QUICK SCAN
Dairy Sector
TANZANIA



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Quick Scan Dairy Sector Tanzania

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Pictures on frontpage:
Crossbred cow with calf (Tanga region): Lút Zijlstra
Tanga Fresh, dairy equipment: van de Heuvel (www.heuvelzuivelmachines.nl/website)
Herd of cattle (near Mwanza): Arend Jan Nell

This Quick Scan is based on data from literature and internet, on discussions with local experts and people who have at one time or another worked in the country, as well as on personal insights and experiences of the authors. Information may not be complete nor comprehensive due to the very nature of a Quick Scan. Authors have done their best to collect good information and to provide proper reference to the sources of information. Any suggestions or corrections of quotes, references or other content is highly appreciated.

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Content

Annexes

Summary

This is a Quick Scan of dairy development in Tanzania to identify opportunities for Dutch involvement in this sector. Major concerns were, among others, a need to develop dairy to save foreign exchange and to provide income opportunities. The report consists basically of two parts, the first describing past and present (till Ch.4), the second (Ch.5 and 6) looking more at possibilities for present and future application of 'technologies'.

Basic assumptions in this Quick Scan are that
- Tanzania is a country of milk drinkers and milk producers even if present production and consumption can increase considerably;
- dairy fits the local ecology, available resources and economic developments in many parts of the country quite well, especially with adjusted levels of milk per cow;
- 'technology' includes social aspects and organization as well as feed, fertilizer, vaccines or stainless steel, at farm as well as regional or national level. Another distinction is between 'face value' (obvious short term) solutions and solutions that address root causes;
- the country is highly variable in dairy production systems, value chains and farmers' goals requiring 'tailor-made' development approaches. That variation is combined into a policy-diagram which with simple scenario studies identifies opportunities for 'technologies';

Given the nature of a Quick Scan the report had to make choices and conclusions are tentative, rather bold statements to trigger discussion rather than to give final answers.

In this context this Quick Scan describes past and present of dairy in Tanzania, lessons learned from past and present Dutch projects, together with experiences from other donors, NGOs and the private sector. Models of dairy systems and value chains from other countries are also given to provide examples for development in Tanzania. The most basic conclusions are that:
- the informal market is large and strong, over 85 % of the marketed milk is going through the informal market. The licenced market is small with many relatively small processors. Still the major share of the milk is produced by local herds of pastoralists and agro-pastoralists with seasonal fluctuations in production.
- Tanzania has known many donor supported dairy development projects which altogether have contributed to an increase in milk production or extraction of more than 7 % per year over the last 20 years. The share of total milk production coming from crossbred 'grade' cattle increased from 3 % in 1973 to 30 % in 2010.
- successful dairy development requires a holistic approach, distinguishing well-defined niches with [potential] demand for milk and a tailor-made approach in the sense that every production system, value chain related to goals has specific options.
- support of a stronger commercial sector does not necessarily imply savings on foreign exchange, and providing labour opportunity requires due attention to small holder dairy.

More general issues in the dairy sector are skill training, recognition of local resources and skills, social organisation, aspects such as feed availability, reproduction, continued supply of suitable genetic materials, calf rearing, animal diseases, seasonal milk supply and reliable collection, distance between production and markets and poor business climate. Opportunities lie in variable milk pricing (wet and dry season), diversification in dairy products and long-life products, import of milk powder for continuous processing, input supplies (premixes, AI and bulls, animal health service), improving business climate and regulations, and cross breeding of local cattle in suitable areas.

1. Introduction and background to this report

1.1 Dairying in Tanzania

The motive for writing this document is the interest of the President of Tanzania, Mr Jakaya Kikwete, for dairying in his country. During a visit to the Netherlands in April 2013 he visited a dairy farm, a milk processing plant and a dairy processing equipment manufacturer, together with officials of the Netherlands Ministry of Economic Affairs. The parties agreed to explore options for cooperation between the two countries in dairy development. This Quick Scan describes the present situation and main issues in Tanzanian dairy, lessons learned from the past [Dutch] cooperation projects in this field, and experiences from other donors and NGOs. Furthermore, this Quick Scan looks at present activities of the Dutch private sector in Tanzanian dairy as well as new opportunities.

The document gives information on the current situation in the dairy sector in Tanzania with special emphasis to the variability of dairy production systems and their potential for further development or exploration in the various regions of Tanzania. This Quick Scan is not a detailed and comprehensive study but it aims to open up discussion by making some bold statements and by doing simple scenario studies. It uses information from published and unpublished documents supplemented by discussions with resource persons and by experiences of the authors themselves. A list of references, interesting documents and websites is given in Annexes 3 and 4.

This Quick Scan is incomplete by its very nature. Choices have to be made, e.g. on issues like:

- Tanzania is not an isolated country, but effects of international politics, disease situations and markets on dairy development in Tanzania have not been covered;
- data used come from existing databases and expert advice but reliability of at least part of the data is doubtful. Also data such as used on sensitivity analysis for herd-replacement, feed costs and the like need to be checked against local conditions. The point of short calculations and policy diagrams is to trigger useful discussions, not to give a final 'verdict' on what happens or should happen in the field;
- statistics on 'production' may actually refer to 'extraction', implying that collection 'extracts' more milk from the farms even if no more milk is being produced in a strict sense. Overall we assumed that data on milk yield exclude milk consumed by calves. Another issue in use of statistics is that it is often unclear whether data on GDP include or exclude the value of products that do not enter the formal markets;
- not all current developments could be checked or discussed in full, e.g. persistent rumours on the possible import of large numbers of heifers. New developments on issues of people, planet and profit are not elaborated in detail but often mentioned implicitly in the text;
- approaches differ between macro and micro level, e.g. between policy makers working on country level and entrepreneurs looking for individual [niche] opportunities. Both approaches can serve common interests but this report looks primarily from a macro point of view while referring to opportunities for entrepreneurs as much as possible in the context of this Quick Scan;
- the term ‘technology’ is always placed between inverted comma’s since it also refers to issues of skills, motivation and organisation (even if the emphasis in this report tends to be on ‘technical approaches’) ;

- too many ‘technologies’ exist for each receive to full coverage. Unfortunately this Quick Scan had to choose not to elaborate extensively on important issues such as animal feed, local skill building and the like;
- the need for tailor-made approaches is basic to this report, leading to distinctions between production systems and value chains, with associated differences in suitability for ‘technologies’. The Quick Scan can only indicate the approach. More specific work on that, also on distinctions between R&D approaches can only be done with people in the field and the report is therefore not meant to have a cookbook approach.

Milk consumption is important for human nutrition, it provides essential nutrients and in cases where there is little variation in the diet milk contributes to general health and condition of the people, especially in cities where poorer sections of the population often suffer from malnutrition. Particularly for children in the first two years of their life (the critical 1000 days) regularly consuming milk contributes to long term health and physical and mental development

Milk is common food to many people in Tanzania, especially for pastoralists and agro-pastoralists in the central part of the country and east and south of Victoria Lake. In the cities milk consumption is also common for people who can afford it. In semi-humid and humid areas, such as the south-eastern and western part of the country, milk production and consumption is less common.

Tanzania has a high variation in agro-ecological zones with corresponding differences in potential for dairy development. The highlands are suitable for milk production, although the pressure on the land is already high as a result of intensive crop production. In other agro-ecological zones dairy programmes have been implemented as well with more or less success. Government, private sector and NGOs alike have shown much interest in the dairy sector and are developing initiatives for dairy projects.

With rising incomes demand for milk and milk products is on the increase. Overall, increased income always tends to lead to increased demand for foods from animal origin and diversification of products. For milk this generally means a shift from buying at the informal market to the formal market and from plain milk to processed products.

At the end of this first chapter and more elaborately in Ch.2, the report shows that for production of milk several different production systems can be distinguished, ranging from pastoral systems with low yielding animals to modern systems with high yielding dairy breeds (Fig 1.3). We also stress the existence of different dairy value chains, each with their own development opportunities. In the course of this document the production systems and value chains are presented in different policy diagrams as in Fig 1.3.

1.2 General country information

Tanzania has a total land area of 884,000 km^2, of which around 40% is classified as agricultural land. The human population is 47 million in 2012 with an annual growth rate of 3% of which around 75% is rural. The population density is just over 50 persons/km^2. The official capital is Dodoma where the national assembly, the presidential office, some ministries and government offices are located. Dar es Salaam (DSM) is the principal commercial city and location of most government institutions including the Ministry for Livestock and Fisheries Development (MLFD) and the Ministry of Agriculture, Food Security

and Cooperatives (MAFC). Administratively the country is divided in 30 regions (25 on the mainland and 5 on Zanzibar), which are divided in total 169 districts. A map of Tanzania is in Annex 1.

Tanzania is a low-income rural-based economy with agriculture (incl. livestock) contributing 26 % to the GDP. Over the past decade Tanzania has experienced a period with a relatively high and stable growth rate. The main drivers of growth have been the mining sector, telecommunications, tourism and construction. However, the agricultural sector faces stagnation in its product growth. Problems include low adoption of improved technologies, high transport cost and lack of adequate market competition. Recent government commitments under KILIMO KWANZA (Agriculture First) offer the promise of greater coordination of public and private commitment to make Tanzania's agriculture more competitive. The government is investing a growing share of its budget in agriculture and is encouraging broader commitments to agribusiness development. Economic growth is increasingly based on government spending rather than on private investment. Growth is expected to continue with approximately 6 – 7% as a result of investments in mining (especially gold) and the emergence of private activities boosted by better infrastructure, regional growth and policy reforms in the business environment. Tanzania has a good prospect of becoming a major producer of natural gas in the next decade (World Bank[1]).

1.3 The Tanzanian livestock sector

Tanzania has the third largest cattle population of Africa; estimates vary from 18 to 22 million head. Most cattle are owned by smallholders and pastoralists. In total there are some 1.7 million livestock owners primarily in arid and semi-arid areas and the highlands; cattle densities are low in the humid and semi humid areas. Based on the livestock census of 2007/08 (Tanzania, 2012a and 2012b) there are 209 large scale cattle farms with in total 21,300 head of cattle mainly on beef ranches, and only a few large dairy farms. A few beef ranches are used as Heifer Breeding Units (HBU) to produce crossbred dairy heifers. The main cattle breeds are the Tanzania Shorthorn Zebu (TSZ), the Boran (coming from Kenya) and the Ankole (coming from Uganda) in the north western part of Tanzania. The population of crossbred dairy cattle is relatively small (3-4 %). The goat population is around 15 million, mainly concentrated in the northern part of the country. The Livestock Sector Development Strategy (MLDF, 2010) states a dairy goat population of 40,000 head (Toggenburg, Saanen and other breeds) mainly distributed through GIT (Goat in Trust schemes). Tanzania has a sheep population of almost 6 million and 1.6 million pigs.

The livestock sector contributed only 5.9% to the GDP in 2005 and 30% of this came from dairy. However, livestock has a very important role in the rural economy; around 40% of the households in Tanzania own livestock and rely on them for an often major part of their income. Tanzania is self-sufficient for most of its livestock products; exports as well as imports are limited. Milk imports are around 2 – 3% of the total consumption while cost of imports of dairy products amounted to 7.7 million US$ in 2009. Dairy imports mainly originate from Kenya, South Africa and the Netherlands (NIRAS, 2010).

Main resources for livestock production are the extensive grazing lands, skills, labour (especially from resource poor farmers (RPF)) and capital inputs. Differences in agro-ecological zones strongly relate to the differences in the livestock and dairy production

[1] http://www.worldbank.org/en/country/tanzania/overview

systems. The map in Fig.1.1 shows the major agro-ecological zones in Tanzania with a brief description of the characteristics and related production system in Table 1.1.

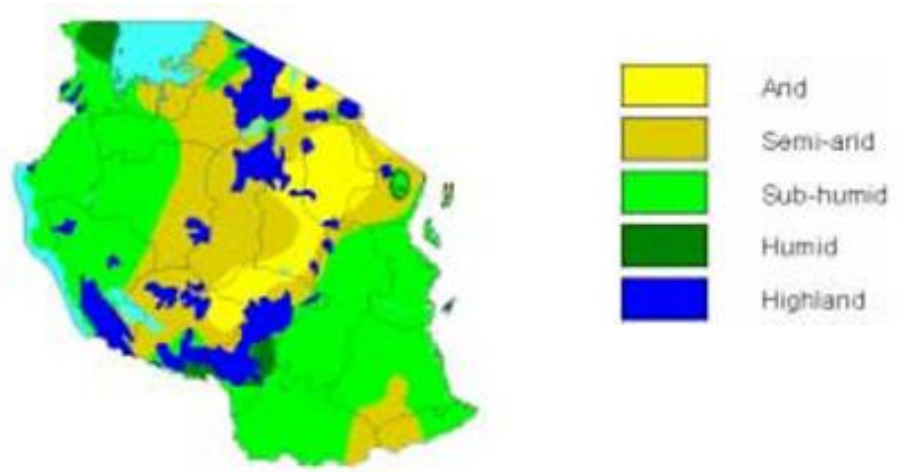

Figure1.1 Agro-ecological zones (FAO, AGAL, 2005)

Table 1.1 Agro ecological zones (based on Jahnke 1982 and the authors)

Agro-ecological zone	Description	Prevalent dairy system
Arid	Growing days below 90	Pastoralism
Semi-arid	Growing days from 90 – 179	Agro-pastoralism
Sub-humid	Growing days from 180 – 269	Small holder
Humid	Growing days 270 or more with high temperature and high relative humidity	Smallholder dairy
Highlands	Growing days 90 – 365; over 1500 m altitude, ranges from semi-arid to humid but average temperature below 20 C in the growing season	Smallholder dairy and medium and large scale dairy

Average density for cattle is just over 20 head/km^2 (1 head/5 ha) with considerable differences in the country (Fig.1.2). Especially the semi-arid areas east and south-east of Lake Victoria have a high stocking rate (mainly agro-pastoral areas) of over 100 head/km^2 (1 head/ha) and in the sub-humid areas the density is generally less than 10 head/km^2. Cattle density corresponds very well with the milk off-take or density (Fig.2.5). Further down we use this variation in milk yield and cattle density (≈milk density) as one of the 'factors' to better understand the variation and to better apply differentiation of production systems and segmentation of value chains for more effective development (Ch.2)

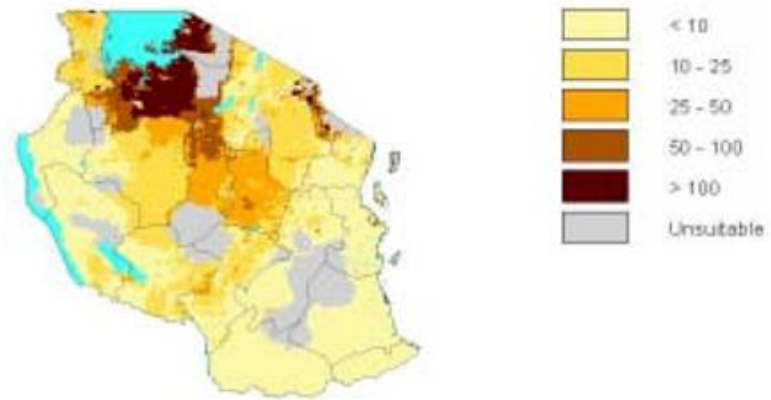

Figure 1.2 Head of cattle/km^2 with grey areas marked as 'unsuitable' are mainly national parks for wildlife (FAO, AGAL, 2005).

Livestock diseases are among the more serious constraints, limiting development of the livestock industry. Most prevalent diseases in Tanzania are some tick-borne diseases (TBD), trypanosomiasis and CBPP (Contagious Bovine Pleuropneumonia). Trypanosomiasis used to be prevalent in the more humid areas of Tanzania but presently pressure is less due to land clearing and increasing population which makes the habitat less suitable for the tsetse fly. Of the TBDs East Coast Fever (ECF or theilleriosis) is the most important and can result in high death rates of especially calves. Regular spraying or dipping is recommended, although not many dips for which Local Government Authorities (LGA) are responsible are in working order. Cost of medicines and acaricides for treatment and prevention of TBD are high. The use of ECF immunization of cattle in the traditional sector has yielded positive results and needs to be spread more widely. Other infectious diseases are Anthrax, Blackquarter and Foot and Mouth Disease (FMD), of which FMD has not been reported for several years now. The Central Veterinary Laboratory (Temeke, Dar es Salaam) has a special sub-station for trypanosomiasis research in Tanga and further 6 regional laboratories for first line diagnostics (based on MLFD, 2006; MLFD, 2010 and other sources).

The extensive grazing lands and crop residues of the arid and semi-arid areas are the main feed resource for the millions of cattle owned by pastoralists and agro-pastoralists. These animals hardly receive any supplementary feed resulting in nutrient shortages and low yields at the height of the dry season when all crop residues are finished. For the cattle in the semi-humid areas grazing under coconuts is common. In addition, feed from mixed farming (crop residues, weeds) and roadside grazing is used. Feed shortage in the dry season is less severe in this system, but here as well providing supplementary feed to traditional cattle is not common and possibly not profitable. In the highlands, where most of the dairy cattle at smallholder level are found, feeding is based on crop residues, roadside grazing and occasionally on fodder crops; conservation of feed (roughage) is not very common and technically not easy at smallholder level. If available and considered profitable by the farmers they will purchase concentrates ingredients (maize bran, cottonseed cake, sunflower cake,) or mixtures. Urban and peri-urban farmers purchase hay, roughage, and concentrates. Medium and large scale dairy farmers will have improved pastures for grazing or areas with fodder crops, and practice feed conservation (mainly hay making). Year round feed supply, general feed shortages and feed quality are major constraints for milk production. Especially for the intensive and semi-intensive dairy sector the lack of supplementary feed or feed concentrates, irregular feed supply, problems in feed conservation and land shortages for cultivation of fodder crops are the major limitations. Information based on authors' experience, interviews and Lwoga and Urio (1985).

1.4 Variation of dairy production systems and value chains in Tanzania.

There is a high variation in milk production systems and potential for development as a result of differences in agro-ecological zone, type and breed of cattle, marketing options and demand. To understand and handle this variation and to investigate the potential for development we use a 4-quadrant 'policy' diagram to describe and visualize the differences and opportunities between the systems. That is a step away from or an addition to a more traditional approach of distinguishing Tanzanian livestock production systems as elaborated in Ch.2.2. One difficulty is, however, to combine the dairy production systems with the different processing and marketing systems. Segmentation or differentiation, the distinction into different production, processing and marketing systems, is done to effectively discuss possibilities for action in dairy development in countries with such a variability in production systems and market chains like Tanzania. The report uses the term 'differentiation' to

describe the variation and transition in production systems and the term ‘segmentation’ to describe the variation in dairy value chains.

