Dairy Development Programme in Nigeria

Baseline Report

Key Findings and Recommendations

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This publication was produced for the International Fertilizer Development Center. It was prepared by the consultants Heko W. Köster and John de Wolff, assisted by Kobi P. Ikpo, for the Accelerating Agribusiness in Africa (AAA) Bridge project.

IFDC

Caption of the cover page pictures:

First picture: ***Fulani cutting branches for the herd during the dry season***

Second picture: ***Zero grazing, large scale dairy during the dry season***

Executive Summary

The company FrieslandCampina WAMCO Nigeria Ltd (FCW) is the largest importer and processor of milk products in Nigeria. The company intends to locally source 10 percent, equal to 60 million liters per year, of its raw milk requirement by 2016, at a price comparable to world market prices. . It has been formulated in a MoU as the Dairy Development Programme (DDP) signed in 2011 by the Nigerian Federal Government and FCW.

Indications from an inventory of the actual local Nigerian production (estimated at 350 million liters per year) showed that more than 80% of this milk is produced and sold as yoghurt by nomadic Fulani, dispersed all over the country. Their zebu cattle (White Fulani and other zebu breeds) are herded in the lowlands, amidst land progressively used by the Yoruba for crop production. Their conflicting interests with respect to land (and water) are a source of regular incidents with varying degrees of violence.

The Federal, State and Local governments promote 'pacification' by the establishment of grazing reserves providing the Fulani herders opportunities to settle and obtain land-rent titles. In addition to this FCW focuses on these Fulani to purchase the milk they produce. For this purpose, 40 Milk Collection Centers (MCCs) have been planned, the first of which has been erected.

Beginning December 2011 milk has been delivered to this MCC, by semi-settled Fulani situated in Bale village, near Fasola town in Oyo State. The milk is cooled and transported by FCW to Lagos where it is processed. The access roads to the MCC, water provision for the cattle, milk hygiene training and veterinary care are taken care of by the joint effort of FCW and the Federal, State and Local governments of Nigeria.

The delivery of milk to an MCC is restricted by the durability of fresh milk, which has to be delivered within 3 hours after milking commences. Milking of a herd takes about 1 hour. Data indicate that milk can be delivered from about 4,500 cows within 2 hours driving distance of a MCC. This implies that the present milk production of these cows has to be increased, in order to meet FCW's annual target of 60 million liters of milk, from about 40 MCC's.

The following seems needed to achieve this. Supplemental-feeding of concentrates to double the very low 0.75 l/day of lactating Fulani cows, and to reduce the 30% calf mortality. And raising the milk production too by Fulani-European dairy crossbreed cows, up to a fraction of 7% of the cows, in the herds delivering milk. A total of 13,000 crossbreed cows is required for this. On the 20-30 large scale dairy farms in Nigeria are probably not more than 4,000 crossbreed and pure European-dairy breed cows for crossing with Fulani. A far too small number to obtain 13,000 crossbreed cows by 2016. It is also not possible to obtain these in time by insemination local Fulani cow with semen from a European breed. Considering the time

span of 33-39 months between AI of a cow and the first calving and lactation of the new (crossbreed) heifer.

Three options remain to source the annual 60 million liters from cattle actually present in Nigeria. The meat, or liveweight, production of these options have been estimated. For this herds have been postulated with 110 cows, of which 50-65 lactating depending on the feeding and management, containing further about 150 young animals (heifers and steers) and 15 bulls, the total number of head from 300 to 315. This herd does not change in time, as a dynamic equilibrium is assumed, through sales and mortality in balance with the growth of all animals and their offspring. Based on calving intervals, lactation periods and growth rates, the yearly milk production and liveweight gain of the herds has been calculated for each of the three options.

Option 1. Sourcing milk from semi-settled Fulani herds in grazing reserves, calves suckling milk during the day. Drawn milk for human consumption 0.75 l/d/lactating cow. The collection of 60E6 l/yr will require around 117 MCC's each supplied by 4,500 milking cows. A herd (the postulated 110 cows and other animals) produces around 11.3 ton milk/yr and 6.0 ton lv.wt./yr without concentrates.

Option 2. Sourcing milk from semi-settled Fulani herds in grazing reserves, calves suckling milk during the day, lactating cows fed av. 1 kg concentrate per day, young calves in the dry season 250 g concentrate/day. Drawn milk for human consumption 1.5 l/d/lactating cow. The collection of 60E6 l/yr will require around 51 MCC's each with 4,500 milking cows. The total quantity of concentrates needed is estimated to be 45,000 ton/yr. The postulated herd produces 27 ton milk/yr and 9.5 ton lv.wt./yr using 20 ton concentrates/yr.

Option 3. Sourcing "a" all the milk produced by 5,000 crossbreed and pure dairy breed cows in large scale dairies. (The total number of such animals present in Nigeria, by which 57,500 Fulani cows can be replaced). Concentrate supplementation av. 4 kg/d for all cows, all other animals av. 2 kg/d. A herd produces around 340 ton milk/yr and 24 ton lv.wt./yr, using 292 ton concentrate per year. And in addition to sourcing "a", sourcing "b" the milk of 172,500 Fulani cows managed as in option 2. With sourcing "a" and "b" together the 60E6 l/yr can be achieved with 34.00 ton concentrates/yr and about 43 MCC's.

The decision which of the three options will be preferred in the coming years is a discussion point between FrieslandCampina WAMCO, Nigerian Federal, State and Local governments and the Fulani herders. For the last the interest or willingness to sell cattle and to use concentrates or not will be crucial, and also the costs of concentrates and the returns from delivered milk and sold cattle.

For both options 2 and 3 a lot of concentrates are needed. Thus feeding of concentrates has to be replaced as much as possible by year-round grazing of improved and fertilized forage. A first step has been made by National Livestock Development Project (NLDP) by establishing pastures

in several grazing reserves, to serve as standing hay in the dry season. Further demonstrations of recent internationally tested innovations (improved cultivars of grasses, legumes and fodder crops, planting methods and proper management) are recommended to be carried out, both in grazing reserves and on large scale dairy farms.

Other main points covered in the Baseline report are: milk/beef and crop/cattle mixed farming systems; tsetse flies, diseases and heat stress; mortality; crossbreeding; feed, grazing, forage and fodder species; water aspects for cattle; mineral and salt supplementation; manure and ISFM; Nigerian applications of remote sensing; herders/dairy farmers way of life and innovation; MCC's record keeping, interpretation; social impact of DDP, Base of Pyramid, gender; etc. Key findings, insights and recommendations for DDP were elaborated on each of these points.

Potential side effects of the Dairy Development Programme by its support to Fulani and its innovations have been indicated on: community stability and tensions (Fulani, Yoruba), gender, water provision, base-of-the-pyramid developments, and environmental sustainability. They require attention and alleviating mitigating measures. IFDC can play an assisting role in this.

The Baseline Report has been presented and discussed in April 2012 during a three-day IFDC workshop at Ibadan. The 26 participants represented: Nigerian Federal, State and Local Government Institutions (Policy, Research, Extension); Fulani Herders and Large Scale Dairy Farmers; ILRI; Friesland Campina (International); FrieslandCampina WAMCO; and IFDC. Based on the report and it's discussion detailed action-steps for DDP were formulated, programmed and mutually agreed upon.

Acknowledgements

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The contents of the report have been made possible thanks to visits, discussions, and information received from the professionals dedicated to the agriculture in Nigeria. These professionals comprise herders, farmers, technicians, researchers and managers. Their names have been included in the report in two appendices: “List of Visits”, and “Persons Contacted”.

A special word of thank is for Lawrence Ohue FCW’s DDP Manager. He made his time available for us at any moment, accompanied us on our field trips, which he scheduled and arranged in a most perfect and comfortable way.

