g. sowing the seeds too deep.

4) The failure to germinate may be due to mortality of emerged seedling caused by environmental stress, plant competition, pathogens and pest attack.

**Crop management**

The main objective of management of forage seed pastures is to produce high yielding seed crops. It should not be forgotten that tropical pastures species have been bred for their forage potential that is production of the leaf and not for seed yield. Tropical pastures by their nature have very low seed yield and yields seldom reach more than a tonne per hectare.

Nitrogenous fertilizer should be applied to grasses to ensure large number of seed heads. The forage should be cut at the end of the rainy season to ensure vigorous growth the following rainy season.

Efforts must be taken to close the gaps in the field so that canopy closes as soon as possible before flowering begins. If the field is well covered with vegetative growth, this ensures maximum seed production and control of weeds is quite effective. Most legumes require frost – free environment, a reliable and well-defined wet season. A rainy season of about four to six months duration is suitable for forage seed yield.

Legumes need to be cut during the growing season to avoid excessive growth. For example, stylo needs to be cut as it produces tangled mass of stems of about two meters. Cutting the compacted mass of stems is extremely difficult and a machine cannot be used to cut the forage since most of the forage will be left on the ground.

**Pest and Diseases**

Pest and diseases are generally more severe with legumes than grasses. Moth, caterpillars sucking bugs are some of the pests, which feed on the pods or flowers. Aphids may require spraying especially in fields of lablab.

**Seed harvesting**

Harvesting grass seeds such as Chloris gayana, Rhodes grass, is relatively simple because the heads can be harvested once or twice. The forage may be cut and stooked then threshed. However, to harvest legume forage seed is rather a complicated decision because some immature seeds including flowers will always be present. All indicators for harvest are somewhat subjective; therefore, for accurate assessment, there is no substitute for experience aided by keen observation.

The seeds are harvested manually using simplest tools as knives and sickles. Where labour is still cheap, hand harvesting is the simplest method and is the most sensible to use. The cost of the tools is cheap and easy to maintain or repair, are dependable and the farmers are familiar with them. It is estimated that 75% more labour is required when knives are used than using sickles. Labour requirements of 100 – 175 man-hours per hectare for sickle harvesting are common but vary with yield, species and moisture content.

Pods are hand picked and dried then threshed. The seed is winnowed in flat baskets and the remaining parts of the pods and chaff are removed by hand.

The grass seed heads or stooks are threshed and seed winnowed and chaff separated from the seed. The seed is dried several
times during the next two months to about 10% moisture, for long storage. The seeds can be graded and packed in appropriate package after observing that the seed is indeed dried to 10% moisture content.

**Seed Quality**

This can be done where regulations are in force.

**Seed Marketing**

The seed marketing is based on building a reputation for seed. High quality seed with high germination percentage is the criterion the farmers require for any seed. The suppliers must strive to fill this market. We sell forage seeds of high quality, Centrosema and Stylo whenever our seed requirements are exceeded. We also sell sets of Pennisetum purpureum on regular basis.

**Future solutions**

There is no doubt that if the dambo or grazing area is improved especially if fenced; animal production will greatly improve several folds. The main idea is to fence the area with materials smallholder farmer can afford such as sisal or lunguizi. This can be done by a group of smallholder farmers or can be done on individual gardens. Improved legumes or even grasses can then be introduced in the fenced area and principle of pasture management can be applied.

Since source of pasture seed is a major constraint to pasture introduction in Malawi (Kumwenda and Ngwira, 2003) we may have to buy seed from farmers we can promise to buy the seed they grow, then we can either sell to the smallholder farmers in the project or loan them the seed so that they return a reasonable amount to distribute to other farmers the next growing season(A separate paper on seed production is attached). For vegetative cuttings, we can use the same method whereby we buy these from selected smallholder farmers then distribute to the farmers in the project area. We could also have nursery for demonstration which can also be a source of seed and cuttings. It is the existence of such a nursery at Bunda that enabled us to preserve some of improved pastures which were introduced in the sixties in Malawi. Such a nursery would enable our project to be one more source for preservation of improved pasture seed in Malawi.

Legumes and grasses should be selected for ease of establishment under village conditions. For example, legumes which require no inoculant since rhizobia in the inoculant are readily killed by inexperienced handling. Lucerne requires inoculant; seed scarification can only be done by a seed producer successfully. For example, silver leaf, Townsendville stylo require no scarification whereas Schofield stylo does; legumes which can be propagated vegetatively may be more appropriate for the village conditions. Free seeding legumes that are easily harvested such as Schofield stylo, Townsendville stylo may be more appropriate under village conditions. In tobacco rotations, legume inclusion is undesirable because the quality of the leaf is reduced. Legumes which tolerate water logging (Schofield stylo, Silver leaf, Green leaf but not Leucaena or glycine) may be appropriate.