Four major ‘value chains’ consisting of a combination of production, processing and marketing systems are therefore distinguished in this report, by plotting production systems into a diagram with scales on milk yield and marketing system. The diagram in Fig.1.3 represents four different value chains, using milk per cow (from traditional to modern dairy) as the x-axis and differences in marketing, ranging from informal and rather direct sales to formal and indirect sales of milk on the y-axis. This distinction into four major value chains, with more variations if necessary, is used throughout this report to further identify and analyse development options.

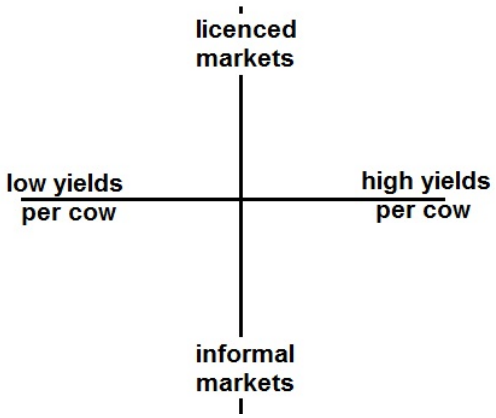

Figure 1.3. Policy diagram to distinguish production systems and value chains

2. The dairy sector

2.1 A brief history of dairy in Tanzania

Dairy and milk drinking is part of much of Tanzanian culture even if exclusive production of milk only as a commodity may so far be alien to many animal keepers in the country. Milk is, however, an integral part of life in the pastoral communities in the arid and semi-arid areas, while the colonial times have also had an impact in a few areas. One of the first official references on a new dairy sector in Tanzania is about dairy farms supplying milk to the government civil servants in Dar es Salaam in 1921 (Kurwijila, 2001). A few settlers, though far less than in the Kenyan so-called 'white highlands', started dairy farming in the highlands around Arusha and Iringa in the period between the 1st and 2nd World war. In 1932 - 1935 the Mpwapwa Livestock Research Station developed the Mpwapwa breed based on Indian, European and Tanzanian breeds for the semi-arid regions with a higher potential for milk production. Unfortunately almost all animals were kept at research stations and not many serious attempts were made to spread the breed to the local farmers. FAO has now classified the Mpwapwa breed as an endangered breed with less than 100 breeding females left mainly at research stations (Kurwijila, 2001).

After independence the livestock and dairy sector got more attention. Tanzania adopted the Policy of Socialism and Self Reliance and established as part of the policy parastatal companies for the livestock sector to increase production and work as catalysts for development. The first dairy development plan was designed in the early 1970s and implemented through a World Bank credit for the development of large scale parastatal dairy farms, large scale dairy plants and communal dairy units in the villages (World Bank, 1985). From 1982 the emphasis switched to smallholder dairy development supported by donors (e.g. the Netherlands, Switzerland). In the period 1985 – 1995 most of the parastatal companies were privatized and the policy of a fixed milk price was abandoned.
The Tanzania Dairy Board was established in 2005 on the basis of the Dairy Industry Act of 2004 as a response to a need to regulate and coordinate the development of the dairy industry.

Time line history milk and dairy production (Kurwijila, 2001 and other sources)

1900:	and much earlier (and continuing to 2013 and beyond): Traditional herds of pastoralists and agro-pastoralists in savannah areas
1921:	First dairy farm for supply of milk to government civil servants in DSM
1920 – 1940:	Few white farmers settling in the highland areas (Kilimanjaro – Iringa)
1932 – 1935:	Start of the development of the Mpwapwa dairy breed
1961:	Independence of Tanzania
1968:	Arusha declaration and adoption of Socialist and Self-reliance Policy
1973:	National milk production: 2-4 % from grade cattle and 96 – 98 % from local cattle
1975:	1st Dairy Development Project (parastatal dairy farms and processing plants, and ujamaa village (communal) dairy farms);
1976:	Heifer breeding units (F1) with bilateral donor assistance
1978:	Small holder dairy development project Southern Highlands
1978:	HPI, 33 heifers distributed under the HIT scheme around Arusha;
1981:	Loans to individual small dairy farmers became part of the World Bank project;
1982 – 1985:	Start of small holder dairy development projects (Tanga and Kagera) active up to 2000 with an exit phase to 2005
1983:	First national livestock policy launched to stimulate livestock development in the centralised economy with emphasis on large-scale parastatal institutions for production, processing and marketing
1985:	Start of fundamental changes in government policy towards transformation to a market-based economy
1990/98:	Privatization of TDL dairy plants and DAFCO dairy farms

1997:	The Agricultural and Livestock Policy, policy in line with the on-going reforms and redefined roles of public and private sectors.
1998-2000:	Decentralization of agriculture and livestock services to Local Government Authorities (LGA)
1999 – 2010:	Land o Lakes projects in dairy training and organization of farmers
2006:	MLFD: National Livestock Policy; Based on national and international development priorities (e.g. poverty reduction and Millennium Development Goals) and technological development in the livestock sector;
2008:	National milk production: 30 % from grade cattle and 70 % from local cattle
2009:	Withdrawal of permission for Brookside Ltd(Kenya) to collect milk in Tanzania
2010:	MLFD: National Livestock Sector Development Strategy
2011:	MLFD: National Livestock Sector Development programme
2012:	Development of Dairy Development programme Bill and Melinda Gates Foundation (Dairy Hubs)

2.2 Milk production systems

The dairy sector is usually divided in two main categories. The traditional sector with local breeds and the more modern sector with crossbred and purebred Bos Taurus cattle. Sometimes milk produced on large scale farms with grade cattle (crossbred and purebred Bos Taurus dairy breeds) are counted as separate third category. Total grade cattle are 600,000 to 700,000 heads, some 3 % of the cattle population. Dairy goats are a separate category, mainly Toggenburger, and Saanen breed, however, the number is small and milk production is estimated at 22 million kg/yr or less than 1.5% of the total milk production in the country.

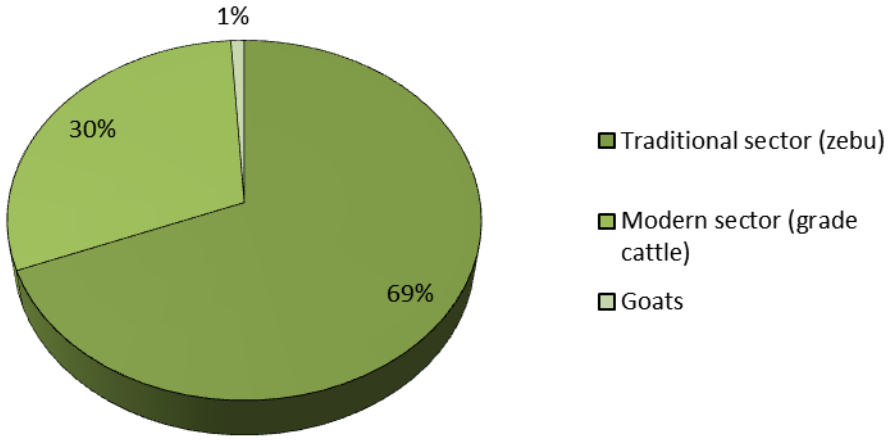

Figure 2.1 Milk production (%) by type of livestock and production system 2008.

According to statistical data milk production increased from 1995 to 2010 with around 7% per annum from 555 million litres to 1,600 million litres in 2010 to which the traditional sector contributed about 70%. (Livestock Development Policy, MLFD 2006 and FAO statistics, 2012). Estimates for milk production from local zebu cattle is based on around 160 – 180 lts/cow/yr, excluding the milk for suckling (Kurwijila, Pers. Com.). Total national milk production is estimated at 1,600 million lts/yr including the milk for home consumption. In 1973 the commercial sector with non-indigenous dairy cattle contributed only 2 to 4 % to the total estimated national milk production of 485 million lts (World Bank, 1985).

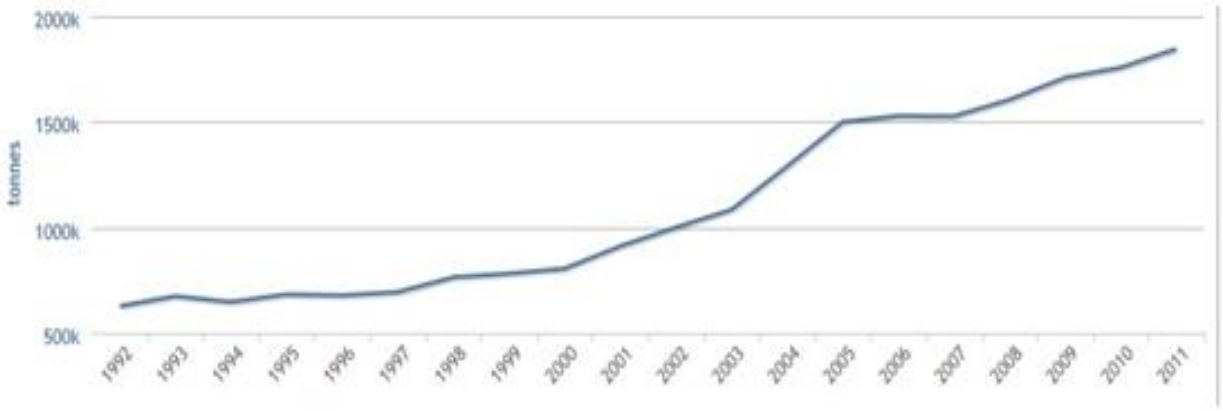

Figure 2.2 Milk production in Tanzania 1992-2011 (in '000 tonnes). (FAO statistical summary 2012)

Milk yield estimates for local cattle vary from around 180 (0.5 ltr/day) to 500 lts/yr. For grade cattle average production is estimated at 2000 lts/yr (Njombe et al., 2011, MLFD 2006). Traditional systems are dominant in the arid and semi-arid areas of northern Tanzania, particularly in Mara and Mwanza regions and the Maasai area south of Arusha. Smallholder dairying with grade cattle is concentrated in urban, peri-urban and rural areas of Arusha, Kilimanjaro, Tanga, Iringa, Kagera, Dar es Salaam and Mbeya. The national per capita consumption is about 39 lts/yr (2005); in government publications this is often compared to the FAO recommendation for milk consumption of 200 lts/head/yr. Fig.1.2 showed the livestock density for the traditional sector and Fig.2.3 gives the grade dairy cattle population per region indicating a higher concentration of grade cattle in the highland areas.

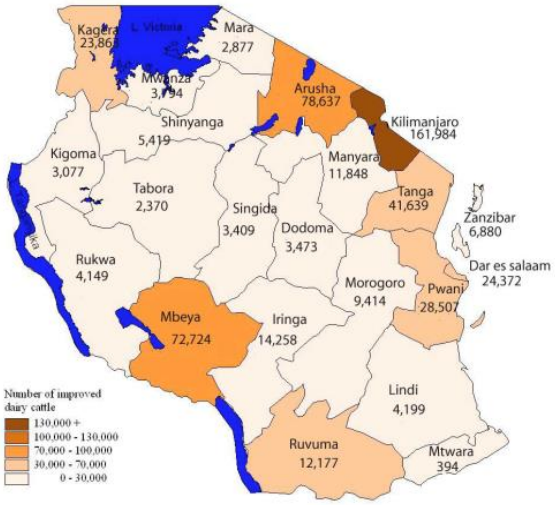

Figure 2.3 Grade dairy cattle population by region (1st October 2008; Tanzania, 2012a)

Due to seasonality in rainfall with corresponding fluctuations in availability of grazing there is a big difference in wet and dry season milk production. Fig.2.4a shows the differences in daily milk yield in the dry and the wet season for all the regions of Tanzania based on data collected for the 2008 Livestock Census and Fig 2.4b shows the fluctuations in milk deliveries over the year for a plant in Mara region in 2010 (based on Kurwijila et al., 2012).

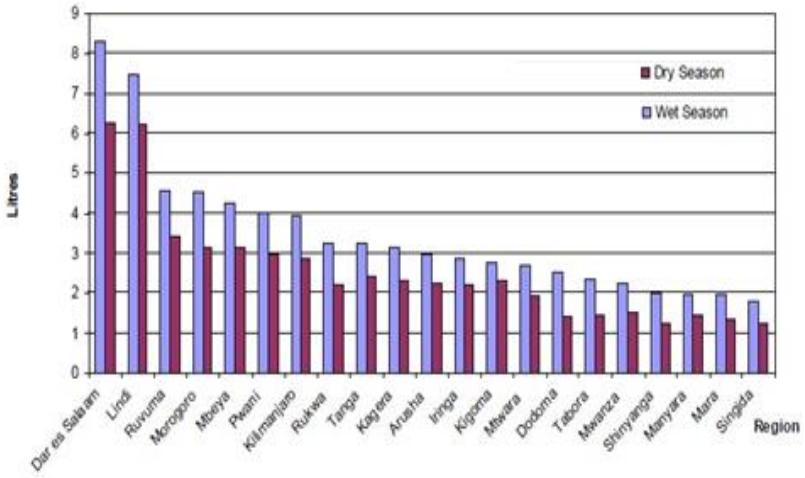

Figure 2.4a Average milk production (litres/cow/day) by region and season (from Livestock census 2008)

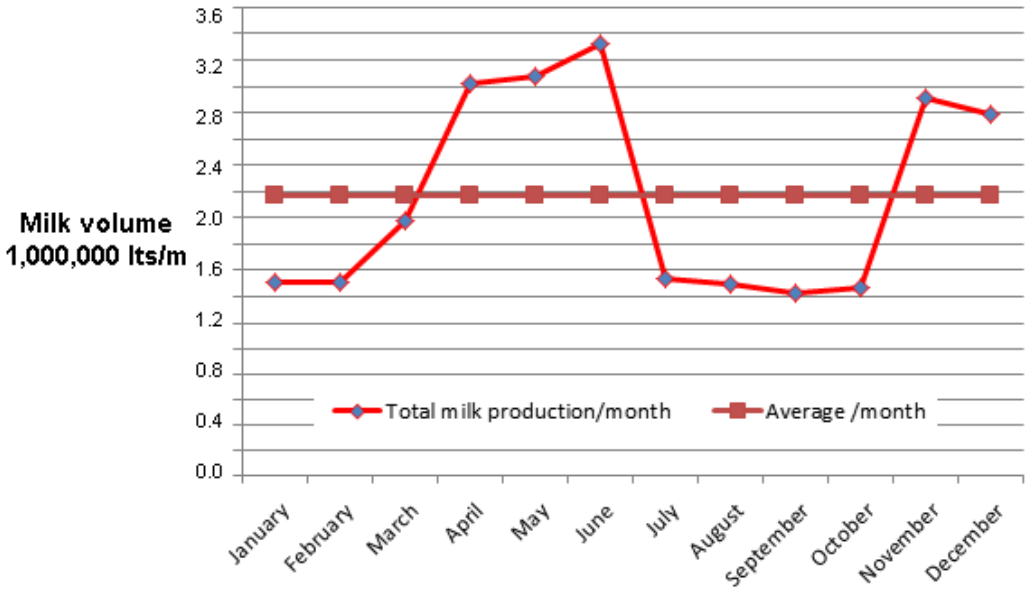

Figure 2.4b Seasonal fluctuation of milk production in Mara region (2010; based on Kurwijila et al., 2012)

Milk off-take/km^2/yr is presented in Fig.2.5 (FAO, 2005), this is considered a good measure for the milk production density. This map shows where milk is produced and where there could be a potential for improving and intensifying milk collection.

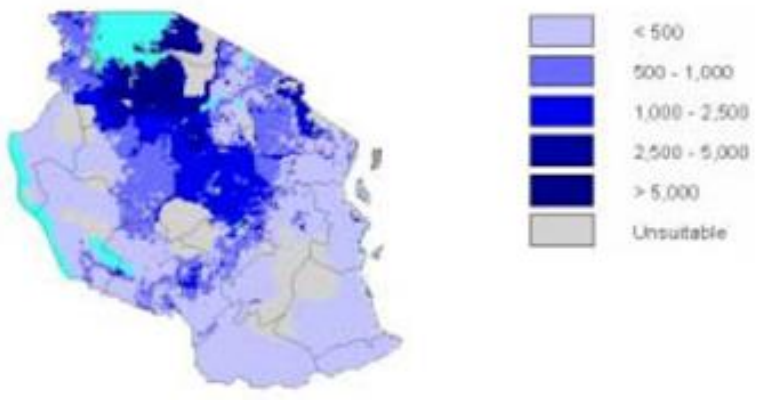

Figure 2.5 Milk offtake lts/km^2/yr (FAO, AGAL, 2005)

As said before, dairy production systems in Tanzania are divided in two main categories:

- Traditional systems are the largest category, based on local zebu cattle where milk is one of the products besides savings, meat, draft etc. The milk is mainly used for home consumption and only marketed if there is need for cash and an opportunity to sell.
- Dairy systems based on grade dairy cattle are the second category, mainly crossbreds of exotic dairy breeds with the TSZ (Tanzania Shorthorn Zebu) or Boran. Producing milk is the main aim and most of the milk is marketed as fresh milk, preferably year round or processed before being sold on the market.

Further sub-systems can be identified based on agro-ecological zone, management type and level, inputs, level of commercialization and marketing options, etc. The main categories and their sub-systems are described below and summarized in Table 2.1. Tables 2.2a 2.2b give a brainstorm summary of potential 'technologies' to improve milk production and milk collection or extraction in the described production systems.

A. Traditional systems with local zebu cattle:

a. Pastoralism and transhumance: pastoralists move with their cattle through a fairly large area according to available grazing on natural pasture or harvested crop land. It is a low input system mainly occurring in arid and semi-arid areas. Milk is an important product for home consumption and seasonal surpluses are available for marketing provided there is an opportunity to sell;

b. Agro-pastoralism: Agro-pastoralists graze their cattle on communal grazing land during the wet season and on crop land after harvest when crop residues are available, owners of the crop land benefit from manure for improved soil fertility. Also agro-pastoralists use milk for home consumption and seasonal surpluses can be marketed. Establishment of a marketing channel could be easier because herds do not move over a large area and return often to the same spot in the evening; it is a low input system, prevalent in semi-arid areas;

c. Small holder mixed farmers (sedentary): a production system mainly in the sub-humid areas e.g. cattle under coconuts or banana farmers who keep cattle for manure (e.g. in Kagera). Cattle are important for manure and soil fertility. Cattle density is generally low because of other important income opportunities but also due to disease problems (tick-borne diseases and trypanosomiasis) and there is less tradition of cattle keeping. Milk production is low and consequently milk off-take/km^2 is low with high collection cost. Milk production and consumption are less common for the owners.