Kobi Ikpo arranged in a very supportive way our daily life and the important appointments with researchers and directors of the many Institutes and Government Departments visited.

The final content, wording and lay out of the report is the responsibility of the authors, but would not have found this final form without all the attention provided by Raphael Vogelsperger, IFDC’s Project Manager of the DDP.

Thank you all,

Heko W. Köster and John de Wolff

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Acronyms

2SCALE	-	Towards Strategic Clusters in Agribusiness through Learning in Entrepreneurship
10% goal	-	Local sourcing by FCW of 60 million liters of milk per year by 2016
ADP	-	Agricultural Development Program
AI	-	Artificial Insemination
BAIF	-	Bharatia Agro-Industries Foundation (India)
BoP InC	-	Base-of-the Pyramid Innovation Center
BSS	-	Business Support Services
CBPP	-	Contagious Bovine Pleuro Pneunomia
cf	-	crude fibre
cp	-	crude protein
DGIS	-	Dutch Directorate of International Development Cooperation Directoraat Generaal Internationale Samenwerking
DDP	-	Dairy Development Program
dm	-	dry matter
FCT	-	Federal Capital Territory, Abuja
FCW	-	FrieslandCampina WAMCO
FMA&RD	-	Ministry of Agriculture and Rural Development
FMD	-	Foot and Mouth Disease
IFDC	-	International Fertilizer Development Center
HBU	-	Heifer Breeding Units
IITA	-	International Institute of Tropical Agriculture
ILRI	-	International Livestock Research Institute
IFDC	-	International Fertilizer Development Company
ISFM	-	Integrated Soil Fertility Management
LGA	-	Local Government Area
LoL	-	Land O' Lakes

MARD	**-**	Ministry of Agriculture and Rural Development
MCC	**-**	Milk Collection Center
MoU	-	Memorandum of Understanding
NAPRI	**-**	National Animal Production Research Institution
NITR	**-**	Nigerian Institute for Trypanosomiasis Research
NLDP	**-**	National Livestock Development Project
PM	**-**	Project Manager
PPP	**-**	Public Private Partnership
SoW	**-**	Scope of Work
STTA	**-**	Short Term Technical Assistant
2SCALE	**-**	Towards Strategic Clusters in Agribusiness through Learning in Entrepreneurship
TDN	-	Total Digestible Nutrients
USAID	-	US Agency for International Development
WAMCO	-	presently synonymous to FrieslandCampina WAMCO, outdated original meaning West African Milk Company

1 Introduction

1.1 The Private Sector and Agricultural Development

Agriculture remains the key driving force for economic growth in most African countries. Higher productivity and improved performance of the agricultural sector as a whole are necessary conditions for increasing farm incomes and rural well-being. An analysis of successes in rural poverty reduction identifies 'key ingredients' for successful private sector led agribusiness development:

- Output markets exist and there is a competitive opportunity to respond to these markets;
- Farmers and supportive service providers are linked with the agro-processors or other buyers;
- Appropriate inputs to achieve the quantity and quality of product are available and accessible;
- Farmers are organized in Farmer Groups, Producer Organizations or Cooperatives;
- Farmers have access to best agricultural practices needed to increase productivity to meet market demand;
- Rural finance options exist – credit issues are at least partly solved; insurance; weather and pests;
- Enabling policies for agricultural development are in place, or, at minimum, existing policies are not hampering development in the targeted commodity;
- Entrepreneurship exists – the effort is private-sector driven;
- Leadership is present at various levels;
- Market information is available – preferably both for inputs, quality control and outputs.

A market-oriented approach, particularly in high- and medium-potential regions, can lead to general expansion of agribusiness (production, agro-input and other service provision, value-added storage and processing) and to increased labor demand, potentially benefitting those with insufficient or no landholdings and other marginalized people. The rural as well as urban poor are mostly net food buyers. Increased productivity and efficiencies will lower the costs of food while also increasing farm incomes.

There is a renewed commitment in Africa to place agricultural development (led by the private sector) at the centre of the development agenda. Governments and donors are promoting remarkably similar remedies for tackling the chronic underdevelopment of Africa's agriculture. Policy documents promote market-driven intensified agricultural production: agribusiness investment, strategic development along commodity value-chains, improved seed and fertilizer use, farmer education and organization, and conservation of soil and water resources. Ongoing efforts and interest mean more opportunities for partners to leverage funding and impact.

1.2 FrieslandCampina WAMCO (FCW)

As a result of political pressure, FrieslandCampina WAMCO Nigeria Ltd (FCW), a subsidiary of the Dutch multinational company Royal FrieslandCampina, and the largest importer and

processor of milk products in Nigeria, intends to locally source milk for processing and sales in the local markets. Specifically, it aims to source at least 10% of its processed milk volume from Nigerian farmers and cattle herders by 2016. The 10% amounts to 60 million liters of milk per year. In the following text reference will be made to the 10% objective, or the 10% goal, implying local sourcing of 60 million litres of milk per year by 2016.

To achieve the 10% objective is a very high set goal. Presently there are less than 3,000 dairy cows or crossbreed beef-dairy cows in Nigeria. The processing plant of FCW is located at Lagos in the lowlands, in fact beef-country, the plant is too far away from the highlands (potential) dairy-country. Practically speaking before 2016 milk can only be obtained by FCW from zebu cattle (white Fulani, and other zebu breeds) present in the lowlands and herded by Fulani. FCW started in 2010 with a Dairy Development Project (DDP) and a first Milk Collection Centre (MCC) in 2011. For the Fulani to deliver milk subject to hygienic quality criteria is a big challenge, as it is for FCW to collect a large volume of milk from dispersed herds with very low milk yields.

FCW has expressed interest to explore potential collaboration with the International Fertilizer Development Centre (IFDC) on the Dairy Development Programme for Nigeria for the period 2012 – 2016. In view of this, IFDC contracted dairy consultants with the mandate to assess the dairy development constraints and potentials existing within the Nigerian setting. This report highlights key findings and recommendations resulting from two investigative visits carried out in FCT and the following states: Kaduna, Kwara, Niger, Nassarawa and Oyo.

1.3 IFDC Background and Cluster Experience

IFDC has a longstanding experience in West Africa in supporting smallholder producers in commercialization and professionalization of their products. IFDC facilitates the formation of agribusiness clusters consisting of major actors around a commodity, which includes input suppliers, smallholder producers, financial and technical support services, traders and processors. As a result approximately 700,000 smallholder producers in seven countries in West-Africa successfully conduct farming as a business in various commodities.

Recently IFDC has teamed up with the Base-of-the-Pyramid Innovation Center (BoP InC) and the International Centre for development oriented Research in Agriculture (ICRA) to formulate a new proposal to further expand this approach in Africa with more specific attention to public-private partnerships with medium- and large-scale enterprises in the agricultural sector. This upcoming project entitled 'Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship' (2SCALE) which will be implemented in the period 2012 - 2016 has the goal to *improve rural livelihoods and food security in Africa through the development of robust and viable agricultural value chains.* Two of its specific objectives are:

- To attain viable agribusiness clusters consisting of professionalized members linked to profitable commodity value-chains and sustainable production systems;
- To attain a reliable, affordable and quality supply of food for consumers of value chain products.

The role of IFDC in agribusiness cluster development and development of Public-Private Partnerships (PPPs) is ultimately focused on the production of high quality agricultural products of sufficient quantity for interested local and regional market parties. In these clusters

smallholder farmers are linked to financial services, technical service providers, agro-input dealers, processors and market actors. IFDC staff and its partners support agribusiness cluster development, and define an exit strategy within 2-4 years after creation of a cluster.