For conservation of forage, hay is the best alternative and not silage because there is too much wastage. A recent method has been developed of using tobacco baler or any suitable baler with linya (nylon threads taken from old tyres) as the baling twine.

**Concentrates**

The major concentrates for feeding dairy animals are maize meal, maize bran and soyabeans. Mineral supplements such as sodium chloride and calcium monophosphate may be purchased on the open market. Maize presents a problem; because, there is not enough in stock during the rainy season especially in the months of January, February and March every year. This is a problem which is most likely to remain with us until our agriculture is mechanized.

Soyabeans used to be readily available and cheap too during the harvesting period. However, from last year 2008, the prices went up from the usual K18 -20 per kilogram to over K100/kg during the harvesting period. At the time of planting the present crop in the field the soyabean price was around K150 per kilogram. If the price of soyabean does not come down, which is most likely, the cost of production of milk, poultry products and pork will be too high for many people to afford. The best way to grow soyabeans for the smallholder farmers is to loan them seed and let them return a stipulated quantity agreeable to both parties and redistribute the quantity returned to another group the following growing season.

**Seed**

The most profitable way is to grow the forage seed under contract. This allows the producer to plan the hectarage, labour and other inputs required to meet the demand. There are many smallholder farmers and even well to-do farmers or people with potential in farming that require the seed but always want it for free of charge. They never want to pay for it. This cannot work!

In conclusion, deliberate efforts have to be made to ensure that the dairy animals have feed throughout the year. These feeds are forages and concentrates. Legume forage is mandatory to grow for improving the quality of the ration and substantial amount of milk can be produced on forage alone if legumes are included in the ration.

**References**


PASTURE HANDBOOK FOR MALAWI .1983 Ministry of Agriculture, Blantyre Print & Packaging, Blantyre, Malawi


Milk Keeping Quality in Malawi
Thomas Chimbaza

Introduction
Malawi has a small livestock industry with a total cattle population of 947,000, 188,000 sheep, 3,100,000 goats, 1,229,000 pigs and 15,000,000 chickens. The livestock sector contributes about 8% of the Gross Domestic Product (GDP).

Dairy
The smallholder dairy is concentrated around the major cities of Blantyre, Lilongwe, Zomba and Mzuzu. There are 30,200 dairy cattle in Malawi owned by about 8,000 farmers. The main breeds of dairy cattle are Friesians, Holsteins, Jerseys and their crosses.

There are a number of non Governmental organizations which are promoting dairy production in the country and the major ones are Land O’ Lakes, World Wide Sires, World Vision International, Small Scale Livestock Promotion Programme and Farmer Organizations.

Milk Production
Current total milk production is estimated at 35,400 metric tons from both beef and dairy cattle. Production of milk for the past three years was as follows.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dairy</th>
<th>Beef</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005/06</td>
<td>15,397</td>
<td>10,075</td>
<td>25,472</td>
</tr>
<tr>
<td>2006/07</td>
<td>18,830</td>
<td>10,909</td>
<td>29,739</td>
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<tr>
<td>2007/08</td>
<td>23,649</td>
<td>11,835</td>
<td>35,484</td>
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</tbody>
</table>

Source: Ministry of Agriculture and Food Security

Milk production per cow per day is generally low. Pure bred dairy cows produce between 16-30 litres per day while the crossbred give 6-11 litres per cow per day.

Demand for milk in Malawi is estimated at 40,000 metric tons for urban and 80,000 metric tons for rural areas.

The current per capita consumption of milk is estimated at 4.5 litres which is far below the 200 litres recommended by the World Health Organization (WHO).

Marketing and Milk Processing
Small scale dairy farmers sell their milk through milk collection centres called milk bulking groups (MBGs) established in dairy areas.

The major buyers/processors are Dairibord Malawi, Suncrest Creameries and Lilongwe Dairies. Other smaller processors include Katete Dairy, Northern Dairies, Nature’s Gift, New Capital Dairy and Mwera Mkaka Dairy Cooperative. The installed milk processing capacity is estimated at 188,000 litres per day.

Most factories operate at about 20% capacity due to inadequate supply of milk. About 10 million litres of milk are processed and sold through formal channels. Figures for informal milk trade are not available.

Milk Quality
One of the major problems on small scale dairy farms is the production of poor quality milk which results in losses and reduced earnings.