B. Dairy production systems with grade cattle:

a. Rural smallholder dairy: small mixed farms with crops and livestock in the rural areas away from the cities, farms with 1– 5 dairy cows mainly originating from smallholder dairy development programmes; cattle are kept under semi-zero grazing systems based on cultivated fodder, crop residues and cut grasses from waste or communal land with varying levels of inputs (AI, bull services, veterinary care by CAHW, supplementary feed, feed conservation). Direct marketing to consumers is limited and farmers rely on milk collecting centres or middlemen. Farmers use inputs depending on marketing opportunities for milk and on their milk income;

b. Urban / peri-urban smallholder dairy: this sub-system is similar to the above group but uses a higher level of inputs (depending on milk price), especially for

feed and animal health services. The major part of the milk is marketed through the informal market. At present supplying the informal market is often more profitable than selling at the formal market. Marketing problems could occur for the more distant farmers during the wet season when middlemen could buy enough milk close to the cities;

c. **Medium and large scale dairy farming (private)**: Farms keeping crossbred and purebred dairy cattle, having land available for fodder production and conserving roughage (hay or silage) for the dry season. Farmers are responsible for organizing external inputs, (e.g. animal health care, feed premixes). Farmers deliver direct to milk plants or milk is processed on the farm and products sold in the cities. For new farmers it is hard to develop this model due to poor infrastructure, credit facilities, communications and transport. There are not many of this type of farms.

Table 2.1 Characteristics and production estimates analysis of current dairy production systems *)

	Dairy Production System					
	A. Traditional production system with local zebu cattle			B. Dairy systems with grade cattle:		
Dairy system	**Pastora-lism**	**Agro-pastora-lists**	**Rural small-holders**	**Smallholder dairy farms**	**Urban-, peri-urban dairy farms (small)**	**Medium/large dairy farms**
Ecological zone(s)	Arid / semi-arid	Semi-arid	Sub-humid	Highlands (and special project areas)	Around main cities	Highlands and around cities
Cattle breeds	Indigenous zebu cattle			Crossbred dairy cattle		Pure- and crossbred
Daily yields per cow **)	0.5 - 1	1	1	5-8	8-10	10-15
% of total milk **) produced	20	40	10	15	10	5
Seasonality: % high/low season **)	90/10	80/20	70/30	70/30	65/35	65/35
Milk sold on formal and informal (in mln lts): ***)						
Milk sold (%) **)	5	12	15	60	80	80
Total per annum	11	55	17	103	92	46
Wet season	10	44	12	72	61	30
Dry season	1	11	5	31	32	16
Relative milk density	Medium/ high	High	Low	Medium	High/ medium	Medium/high (or not applicable)
Interaction with other production systems		X-breeding	Manure for crops/ X-breeding	Calf rearing		

*) **Note:** data on total milk produced and marketed from the traditional and the grade cattle system are based on the report of Tanzania Scanagri and Business Cares services from April 2005 (quoted by Quaedackers et al., 2009 and RLDC, 2009). These data on milk production and utilization are probably of 2003 or earlier. Total milk production was estimated at 1,150 million ltr/year; current estimates are higher, around 1,900 million ltr/year. However there are no reasons to believe that the relative distribution over categories of production and utilization are now significantly different than from the time these estimates were made.

**) Daily yields in litres. Estimates based on expert opinion (by the authors)

***) Total milk sold: 324 mln ltr (71 % in the wet season and 29 % in the dry season)

Table 2.2a Options for improved milk production and collection in –**traditional**-- production systems, a brainstorm

	Traditional production systems		
	Pastoralists	**Agro-pastoralists**	**Rural small-holders**
Collection	fixed or mobile milk collection centres with solar powered cooling	reliable year round collection, increasing network of collecting centres; milk delivery contracts (milk pricing),	near cities: direct sales or active middlemen, or areas where milk collection has been organised
Breeding	cross breeding with Boran or Mpwapwa breed,	cross breeding with improved zebu breed and possibly crossbred dairy bulls,	crossbreeding and dairy programmes around market centres
Feeding	supplementary feeding in dry season;	supplementary feeding during dry season;	Hay making
Veterinary care	supporting vet services: vaccinations, dipping/spraying	support vet services: vaccinations, dipping or spraying	support vet services (vaccinations and dipping),
Transformation to another system	resettlement or villagization	small holder dairy in mixed farming	in areas with less disease pressure and good market potential may shift to peri-urban dairy

Table 2.2b Options for improved milk production and collection in –**dairy**- production systems, a brainstorm

	Dairy production systems		
	Smallholder dairy farms	**Urban-, peri-urban dairy farms (small)**	**Medium/large dairy farms**
Collection	reliable collection and price; relate price & quantity for in and off season; milk collecting centres (with cooling),	legislation quality control suitable for micro- and meso-markets (i.e. short chains); innovation in product processing	price and delivery contracts for milk; quality standards for macro markets (large anonymous chains)
Breeding	support AI service, HIT calf rearing schemes (partly suckling or using milk replacer), supply of F1 dairy heifers	calf rearing schemes or calf rearing away from production centres,	reliable AI, suitable animals, work on calf rearing and selection schemes; use of suitable milk replacers
Feeding	use of by-products and fodder crops, feed supplements and concentrates	supply roughage, hay, feed supplements, by-products and concentrates, /supply dairy cows or F1 heifers	proper pre-mixes and complete feeds for use with low quality roughages
Veterinary care	(para)vet services, concentrated around collecting centres,	veterinary services, curative care and/or private / company practitioner	veterinary services, curative care and/or private / company practitioner
Transformation to another system	Medium scale commercial dairy farming	Medium scale commercial dairy farming	processing on-farm and/or larger scale, organic or farm with 'community' activities
Infrastructure	involve private sector and communities in input supply and development	Improving input supply through private sector	These farms could be service centre for smallholders: need land title, credit, skills & management (training), providing transport & inputs

The diagram in Fig.2.6 re-arranges the described production systems in a policy quadrant, as introduced in Ch.1.4, with approximate yields (from low to high) per cow on the x-axis and marketing from informal to licenced markets (milk plants or collecting centres connected to a recognized milk plant) on the y-axis. The ovals indicate the approximate range the production

systems cover in the diagram, the size of the ovals is no indication whatsoever of the relative quantity of milk produced in that particular system. The basics of this diagram are used several times in the report to visualize aspects such as characteristics, constraints, opportunities, development potential and suitable technologies. The dashed line in the upper part of the policy quadrants indicates the situation in the dry season when a significantly larger proportion of the milk is sold in the informal market.

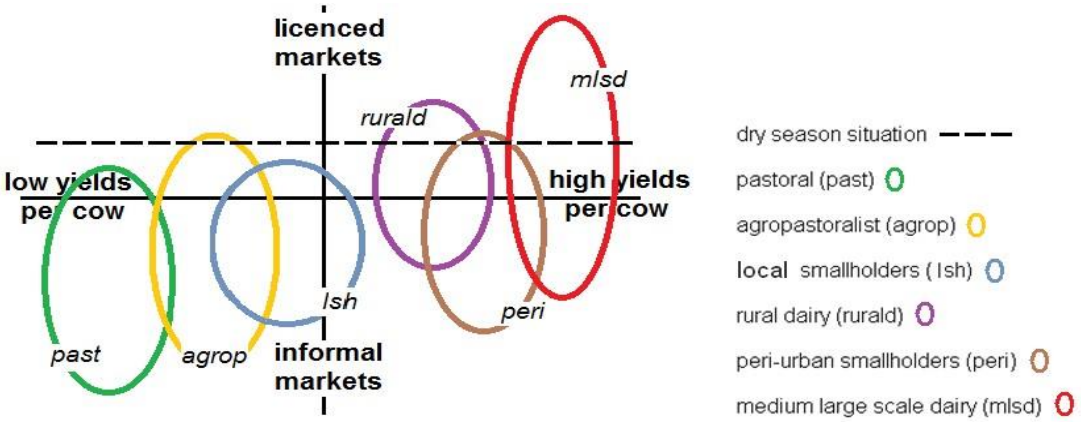

Figure 2.6. Policy quadrant with the major production systems 'overlaid' with the major types of value chains (see text for explanation). Note: the basic diagram refers to the situation in the wet season, the dry season situation is presented with the dashed line to show that a higher proportion of the milk is sold on the informal markets.

Fig.2.7 is a milk production - utilization diagram showing relative importance of the milk streams from production and imports to on-farm consumption, informal market and the licenced processed market. Some of these data are presented as percentages in Table 2.3, e.g. milk imports are only 2% of total consumption, 71% of the milk is consumed by the livestock owner families and only 2% of the local milk produced is traded through the formal market. Milk consumption by livestock owning families is almost 7 times higher than of non-livestock owners.

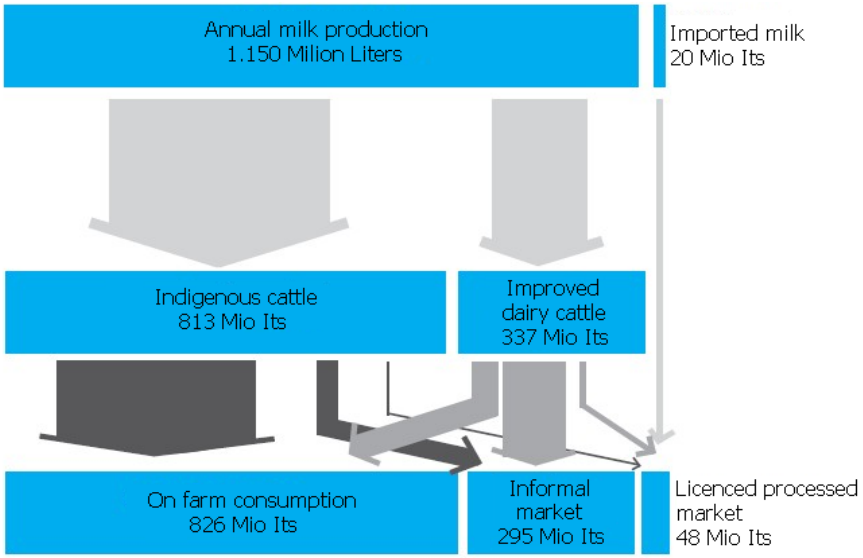

Figure 2.7. Milk production and utilization diagram. (based on data from: Scanagri and Business Cares Services, April 2005, cited in RLDC –Dairy Subsector Development Strategy (2009)

Table 2.3 Milk utilization as percentage of total local production. *)

Produced in traditional sector (local breeds)	71 %	
Produced in 'grade cattle' sector (crossbreds)	29 %	
Consumed milk and milk products	102 %	
Imported milk and milk products	2%	
Processed milk (in licenced plants)	2 %	As % of total milk produced
Local milk processed in licenced plants	9 %	As % of total milk marketed
Consumed by producer families	71 %	Est. consumption: 68 ltr per person/year
Sold mainly as fresh milk in informal market	25 %	
Consumed by non-livestock owners	29%	Est. consumption: 10 ltr per person/year

*) Based on the data in Fig 2.7.

Considerable variation exists in estimated milk consumption (roughly 10 x higher) between livestock owners and non-livestock owners in rural areas and between 'rich' and 'poor' inhabitants of the city (Table 2.4).

Big differences exist in milk consumption levels between the various population categories. Especially milk consumption by urban poor is very low and falls far short of normal nutritional standards for a healthy life and mental and physical development of young children.

Table 2.4 Assumed milk consumption per head of the population (prepared by the authors)

Population category	**Assumptions *)**	**Population size (millions)**	**Milk consumed (million lts/yr)**	**Consumption per head (lts/yr)**
Livestock owning families	1.7 million livestock owners, 7 members per family consume milk	12	826	68.8
Non-livestock owning families (rural)	Remaining rural population consume 50 % of the informal market	23	148	6.4
Urban	26 % urbanization = 12 million people; milk consumption 50 % informal market + total processed and imported products = total 195 mln lts			
Urban families (rich)	33.3 % of urban population, 80 % of the milk sold in urban areas	4	156	39
Urban families (poor)	66.7 % of urban population, 20% of the milk sold in urban areas	8	39	4.9
Total		47	1170	25

*) Assumptions based on expert opinion.

2.3 Milk marketing and collection

Large variety exists in systems for transfer of milk from farm to processor or directly to the consumer (Table 5.3). The farmer's preference for a marketing system depends on quantity of milk available, distance, and reliability of the purchaser. Milk is traded from the farm to consumers directly, to hawkers or milk vendors, to collecting centres, or directly to processors or micro-processors. The main systems are:

- Direct sales of fresh milk to the consumer:
- Home processing and selling of processed products
- Middlemen, hawkers or milk vendors: they collect milk from the farm and sell it e.g. to consumers, other middlemen, collecting centres, or to micro-processors or milk plants;
- Milk Collecting Centres (MCC): accepting milk from farmers or middlemen and selling to milk processors or on the informal market in the urban areas (milk kiosks, consumers, microprocessors). MCCs can be owned or operated by farmers organizations, milk plants or private individuals;

- Direct delivery to milk plant (mainly by large producers);

Generally there is a strong seasonal fluctuation in milk production due to fluctuations in rainfall and feed production. Such seasonality in collection from two different production systems is shown in fig 2.8, one in the Southern Highlands from smallholder dairy farming and one from south of Arusha from traditional Maasai herds.

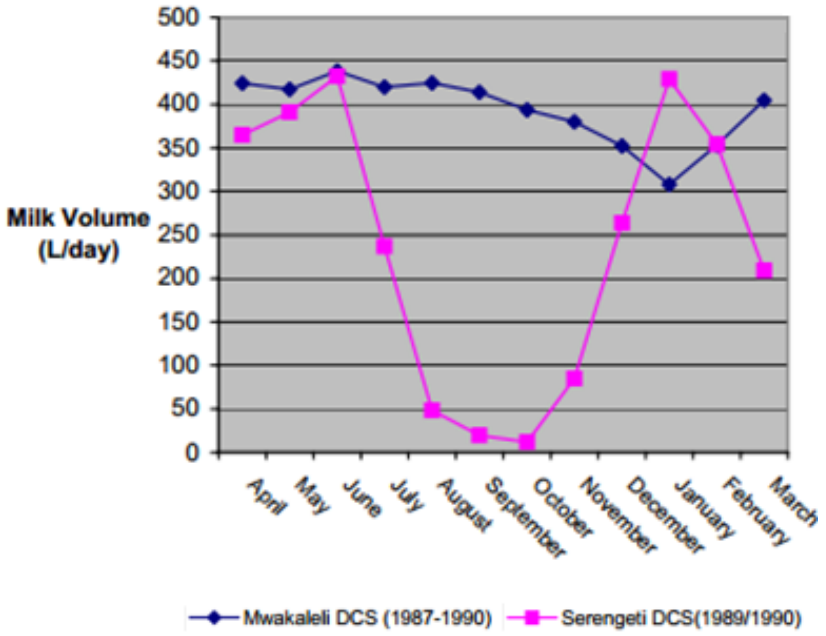

Figure 2.8. Milk collection in Rungwe district from crossbred dairy cattle (blue line) and at Serengeti Dairy cooperative from entirely traditional cattle (pink line);

Start and end of dry season could differ for different regions in Tanzania. In 2012 the Tanga Fresh milk processing plant benefited from high milk yields and increased milk collection in the traditional sector near Morogoro at a time when the collections closer to Tanga from the dairy smallholders were already low following low rainfall. (Ben Weijers, Pers. Com.).

2.4 Milk processing

Up to 1990 almost all processing capacity was in the hands of the Tanzania Dairy Limited (TDL) one of the parastatal companies of government-owned LIDA (Livestock Development Authority). Milk was collected from local cattle for the plants in Tabora and Musoma, and from parastatal dairy farms, however, the main source was skim milk powder (SMP) and butter oil (BO) donated by World food Programme and European Union. Donations of SMP and BO dropped at the end of the 1980s and TDL was making losses. In the 1990s the plants of TDL were privatised. Many new, local and foreign, entrepreneurs took the opportunity to set up small to medium size processing facilities, however of the 35 new plants 13 closed down because they were unable to make profit. The main causes for closure of so many factories after the privatization of TDL milk plants between 1990 and 1995, were low milk prices for farmers, concurrent increases of milk sales on the informal market, the decline in milk powder donations and commercial imports for reconstitution of milk on which quite a few factories depended.

At present there are around 50 processing units in the country, the locations are shown in Fig.2.9 (Kurwijila et al., 2012). The major production and processing regions are Mara, Tanga, Arusha and Iringa. Mara region has two large processors Musoma Dairies with a capacity of 120,000 lts and Mara Milk with 15,000 lts capacity (used for respectively 20,000 lts and 6,000 lts) with a daily production capacity of more than 10,000 lts. Tanga currently houses the largest processor (Tanga Fresh) of the country with a daily capacity of 50,000 lts and an average daily production of 30,000 lts. Arusha has one medium size processor (International Dairy Products Ltd) who handles around 4,000 lts daily and several micro-processors that serve their localities and the cities Moshi and Arusha. Finally Iringa with one large processor (ASAS Dairies) currently handles around 10,000 litres of milk daily. On the official list a total of 42 processing plants are registered with a total processing capacity of 353,000 (varying from 500 ltr to 120,000 per day) with an average of 25 % utilized capacity.