1.4 Nigeria Land Cover and Land Use Rights

Although Nigeria has extraordinary biological diversity, it faces many environmental problems brought on by ever increasing population numbers, poverty and industrial damage. A century ago, there were five million hectares of trees and in 1897 two-thirds of Nigeria was covered by rich tropical rainforest. Today only 4% of this original rainforest remains, with most of the deforestation having happened since the 1980s – between 1981 and 1994 Nigeria lost 3.7 million hectares of rainforest through logging and bush burning. Causes include fuel wood gathering, conversion of natural forest to commercial tree plantations, oil exploration, mining and urbanization. And of what's left over, 3% is lost annually, and only a third is in protected areas either under the protection of the forestry department or in national parks. All secondary forests are part of the shifting cultivation. Of the total land mass of 92.4 million ha of land, it is assumed that 72 million ha of land is available for cultivation. Of this area, 38 million ha is currently being cultivated and 34 million ha is used for fallow, grazing, etc. This implies that a huge area is still available for additional cultivation. The uncultivated areas have a very important role to play for restoring soil fertility even if fallows are modified to the cultivation of green manure and for grazing and feeding the 16 million head of cattle. With the ongoing population growth (88.5 million people in 1991, and 167 million people in 2011) competition for land has become a constraint, despite the fact that most people still consider land as an abundant resource.

Nigeria is made up of 36 states and a Federal Capital Territory. The constitution of the Federal Republic of Nigeria stipulates that all lands belong to each individual state consequently only the Governor can sign and issue Certificates of Occupancy which usually is for 99 years. Rules and regulations regarding land ownership are therefore not uniform as it varies from state to state. Surveyed lands are administered by the Ministry of Lands Urban planning. For unsurveyed areas, customary and tribal laws are applicable, depending on population pressure. Land rents are still low and payment is only made for surveyed plots of land with a Certificate of Occupancy.

1.4.1 Grazing Reserves

In several States of Nigeria major conflicts have arisen between Fulani herdsmen and Yoruba crop farmers over a lack of access to grazing lands and crops damaged by Fulani cattle in search of feed. To forestall this dangerous trend and convince the Fulani herdsmen of the benefits of settling down as opposed to a continued itinerant existence, Government through the National Livestock Development Project (NLDP) established a total of 415 grazing reserves with numerous stock routes in the whole country. The total area of the 415 grazing reserves is 4.3

million ha, 35% of which i.e. 141 reserves (2.7 million ha.) has been gazetted (i.e. the land has been legalized and rent titles are completed). Government has established infrastructures like fences, boreholes, dams and pastures development with Stylosanthes (townsville/cook), and grasses/legumes introduced some 20 years ago by the International Livestock research Institute (ILRI). The average total cost to develop a grazing reserve is 1.3 million Naira per ha. A multidisciplinary team will assess the potential and need for each new grazing reserve before the actual development commences.

Paikon Kore Grazing Reserve

It is believed that the total area available within this reserve is 8,000 ha. It houses a total of 5,000 Fulani families although not all of the families have cattle. Very little grazing area exists within the reserve as virtually all the 5,000 families are involved in crop farming. The number of animals within the reserve is unknown as there are no movement restrictions for animals outside the reserve. NLDP however established about 100 ha excellent pasture with Gamba grass and Setaria which are used by the Fulani as a dry season feeding reserve. Besides pasture development, the grazing reserve has watering points, boreholes, water dams, fencing, access roads, staff housing and offices which are presently unused.

1.4.2 Land and Settling of the Fulani

It is reported that contrary to popular belief most Fulani want to settle. Herding is a monumental task for the Fulani, who are always trying to find the best grazing condition for their animals. The migrant Fulani in Nigeria move because they have no other choice. A survey reported that three-quarters of the Fulani indicated that herding is not only toilsome, it is becoming more strenuous. Nevertheless, about 10% of the Fulani, mostly those who are near dams and grazing reserves, say herding is becoming easier. Ninety-seven percent, including those who say herding is becoming easier, prefer raising animals within the precinct of the homestead (Aregheore, 2005. p.18).

The above was confirmed in a meeting of IFDC with NLDP officials in November 2011. According to the officials the Fulani pastoralist are willing to settle for 100% and to intensify their production. Main reasons are grazing conflicts and security.

1.5 Actual Milk Production Systems

An overview of dairy activities up to 2000 in Nigeria is given by NLDP (Yahuza, 2001).

At the last livestock census held in 1991, the total livestock population in Nigeria was 16 million head of cattle. This census however made no distinction between the various breeds available in the country. In the six areas visited by the consultants in Nigeria, there were no small holder

dairy farms integrated with cropping systems, nor specialized dairy farms based on grazing of pastures or ranch. This despite the fact that the integrated smallholder dairy farming system is common in tropical countries, though mainly in the high lands. These high land farms are often known to produce the bulk of the milk for its populace. In Nigeria milk is produced, mainly in the low lands, from four farming systems:

The settled Fulani Pastoral system:

In this system, the farmer/herder keeps some 20 to 100 herds of cattle, goats and some sheep and at the same time cultivates crops. For grazing the animals, two types of areas are used: (a) recently harvested areas and (b) fallow ground. The grazed areas could either belong to the farmer or neighboring villages. Cows are milked only once daily. They are left with their dams during day time but during the night they are separated from their dams (tightened on a rope). Findings show many of these settled Fulani herdsmen have stayed in their villages for over 20 years.

The non- settled Fulani nomadic (bororo) system:

These itinerant herders do not engage in any form of farming or cropping. They move their cattle over long distances crossing national and international boundaries at will. Dry season feeding of the cattle consists mainly of grazing on fallows as well as on harvested fields of farmers. And for the dry season grazing, an additional source will be the river plains. There water levels recede during the dry season leaving many islands in the river basin. This unique system differs widely from pastoral systems in Kenya and Tanzania, where herders follow isolated rain showers and regular rains in specific known areas like mountain slopes in an arid area.

Large-scale dairy farming:

Three large-scale dairy farms were visited. In all three farms, the dairy animals were imported from either South Africa or the Netherlands. In one of these farms, efforts at cross breeding the local Fulani cattle with Friesian semen had already begun. Some common characteristics observed on these farms are as follows:

- Large herds (more than 50 mature cows)
- Generally zero grazing
- Heavy/very heavy mechanization
- Disease problems and heat stress
- Low production
- Artificial Insemination (AI) as the common mode of insemination
- Processing facilities to enable direct sales to the customers
- Farms started with imported animals which cost 500,000 Naira per pregnant heifer.

The indirect milk producers:

These are farmers who mainly grow crops for subsistence or for cash. They are a part of the milk production chain as they supply crop residues for the Fulani herds, after harvesting in the dry season and during critical periods. Some crop farmers have livestock which they either tether around their homestead or entrust to the Fulani herdsmen. Both groups benefit from this interaction as the farmer reduces the amount of labor for clearing the field for the next season and also gets manure on his land when the herd rests at night. The amount of manure to these fields can be quite substantial.

1.6 Dairy Cattle in Nigeria

No inventory or records of crossbreed dairy cattle and pure breed (European) dairy cattle has been taken or kept in Nigeria. At present (2012) the only locations where crossbreed dairy cattle and pure breed (European) dairy cattle can be found are:

- research institutes. NAPRI at Zaria, Kaduna State does cross breeding of Fulani cattle with European dairy breed. A total of 250 crossbreeds, males and females, were sold to farmers outside the station during the last 4 years. ILRI-Nigeria does not execute dairy research.
- large-scale dairy farms. Maizube and Nagari farms as well as the farms established near Shonga, Kwara State. Some of the farmers imported pure breed (European) dairy cattle. These did not thrive due to heat stress and a specter of serious diseases. No overall image exists of these farms, neither of the cattle present at the moment.