It is estimated that about 17% of the milk produced by smallholder farmers is rejected by milk processors as being unfit for processing.

There are a number of factors which contribute to poor milk keeping quality on smallholder farms, milk collection centres, milk processing plants and the retailers.

a) Small Holder Farms
- Dairy cows are hand milked in the open milking sheds. Milk is exposed to dust, manure and flies resulting in milk with a high bacterial content.
- Inadequate knowledge on basic hygiene practices by the milker on milking and cleaning milking utensils.
- Lack of milk cooling facilities (refrigerators) on smallholder farms. Micro-organisms in milk can be minimized by cooling the milk soon after milking.
- Animals being milked. Animals infected with mastitis and other diseases, dirty teats, udders flanks, legs and tails during milking (hand milking) may contaminate the milk with dirt and micro-organisms.
- The water used at the farm. The major sources of water on smallholder dairy farms are wells (open or covered), rivers, boreholes and rarely tap water. If the water is not boiled or treated it may act as a source of microorganisms introduced to the milk.
- Distance from the farm to the milk collection centres. Dairy farms are supposed to be located within 8 km radius from the milk collection centre which is a long distance to walk or cycle. Worse still, other farmers are located much further than 8 km. This means that it takes longer to transport milk and makes it difficult to deliver morning and afternoon milk separately.
- Hygiene around the farm. Manure allowed to accumulate near the dairy unit may attract flies and this increases the chances of milk contamination.
- The feed given to animals during milking, if not correctly handled may act as a source of bacteria to the milk.
b) Milk Collection Centres

The quality of milk at milk collection centres is influenced by:

- Sanitary condition of the milk cooling facilities, buildings and the surroundings.
- Non collection of milk by processors which result in losses due to spoilage.
- Interruption of electricity supply.
- Distance from the farm to the milk collection centres. If the distance is too long, the milk will turn sour before delivery.

c) Milk Processing Plants

- Milk is pasteurized to make it safe for human consumption and to improve the keeping quality of both milk and milk products.
- Milk keeping quality at the processors level is influenced by the efficiency of handling and the actual treatment of milk.
- The time between milking and pasteurization influences the bacteria load in the raw milk.
- The sanitary condition of the milk processing equipment. In effective cleaning procedures for the equipment result in poor milk quality.
- Transport tankers from milk collection centres to milk processing plants. Lack of refrigeration/cooling facilities contribute to poor quality milk.
- Storage temperature for pasteurized milk. Interruption of electricity supply by ESCOM result in spoilage of milk.

d) Retail Shops

The temperatures of refrigerators and display cabinets in shops are important in maintaining milk quality. Temperatures should be maintained at 6 °C or below.

- Poor sanitary conditions of milk processing equipment through which the milk passes can be detrimental to product keeping quality.
- Ambient temperature during distribution may influence on the temperature rise of liquid milk during distribution and also depends on vehicle type.
- Interruption of electricity supply may result in milk spoilage where there are no stand by generators.
- Milk distribution vehicles to retailers.
Refrigerated vehicles are the optimal solution to effective distribution.

Milk Quality Control

Main activities carried out on milk quality control are:

- The milk buyer at the milk collection centres conducts Alcohol and Gravity tests on milk delivered by farmers.
- The Department of Animal Health and Livestock Development through its milk quality control section at Central Veterinary Laboratory conducts routine inspections to milk collection centres and milk processing plants. Milk and milk product samples are collected and analyzed at the laboratory.
- The Malawi Bureau of Standards (MBS) a parastatal body, provides standards for milk and milk products and promote their adoption. Malawi Bureau of Standards conducts inspections to milk processing plants and supermarkets.

Conclusion

Malawi has the potential to produce more milk for the domestic market. This can be achieved through improved Artificial Insemination Services, promotion of commercial farms and breeding centres for genetic improvement.

Losses resulting form poor quality milk can be minimized through training of farmers on basic hygiene practices and handling of raw milk.

References


The improved legumes which have been recommended for Malawi for various soil-climate-management-environmental conditions (Mtimuni, 1995) are as follows:

<table>
<thead>
<tr>
<th>COMMON ENGLISH NAME</th>
<th>BOTANICAL NAME</th>
<th>ENGLISH NAME</th>
<th>BOTANICAL NAME</th>
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<td>STAR GRASS</td>
<td>Cynodon dactylon</td>
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<td>STAR GRASS (HENDERSON NO.2)</td>
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<td>THATCH GRASS</td>
<td>Hyparrhenia filipendula</td>
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<tr>
<td>SPECTABILIS</td>
<td>Senna spectabilis</td>
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