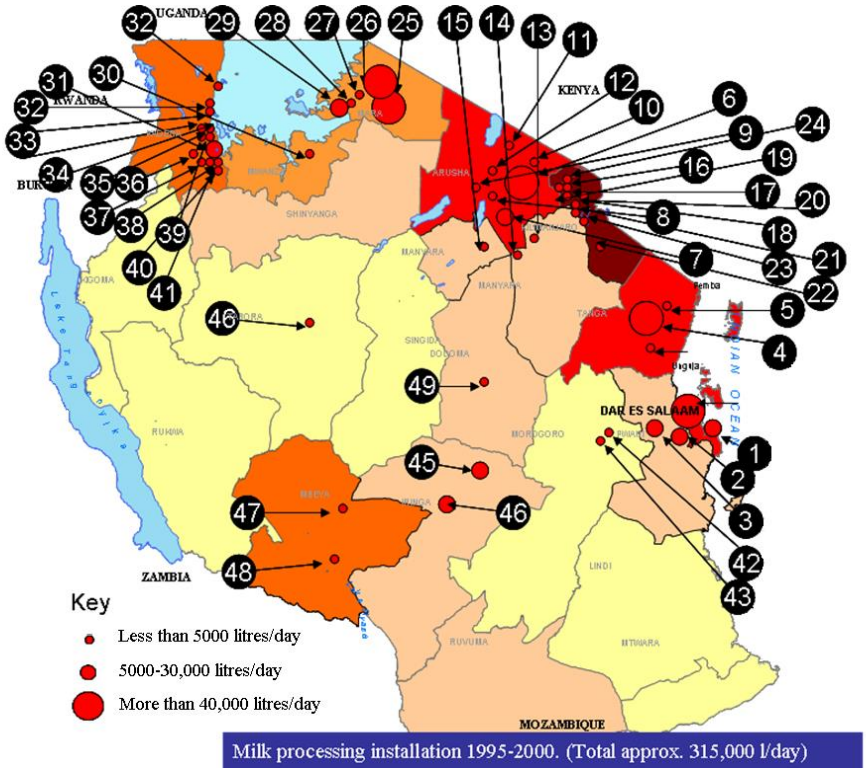

Figure 2.9 Milk processing plants (based on data from 1995 – 2000) Kurwijila et al., 2012,

The main products from the processing industry are fermented milk (mtindi), pasteurized milk, ghee and butter, yoghurt and drink yoghurt, occasionally Mozzarella, and, only in Mara region, UHT milk. The main products from Tanga Fresh are pasteurised milk and mtindi in ½ and ¼ ltr sachets (resp. 60 and 30 – 35 % of the milk) other products are yoghurt, butter, ghee and Mozzarella cheese. Production of UHT milk is being considered. Sachets will in the future no longer be permitted for environmental reasons and a change will have to be made to plastic bottles or tetra pack (Ben Weijers, Pers. Com.).

A recent publication (Niras, 2010) by the Tanzania Milk Processors Association (TAMPA) states that, while imports have been rising by about 9% annually, locally processed milk has declined by more than 80% over the last 15 years accompanied by the closure of 13 dairy plants over that period. The volume of milk imports is currently equivalent to the quantity processed from local production. Current imports (2010) are estimated at about 30-40 million litres of liquid milk equivalent in the form of mostly milk powder (both whole and skim

milk), infant formula, UHT milk, butter and cheese. Imports have been growing since 1995 when the industry was liberalized for private sector participation. Milk imports from outside the EAC countries, except infant formula, attract 60% Common External Tariffs (Kurwijila et al., 2012). At present the quantity of processed local milk is more or less the same as the quantity of imports. Especially Dar es Salaam is an attractive market with a large number of relatively wealthy consumers. Imported milk and milk products from e.g. Kenya, South Africa and the United Arab Emirates are also available on the market. Imports from Kenya are mainly UHT milk, yoghurt and cream.

3. Government role and policy

3.1 Ministry of Livestock and Fisheries Development

The livestock sector was separated from the Ministry of Agriculture and Cooperatives in 2006 when the Ministry for Livestock Development was formed. In 2010 the fisheries sector was added and it was renamed: Ministry for Livestock and Fisheries Development (MLFD). The ministry is located in Temeke, Dar es Salaam. The ministry has the mandate for overall management and development of the livestock and fisheries resources for sustainable achievement of Millennium Development Goals, the National Strategy for Growth and Reduction of Poverty, improved livelihood of communities dependent on livestock and fisheries, and food safety and security without compromising animal welfare and environment conservation. The ministry has to build and support the technical and professional capacity of local government authorities and the private sector to sustainably develop, manage and regulate the livestock and fisheries sector [2].

The most relevant divisions in relation to dairy and dairy farming within the MLFD are
(a) Livestock Product and Marketing;
(b) Veterinary services, and
(c) Research Training and Extension.

Furthermore the following boards or agencies have strong organizational and technical relations with MLFD: Tanzania Dairy Board (TDB), Livestock Training Agency (LITA) and the Tanzania Veterinary Laboratory Agency (TVLA).

The Livestock Product and Marketing Division has 3 sections:
- Land for Livestock development (rangelands, pasture seeds, fodder conservation and water catchment areas);
- Livestock products development (beef production and meat sector , dairy sector, small ruminants, non-ruminants, other livestock, feed sector, hides, skins and leather industry);
- Livestock infrastructure development (livestock market infrastructure and water dams);

The Research, Training and Extension Division has 2 sections:
- Research and Training (coordination livestock research and training);
- Extension and registration section (development of extension messages, demonstration, formation of farmers groups);

The Veterinary Services Division has 3 sections:
- Trans-boundary animal diseases (TAD) and ZOO-sanitary services (policies, TAD programmes, control of non-infectious diseases, disease free zones, quarantines, etc.);
- Vector and parasitic disease control (tick control, parasites, tsetse flies, dip tank rehabilitation, laws and regulations);
- Veterinary public health: (quality control of livestock products (meat, milk) livestock feed, veterinary drugs, vaccines and biological, toxicity and residues in animal products);

[2] http://www.mifugouvuvi.go.tz/.

3.2 Government policy and development targets

The Ministry of Livestock Development has formulated a National Livestock Policy in December 2006 (Mifugo Livestock Policy, 2006), followed by a Livestock Sector Development Strategy (MLFD 2010) and a Livestock Sector Development Programme (MLFD, 2011). For the dairy sector the policy documents emphasise the need

- to improve the genetic potential of the dairy herd;
- to strengthen technical support services and promote use of appropriate technologies;
- to promote investments in production, processing and marketing; and
- to promote dairy organizations and strengthen the Tanzania Dairy Board.

The national government policy promotes privatization and aims at providing more facilities for private sector initiatives.

The targets for 2016 on dairy development formulated in the Livestock Sector Development Programme (MLDF, 2011) are:

- Increase number of dairy cattle from 605,000 head kept by 150,000 farm households through annual insemination with 100,000 doses to 985,000 cattle kept by 300,000 farmers;
- Increase milk production to reach 2,250 million litres in 2016;
- Improve existing and start new Heifer Breeding units;
- Promote the Heifer in trust scheme;
- Improve AI services and facilitate Embryo Transplantation (establish a new AI centre in Sao Hill);
- Imports of pure breed dairy cattle, embryo's and semen;
- Development of new technologies for dairy production;
- Support organization of farmers and develop milk collecting centres;
- Provide technical support to the traditional livestock milk producers;
- Promote milk collection and processing;
- Promote compliance to standards in internal and international markets (training of stakeholders);

3.3 Institutional framework, legislation and stakeholder organizations

Part of the Smallholder Dairy Support Project (SDSP), the final phase of the Dutch involvement in the dairy sector in Tanzania, was the development of dairy stakeholders organizations at national level and strengthen their cooperation. The SDSP together with other NGOs and donor organizations has been instrumental in the establishment and development of the stakeholder organizations TAMPA (Tanzania Milk Processors Association) and the TAMPRODA (Tanzania Milk producers Association).

In 2004 National Parliament approved the Dairy Industry Act which formed the basis for the Tanzania Dairy Board TDB). The TDB[3] established in 2005 has to support, promote, regulate and represent the dairy sector of Tanzania. The website is currently under maintenance (December 2013).

TAMPRODA was established in 2002, to represent the interests of milk producers and it strives for the development of a stakeholder-driven modern milk production sector. In Tanga region TAMPRODA has implemented training programmes for dairy farmers. TAMPA represents the interest of the milk processors and has the objective to create a better business environment for milk processing in the country. TAMPA is an active organization and has successfully lobbied with the government for tax facilities for the dairy industry, no VAT tax

[3] http://www.tanzaniadairyboard.or.tz/

on dairy equipment and zero rating for milk and milk products. Both associations are represented in the Tanzania Dairy Board. Judging from the TDB website they are also the only 2 active board members (according to the act there should be 12 board members).

Below is a list of government acts related to livestock and dairy development

- The dairy industry act – 2004: establishment of the Tanzania dairy Board
- The animal diseases act – 2003: control of animal diseases and zoonoses
- The veterinary act – 2003: organization and rights and duties of veterinarians
- The Tanzania livestock research institute act – 2011: establishment of the national livestock research institute

3.4 Knowledge infrastructure for livestock: research, training, education and extension

Tanzania has one national research station for livestock production and several zonal research stations with a livestock component (Table 3.1). Veterinary research is concentrated at Temeke Veterinary Laboratory Agency in Dar es Salaam, a specialized branch in Tanga Tsetse Research Station and several regional laboratories. At national level the research organizations fall under the Department of Research and Training (DRT) of the Ministry of Agriculture Food Security and Cooperatives (MAFC) and the Department of Research Training and Extension (DRTE) of the Ministry of Livestock and Fisheries Development (MLFD). A brief overview of research stations and topics can be found in Table 3.1

Table 3.1 Research stations with a livestock component.

Research station	Location	Research topics
National Livestock Research Station	Mpwapwa	Breeding, Nutrition, Management, Economics
Lake zone	Mabuki	Beef cattle, local chicken
Southern Highlands	Uyole	Dairy cattle (and diploma, certificate and farmer training)
Northern zone	West Kilimanjaro	Dairy cattle, small ruminants, animal health
Eastern zone	Tanga	Dairy cattle
Southern zone	Naliendele	Goats and traditional chickens
Central zone	Kongwa	Pasture, forages
Western zone *)	Kigoma	Small ruminants, tsetse and trypanosomiasis
Central Veterinary Laboratory	Temeke	Animal diseases and disease management
Tsetse and Trypanosomiasis Research Institute,	Tanga	Animal health, tsetse trypanosomiasis, research and control of other pests.
Tanzania vaccine Institute	Temeke	Technological development of biologicals, reagents and vaccines production
Regional veterinary laboratories	Arusha, Iringa, Dodoma, Mwanza, Tabora, Mtwara, Kigoma	Laboratory diagnostic services

*) to be established.

Sokoine University of Agriculture in Morogoro provides academic education for livestock production, veterinary science and dairy processing. The Faculty of Agriculture has a Department for Animal Science and Production and offers a BSc in Animal Science (251 students in 2011/12), a BSc in Range Management (99 students) and an Msc in Tropical Animal Production (15 students). There are ongoing research programmes on dairy goat breeding (funded by Norway) in Morogoro region, and a research programme with ASARECA on Exploiting market opportunities for value added dairy and meat products in the ECA region. The department has 26 academic staff members.

The Faculty of Veterinary Science has a BSc in Veterinary science (261 students in 2011/12) and a BSc in Biotechnology and Lab Science (214) and 64 MSc students in various veterinary subjects. The Department for Food Science and Technology has a BSc and MSC programme but judging from the curriculum there is very little attention to milk processing
Other BSc and MSc studies at SUA relevant to livestock production and dairy are Agricultural Education and Extension, Agriculture Economics and Agribusiness[4].

Livestock Training Institutes (LITI) offer regular courses at certificate and diploma level, as well as specialized courses and farmer training. The LITIs fall under the Livestock Training Agency (LITA) of the MLFD. LITIs are located in Mpwapwa, Morogoro, Tengeru, Madaba, Temeke and Buhuri. The general opinion was that these institutes did not operate efficiently nor effectively due to challenges that include inadequate human resources, low retention of staff, unmotivated staff, infrastructure, inadequate teaching facilities and financial resources. Therefore, the government formed the LITA to strengthen the training institutes and improve the performance. In addition to livestock training at the LITIs training at regional level is organized by regional governments as well as training provided by NGOs and donor organizations (e.g. Land O' Lakes).

Livestock extension services deal with transfer of knowledge and skills from experts to livestock farmers and sharing of information and experiences among stakeholders to increase livestock production and productivity. Several approaches have been used in the past to deliver livestock extension services including training and visits, livestock farmer field schools and livestock product promotion. Other approaches include study tours, farmer field days, mass media, agricultural shows, residential training and demonstration units/plots. Currently, the Central Government is responsible for formulation of a livestock extension policy, give guidelines and provide technical backstopping. Major actors in the delivery of extension services to the livestock farmers are Local Government Authorities (LGAs) and the private sector. Livestock extension services are constrained by weak collaboration between stakeholders, insufficient expertise, weak research-training-extension-farmer linkage, inadequate incentives, infrastructure and facilities.

The RLDO and DLDO (Regional or District Livestock Development Office) are responsible for livestock production-related extension but in practice staff is very limited and there is little funding for livestock development extension. However, there are examples where regional authorities have funded training of individuals e.g. in AI or as Community Animal Health Workers (CAHW) to enable them to set up a small private business. Stocking of semen and making it available to private AI technicians is also the responsibility of the LGA.

[4] http://www.suanet.ac.tz/.

4. Dairy project experiences

4.1 Introduction

This chapter deals with experiences related to the many dairy development projects that were implemented in Tanzania. Bilateral and multilateral donors have been active in the livestock sector, particularly in smallholder dairy development. This chapter gives a short description of a selection of projects and aims to highlight the main lessons learned. It also lists the involvement of the Dutch private sector over the last 10 years.

4.2 The time span 1970 – early 2000s

In the decades after independence in 1961 the country pursued a policy of Socialism and Self-reliance (Ujamaa -village community projects and enterprises). The donor community generally sympathized with these political ideas. Dairy development was one of the priority sectors for Tanzania and several donors were active in the period 1975 till 2000 and beyond. The first major project started in 1976 with a loan from the World Bank.

4.2.1 Dairy Development Project (World Bank Loan) 1976 - 1985

This project aimed to develop large scale parastatal dairy farms, heifer breeding farms to produce F1 Bos Taurus crosses, large scale processing plants and communal dairy projects in the villages. This project generated a lot of interest from other donors (Netherlands, DANIDA, FAO) who joined in by providing technical assistance for e.g. farm management, veterinary drugstore and machinery workshop. However, eventually this project was considered a failure due to management problems of parastatals, lack of foreign currency to support mechanization, and an unfavourable government pricing policy for milk. On the positive side the gene-pool for dairy cattle increased through imports of heifers from e.g. Zimbabwe and New Zealand (World Bank, 1984). Around 1980 the attention for dairy development switched from large scale parastatal dairy farms and processing plants to smallholder dairy development in Kagera and Tanga (both supported by the Netherlands) and in the Southern Highlands (supported by Swiss Aid).

4.2.2. Kagera smallholder dairy development 1980 – 2000

Mixed farming is the predominant production system in Kagera where farmers value their cattle highly, mainly as suppliers of manure for banana growing. The HBU (Heifer breeding unit) originally planned as part of the World Bank project was eventually paid for by the Netherlands and formed the start of the smallholder programme when F1 heifers were distributed to smallholders. From 1980 onwards project activities included a Heifer-in-Trust (HIT) scheme, farmer training centre, extension and technical support for smallholders and nine micro dairy processing centres each with a capacity of a few hundred litres a day. In 1988 activities extended towards indigenous livestock (veterinary services, cattle dips, extension centres). From 1990 – 1998 the emphasis was to provide support services through extension centres and livestock development committees and to organize farmers in livestock extension groups and cooperative societies. Most of these groups were developed under the umbrella of the government and they were expected to take over the project activities and input supplies (HIT scheme, training, extension, AI, milk processing, veterinary services).The donor emphasized the need for privatization but this turned out to be a slow process, and in 1999 only the veterinary services were privatized to some degree. Project management and LGA considered it difficult to privatize activities such as AI, extension and training, without endangering the project efficiency (IOB, 2001; IOB, 1994; and interviews with resource persons).

4.2.3 Tanga smallholder dairy development 1982 – 2000

In Tanga the Netherlands financed Mruazi Heifer Breeding Unit (started in 1976). In the period 1976 to 1982 Netherlands support in Tanga area mainly focused on large-scale dairy farming activities (support for farm management, large scale zero grazing unit, ranching, research and farm management training). From 1982 – 1985 the focus changed entirely to small-scale dairy development (zero-grazing, mixed farming, training) to support farmers who received F1 heifers from the HBU. These activities continued for more than 15 years with emphasis on training, extension, heifer distribution (heifer-in-trust scheme), formation of farmer groups and cooperatives, milk marketing (including a private initiative of a group of Dutch Friesian farmers to invest in the Tanga milk plant – later Tanga Fresh). The project also supported setting-up 70 medium-sized dairy cattle farms (Pongwe scheme) and a credit institution for the dairy sector (Maziwa Coast Ltd), however not with much success. Sustainability became an issue towards the end of the projects and plans were made to hand over the heifer-in-trust scheme and or privatize services and input supply. However, progress in handing over was very slow and only partly successful (IOB, 2001; IOB, 1994; Ogutu, 2012; and interviews with resource persons).

4.2.4. Smallholder Dairy Support Programme (SDSP) 2001 -2005

In 1999/2000 the Netherlands wanted to withdraw support for the Kagera and Tanga smallholder projects and agreed on a 5-year exit phase in the form of the SDSP with the main aim to privatize the input supply services and hand them over to the established farmers' groups and organizations.

The SDSP had a regional and a national focus. The emphasis continued to be on sustainability in the form of privatization of supply of services and on transfer of the ownership of the Heifer-in-Trust scheme from the project or the government to the local farmers organizations while making them responsible for the operation. This was more successful in Tanga than in Kagera. In April 2005 when the project was evaluated quite a few of the farmers' organizations in Kagera still had to be formed and formalized. The regional government found it difficult to accept and believe that the farmers' organizations were capable of taking up that responsibility; they also might have found it a loss of power and income from returned heifers.

At national level the SDSP played an important role in establishing national stakeholder organizations such as Tanzania Milk Producers Association (TAMPRODA), Tanzania Milk Processors Association (TAMPA) and also the Tanzania Dairy Board (TDB), which aimed at regulating and structuring the dairy industry (Kurwijila et al., 2005; and interviews with resource persons).

Follow-up in Tanga: The Tanga Dairy project generated considerable NGO and private investments from the Netherlands in the dairy industry in Tanga. Separate from the SDSP a group of Dutch farmers from Friesland invested in the Tanga milk plant. One of the Dutch board members visited Tanga regularly to assist and advise in management matters and contacts with the Tanga Dairy Cooperative Union (TDCU). In addition several technical advisory missions were implemented to advise the plant on dairy processing techniques, dairy production and farmers organizations. In 2007 a Dutch NGO 'd.o.b. investment fund' took a major share in the milk plant Tanga Fresh and invested € 3,000,000 to buy and refurbish the factory, buy and install new equipment and cooling facilities and buy additional transport vehicles for incoming milk, transport to Dar es Salaam and for sales and distribution. Co-

investors are the Tanga Dairy Cooperative Union and the NMB (National Microfinance Bank)[5].
Another Dutch NGO 'Farm Friends' supported a HIT scheme and issued 1000 heifers to small-scale farmers in the Tanga region. The responsibility of this scheme was transferred to an independent NGO in 2010: Farm Friends Tanzania[6].