Of the several large dairy farms visited, one of them still had a herd of pure Jersey animals. According to the farmer Jerseys cope somewhat better than the Friesian-Holstein in this for European dairy breeds alien environment. On the other farm most of the imported Friesian Holstein cattle had died, the herd of 270 head consisted mainly of Jerseys and some Jersey-Fulani crossbreeds.

In conclusion, it is estimated that the number of crossbreed dairy cows and pure breed (European) dairy cows will not exceed 4,000.

1.7 Milk from Fulani Herds, Imports, Milk Marketing, Collection, Consumption

Three Fulani herds were observed during the milking exercise. In one particular herd, 14 cows were milked. The total milk production was 10 liters while 18 other cows where dried off. In the other herds, more than 50% of the cows were dried off. Given that it was the end of the rainy season, it can be expected that at the end of the dry season the percentage of dry cows will be higher. This production data is similar with those of East African pastoralists whose percentage of bulls and oxen in the herd depends on the use of oxen for cultivation of the land.

Milk marketing is carried out mainly by various importers, one of which is FCW which has the biggest market share. FCW converts milk powder into tinned milk under the 'Peak' trade name and a considerable amount of the imported milk powder is converted into yoghurt. The range of products offered to the Nigerian customers consists of a very limited range of products, compared with countries like India. The main products for sale consist of milk powder, evaporated milk, yoghurt and condensed milk. Fresh milk was not observed.

From the available data, it can be deduced that probably more than 20% of the milk consumption is produced mainly by the Fulani pastoralists (Wolff de, and Ikpo. 2011). The following inflow of milk and milk products can be established from reports and discussion carried out:

- Local producers 350 million liters
- FCW imports 550 million liters
- Other Importers 550 million liters
- Total milk available 1.450 million liters

If a population of 167 million people is assumed, then the annual consumption per capita should be about 10 liters of milk per capita per year (the figure for Kenya is 200 liters while for Tanzania it is 40 liters per year per capita).The above data clearly shows the enormous potential for increasing the local milk production.

The following prices were observed in a supermarket:

- 900 grams of powdered milk N1900 to N2,250
- 380 ml evaporated milk N250
- 78 grams condensed milk N70
- ½ liter yoghurt N180 to N310
- 1 kg Gouda cheese N2,900
- 1 kg cheddar cheese N3,090

Compared to other countries, Nigerians pay a high price for their milk products.

Marketing of locally produced milk is done mainly by the Fulani women who only sell excess milk that remains after meeting household needs. Most of this milk is sold as fermented milk. Periods with peak production is causing problems in their milk marketing.

Some information on prices of inputs and outputs is presented in Appendix 7.

1.8 Milk Collection Start

Records show that two projects started milk collection from Fulani farmers. The Nigeria Dairy Enterprise Initiative (NDEI) implemented by Land O' Lakes and the National Livestock Development Project (NLDP). Unfortunately, the milk collection centre started by NDEI has closed down. NLDP has several milk collection centers in Kaduna state, two of which were

visited. Both centers receive a total of about 200 liters of milk per day from about 120 farmers. Every farmer's milk is subjected to the lactometer and the alcohol test. Milk from a few farmers was rejected because they failed both tests. Usually, milk from the first centre is brought in a pickup van to the second centre where all collected milk is pasteurized in a batch pasteurizer. After pasteurization, the milk is transported by the same pickup van to the factory in Kaduna which is a 140 km from the first centre

The following strong points were observed:

- Low investment costs
- Low running costs
- Only females were delivering milk
- The records kept by the treasury indicated only female names
- The weekly payments we were told were made to the females.

Weak points:

- Late collection and transportation of milk
- Poor pasteurization
- Poor Hygienic conditions

With stricter project/factory management, these weak points can be easily corrected.

On the day of our visit, MILCOPAL, the milk factory in Kaduna, received a total of 1,800 liters from 5 milk collection centers transported in 3 pickups vans. All the milk collected is usually processed into sweet yoghurt sold at N250 per liter.

Table 1.8-1 displays some information extracted from three annual reports of the NLDP:

Table 1.8-1 Extract from the NLDP annual reports

	2008	2009	2010
Liters of milk purchased	187,250	226,454	265,993
Liters of milk equivalent sold	169,603	210,654	241,738
Average purchase price per liter " off gate" at collection centre	32	53	53
Average selling price per liter	159	159	157

Only two years expenses (2008 and 2009) of the milk collection were available in the annual reports. Transportation cost per liter of milk came to N7.2 per liter on the low side (no salaries, only fuel and car repair). Furthermore, the National Animal Production Research Institute (NAPRI) in Zaria daily collects 200 liters of milk from neighboring farmers. Here, we were

informed that the demand for yoghurt from local milk was much better compared with the yoghurt made from milk powder. Some large-scale dairy farms like Nagari and Shonga farms are also involved in the purchase of milk from the Fulani pastoralists.

1.9 Group Formation Promoted by MCCs

The establishment of a MCC is coupled to providing training of producer groups on milk hygiene, animal health, feeding for milk production, etc. Milk is delivered to the MCC by a pick up after being collected from one or more herds. Thus in several ways new social contacts are promoted by the establishment of a MCC. Producers have often common interests. All this may lead to formation of unofficial groups or official cooperatives.

Experiences with the groups at the MCCs under the supervision of NLDP show that these groups are in the producing phase. The groups are registered officially as cooperative societies. These cooperative societies do not have their own financial administration. Only 5 out of the 40 registered cooperative societies are functioning; 5 others are no longer in existence, 9 others are dormant and need motivation and training; and 11 other groups do not deliver milk due to poor roads.

These 40 registered cooperative societies are united in a federation. This federation owns 55% of the milk processing plant in Kaduna while 45% is owned by the Government. Obviously, the 55% ownership by the farmers is a theoretical phenomenon, as the money was actually paid by the World Bank and not the farmers themselves and the 5 cooperative societies which no longer exist were not refunded their 'ownership' funds as would be expected if they actually made the initial payments themselves. It is generally claimed that the Anand model of cooperative organization is followed but this appears to be in theory, because farmer's involvement is limited. In addition, officers responsible for the registration of these groups appeared nonexistent. Hence it was difficult to evaluate the effectiveness of possible follow up visits of these groups.

The groups' development around the future FCW milk collection centers is still at a formative stage. Generally the membership of one group consists of members of the same extended family. This portrays the development of little group formations.

1.10 Estimated Cost Price Milk

Access to data on farm economics was not readily available but findings from observations indicate that (Wolff de, and Ikpo. 2011):

- cost price per liter in the Fulani system is N50;
- cost price per liter for the Zimbabwean farmers is between N80 and N120;
- cost price per liter for the large scale dairy farms N250.

The off gate milk price varying from 60N – 100N per liter, shows that only the Fulani system is profitable. It is not clear whether the valuation of the live weight or beef production has been included, in these estimates. For a clear picture on profitability of the existing production systems in Nigeria more time is needed to collect data, which are not eagerly provided by the producers. The last is common to several producers in many countries.

Some information on input and output prices is presented in Appendix 7.

1.11 The Distinction of Key Findings/Insights and Recommendations

In the following Chapters topics of basic importance to dairy production and thus to DDP will be discussed further. Of some topics some general or basic knowledge on the topic will be given, either as an introduction or separately in an Appendix. This will be followed by highlighting the "Key Findings/Insights" of the topic under discussion. The highlights will serve as the base for "Recommendations", which are presented in the next and last section dealing with the topic. Often a recommendation has to be restricted to the advice to get further general and specific info before a certain practice can be recommended for application by herders or farmers. This is due to the fact that there is no or hardly any dairy farming in Nigeria, and that as a consequence there are no (proven) practices which can be recommended, with a guarantee that they will be successful. Furthermore international information is practically non-existent on commercial milk production in tropical lowlands using grazing zebu cattle. Thus even the use of concentrates cannot be recommended to herders/farmers without knowing its logistics, economic benefit, side effects, etc. So the recommendation has to be: to get first info on the most crucial points, after which it can be determined if the use of concentrates can be recommended.