4.2.5 Dairy development project Southern Highlands 1978- 2003

A third major smallholder dairy development project is the Southern Highlands Dairy Development Project (SHDDP) financed by Switzerland for almost 25 years. This project also started from a heifer breeding unit (Sao Hill, near Iringa) but the approach was different. F1 breeding bulls were issued for upgrading local cattle with the aim to increase milk production and home consumption of milk for better health. This was not very successful and from 1985 the project switched to selling F1 heifers and providing extension and training to recipient farmers. With the aim to reach poor farmers the heifers were later distributed through a heifer in trust (HIT) scheme to reduce starting cost. From 1996 onwards a more holistic approach of the dairy sector came into focus by organizing Dairy Farmers' Groups, input supply, extension and marketing. In the exit phase (2000 – 2003) focus shifted to strengthening farmers' organizations to organize or purchase services, improvement of animal health services and involvement of the private sector in creating a functional milk marketing and processing system (Bachmann, 2004; Mwakalile, 2004; Mwakalile et al., 2004; and Van Weperen et al., 2003).

4.2.6 Other donors and projects 1980 – 2000

More donors supported dairy development projects during this period. These projects are only mentioned briefly and could not be reviewed extensively within the scope of this Quick Scan. Most information is based on Kurwijila (2005).

- Austria supported small-scale dairy farmers of the Dar es Salaam and coastal regions, and pastoralist producers around Dar es Salaam since 1993; This mainly was marketing support through provision of technical assistance and soft loans;
- The Heifer Project International (HPI) mainly worked through the Lutheran Church. It pioneered the Heifer-in-Trust scheme when 33 heifers were distributed to farmers in three villages around Arusha in 1978. Dairy stock is mostly imported for distribution to resource-poor farmers. By 1998, the HPI led HIT scheme had been able to reach 17 thousand farmers distributed across every region of Tanzania;
- Japan provided support to pasture seed production and funding for HIT schemes;
- WFP and EU provided food commodity aid in the form of butter oil and SMP for dairy plants of which the proceeds were meant for dairy development projects. Only HBUs benefited from these funds; most funds were used for other livestock projects;
- UNDP and FAO supported smallholder dairy development in the Arusha and Kilimanjaro regions;
- New Zealand supplied spare parts for the milk processing plant in Tanga and for the Livestock Training Institute in Tengeru, Arusha;
- Sweden provided support to AI—the National Artificial Insemination Centre (NAIC), Arusha. The centre produces semen, which is being distributed throughout the country;
- Germany provided assistance to smallholder development in Lushoto and to the regional veterinary service at Tanga;
- Finland provided assistance to the Elecster milk processing plant in Mbeya (in 1976);

[5] http://www.dobequity.nl/east-africa-fund/tanga-fresh-tanzania/
[6] http://www.farm-friends.nl/english/

- Ireland supported dairy farms and heifer breeding units at Kilosa, Morogoro Region;
- The United Kingdom provided support to the large-scale dairy farm and HBU at West Kilimanjaro;
- USAID contributed to the development of small-scale producers with a strong emphasis on training in extension, particularly training carried out in Rural Development Centres throughout Tanzania.

4.2.7 Lessons learned

The results and impact of the three major dairy development projects (Tanga, Kagera, Southern Highlands) are quite different. All three projects have distributed a large number of F1 heifers (mainly through HIT schemes), trained farmers, built up infrastructure, organized farmers and developed marketing.

In Kagera and Southern Highlands there are still many nuclei of dairy farmers but they have reportedly not developed into major milk producing areas. The farmers are more scattered, relying on local marketing to the informal market or on small dairy processing units. Farmers' organizations are no longer very strong or non-existent. However, there are exceptions to the rule as proved by Vwawa dairy cooperatives in Mbozi with 750 members (30 % women), a milk plant that processes around 1500 lts daily with a successful private AI service. The Vwawa cooperative works together with the Dutch Kuungana Foundation (originally from ZLTO) in the Netherlands.

Tanga region has become a major dairy shed; the farmers are concentrated in certain areas, 4,500 farmers are members of TDCU, and Tanga Fresh is the main buyer and at the same time the main dairy plant in Tanzania.

A possible explanation for the more successful dairy development in Tanga compared to the two other areas is that the other areas had alternative economic activities and sources of income from coffee in the Southern highlands and from bananas in Kagera. Especially in Kagera farmers consider cattle more important for manure for the bananas than for milk. For Tanga keys for success seems to have been the concentration in limited areas, the strong emphasis on the organization of the farmers in the TDCU (inputs and milk collection), the long-term emphasis on milk marketing, the private investments and management support creating a reliable market for the farmers in the form of collection centres, a well-equipped dairy plant and a large market for processed products in Dar es Salaam.

For most other projects information is not so easily accessible in order to make an assessment of the results and impact. From discussions with resource persons and available data the following conclusions can be drawn:

- Problems in producing sufficient replacement stock through a combination of poor reproductive performance and calf and young stock rearing; this statement is partly supported by data on performance of HIT schemes collected by De Jong (1996) showing a pass-on rate varying between 20 – 60 % in a period up to 4 years after receiving a pregnant heifer. This is further supported by the continuous demand for F1 heifers even in areas where smallholder dairying has already been established for more than 30 years;
- Animal nutrition remains a major problem for getting satisfactory milk yields; farmers mainly rely on crop residues, roadside grazing and other occasional feed resources and are unable or not prepared to cultivate special fodder crops or purchase enough feed. Land in the main dairy areas is often scarce and farmers tend to see livestock mainly as

consumers of ‘waste’ and producers of ‘fertilizer’ and maybe only a little bit as source of income;
- A reliable market outlet - provided by a formal or informal sector - is an important incentive for dairy farming development; a grade dairy cow is not necessary for mere home consumption; in that case a local (low risk and low needs) cow could produce enough milk;
- Services such as AI, vaccinations, animal treatment and extension can be supplied through the private sector (e.g. CAHW – Community Animal health Worker, private companies, etc.), but the demand for it ought to be high enough to make a living; in other words there should be enough farmers and cows in a specific area;
- Training and extension for farmers are essential to improve management, farm performance and introduction of innovations. This training could be provided by LGA, NGOs as well as the private sector. However, this kind of training should start from the needs of the farmers and not from the wish to propagate a prescribed or preferred theoretical model;
- Cooperatives or farmers' associations could play an important role in the organization of input supply, service and milk marketing. However, such organizations could do with some outside independent leadership and management support to improve continuity and sustainability;

It is important to note the mutual dependency between dairy production and processing: the processing industry cannot produce without milk from local producers, and producers cannot produce without a consistent demand and good price.

4.3 Support for dairy development 2000 to present (donors and private sector)

Many donor organizations and NGOs continued to be involved in the dairy sector after 2000. A few examples are:

- SNV (Dutch development organization): SNV focuses on the development of the value chains of red meat, dairy, and other sectors. SNV has undertaken and supported several studies on the dairy chain especially in the Lake Zone. SNV is supporting capacity development of the national dairy bodies (TDB, TAMPA and TAMPRODA) and further active in Tanga region supporting the Tanga Cooperative Dairy Union through training, inputs and extension and establishing milk collecting centres.
- Rural Livelihood Development Company (RLDC): RLDC aims to reduce rural poverty in Tanzania by linking the poor with markets and employment creation. RLDC works in poverty stricken areas with a focus on creation of assets and income generation. RLDC has prepared a Dairy Sub Sector Development Strategy for Tanzania in general and particularly for the Central Corridor (RLDC, 2009). RLDC supports milk marketing and processing activities in Morogoro and Shinyanga. Lessons learned are: formation of producer groups are effective means to mobilize milk collection; and access to a market motivates farmers to sell and earn money instead of focussing on home consumption;
- Irish Aid and DANIDA have initiated a Scoping Study on Value Chain Initiatives and Studies in Tanzania (Tarimo and Uliwa, 2012). The study was undertaken for the benefit of the Business Sector Programme and the Programme for Micro, Small and Medium Enterprises. The Dairy Value Chain was one of the Value Chains studied;
- ILRI-CIAT: As part of the CGIAR Livestock and Fish Research Programme, ILRI and CIAT study and support the dairy value chain to increase the productivity of small-scale livestock in a sustainable way by making milk available to the poor consumers. The group in Tanzania works with several stakeholders and has set up a Dairy Development Forum. It is also involved in the development of EADD2 (East Africa Dairy Development phase 2) for Tanzania (Workshop ILRI-CIAT, 2012)

- Land O'Lakes implements a USDA funded programme (2010 – 2013) of $ 8.1 million (from imported and donated milk powder) to improve commercial milk production, processing, marketing and consumer awareness through a range of activities, especially awareness sessions, farmer training and cooperative development. Similar programmes have been implemented from 1999 onwards. (Land O' Lakes Brochure, undated)
- Bill and Melinda Gates Foundation through EADD2. In general the emphasis is on smallholder dairy development and on chain approach. Replication of Dairy Hubs (successful Kenya experiences). (Msuva, 2012 and Heifer International, 2012)
- D.o.b.: From 2007 d.o.b investment fund is the major shareholder and investor in Tanga Fresh;
- Farmers Friends Tanzania: FFT is an independent branch of Farm Friends Holland operating a HIT scheme with dairy heifers in Tanga area.
- Het Groene Woudt is an NGO from the Netherlands which is implementing a project in the Maasai area (South of Arusha) to develop small local enterprises. This includes a dairy component with small scale dairy processing units in the semi-arid areas and dairy farming with Jersey crossbreds closer to Arusha. (Breur, 2010)
- ZLTO (Kuungana Foundation) together with Agriterra: Involved with a dairy cooperative in Mbozi district (see also Ch.4.2.7.)

(Netherlands) Private sector interest and activities in Tanzania:

- d.o.b. investment fund: shareholder in Tanga Fresh (http://www.dobequity.nl/east-africa-fund/tanga-fresh-tanzania/)
- Van de Heuvel, Dairy Equipment (http://www.heuvelzuivelmachines.nl/) , several deliveries of dairy equipment
- RABO bank has a 35 % share in NMB (National Microfinance Bank). The aim is to improve access for the Tanzanian population to affordable financial services. (https://www.rabobank.com/en/rabo_development/PartnerBanks/NMB_Tanzania.html). At present the dairy sector in Tanzania is not a priority for RABO-bank, but there are special schemes for the dairy sector in Zambia and Kenya. The NMB has given a loan to Tanga Fresh milk plant.
- KI Samen (http://www.ki-samen.nl/index2.php?lan=en), sales of bull semen. With an agent in Tanzania
- The Friesian is a Dutch dairy consultancy and has been involved in studies on dairy sector in Tanzania; (http://www.thefriesian.nl/)
- SIMGAS Tanzania Ltd is a joint venture between Simgas B.V. and Silafrica Tanzania Ltd Biogas Company. It offers a range of biogas digesters and appliances suitable for different situations and requirements, from households to small enterprises and institutions like schools. (http://www.simgas.com/contact/about-us/item25)
- CRV (in combination with CRV Brasil and CRV South Africa), sales of bull semen (http://www.crv4all.com/)
- Dairy Training Centre is interested to offer training programmes in Tanzania (http://www.dairytrainingcentre.com)
- Several private dairy farmers from the Netherlands are working in Tanzania
- Farm Friends, the Netherlands. NGO organization interested to support dairy enterprises, They have established an independent NGO in Tanzania: Farm friends Tanzania (http://www.farm-friends.nl/english and http://www.farm-friends.nl/farm-friends-tanzania/)

- NABC (Netherlands Africa Business Council) has formed a Consortium of Dutch enterprises focussing on the whole dairy value chain. This consortium presently aims primarily on Kenya and Uganda but considers to expand to Tanzania and Ethiopia. (http://www.nabc.nl/Services/Consortia/Dairy(KenyaUganda).aspx)
- African Agribusiness Academy is developing a network of entrepreneurs from small and medium enterprises in the Agribusiness sector. (http://www.aa-academy.org)

The NABC as well as AA Academy could be focal points for the follow-up of Tanzania – Netherlands cooperation in development of the dairy chain by sharing information and experiences making connections as a gateway to the Dutch private sector.

5. Dairy development models and strategies for the future

5.1. Introduction

Past experiences with different production systems, value chains and strategies in Tanzanian dairy development are given in previous chapters. This chapter looks at the future, based on variation of production systems and value chains in the policy diagrams, while stressing the need for tailor-made approaches. Relative importance of different production systems and value chains is likely to change and new forms need to be considered for the future, with attention to issues of people, planet and profit. Therefore, this chapter reviews still some more experiences from Tanzania but also from abroad at various system levels (farm, community, country). It briefly gives three approaches to scan production systems and value chains for possible interventions. It then takes 'technologies' in selected fields, discussing how/where they may be useful, based on the policy diagrams and/or simple scenario studies.

5.2. Dairy Production Systems and Value Chains, what to do?

Tanzania combines production systems and value chains in different ways as illustrated in the policy diagram of Fig.5.1. That diagram is repeated in Fig.5.2 to sketch milk volumes in the different quadrants, to further help establish tailor-made approaches. The left hand side of the policy diagram shows less project activity, even if that appears to be perhaps more significant source of milk (incl. local consumption) than the right hand column that seems to be getting most attention. One may seriously wonder whether this is a case of missed opportunities, also because production by smallholders can be argued to be cheaper and more efficient (Van Der Ploeg, 2008; Schiere et al., 2007).

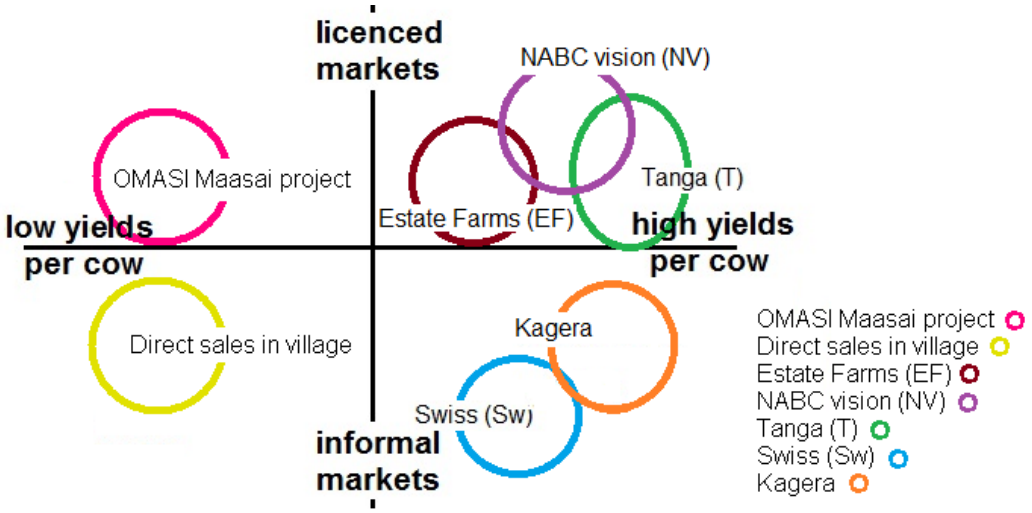

Figure 5.1. Position of different dairy development models in Tanzania, a sketch. Note: the left hand side appears to show less project activity than the right hand side, a case of missed opportunities?

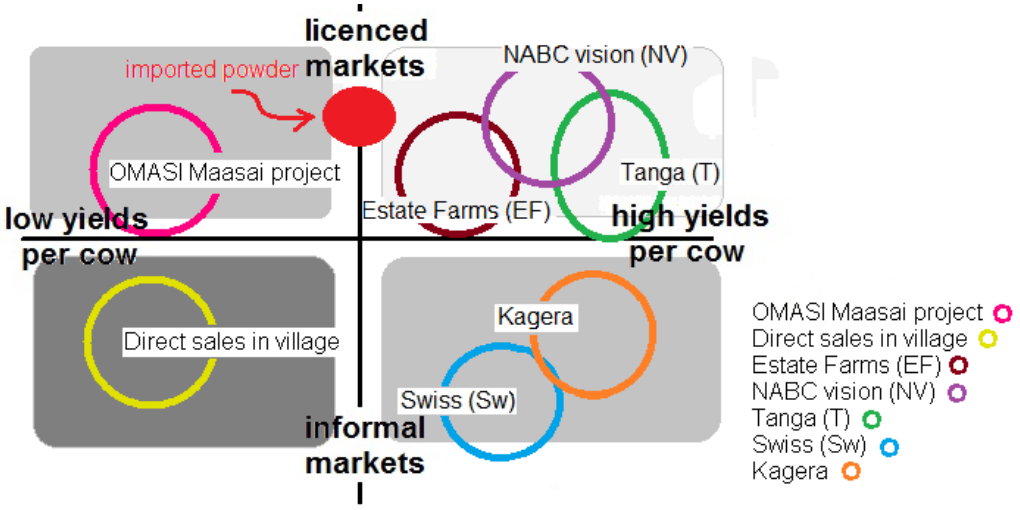

Figure 5.2. Relative importance of milk flows (volumes) in different markets, a sketch, with darker shades implying more milk. The red dot in the top centre shows role and place of imported milk. (See also Fig.2.7).

'Technologies' to suit the different quadrants of the policy diagram can be identified with the help of two system diagrams, one for the production system (Fig.5.3) and one for the value chain (Fig.5.4). Many more approaches and diagrams are possible while focus can be more on organisation and/or skills than what is done in the context of this Quick Scan. The identification of production goals is also important (Fig.5.5), taking into account social issues and farming styles (Van Der Ploeg, 2001) and to balance a single-focus on technical approaches, however broad we define 'technology'. Last but not least one needs to increasingly consider issues of people, planet and profit, of which 'simple' farm economics is the main point in this report with other aspects more implicitly mentioned. The rest of this chapter discusses a few selected 'technologies', based on the system diagrams in Fig.5.3 and 5.4 and the goals of Fig.5.5.

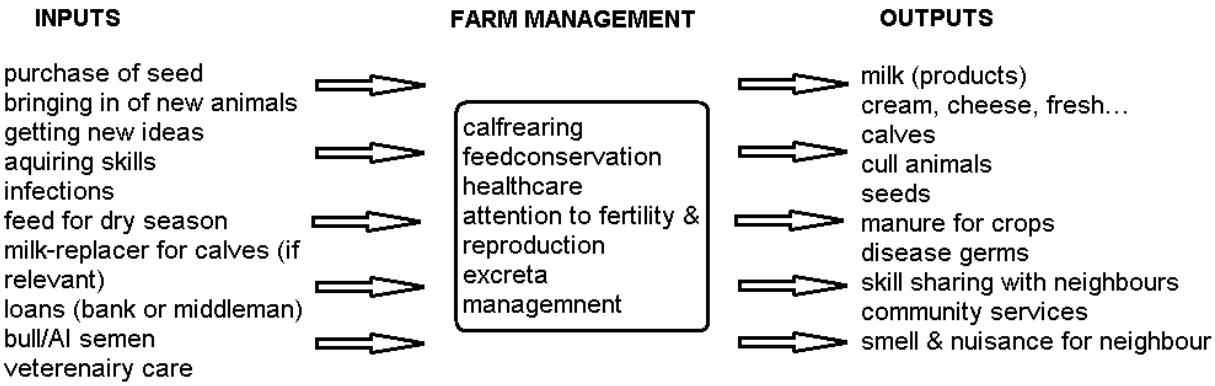

Figure 5.3. Basic diagram of a dairy production system, for large as well as small dairy farms.

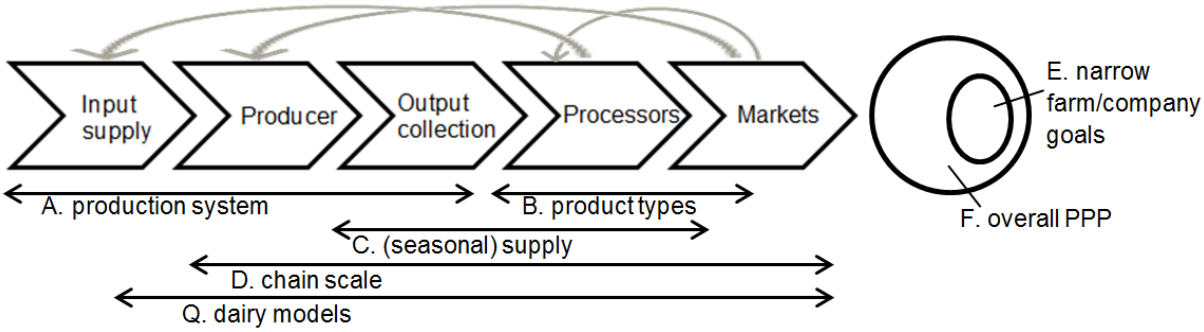

Figure 5.4. Basic diagram of a value chain to help specify possibilities for development and 'technologies' along the chain. Many parts of this diagram as indicated by arrows are referred to in the text, e.g. A (Fig.5.3 and Ch.5.3.3), B (Ch.5.3.5), C (Ch.5.3.6), D (Ch.5.3.4), E (Fig.5.5), F (implied several times in text) and Q (Ch.5.3.1). The grey, curved arrows on the top imply various types of feedback.

Opportunities for 'development' depend on the goals and functions of livestock keeping (Fig.5.5), which differ over and within the major quadrants, e.g.:

- emphasis on petty cash and local food supply in the bottom left corner leaves little room for long-term investments;
- emphasis on milk supply to cities and dairy as a high output commodity in the right implies a need for steady supply of milk and thus for strategies that ensure steady feed supply in the dry season (with quality labour, silage, concentrate, water and/or fertilizer) or even [occasional] import of milk powder! ;
- support to dairy in the left hand quarters would primarily aim to bring income to rural areas, while in the right hand quarters it would in addition aim to save foreign currency and ensure cheap food in the cities. Whether it actually does save foreign exchange is a matter of debate;

Remarkable differences in program activities can thus exist between the quarters of the policy diagram. Emphasis in the bottom right would be on added value products for local use, like drink yoghurts, ice creams, semi-matured cheeses. Emphasis in the upper half would be on quality and supply of clean milk, all apart from differences in emphasis on issues of farming styles and PPP.

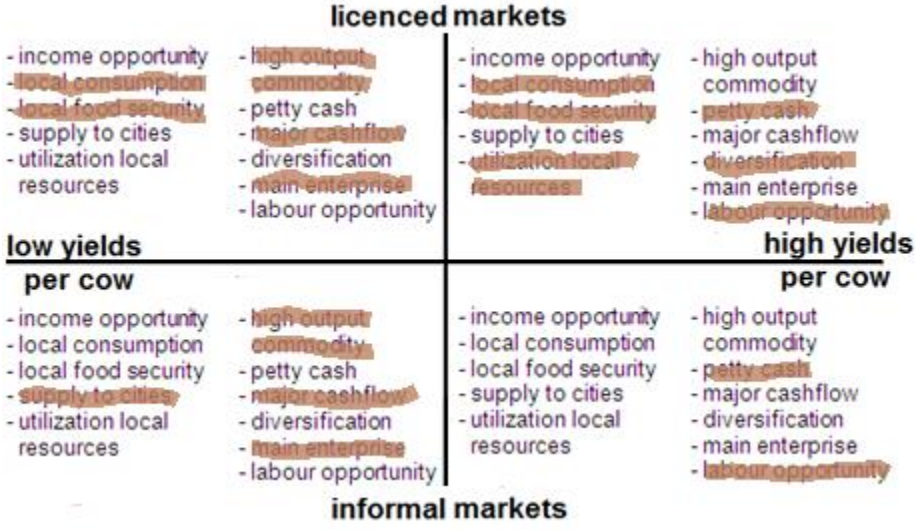

Figure 5.5 A sketch of goals in dairy production for the different quarters of the policy diagram; goals with lower relevance in a particular quarter are 'crossed out'.

5. 3. Future Dairy Systems, different 'models' and 'technologies' for development.

This report assumes a need for tailor-made approaches while looking at the future. It stresses that dairy development in Tanzania can take clues from earlier experiences in the country as described Ch. 2-4. It adds, however, experiences with 'technologies', development models, production systems and value chains from other countries, being well aware that the success of any model depends on local differences in leadership, role/policy of governments, interrelation of milk density (kg milk/km^2), goals of livestock keeping, farming styles, chain development as well as purchasing power of different sections of the population.

The different categories of 'models' relate to challenges and opportunities that face dairy development in Tanzania, a) how to produce and market, b) what type of products to choose, and c) how to cope with seasonal milk supply. Each of these is tentatively placed in quadrants of the policy diagram for further discussion. Other issues like calf-rearing, herd-replacement, product development and so on are given further down in this chapter, with simple 'cigar-box' calculations as another kind of 'scenario-studies' to establish suitability of 'technologies' and approaches at regional- and farm level. A typical choice is between 'face value technologies' and work on 'root causes' (Box 5.1). Face value 'technology' may be preferred for quick fixes and short term results. For long term sustainability, however, the work on 'root causes' is equally if not more important.

Box 5.1. Root causes and face value 'technologies'.

Many of the obvious, 'face value' problems and opportunities in dairy development of Tanzania have been listed in the context of a national development where milk production has tripled in recent decades. Total dairy stock has increased and basics of modern feed production and feeding are not new anymore. Trypanosomiasis seems on its return (though still present) and basic skills in dairy management are at a higher level now than decades ago. Still, examples of new challenges and opportunities are many. They include the difficulty to collect milk in pastoral areas, the lack of good feed in terms of roughage and dairy meal, lack of breeding stock and low reproduction rates, animal health issues and lack of entrepreneurship. Addressing the face value issues with short term solutions is a great way to show short term 'quick fixes' but also a great way to cause frustration if the root causes are not considered. Typical root causes that underlie the challenges are, for example:

- climate and management, probably more than 'improved seeds', causes forage to be of mediocre quality unless much fertilization and water is used. Taking the root-cause approach one might include attention for animals (crops, management techniques etc.) that suit local circumstances rather than 'face value' focus on imports of mal-adapted animals
- education and research programmes aimed at realities outside Tanzania are factors that make agriculture less attractive to young people. Reinvigorating and updating local skills may be as useful as the focus on import of unadapted skills,
- if much land and other production factors are 'allotted' to larger producers then the infrastructure geared to support farming will tilt to the needs and realities of larger farmers and/or chains while ignoring and/or side-lining opportunities in smallholder farming (Fig.5.7)
- if government organisations do not function well it is often not so much the people that need training but the organisation that needs re-shuffle, towards multiple realities rather than a single production paradigm or towards 'taking' rather than 'shunning' responsibility
- nutrient surpluses in large production units may be handled by 'face-value' excreta management but a major root cause might well be that production now takes place at centralized larger units.
- risks for public health may be addressed by all kind of food safety laws, often making it difficult for small and/or creative producers to continue business. Addressing root problems would imply attention to down- rather than up-scaling of food networks
- face value complaints that small producers have no interest to invest may be at least partly caused by root-problems in which smaller sector gets crowded out by the stronger larger sector

The points to juxtapose 'face-value' to 'root-cause' challenges is to stress the need for balanced and creative development, spreading attention over different production systems and value chains. It may appear to reduce options but in fact it opens up newer possibilities

5.3.1. Production and marketing models

Different combinations of production and marketing exist, in Tanzania as well as around the world. A more elaborate description of the models in Annex 7 is tabulated in Table 5.1, and suitability for the different quadrants in the policy diagram is sketched in Fig.5.6. A brief summary in words is as follows:

- 'cooperatives', with or without strong [external] leadership, emerging from existing smallholder dairy production, or started to initiate development of smallholder dairying.
- 'industrial farms', the modern systems emerging around the world, somewhat similar to 'commercial farms' (see below) with the difference that commercial farms tended to be family operated rather than run by corporations hiring staff (industrial!).
- 'state farms', i.e. larger specialized dairy farms, basically started irrespectively of existing smallholder production systems. In Tanzania the model of state-farms is associated mostly with parastatals from the socialist-Ujamaa era (1965-'85).
- 'commercial farms', where immigrants or local entrepreneurs ran commercial, often specialized dairy farms, with or without associated on-farm processing and dairy bars, especially in the so-called 'white highlands' of Western Kenya.
- the 'middleman' (called 'hawkers' in Tanzania) where a dairy farmer or individual entrepreneur collects milk from (other) individual farmers, mostly smallholders and pastoralists, along and on the way to informal markets in villages or peri-urban areas.
- 'urban farms' with small or large dairy farms producing milk close to the market or around cities, often utilizing urban wastes for feed. 'Milk bars' along major roads fit this pattern to some extent by directly supplying consumers with fresh and/or processed milk.
- 'long simple chains', with industrial and/or commercial dairies having processing system and value chain of their own. Basically this used to be done by 'urban dairies' at another scale.
- the 'hodgepodge' where cities and villages are supplied by a mix of middlemen, peri-urban farms, imported milk and the like. Systems like this have opportunities for dairy development, especially to expand the market for fresh milk based products.

Unfortunately, it is not easy to briefly describe milk collection for pastoral systems in the context of this Quick Scan. Experiences are available, however, and a review of this work is recommended. Generally speaking, the road network in areas where nomadic and transhumant livestock keepers live is very basic or non-existing. Smaller producers can bring the milk to a collection point or the processing unit by foot, bike or motorbike, and collectors can come to larger producers by bike or motorbike. Up to 60 and 120 kg can be transported by well-equipped bikes and motorbike, respectively. Different prices should be paid for delivery at the farm, at the collection point and at the processing unit; the difference is used to pay the collectors. Using bikes and motorbikes for milk collection increases the local income from the value chain. Cars can be used to transport larger quantities (otherwise it is too costly) when the roads are hard and distances longer, and for the marketing of the processed products. It is recommended to use stainless steel, both for milking and transport. Quality control of milk can start at the collection points and emphasis should be on rapid cooling, even if done in a simple way to below 15-18°C in order to save time before reaching the more sophisticated cooling system (based on information by Roel Bosma).

Table 5.1. A summary of dairy models (scenarios) and their applicability in Tanzania (see text and Annex 7)

Positive	Negative	Relevance for Tanzania/ policies needed	Type of chain (see Table 5.1)
Cooperative			
More bargaining power; Share cost; Joint input supply; Employment	Difficult to establish, Loyalty of the members	Excellent for smallholders & NGO; Establish coop law, Good start of vibrant dairy sector (as in W. Europe)	Macro- and meso market; Milk plant; Network;
Industrial			
High production; High use of external resources; Draws added value from country side;	High investment; High environmental and social cost; High tech- level;	Possible but not recommended no conducive environment for high yields	Macro-, meso- or even direct selling of products
State farm			
Government control;	High overhead cost; Problems in management;	History, parastatals are being privatized;	Macro/meso; Direct;
Commercial			
Produces surplus calves/cows	Many government regulations	Clear regulations on land titles	Macro/meso Can be direct
Middleman			
Accepts small quantities; Less fuss on quality; Flexible	Public health Reliability	Good start of vibrant dairy sector (as in W. Europe)	Micro/meso Rather anonymous
urban farm			
Short chain; Hi-milk price (prod); Low milk price (cons)	Feed supply; Source cattle/cows; Environment; Public health; Gov. regulations	Relevant around cities, milk bars and local added value	Micro / meso Rather direct
direct chain			
Long but simple chain; Valuable product; Medium life products	Extracts added value from countryside; High demand fossil energy and concentrated feeds	Possible, but not recommended	Macro
Hodgepodge			
Creative place for entrepreneurs; Low transaction costs	Not possible to give direction	No or few (crucial public health) regulations; Market forces decide	Micro/meso/macro

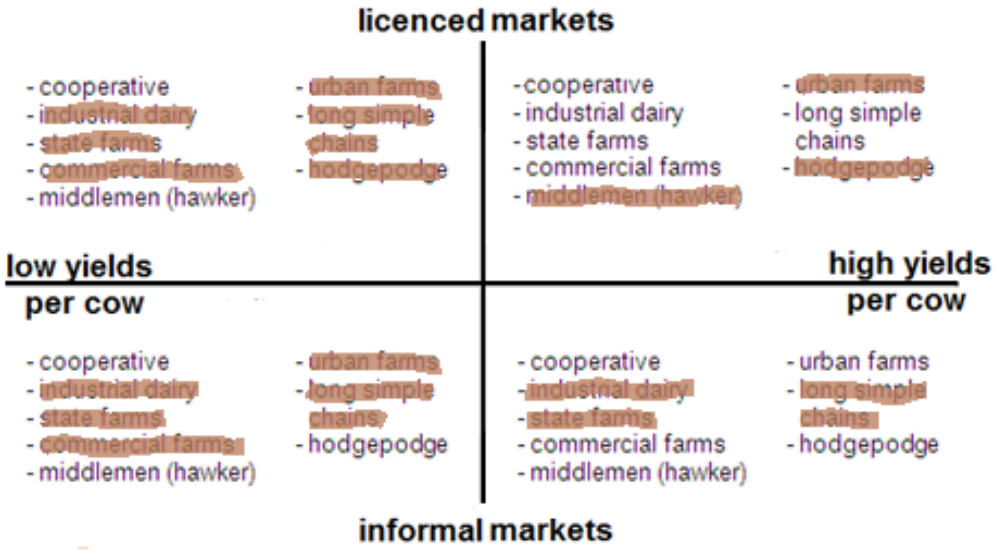

Figure 5.6 A policy diagram, sketching suitability of dairy development models for Tanzania

5.3.2. Veterinary services and public health

Previously very serious health problems for animal production in Tanzania were tick-borne diseases and trypanosomiasis, apart from veterinary and public health issues like internal parasites, infections, mineral deficiencies, unhygienic milk products etc. Trypanosomiasis appears to be somewhat on the decline (higher population pressure leaves less bush as habitat for the tsetse fly transmitting the parasite). Many other public health issues and veterinary care are still relevant to dairy in Tanzania, represented in Fig.5.7 and organized differently than in the policy diagrams thus far. Upper- and lower rows, as well as right- and left hand columns require different 'technologies' if one aims for a tailor-made approach. Basically that is nothing new but two points to be made:

- for example, supermarket chains and ISO standards are most relevant in the upper half. Veterinary work in areas with better 'infra-structure' also has different priorities and opportunities than in the thinner populated and less well accessible left half. It uses 'technologies' and mindsets that operate with higher levels of system control (generally requiring higher levels of fossil fuel and scarce resources). The left hand tends to use mindsets and approaches with a more flexible localized approach, perhaps less effective but handling resources more efficiently
- the second point is that the public and private sector do influence patterns of national development by choosing one approach over the other. Focus on straightforward modern and mainstream 'technologies' tends to favour entrepreneurs and urban populations while disfavouring rural communities. Focus on standard approaches, R&D, curricula and legislation reduces flexibility. That is likely for veterinary work as well as for the entire dairy sector.

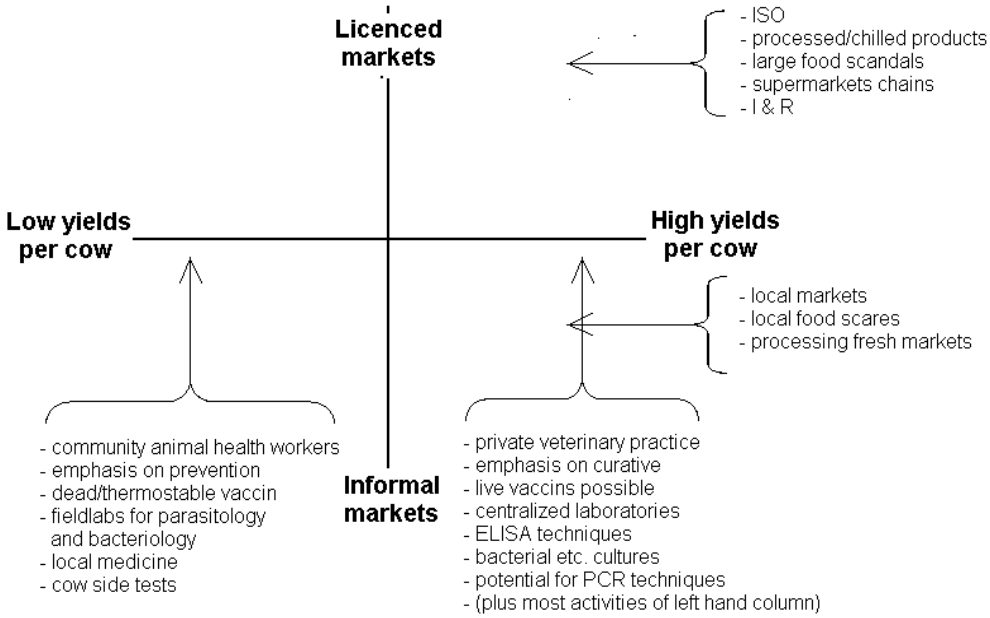

Figure 5.7. Different issues in veterinary care and public health for dairy development (based on discussions with Gerard Wellenberg).