To facilitate retrieval and further discussions each recommendation will be given a number. Recommendation 1 in paragraph 2.2 will get the number R2.2-1; recommendation 9 in paragraph 7.2 will get number R7.2-9.

1.12 Remote Sensing

Remote sensing (RS) is the practice of acquiring information using instruments that are remote to the earth's surface – usually aircraft or satellites. It was first practiced by a French photographer in 1858 taking pictures of Paris from a balloon. Since then RS has expanded its developments and innovations continuously. Remote sensors can see more than the human eye. Recording not only daylight images, but using a broad range of wavelengths of the electromagnetic spectrum. For instance regions with an almost continuous cloud cover can be sensed day and night by using radar. RS images can be manipulated allowing 3D interpretation, so length and width of objects can be measured as well as their height, as can the relief in landscapes. In fact RS can be ranked as a 4D tool including time, considering the possibility to

use all images of a particular area obtained over long time intervals. Use and applications of RS require well trained specialists. Interpreting the RS images and coupling these desk-interpretations to the “old fashioned’ inevitable field checks. Nowadays the first office or lab interpretation of the RS images is increasingly done by computers, and can be linked to Global Positioning Systems (GPS) and Geographical Information Systems (GIS). The applications of RS in support of agriculture are manifold (Bafana, et al., 2012; Crum, 2000; Wikipedia).

Historically Nigeria has been and remains a centre of RS in developing countries. During the 1980’s a sister-institute was established of the Dutch International RS Training Centre (ITC) in Enschede: the African Regional Centre for Training in Aerospace Survey (RECTAS) on the campus of Obafemi Awolowo University in Ile-Ife, Osun State. RECTAS is independent since many years, and now of important support to the UN affiliated African Regional Centre for Space Science and Technology Education (ARCSS) inaugurated in 1998 on the same campus. In 1999 the Nigerian National Space Research and Development Agency (NASRDA) was established. It has six activity centres spread about the nation. The government policy is that NASRDA acts as the national archive of all RS satellite data acquired over Nigerian territory. In addition to that NASRDA launched the satellite Nigcomsat1R-NigeriaSat2-NigeriaSatX in 2011.

A few Nigerian RS studies have been executed with respect to agriculture, they provide a first indication of the potential use of RS. Studies related to DDP topics are: present land use (Ojigi, 2006); land use change over time (Olaleye et al., 2009); land cover/vegetation type (Okhimamhe, 2002: Okhimamhe, 2003); weed invasion, ranch degradation (Meer van der, et al., 2002). A recent example is the ongoing study of the mapping of the Fulani cattle track-routes from satellite images captured the last 20 years. With the aim to get more insight into the problem of the friction between the Fulani people moving their cattle and the settled farmers (Akinyede, 2009). For the DDP project the use of RS can offer many benefits, for instance survey-inventories and/or mapping and selection of: unpaved-roads providing access to MCC’s; relief conditions suited for water-catchment and storage by construction of a (small) dam to conserve water for herds during the dry season; actual ranch-vegetation condition and changes over time.

2 Milk/Beef and Mixed Farming Systems

2.1 Key Findings/Insights

Production figures are not available of Fulani herds and cattle farms in Nigeria (see Par. 1.9). In order to get insight in milk and beef production, both have been guestimated of seven different production systems (both actual and potential production systems). The guestimates have been made based on international and Nigerian literature, and expert judgment. Details of this are presented in Appendix 1 . In Table 2.1-1 below a summary of the results is presented. The seven

production systems are considered for conditions as reigning in the “Tall Grass Savanna” or “Guinea Savanna” in the Central East-West belt of Nigeria (see Appendix 3).

The actual production systems are in fact limited to “Fulani nomadic”, “Fulani grazing reserve”, “Fulani semi-settled” and transitions between these three systems. Besides there are a few, probably less than 100, large scale dairy farms, and a negligible number of “Fulani settled” and “crop-dairy smallholders” with or without crossbreed cows; and probably no “dairy smallholders” at all.

For the production calculations of the 7 systems, herds have been assumed of 100 cows and related cattle (calves, heifers, steers and bulls or AI). Total head of cattle in each herd is around 300. A crop-dairy smallholder, and a dairy smallholder, do not have a herd with 100 cows. To make this clear the number of families that possibly own 100 cows is presented in the Table.

Table 2.1-1 Characterization and production levels of individual cattle and herds (100 cows + other cattle) in Nigeria, considered for 7 different production system [1)]

	Fulani nomadic	**Fulani grazing reserve**	**Fulani semi settled**	**Fulani settled**	**Crop-dairy smallholder**	**Large scale dairy**	**Dairy smallholder**
Use of Concentrates	No		Yes				
No. of families	1	1	1	1	**10 - 20**	1	**5 – 10**
Cattle breeds in the herd [2)]	F	F	F	F, C	F, C	C, E	C
l/d/lactating cow	0.75	0.75	1.5	5	8	15	10
Calf mortality %	35	30	20	20	20	15	20
Milk ton/yr considering loss due to mortality ton/yr	10.9	11.3	26.3	72.5	136.8	311	171
Live weight gain considering loss due to mortality ton/yr	4.9	6.0	9.5	11.9	17.9	23.9	17.9
Milk value (60N/l) N/yr [3)]	0.65 E6	0,68 E6	1.6 E6	4.4 E6	8.2 E6	18.7 E6	10.3 E6
Lv.wt. value (500N/kg)N/yr[3)]	2.45 E6	3.00 E6	4.8 E6	6.0 E6	9.0 E6	12.0 E6	9.0 E6
Gross value of (dairy+beef) production/family N/yr [3)]	3.10 E6	3.68 E6	6.4 E6	10.4 E6	0.9 E6 up to 1.7 E6	30.7 E6	1.9 E6 up to 3.9 E6

[1)] Table 2.1-1 is a condensed version of Table A1-2 in Appendix 1

[2)] F=Fulani or other native breed, C=Crossbreed Fulani with European dairy breed, E= European dairy breed

[3)] 1 N = 1 Naira = 0.005 Euro

It is very striking that of the three “more primitive” systems, with only Fulani cattle, the potential income from beef sales is 3-4 times more than the sale of milk. Only in the “large scale dairy” system the value of the milk production exceeds that of the beef production, viz. by 50% of the beef production value.

It is clear that the value of the beef production is considerable in all milk/beef production systems.

The milk production of the "Fulani nomadic" system is extremely low: 0.75 l/d/lactating cow and a yearly (365 days) average of 0.3 l/d/cow. This increases with 4% in the grazing reserve, thanks to a lower mortality. With the use of concentrates "Fulani semi-settled" the yearly milk production increases from 10.9 to 26.3 ton milk/yr/100 cows, or an increase of almost 2.5 times. But the yearly (365 days) average remains low at of 0.7 l/d/cow. Only by introducing crossbreed cows and feeding more concentrates in the "Fulani settled" system a level is reached of 5 l/d/cow with a yearly (365 days) average of 2 l/d/cow.

A certain fact is that the high mortality is reducing the production and its gross value considerably, as shown in Table 2.1-2

Table 2.1-2 Reduction of the production and of the gross value of the production due to mortality

	Fulani nomadic	**Fulani grazing reserve**	**Fulani semi settled**	**Fulani settled**	**Crop-dairy smallholder**	**Large scale dairy**	**Dairy smallholder**
	Reduction due to mortality						
Milk production reduction	13%	11%	8%	6%	5%	7%	5%
Live weight production reduction	61%	52%	40%	31%	23%	25%	23%
Gross value production reduction	56%	41%	20%	6%	16%	15%	16%

The integration of crop and dairy farming is complex (dairy farming by itself is already very complex), but can have advantages. Such as for instance: "Transport of soil fertility" from grazed land to arable land (see Chapter 9); use of fallow vegetation for feed; the use of crop products and crop residues for feed; erosion control by (zero) grazed contour strips of grass; improvement of the soil after some years of ley. Irrigation of pastures and/or cropland has not been observed, it receives some attention in Paragraph 6.2 together with mixed farming.