5.3.3. Importation, breeding stock, AI, ET and calf rearing systems

Cattle import is an obvious but face value, solution to shortages of dairy animals and/or quick desire to produce more milk. Import is a well-known and often tried strategy pursued with sometimes more and often less success, already since the 2nd World War (IOB, 1987 and Development Cooperation, 1992). After many years one may find and be happy with, 'left overs' of such imports but more effect might have been achieved using imported semen (via bull or AI) at lower cost. A face value solution like imports of exotic dairy cattle, however, tends to overlook root causes of dairy production in a tropical country like Tanzania, e.g. disease pressure, poor feed supply, lack of management, poor adaptation of foreign animal to local conditions and so on. Modern private companies of the top right quadrant may claim to be capable of overcoming the problems of disease, feed, management and the like but such arguments have been used before. Moreover, their modern feed production (e.g. with maize) tends to cost extra irrigation (water that might be more profitably used elsewhere with a greater macro-economic return). Moreover modern commercial dairy may outcompete more efficient (though less effective) smallholder systems and their mode of operation may tend to shift income from rural to urban settings.

One root cause of breeding stock shortages is the difficulty to raise replacement stock for dairy cows. Reproduction of dairy cows is a slow process (Table 5.2). In addition, for poorer parts it tends to be very unattractive to do calf-rearing in an economic way, considering short term cost of milk (suckled from the cow), feed etc., set against risks of mortality, even theft, as well as alternative use of cash for more rapid returns on crops or other activities. Wealthier producers with good access to markets tend to find calf rearing also unattractive since they have a better (short term) alternative to sell milk rather than feeding the calf. Smallholders as well as commercial companies, may take a look at issues of low numbers of surplus animals when reproduction is low and mortality is high (Table 5.2). And more work is suggested on the economics of calf rearing for [the different reasoning of] large and small farmers in the different quadrants, also considering the (perhaps faulty) attractive data on calf rearing in Box 5.2.

Table 5.2. Simple arithmetic of herd replacement and heifer rearing, apart from economics aspects, sketching scenarios from poor to reasonable; excl. calves born from heifers; in bad cases the 1st calf in 3rd or 4th year)

	Herd particulars	management system		
		low	medium	high
1	herd size (milking cows)	100	100	100
2	calving rate	80%	80	90
3	mortality before weaning	20%	10	10
4=1*2	calves born	80	80	90
5=4*(100%-3)	calves weaned	64	72	81
6=5*50%	heifers weaned (50% of all calves)	32	36	41
7	mortality from weaning to adult	20%	10	10
8=6*(100%-7)	heifers raised to adult	26	32	36
9	culling of cows % / year	40%	30%	20%
10	cows culled	40	30	20
11=8-10	**'surplus' heifers**	**-14**	**+2**	**+16**

Note: red, yellow and green marking imply resp. negative, close to zero and positive replacement rates.

Box 5.2 Rough costs of calf rearing set against the purchase of a heifer and associated opportunities

Discussions on calf rearing should consider that a calf drinks some 300lts of milk (from the dam or milk-replacer, that she eats some 250kg (from 200-300kg) of concentrate, apart from other expenses and risks before lactating. In Tanzania that would imply a cost of:

300 lts of milk @ 600Tsh	180,000
250 kgs of concentrate @ 500Tsh	125,000
Other expenses	100,000
Total	405,000

The opportunities hidden in this 'core problem' tend to be supply of milk-replacer (various qualities and prices are available), supply of good concentrate (broiler feed may be expensive but a good option for early growth and health); subsidy or credit programs for 'custom-rearing of calves', growing out of calves in areas with plenty feed and no good access to markets (see also Table 5.5), training for more hygienic calf rearing and medicine use to ensure better survival.
The above 'cost price' of Tsh 405,000 might be compared with a current sales price of Tsh 1,000,000

Much was done, however, in Tanzania, with different heifer multiplication schemes (Box 5.3). And there are many ways to skin the cat (of overcoming short supply of young stock). In other words, many alternatives exist to importations of live animals, such as:

- work on improving reproduction, x-breeding and survival rates may be better use of public money than imports (De Jong, 1996).
- crossbred animals and semen are now available from other tropical countries[7], i.e. opening opportunities to import better adapted animals.
- rearing of replacement stock can be done in areas with little demand for milk (Table 5.5). As said by one of the informants: *in Kagera the milk used to stay in the village (staying out of the licensed chains) and calves as well as dry cows moved to other areas.*
- Artificial insemination with imported semen and/or from imported bulls may be considered, but also embryo transfer in very special cases.

[7] www.crv4all.com

Box 5.3. Heifer breeding and livestock multiplication schemes

Many systems exist to produce replacement and breeding stock, apart from imports. Countries like India have experience with upgrading by AI in rural areas (Patil, 2006), and local initiatives in Tanzania as well as NGO's like Heifer use a so-called heifer-in-trust scheme (HIT). In that case a farmer gets a heifer on the condition that he/she 'passes that gift' (a new-born heifer) to a colleague farmer. Other systems include 'subsidies' for farmers that 'properly raise' calves (De Jong, 1996). Tanzania itself attempted in the period 1980 - 1985 to supply surplus dairy stock from government parastatals but in reality there never was any surplus to cater for the needs of dairy development plans for the smallholders.

The Government of Tanzania thus initiated programmes for heifer breeding units (HBU) or livestock multiplication centres (LMC). HBU are private or public ranches where local zebu cattle are crossed with temperate dairy bulls, e.g. through artificial insemination. The F1 crosses are reared under an extensive system and sold to interested farmers. These large units require substantial investment and recurrent funding. A large foundation stock was required as a start (e.g. breeding 1700 cows at Kikulula in Kagera) and replacement stock was needed because 10 to 30 % of the cows were culled each year. The offtake was issued to smallholder farmers at low prices or at prices subsidized by donor projects. Without donor projects the income of the HBUs would have been insufficient to meet the operating cost. It would have been more appropriate to sell the crossbred heifers (and bulls) at open market prices to ensure that the operations are viable and self-sustaining (data for 1984–88 were: total stock 8600; cows 1550; calving rate 57%; weaning rate 45%; calf mortality 19%; F1 born 370/yr; sold females 184/yr (based mainly on Walshe at al., 1991). Mruazi HBU in Tanga followed a more intensive rearing scheme compared to Kikulula for the F1 heifers (improved pasture and some supplementary feeding in the dry season).

The Swiss project of the Southern Highlands had initially a different approach, with crossbred bulls used for upgrading of local zebu stock to promote dairying among smallholders. Bull centres were established under ownership of local authorities, while some farmers received bulls free of cost provided they castrated their indigenous bulls. All this had little effect, however, and as the next step the Sao Hill Livestock Multiplication Unit was developed to produce Boran x Ayrshire crossbred heifers to be issued to farmers.

Around 1990 the total of seventeen HBU's and LMC's produced 2000 heifers/yr for distribution, by far not enough to cater for the annual need of 8000 heifers at those times.

5.3.4. Value chains, from local to (inter)national level.

For the value chain one can distinguish three major 'scales' as shown in Table 5.3, from family level, via community to (inter-) national level chains, here simplified as the difference between the informal and the licensed markets. Much was said on organisation of the dairy chain in Ch. 2 and 4 but the distinction into three scales is useful, relatively to all kind of 'technologies' and implications for training, R&D as well as legislation in which the Netherlands have much experience. All together this is a typical example of a set of 'technologies' that also include 'non-technical' aspects.

Each type of value chain has its own opportunities. Larger business generally operate in the chains to the right. More opportunities for locally added value and food security exist towards the bottom half of the policy diagram. Several opportunities can be suggested per chain type as in Table 5.3, but:

- quality control can be done across the micro-, meso- and macro chains, though in completely different ways
- cooling and preservation (pasteurization, UHT) is more relevant in macro chains
- packaging is more relevant in the meso- and macro- chain than in the micro-chain
- curds, white-cheeses and mozzarella in the meso chain
- drink yoghurts and ice cream a meso and macro chain.

Overall, indeed, highest added value occurs in the macro-chain, though distribution of the added value in that case also shifts from 'mainly farmers' to 'mainly processors' as one moves from micro to macro. In the same way the use of fossil fuel based external resources increases from left to right, implying less 'foreign currency saving and labour opportunity' from left to right, i.e. from low to higher yielders Work on farmer organisation is more relevant in the meso- than in the macro- and micro chains. In terms of sustainability, much is made of the point that emission of GHG (Greenhouse gases) and use of resources per litre of milk is lower for high yielding cows. The trade-off is, however, that intensive systems and

macro chains have higher requirements of fossil fuel, even expressed per litre of milk, and more distorting effect on communities and currency savings than the micro and meso chains.

Table 5.3 Scaling of value chains, at family level (micro-scale), village and peri-urban (meso-scale) and larger level (macro-scale). The micro-chain is especially relevant across the lower half of the policy diagram, and the macro chain for the upper half.

	Home and neighbours	**Village & peri-urban community**	**Urban and national chains**
	Informal markets		
		Licenced markets	
Distance producer-consumer	Short	Medium	Large
Storage	Not so relevant	Cooling	Processing
Food miles	0 - 5 km	5 – 25 km	>25 km
Hygiene	Variable (poor)	Variable (moderate)	Needs to be OK
Community value	High	Can be high	Not relevant
Commodity value	Low	Higher	High
Diversity	High	Moderate	Low
	'Technologies'		
Transport	Bike	Bike, motorbike	Pick-up, truck
Containers	Bottles and small cans	Cans	Cans and tanks
Milk quality tests	Smell Cleanliness	Smell, Cleanliness Lacto-densimeter Alcohol test Bacterial count	Smell, Cleanliness, Lacto-densimeter, Alcohol test, Bacterial count, CMT, Antibiotics, Fat, Protein, SNF
Cooling system	Not relevant, can be by (evaporating) cool water. few hours	Fridge and cooling tanks (solar power) 1-3 days	Cooling by tank/pipe/plate coolers 1-3 days
Preservation	None or boiling Natural fermentation	H_2O_2,/LPS lipopolysaccharides Natural fermentation	Cooling/processing Sophisticated fermentation
Processing	None or hardly	Possibly fresh cheeses, sour milk	Yes
Packaging	Jar, jug, pan	Sachets*, bottles, plastic	Plastic bags/sachets (more sophisticated) Bottles, Carton packs
Products	Porridge, Mtindi (fermented milk)	Mtindi, Yoghurt, Mozzarella, White/fresh cheeses, Ghee	Pasteurized milk, Mtindi, Yoghurt, UHT, Cheeses, Mozzarella and special products

Note: * sachets seem to be on their way out

5.3.5. Dairy products, models from around the world.

Major products to be considered for dairy processing, apart from probably significant amounts consumed fresh at home or in the village, home are mtindi (fermented milk), yoghurt, drink yoghurt, ice cream, pasteurized milk, milk sweets, ghee (butter oil), butter, UHT milk, mozzarella, white cheeses and matured yellow cheeses. Other products are sweetened condensed milk, milk powder, curd each with more or less relevance for Tanzanian dairy as a whole. The first point here is, to decide on 'what to produce where' rather than to dismiss or recommend specific product lines for Tanzania across the board. Selection of products is done by placing the product types in the policy diagram of Fig.5.8. The second point here is that certain products are more suitable for rural conditions with low milk densities and informal

markets to serve local food-security (e.g. white cheeses, curd, fermented milk). Others fit better in peri-urban conditions and informal markets, e.g. mozzarella, drink-yoghurts, pasteurized milk. One may suggest that preserved milk products like powder, UHT and yellow-cheeses are either for the top right quadrant (licensed markets and high milk-densities), or else, that they can be more cheaply obtained (in macro-economic terms) as imports from countries with more competitive advantage for milk production.

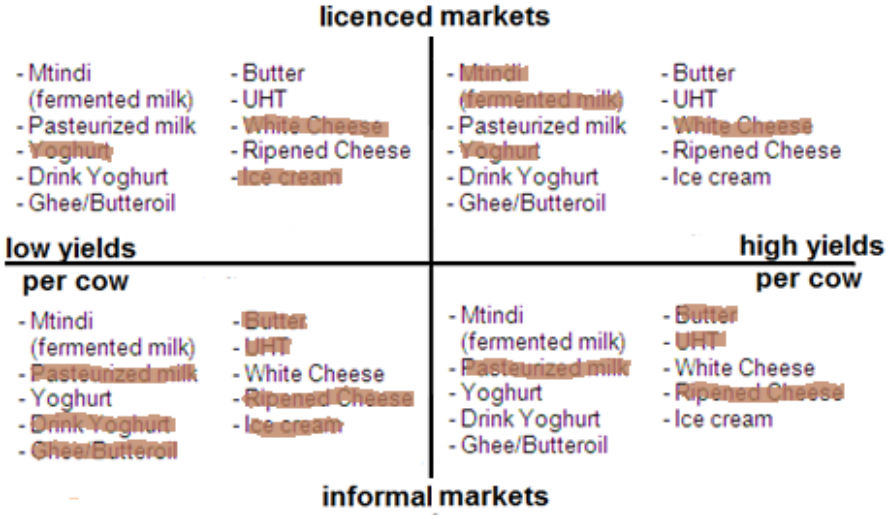

Figure 5.8 A policy diagram for product types as determined by the 'comparative advantages' of the particular combination production system and value chain.

5.3.6. Approaches (models) to cope with seasonal milk productions

Many models exist across the globe for strategies to cope with seasonal fluctuations in supply of milk. Some of such models are shortly described here, even if none serves for Tanzania as a whole, repeating themes of using tailor-made approaches as illustrated by our frequent use of policy-diagrams. The different models to cope with seasonal milk supply include:

- the 'winter-milk' model where farmers get paid a bonus for milk supplied during winter (=slack season) to encourage milk production in the slack season;
- controlled import of milk (powder) in periods of milk shortage (e.g. dry season) to ensure steady operation of the dairy plants and/or consistent supply to consumers (Box 5.4 with a 'cigar-box' calculation on cost of reconstituted milk);
- the 'New Zealand model' with two producer-types: (a) year round supplying fresh milk dairy for the cities; and (b) producing only in times when grass is well available. Cows are dry during the slack months when feed supplies are down and all milk is processed into long shelf life products (SMP, butter, etc), mainly for export[8];
- 'the seasonal product model', operating a market for seasonal products with e.g. fresh cheese and fresh 'season' milk. In other words, accepting seasonality and low supply of consumer products during the dry season;
- shifting of extra seasonal supply of milk for calf rearing in the wet season, sometimes with sale of dairy calves as a special source of income;
- extra feed production and/or -conservation for the dry season (irrigated fodder, use of hay, silage, protein banks, concentrate feed or even straws) (Table 5.4).

Choices for each of these approaches mainly depend on price (policy) and economics, not on one 'technology' being better (across the board) than the other. Tradition is also important, of

[8] Note: much of the competitive advantage of New Zealand is based on cheap land and fodder. Concentrates are expensive, i.e., milk produced for export is feed dependent and yield of cows is 3000-4000 ltr/yr rather than 7000-8000 ltr/yr as common in W-Europe, a matter of economics and NOT primarily of genetic potential.

local producers and of expatriate entrepreneurs. And differences are large across the country, even within regions. Moreover, this approach focussing on general differences represents a situation in a chain where milk is collected, not of an individual peri-urban', industrial and/or 'commercial farm' that has a particular niche for which it wants to know whether or not it pays to start producing and processing.

Box 5.4 Cost of reconstituted milk and imported UHT milk, some rough scenarios

World market prices (based on internet information), mainly average prices for 2013. It is not always clear whether prices are FOB or CIF. Calculations are again primarily meant for illustration and should be checked against real current CIF prices:

Skim milk powder (SMP): US$ 4,250/ton (2013 range: US$ 3,400 – 5,000)
Butter oil (BO): US$ 4,900/ton (2013 range: US$ 4,700 – 5,200)
UHT milk (low fat) US$ 1.05/ltr (current export prices (fob) from USA and New Zealand)

Cost of reconstituted milk (3.4% fat):

1 kg SMP + 0.340 kg BO + 10 kg water equals 11 kg milk of around 3.4 % fat
Price: (1 x 4.25) + (0.340 x 4.90) = US$ 5.92 for 11 kg milk or 0.54 US$/kg. (Tsh 838 or € 0.40/kg)

A similar calculation for semi- skimmed milk (1.5% fat):

1 kg SMP + 0.150 kg BO + 10 kg water equals 11 kg milk of around 1.5 % fat
Price: (1 x 4.25) + (0.150 x 4.90) = US$ 4.98 for 11 kg milk or 0.45 US$/kg (Tsh 698 or € 0.32/kg)

UHT milk of US$ 1.05/lts – equivalent to Tsh 1,630 or € 0.77

In the above calculations import duty, and transport and processing cost are not included.

Duty free and duty paid prices (60 % applied to imports from outside the East African Community):

	Duty free			60 % import duty		
	US$/ltr	Tsh/ltr	Euro/ltr	US$/ltr	Tsh/ltr	Euro/ltr
Reconstituted milk 3.4 % fat	0.54	838	0.40	0.864	1341	0.64
Reconstituted milk 1.5 % fat	0.45	698	0.32	0.72	1117	0.51
Imported UHT milk 1.5 % fat	1.05	1,630	0.77	1.68	2608	1.23

Table 5.4 Prices of milk and feed in different places and seasons (based on information from Tanga Fresh), and feasibility of feeding concentrate as (dry/wet season feed).

	Tanga area			Morogoro			
Chain type	TangaFresh[1] MCC	Hawkers dry season	Hawkers wet season	Tanga Fresh dry season	Tanga Fresh wet season	Hawkers Dry season	Hawkers Wet season
Milk price (Tsh/ltr)	660	1000	800	650	550	1000	600
	Concentrate Prices (using an estimate for dairy meal)[2]						
price range (Tsh/kg)	500-900						
average price (Tsh/kg)[3]	700	700	700	700	700	700	700
Price ratio [4] Milk / conc	1.4	2.1	1.7	1.4	1.1	2.1	1.3
Price ratio [5] Milk / conc	0.9	1.4	1.1	0.9	0.8	1.4	0.9

1) Tanga fresh in Tanga area appears not to use a seasonal price but the price here is an average (see also note 3) of higher and lower prices set by the management and depending on operational levies by the different MCC's.
2) dairy meal is an unreliable mix of feeds but it is taken here as an 'average' to represent 'a feed price' for these sensitivity calculations. More detailed calculations can obviously be done, especially since the prices quoted here appear to be on the high side.
3) 'average' implies that we assume a 'general rule of thumb' and not a 'formal average' price, and not differentiating for different concentrate prices in different production locations (see Table NAKURU).
4) assuming an (optimistic but not unrealistic) 'extra' return of 1.5ltr milk /kg concentrate
5) assuming a practical 'extra' return of 1ltr milk /kg concentrate, especially in difficult production conditions

5.3.7 Confusion and logic, further use of scenarios.

This report stresses that distinction of production systems and value chains is needed for a successful strategy based on tailor-made approaches. Segmentation of production systems runs from left to right in our policy diagram and of markets it runs from the upper to the lower half. However, more 'logic' can be brought into understanding of the variation, challenges, and opportunities. Scenario studies can be helpful, either very simple (cigar box calculations) or more complex (computer models). A simple 'scenario' study to distinguish production and marketing systems is based on distance to a city or collection centre. One example here constructed for Tanzania, based on experiences from Kenya, shows how even over a short distance there can be big differences in production and marketing (Table 5.5). The details may be challenged but the basics are that changing distance to the city or collection centre implies change in production and marketing, in terms of main product, side effects and the like. If done well, such scenario studies can help identify priority areas for further work, saving much money and time and being a great tool in education as well as in business planning.

Table 5.5. A 'scenario-study' on dairy systems, bottlenecks and opportunities, moving from purchasing centres with higher milk prices and lower input prices towards regions with lower milk and fodder prices, but with higher input prices (based on a case from Nakuru by Schiere, 2001)

	distance to the city			
	<3 km	3-10	10-30 km	beyond 50km
Cost of concentrate	400	500	600	not available
Price of milk	1000	800	650	500
Milk yield at peak	around 20	around 15	around 10	5 or less
Ratio concentrate/ grass	high	medium	low	very low
Options for concentrates	high	medium	low	none
Options for premixes	low	medium	medium	low
Type of husbandry	stall feeding	stall / grazing	grazing / stall	grazing / herding
Options feed conservation	low	medium	high	medium (for sale)
Environmental problem	dung disposal	low	low	overgrazing
Public health hazard	flies, parasites, zoonoses	flies, parasites, zoonoses	low	zoonoses
Main production goal(s)	cash / milk	income / milk	milk for home/ dung / income	milk for home / calves / income / tradition
Resources from other zones	lactating cows, grains, fodder, hay	lactating cows, breeding stock	breeding stock	…….
Resources to other zones			calves, lactating cows, fodder	calves, lactating cows fodder

5. 4. Policy quadrants, scenarios and choices, a summary.

Tanzanian dairy development can use experiences from within Tanzania and from abroad that each have their specific usefulness, challenges and opportunities here categorized according to a 'policy quadrant'. That is one basic lesson but other basic lessons are that:

- discussions of 'technology' in dairy development should include attention to organisation, legislation (e.g. on public health and scale/type of markets), skills as well as feeding of concentrate and use of stainless steel milk tanks
- some, but not many experiences exist on milk-extraction /collection for licensed markets from pastoral areas, the top left quadrant, even if it is a potentially large (seasonal) supplier of milk at possibly low cost. The lack of those experiences may have a good reason, e.g. due to low milk density in those regions, strong seasonality of supply and long distances to cities.

- we strongly suggest to do a separate review on experiences with challenges and opportunities for milk collection in the pastoral areas rather than to (a) only focus on the obvious modern specialized systems, (b) ignore high PPP potentials of [agro]-pastoral systems
- attention of the public and private sector to only a rather straightforward face-value modern 'technology' includes promotion of concentrate feeding without considering the importance of price rations, import of dairy cattle without addressing issues in calf-rearing (see below) as well as food-safety issues of large modern chains (rather than issues of local food security) ignores root causes. Face value 'technologies' may be most useful and/or attractive on the short term, they require also attention to root causes to ensure sustainable success and a continuously creative industry

Concluding, expert opinion on use of policy quadrants and [cigar box] calculations for [small and/or larger] sensitivity analysis can help to establish usefulness of 'technologies' and their side effects. In other words, a creative and tailor-made approach to identify challenges and opportunities helps not only to decide on 'how to start a given dairy system' but also to generate creative possibilities for future developments. Expert panels and local discussions are needed to establish useful 'tailor-made' approaches for dairy development.

5.5. Sustainability and goals of dairy in the different chains and production systems

The term 'people, planet, profit' is getting worn out but helps discussions on choice of sustainable technologies. And as said before, the term 'technology' is used for want of better, implying more than use pure bred exotic animals, of stainless steel cooling equipment etc.; it also includes social issues, farmer organisation, skill building, and motivation. More work could be done on this approach but some notes are useful to trigger discussion (Table 5.6). Implicitly this also means that environment and social aspects are part of the issues in milk production, apart from criteria like milk yield per cow or short-term profit.

Table 5.6. 'A choice of selected available Dutch Technologies', arranged according to aspects of people, planet and profit.

1. Chain development (Profit/People)	2. Production System (Profit)	3. Trade, import/export (Profit)	4. People/Planet
1.1 Food safety, HACCP	2.1 Veterinary drugs and vaccines	3.1 Milk powder import	4.1 Emissions
1.2 I&R	2.2 Vet. laboratories	3.2 Trade in by-products food processing	4.2 Natural resource management
1.3 Processing technology	2.3 Fodder production and conservation		4.3 Watershed management
1.4 Processing equipment	2.4 Premix and feed mixing, technology and equipment		4.4 Farmers' organizations
1.5 Renet, cultures	2.5 Breeding / genetics		4.5 Indigenous technical knowledge (ITK)
1.6 Product development	2.6 AI and semen		4.6 Capacity building and resilience
1.7 Cold chain	2.7 Embryo Transplantation.		4.7. Training /education: - dairy technology - animal nutrition - animal feed mixing - laboratory training - animal breeding
1.8 Packaging			

The sustainability aspects of such 'technologies', i.e. PPP-criteria include:

- emphasis on labour opportunity via milk supply to cities as goals of the top left quarter implies focus on methods to better use local labour. That may mean use of milking machines, but it might put greater emphasis on clean milking / handling / cooling and

quality control in the first place. Cooling would be crucial, even if bringing milk temperature down from 37 to less that say 15^0C in a matter of the first hour or so.
- due to the longer transport lines, have quick cooling in collection centres, favouring plate or pipe coolers over tank coolers in areas where cooling is done nearer to the production site (bottom and top right). Expenses on cooling would be of limited use in the bottom left quarter where most milk is consumed and/or processed/fermented locally.
- emphasis on diversification, top left and lower right, combined with the need for petty cash over the entire left hand would not support the use of expensive equipment that could better fit in the upper right and perhaps lower right quarters. It would, however, imply use of variation, basically an issue of mindset, but crucial in terms of PPP. Larger and more modern farms of the top-right corner do not tend to work with variation, but they could if they would like to do so, for whatever kind of (community) interest.
- sub-optimum conditions in terms of feed and input supply for the left side would imply a need for Mpwapwa type cattle or at the most, F1 crossbred cows. The increasing supply of semen from 'hardier' breeds on the world market is an encouraging sign that attention starts to be paid to opportunities for milk production under hardy conditions. It also implies, again, more attention to issues of 'bio-diversity'.
- the emphasis on milk supply for the 'licensed' markets in the top half of the diagram implies a need for quality control systems better suited for large chains; examples of such approaches are available from early developments in western Europe, but also from recent milk collection schemes in Brazil. Attention to tailor-made legislation for quality control might take other approaches, assisting rather than suppressing local enterprises and resilience without risk for public health.

5.6 Options for the private sector

The previous chapter have reviewed many different options for future development of the variable and multi-facetted dairy industry as presented in the 4 quadrants of the policy diagrams. Also the Dutch private sector could play a role in the further development of this sector. Below are some examples of opportunities where the Dutch dairy sector could make a contribution through active participation, knowledge transfer and by investing in the development:

- *Animal breeding*
  - Development and support of AI organizations, AI and bull stations, distribution systems;
  - Supply of semen / breeds from suitable areas and suitable genetic background, e.g. from South Africa or Brazil (Girolando)[9], with or without AI organization and semen production/distribution, breeding plans);
  - Development and implementation of national breeding plan;
  - Feasibility of heat synchronization
- *Animal nutrition*
  - Systems for feed and fodder production and feed conservation;
  - Feed milling and mixing equipment
  - Setting up small local feed mills using premises and supplemented with local ingredients, this could be combined with feed production for pigs, poultry and fish).
  - Improved calf rearing systems (using milk substitutes or milk powder?)
- *Animal health*
  - Strengthening animal health organization, veterinary field laboratories, and local vaccine production (see policy diagram in Fig.5.7).

[9] The Girolando apparently still needs the calf to let down the milk.

- HACCP, I&R and food safety issues, more for the licensed than for the informal market; the later requiring separate legislative approaches to not throw the baby with the wash water (i.e. to lose a productive and efficient informal sector due to legislation geared to address issues of macro markets ;

- *Milk collection and processing*
  - Milk collection systems, quality control and cooling in rural areas;
  - Development milk cooling and processing techniques based on solar energy;
  - Dairy technology for a wide range of products (cheeses, yoghurt, UHT, etc.)
- *Economics and advisory services*
  - Professional farm management advisory services (medium to large scale)
  - Development of milk payment systems
  - Development of scenarios for dairy development models
  - Use of milk-powder to fill gaps in demand, e.g. for bakeries and other industries
- *Research and training* (jointly with Dutch knowledge institutes).
  - Training in practical farm management
  - Training in dairy technology
  - R&D as well as training on: development scenarios, with for example, year round feed supply, animal breeding systems, heat synchronization, product development, animal health services, etc.

Many issues can be suggested for further work which could be taken up jointly with Dutch knowledge institutes, NGOs and Dutch private sector. This Quick Scan cannot be complete but it can suggest examples such as:

- development/design of sustainable dairy systems for different conditions in Tanzania
- scenario studies on dairy development models
- imports of milk powder and butter oil to bridge gaps in local production
- practical training (farm management) a/o adaptation of curricula and R&D programs
- work on issues of land titles, as security for the farmer and as collateral for bank loan
- farm management advisory service (for planning and management)
- for the 'low yield per cow' sector (left side policy diagram): seasonality, thinly spread infrastructure, and adjusting to local conditions and/or working on seasonality in the production systems and the chain, e.g. by filling milk shortage in other regions
- shortage of young crossbred / grade stock (for settled farmers in suitable conditions),
- for systems with higher yield per animal (the right side) there is some scope for grade animals, with work on calf rearing and on processing
- how to earn money on low value activities in micro- and meso- markets
- quality systems for the different chains (both upper and lower half)
- soil fertility and NRM issues in relation with dairy (left side)
- distribution of added value across the chain (upper half)
- persistent problems of low feed quality and fodder (both upper and lower half).

6. Concluding Comments

This Quick Scan was done on the specific request of the Dutch Ministry of Economic Affairs (Dept. of European Agricultural Policy and Food Security; DG Agro) which was made after the visit by the President of Tanzania to the Netherlands in April 2013. During this visit it was agreed to investigate possibilities for further collaboration between Tanzania and the Netherlands in the field of dairy development.

Basic assumptions in this Quick Scan are that

- traditionally Tanzania has a tradition of milk drinking and milk production. Increase has been achieved over the past decades in terms of production and consumption but present production and consumption can still increase considerably.
- dairy fits the local ecology, available resources and economic developments in many parts of the country quite well, especially with adjusted levels of milk per cow and with adjusted models of farm and market development.
- 'technology' is written with inverted comma's in this report to stress that it includes aspects of social issues, organization, curricula and legislation as well as feed, fertilizer, vaccines or stainless steel, at farm- regional- and national level. Admittedly, the more social and organisational aspects could have received more attention, which was not possible in the time constraints of this Quick Scan. A special distinction is between 'face value' (obvious short term) solutions and solutions that address root causes, even if proper action in the area of 'root causes' requires more work at local level.
- the country is variable, requiring 'tailor-made' approach (not 'one size fits it all'), distinguishing production systems, value chains and farmers' goals. That variation is combined in this report into a policy-diagram which with simple scenario studies identifies opportunities for 'technologies
- dairy development (as any other development) requires an holistic approach but that term is open to different interpretations. In this report it refers to the focus on improvements that fit local conditions (also as they change in time) and at a proper balance between development of parts of the system, i.e., between breeds and feeds, between technical and social development and between development of production as well as of value chains.

Given the nature of a Quick Scan the report had to make choices and conclusions are tentative, rather bold statements to trigger further discussion rather than to give final answers.

Milk is a traditional item in the national diet of (agro)pastoralists but much has changed in milk production, especially in the last 3-4 decades, often supported by donor projects that together had a big impact. The grade cattle population increased from some 10,000 in the early seventies to 700,000 in 2010. Total milk-production roughly quadrupled in 40 years and production from non-indigenous dairy stock (incl. crossbreds) grew with some 8.5% per year while the traditional sector grew around 3% per year over the same period. Increased milk production mainly came from non-indigenous cattle kept under tethered, roadside grazing or stall-fed conditions. In contrast, the share of imported milk of the national milk flow is low, some 2% of the total and the share of the licenced dairy processing market is also only around 4 % of total milk produced. That means that at a) present consumption levels the current consumption is nearly self-sufficient and that b) present dairy provides income for the small holder sector. It also means that the dairy sector should be able to cope with the expected increasing demand in the urban areas and that a well organised dairy processing industry might be compelled to look for an export market.

Major policy choices are implied in all this based on the following logic. In the first place, increased local production in large scale commercial units might inadvertently out-compete current production from smallholders and medium producers where dairy is an important income and labour opportunity. More hidden is the fact that large scale commercial units do not save on foreign currency if they replace local produce. Also, their different production methods and (assumed) need for high yielding imported animals might imply extra spending rather than savings of foreign currency. In this case, the need for holistic approaches to dairy development thus also links development of one (sub)sector with another one, and of one aspect (saving of foreign exchange) with another (income opportunities in the country side). Essentially, the combination of such different aspects, often conflicting, also reflects attention to issues of people, planet and profit, e.g. also when milk production from pastoral areas is associated with needs and opportunities for natural resource management. This report notes such aspects but proposing clear policy choices is beyond this Quick Scan. A special concern exists, however, that public money should not be used to develop one sector at the expense of the other, e.g. the 'modern sector' (with no great foreign exchange savings likely) at the expense of smallholders and [emerging] larger peri-urban systems (with a significant role for labour opportunity and rural development).
A need for tailor-made approaches for development implies a need to distinguish dairy systems. In that sense, different production systems are usually described for Tanzania, normally using a classification that distinguishes between 'traditional systems with local zebu cattle' and 'dairy systems with grade cattle' (each with subcategories). A list with 'face value technologies' is given for these categories.

This report suggests to take an alternative approach to the traditional classification of dairy systems. It proposes to use a so-called 'policy-diagram'. That intends to be more future oriented, among others by explicitly linking two major production systems (with resp. low and high levels of production per animal) and two major value chains (resp. informal and licenced markets). Thus, four quadrants with major production & marketing systems are identified:

- low-yield and licenced – low yielding cattle supplying milk to the licenced market
- low yield and informal – low yielding cows supplying to the informal market
- high yield and informal – high yielding cattle supplying to the licenced market
- high yield and licenced – high yielding cattle supplying to the informal market

Many other classifications are possible but this so-called 4-quadrant policy diagram is used throughout this report to describe variations in production systems, value chains, producers' goals and development options. It reflects a choice and need for a holistic approach, using 'tailor-made approaches' for development over an approach of 'one size fits it all', as well as balancing work on production as well as on value chains. This implies that especially the second part of this Quick Scan focuses on identification of options for dairy development in the different scenarios of the 4-quadrant model, rather than to establish a book with recipes on how to undertake one or the other specific activity across the board for the whole country.

The last part of this report indeed focuses on suitability of different production 'technologies', organisational forms and product categories. It briefly shows three ways to analyse, in this case, the Tanzanian dairy sector, i.e. a diagram of a production system, a diagram of a value chain and a set of different production goals. It also introduces the use of [simple] scenario studies to quickly scan the economics and/or PPP-choices of a 'technology'. By doing so the report sets out to use the policy diagram with the 4-quadrant model as basis, taking expert advice as guide together with the simple scenario studies to assess suitability of selected

technologies. An exhaustive list of technologies is beyond the scope of this Quick Scan and painful choices were made. No special section exists on issues of feed supply and not much attention is paid to the organisational aspects of the sector. All that might deserve further work and stakeholder meetings to come to more final conclusions, also on the validity of our 'bold statements' as outcome of the simple scenario studies and/or fitting of 'technologies' into the quadrants of the policy diagram.

Last but not least, the report also distinguishes between face value technologies' and 'technology' for *root causes*. A face value 'technology' focuses on a 'quick fix', i.e. a short term result without addressing the root cause of a problem, thus being more window-dressing rather than a real cure. The focus on root-cause 'technologies' requires and implies more creativity, more inclusion of local partners and a broader area of activity than a one size fits them all approach. Thus, it takes more initial effort but it is likely to yield more long term involvement. Much is gained rather than lost by properly combining work on face value quick fixes and work on tailor-made approaches to address root causes.

Concluding, in short:

- Dairy in Tanzania changes rapidly, the sector seems to be expanding while consisting of different sub-sectors that each deserve special attention. The informal sector plays a very large role, implying opportunities for quick growth of the [small] licensed sector, but also for significant improvements in the large, but generally overlooked informal sector
- A holistic approach implies attention to balanced development of farm components, of production and value chain aspects, but also the need that development of one sector does not develop at the expense of the other. A holistic approach also implies attention to the context, i.e. to 'technologies' that fit local conditions. That is translated into a need for tailor-made rather than 'one size fits them all' technologies
- A traditional classification of dairy systems (production, only implying aspects of markets) is supplemented with a more forward looking classification, represented in a policy diagram that helps to identify opportunities for development on a range from low to high yielding systems, from informal to licensed value chains, and in four quadrants that represent their combination
- The variation of technologies to be considered does includes attention to issues of knowledge and skill building as well as participation in feed manufacture, processing, semen-imports and the like.
- Establishment of large commercial farms must be technically possible and economically feasible in favourable areas. Imports of high yielding dairy cattle have been done before, usually with disappointing results where public and private money could have been better spent in solving root causes. Fortunately many ways exist to skin a cat and alternatives to cattle imports are available, with AI, in selected cases with embryo transplantation and even by using better adapted breeds (also available from Dutch breeders).