2.2 Recommendations

Recommendations can be made on many topics with respect to the above discussed production systems. For instance this can be done on topics as feed and water quality and provision, calf mortality, labor and social processes. Several of these topics are dealt with in specific paragraphs or chapters, and related recommendations will be given there.

R2.2-1 S*election of the production systems for DDP*

As stated in Par. 1.8, presently there are less than 5,000 dairy or dairy-crossbreed cows in Nigeria. This number is by far insufficient to attain the 10% goal. Crossbreeding is not a possible option considering the 2016 deadline of the 10% goal (see Paragraphs 3.1 and 5.1). Thus all

attention should focus on the “Fulani grazing reserve” and the “Fulani semi-settled” production system. Milk collection from the “Fulani nomadic” production system is not considered as a realistic option in the DDP.

R2.2-2 ***Value of beef production***

It is clear that with all economic evaluations of the production systems the value of the beef or live weight production has to be taken in consideration.

R2.2-3 ***Mindset of Fulani people towards value of beef and selling cattle***

Opinions of “outsiders” differ concerning the attitude or practice of Fulani with regard to their practice of selling animals. Some outsiders are of the opinion that Fulani do not sell cattle, apart from diseased animals. Other outsiders say that Fulani sell in a commercial way many animals of their herds. This item deserves further attention.

R2.2-4 ***Mixed farming systems***

A desk study and field survey should be made to evaluate the pros and contras of the integration of arable and dairy farming. In paragraph 1.5 this topic is mentioned briefly under the heading “indirect milk producers”.

3 Concentrate Use, Cow productivity, Number of MCCs

3.1 Key Findings/Insights

As discussed in Paragraph 2.1. the number of crossbreeds and pure European dairy cows in Nigeria is less than 5,000. The increase of this number in order to achieve a considerable contribution to the 10% goal is probably not possible in view of the 2016 deadline. This means that FCW has to collect milk from low producing pure Fulani cows. This has many consequences for the milk collection, as will have the use or not use of concentrates to raise the milk production of the pure Fulani cows. In Appendix 2 calculations are presented providing estimates of the number of cows of MCCs required for milk collection for different milk/beef production systems.

The calculations show that:

- Fulani cattle without the use of concentrates will require at least 117 MCCs each with 4,500 milking cows, for delivery of 60 E6 l/yr. Much more than 40 MCCs planned, as initially planned by FCW.
- Fulani cattle, 220,000 cows, with the use of concentrate will require at least 51 MCCs for delivery of 60 E6 l/yr. The quantity of concentrates needed is estimated to be 45,000 ton/yr (see Appendix 3).
- only with 7% crossbreed cows of the cows in a "Fulani+crossbreed" herd and use of concentrates, the production of 60 E6 l/yr collected in 40 MCCs can be achieved. For this a total of 180,000 cows is required, of which at least 12,600 crossbreed cows. It is not possible to obtain these cows by 2016 by any crossbreeding program in Nigeria (see Chapter 5).
- by collecting the milk produced by 5,000 crossbreed and pure dairy breed cows from large scale dairies in 2016 and the milk of 172,500 Fulani cows the 10% goal can be achieved with a minimum of 43 MCCs. The quantity of concentrates needed is estimated to be 34,400 ton/yr (see Appendix 3).
- lactating crossbreed cows will require for their milk production of 10 l/d/cow, about 5 kg concentrate per day. The quantity of concentrates needed will depend on the quantity and feed value of the grass consumed during grazing, distance to drinking water, etc.
- a larger low milk producing herd is possibly not only a disadvantage for the milk-beef producer. A larger herd with low milk producing cows will produce more live weight or beef at less concentrate cost.
- Remark. With respect to the volumes of concentrate presented above, it can be noted that the estimate of feed, or concentrate, used for poultry production in Nigeria is in the range of 300,000 – 600,000 ton/yr (FAO. 2006. Poultry sector country review, Nigeria).

3.2 Recommendations

R3.2-1 ***Info on the mindset of Fulani people towards feeding concentrates to their cattle***

For FCW milk collection at much more than 40 MCCs to achieve the 10% goal will be very costly. So the use of concentrates by Fulani has to be promoted, in order to collect sufficient milk at each MCC.

R3.2-1 ***Info on the milk/beef economy of feeding concentrates to Fulani cattle***

To which extent does the increase of the live weight production by concentrates affect the decision to use concentrates? It is important to provide correct and complete information on the technical benefits of concentrates. Calculations show that concentrate feeding is marginally economical, and will likely only be practiced by Fulani for concentrates costing per kg less than half the off-gate price of one liter of milk. What is more economic: a) a large herd of Fulani cattle with low milk production per cow and no concentrate feeding, or b) a small herd Fulani + crossbreed cows with concentrate feeding and a high milk production per cow, taking in consideration the difference in beef production of these herds. In addition the info to be obtained from "R2.2-3 *Mindset of Fulani people towards value of beef and selling cattle"* is of crucial importance.

R3.2-3 ***A decision if the 10% goal will be strived for by collecting milk from only Fulani cattle, or will also milk be collected from pure European and crossbreed European dairy cows***

This decision will have some effect of the interest or not in pure European and crossbreed European dairy cows in Nigeria (see R5.2-1).

R3.2-4 ***Reconnaissance of the question how to address the acquiring at a low price, or at low costs, of some 40.000 ton concentrates per year.***

An inventory needs to be made of concentrates and industrial residues of good feed quality obtainable in Nigeria. It includes desk studies of crop cultivation alternatives to obtain concentrates, and desk studies of use of urea as a source of cp for concentrates and industrial residues with low protein contents.

4 Diseases and Heat Stress

4.1 Key Findings/Insights

Traditionally in large parts of Africa the keeping cattle of cattle was impossible due to the occurrence of the tsetse fly the transmitter of the parasitic protozoa Trypanosomes causing in cattle the often fatal nagana. Still today the occurrence of tsetse flies is a constraint for dairy development in large areas Nigeria. In these areas successful dairy development can only take place in an environment where tsetse flies have been completely eradicated. A study in Agaie (LGA) 130 km South of Minna, showed the wide variation 2 - 20% of prevalence of nagana in cattle of 12 herds, totaling 1093 head. Herds all grazing riverine ecosystems near six Fulani homesteads, situated within a circumference of 6 km (Ahmed, 2001). In view of this wide variation it is not surprising that opinions on the (non)problem of nagana in Nigeria vary almost as widely. There has been a reduction in the tsetse fly population due to the use of synthetic pyrethroids (pour on), but it has not been completely eradicated. Nigeria has a well-developed institution for Tsetse eradication (NITR), which should play a crucial role. Fortunately tsetse flies do not occur in the highlands of the Mambilla plateau, area approximately 4,000 km^2, in East Nigeria bordering with Cameroun and in the drier North of Nigeria(< 600 mm/yr).

Several tick-born diseases like Babesiosis and Anaplasmosis are also present in Nigeria, but these are relatively easy to control with proper spraying or dipping. Recovery is usually possible if treatment starts early, otherwise the animals may not survive. Another tick-born disease is Streptotricosis, a skin disease which only occurs in poorly dipped/sprayed cattle. Treatment of the infected animals is possible though difficult.

Contagious Bovine Pleuro Pneumonia (CBPP), a cattle disease caused by Mycoplasma, has not yet been eradicated in Nigeria. This is despite the fact that the vaccine is produced in Nigeria and annually, government vaccinates all animals at no cost to the farmer. Despite this, 300 cases were reported in the slaughterhouses in Ibadan, Oyo State, though there are possibilities that some of the slaughter stocks were brought in from other states. This disease should not give a lot of problems for the future dairy industry, though it should be monitored closely for the Fulani cattle. Other diseases, like Foot and Mouth (FMD), Brucellosis, and laminitis are also present. For the control of brucellosis, Strain 19 is available in the country but FMD vaccines may have to be purchased from Kenya. On a general note, these diseases should not be a severe constraint especially with good management and sufficient veterinary care.

Temperate cattle breeds suffer in the tropics during hot hours or periods from heat stress. It can have very negative effects on reproductive performance of dairy cows and reduce milk yield. In general terms, heat stress does not kill an animal. Virtually all pure bred dairy cattle observed during investigations were imported. The Dutch Friesians have the least capacity for

withstanding hot humid conditions while the South African Friesians did slightly better. The Jerseys from South Africa fared better than all the others. However, the observed cross breeds (Fulani x Friesians) at NAPRI, Zaria did not show any sign of heat stress at midday.

In general European pure dairy breeds are very sensitive to heat stress. Heat stress is caused by a combination of relative humidity and ambient temperature. High humidity 90-100% causes mild stress at temperatures of 23-26 ^{0}C , severe stress between 27-32 ^{0}C, very severe stress between 33-36 ^{0}C, and can be lethal at temperatures from 37 ^{0}C and higher (Moran, 2009. p.72, 240 for more info).

4.2 Recommendations

R4.2-1 ***Monitoring and control of tsetse flies by NITR and of nagana by veterinarians***

The monitoring of an area is done by traps, and buffy coat examination of all animals at regular time intervals. Control measures by drugs, by an appropriate acaricide also controlling ticks. Only animals with diagnosed nagana should be treated. Blanket treatment with dimininaphen should not be allowed, neither products like Samorin and Novidium.

R4.2-2 ***Avoiding heat stress of pure and European dairy-crossbreeds***

It is obvious that pure bred European dairy cows in the Nigerian lowlands can only be kept in well ventilated stables protected from direct sun heating and high temperatures. But even when these conditions are met reproduction will be below optimal. In periods with high humidity and temperatures above 30 ^{0}C efforts of additional cooling of the stable should be made, e.g. by water-spraying the cattle or the roof of the stable ("desert-cooling" system).

R4.2-3 ***Shade for grazing animals***

All grazing animals, and certainly lactating cows and young calves, should have the opportunity to find shade in periods with high humidity and elevated midday temperatures. This applies to all zebu cattle but even more so to crossbreeds.

R4.2-4 ***Vaccination and tick control.***

Self-explanatory (see Paragraph 4.1.).

R4.2-5 ***Veterinarian control and assistance***

Regular veterinarian control and assistance at vocational level should be provided through MCC support service to producers, coupled to the availability of common drugs and a backup by professional veterinarian assistance.

R4.2-6 ***Exposure of improved dairy breeds to Fulani cattle sub-lethal infected with contagious diseases.***

Farmers with crossbreed or pure European cattle should vaccinate their cattle (as most of them generally do) and in addition if possible avoid contact with Fulani cattle which is often sub-lethal infected with many contagious diseases.

5 Crossbreed Dairy Cattle in the DDP Project and Beyond

5.1 Key Findings/Insights

Dairy crossbreeds are considered as one of the crucial factors to increase the milk production in Nigeria (see: Chapter 2; Appendix1). To obtain one crossbreed lactating cow requires at least 3,5-4 years (AI, followed by 9 months pregnancy, birth of calf, followed by age at first calving 33-39 months). Presently the number of crossbreed and pure European-dairy breed cows in Nigeria is at maximum 4,000 cows.

From March 2012 to January 2016 remain 46 months, 2 months less than 4 years. So to have 13.000 lactating crossbreed cows by 2016 is not possible from the crossbreeds and pure European dairy breed cows now present in Nigeria.

An unrealistic optimistic maximum number of 'new' lactating crossbreeeds would be around 4,000. Assuming all cows, which can presently be considered for crossbreeding, come into heat during the next months. And that AI is done with pre-identified semen which guarantees that 90% of the born calves will be female.

The conclusion is that without these crossbreeds the milk delivered to 40 MCCs by Fulani herds will be insufficient to achieve the "10%" goal by 2016 (see: Chapter 3).

However on a longer term the Nigerian policy might favor anyway to increase the dairy-crossbreed herd. Considering this it is worthwhile to elaborate on the topic of crossbreeding in Nigeria.

No inventory has been made and no records are kept in Nigeria of crossbreed dairy cattle and pure breed (European) dairy cattle. At the moment (2012) the only locations where crossbreed dairy cattle and pure breed (European) dairy cattle can be found in Nigeria are:

Research institutes and crossbreeding of zebu with European-dairy breeds

NAPRI farm at Zaria. A total of 250 zebu European-dairy crossbreeds, males and females, were sold during the last 4 years to farmers outside the station.

ILRI-Nigeria. Presently there is no cattle at the institute at Ibadan.

Other Institutes. To my knowledge no other institutes in Nigeria have any dairy cattle.

Large scale dairy farms and crossbreeding of zebu with European-dairy breeds

Some 15 large scale dairy were started 15 years ago near Shonga, Kwara State. Some of the farmers imported pure breed (European) dairy cattle. These did not thrive due to heat stress and a specter of serious diseases. No overall image exists of these farms, neither of the cattle present at the moment.

Two farms were visited. One still had a herd of pure Jersey animals. According to the farmer Jerseys cope somewhat better than the Friesian-Holstein in this for European dairy breeds alien environment. On the other farm most of the imported Friesian Holstein cattle had died, the herd of 270 head consisted mainly of Jerseys and some Jersey-Fulani crossbreeds.

Concluding. It can be guestimated that the number of crossbreed dairy cows and pure breed (European) dairy cows will not exceed 4,000 at present.

Crossbreeding can be either done by inseminating native cattle (Fulani, etc) or inseminating European breeds. The option to inseminate Fulani cattle in a Fulani herd with a European breed poses several difficulties:

- Fulani herd, so far AI not practiced (knowledge of producer, infrastructure for AI not present);
- Fulani cattle will have parturition problems giving birth to a relatively large crossbreed calf (risk of mortality cow);
- Fulani cattle doubtful if feed intake during pregnancy is sufficient, resulting in the birth of a not optimally nourished too small calf;
- Fulani cattle milk for calf initially possibly enough, but after 2-4 months not optimal for calf growth;
- crossbreed calf after 6 months can obtain probably only poor quality and quantity feed;
- the 1 year old crossbreed heifer will be a sub optimally grown, underdeveloped animal.

In brief: inseminating Fulani cows for crossbreeding entails a higher risk of cow mortality, and producing a suboptimal crossbreed animal.

The option to inseminate a European breed present at a large scale dairy with Fulani cattle semen, or semen from 'dairy-zebu' breeds, has several advantages:

- farmer has the knowledge, experience, routine and infrastructure for AI;
- not any special parturition problem;
- conditions are such that cow can be well fed during pregnancy to produce an optimal healthy and large crossbreed calf;
- sufficient milk and/or milk replacer will be available for optimal growth of the calf to a 1 year old crossbreed heifer

A third alternative for crossbreeding can be provided possibly by using the larger zebu beef breed Adamawa Gudali present in the highlands of Tabara in Nigeria.

- Adamawa Gudali cattle will have less or no parturition problems giving birth to a relatively large calf;
- feeding conditions for the cow during pregnancy and lactation, and the feeding conditions for the calf after weaning are possibly better in the Tabara highlands than in the lowlands of Nigeria (this has to be checked);
- if AI is used by the farmers in Tabara has to be checked.

Thus it has to be checked if this third alternative is viable in the short term or possibly even immediately.

A fourth alternative is to link in to registered tropical (dairy-cross)breeds, developed over time for tropical regions in other countries, such as: "Australian milking zebu" (initially Sahiwal or Red Sindhi cross with Jersey, later on some infusion of Ilawara, Guernsey and Holstein-Friesian in Australia); and "Girolanda" (5/8 Holstein with 3/8 Gir in Brazil). This and other information on crossbreeding are presented in the first IFDC consultancy report for DDP (Wolff de, and Ikpo, 2011).

5.2 Recommendations

R5.2-1 Outline a national policy and approach how to obtain Nigerian-zebu dairy-crossbreeds for the lowlands.

At present it is considered a priority to formulate the crossbreeding aims and policy. It has been suggested to establish a National Task Force to come with a proposal (Attema, 2012). The first steps were taken at the DDP workshop April 2012 at Ibadan.

R5.2-2 ***For the present DDP 10% goal it is possibly important to know how many pure and how many European dairy-crossbreeds cows there are and where they are in Nigeria (see Chapter 3, R3.2-3).***

In general an overview of the number of cattle, their breed, their location are part of the census data of any country.

R5.2-3 ***A decision if any effort at obtaining substantial numbers of crossbreed dairy cows in Nigeria should be an objective at present, even though it is of no particular interest for the 10% goal.***

Self-explanatory (see Paragraph 5.1).

R5.2-4 Recommendations for action only in case a crossbreeding programs start is strived for within 1 or 2 years from April 2012.

Setting the goals for such a program, and choosing an approach.

Approach 1. European dairy crossbreeds for the lowland Fulani herds. Using European dairy cattle for crossbreeding

- Selection of large scale dairy's with (some) pure European breed dairy cattle for crossbreeding. Some of these large dairy farms are in contact with DDP.
- Develop a contract between farmer and DDP, guaranteeing both a profitable agreement for producing the first crossbreeds. The first crossbreed heifers can be obtained at earliest 21 months after signing the contact. Namely after the AI 9 months up to parturition, followed by calf rearing over 12 months.
- The assumption that the Fulani want or need these more disease prone, better care requiring potentially high producing crossbreeds has to be checked to some degree. It will become clearer after the first crossbreeds have been introduced and start producing.
- Determining the options how to introduce these first crossbreeds to the Fulani families. Considering amongst others: which payment regulation to obtain the crossbreed heifer, how to guarantee optimal living conditions for the crossbreed heifer and its future milk production.
- An inventory of the crossbreed dairy female cattle and pure breed (European) dairy female cattle, identifying their location, number, health status, etc. Based on this, plans can be developed how to expand the crossbreeding.

Approach 2. European dairy crossbreeds for the Nigerian highlands. Using European dairy cattle for crossbreeding

Details fall beyond the present DDP scope.

Approach 3. European dairy crossbreeds for the lowland Fulani herds, using the larger zebu beef breed Adamawa Gudali cattle for crossbreeding.

Approach 4. Crossbreeding the Nigerian zebu breeds present in the lowlands (white Fulani, etc.) with registered tropical dairy-crossbreeds developed over time in other countries for tropical regions.

Some more details on crossbreeding were presented above in Paragraph 5.1. Further details fall beyond the present DDP scope.

6 Feed and Grazing

6.1 Feed Quality and Feed Requirements

In Nigeria improved pastures have not been established except on Government and University, experimental, teaching and demonstration farms. Consequently cattle depend for feed on natural grasslands that are nutritionally poor during a large part of the year, crop residues, and/or provision of costly concentrate feeds (see Appendix 4). Possibly in some exceptional cases urea supplementation can be used as a source of crude protein.

Cattle need feed to obtain energy and proteins for their maintenance, activity, growth, pregnancy, production of milk and meat. Upon intake by cattle feed is ruminated and (partly) digested. The undigested part, mainly fibres, is excreted by the animal as faeces. The energy in feed is expressed as the total digestible nutrients (TDN) Protein in feed for ruminants is expressed as crude protein (cp) The indigestible or least digestible fiber material in feed is often named crude fiber (cf). In a more general way, one speaks of the feed value of feed. A high or good feed value means feed with a high TDN and cp content, and a low crude fibre content and the opposite for a low feed value.

The quality of the grass varies, depending on its management and the season. This determines the milk production and condition of lactating cows as shown in Table 6.1-1 below. Table 6.1-1 also shows the varying moisture content of grass. This does not affect the feed value of the grass. It is most practical to express the feed value (TDN and cp) of the grass on a dry matter (dm) basis.

Table 6.1-1 The feed value of grass depending on maturity and season, and corresponding milk production and condition of lactating cows

	Moisture content (dm content)	**Feed value dry matter**		**Milk production by lactating cows**
		Crude protein	**TDN**	
	% H_2O (% dm)	**% cp in dm**	**kg TDN/kg dm (% TDN in dm)**	
Leafy grass green	75-90 (25-10)	7-9	0.55-0.65 (55-65% TDN)	Just enough for healthy production of 1-5 l/d/lactating cow
Stemmy grass green (at beginning of dry season)	75-65 (25-35)	5-6	0.50-0.55 (50-55% TDN)	Just enough for maintenance, milk production with condition loss
Straw like grass (after 3 months dry season)	30-40 (70-60)	3-4	0.35-0.50 (35-50% TDN)	Below maintenance, milk production very low, with serious weight and condition loss (very unhealthy milk production)

As is clear from Table 6.1-1 above, a healthy milk production just from grazing, even of 1-5 l/d/lactating cow, is not possible during most part of the year. Other feeds with a higher feed value than grass has to be supplemented. Some examples of feeds with good, medium and poor feed values are presented in Table 6.1-2 below.

Table 6.1-2 Good, medium and poor quality feed

Quality (crude fibre content) and feed type	cp % in dm	kg TDN/kg dm
Good (crude fibre <0,15 kg/kg dm)		
oilseed cake	28	0,70
concentrate feed	15	0,65
legume-tree leaf (cf >0,15 kg/kg dm)	24	0,60
Medium (crude fibre 0,15-0,3 kg/kg dm)		
very young fertilized tropical grass	10	0,60
rice bran	11	0,55
young tropical grass	8	0,55
Poor (crude fibre >0,3 kg/kg dm)		
mature tropical grass	6	0,50
maize straw	5	0,50
rice straw	4	0,45

Weeds and grasses present on cropland can be “grazed” after the harvest of the crop, they provide some feed in the dry season. Their quantity will be small, and their quality will deteriorate within one or two months of the dry season. Then their feed value, 0.3-0.5 kg TDN/kg d.m. and cp <5% will be below maintenance (see Table 6.1-1). Cattle will lose weight, milk production decreases, and several calves will die.

The residues of most crops can be used as feed, though their quality (TDN and cp) is generally very low, and is insufficient for cattle to maintain weight and a reasonable condition. Regrettably this is the case for the residues of grain crops as maize, sorghum, millet and rice (see Table 6.1-2 maize straw and rice straw). Sweet potato vines, cassava leaves, bananas leaves and stem, leaves of bean plants and sugarcane tops can be of mediocre feed value immediately upon harvest, only when the leaves are still green. The big problem with the use of crop residues as feed is that the material comes available in a short harvest period in a large quantity, and that its generally low feed value will deteriorate fast.

Of several crops the crop residues have a reasonable feed quality. The last decennia more value has been set on this property by breeding “dual-purpose” varieties, with an increased yield of crop residues to be used as animal feed. Field research and some promotion of dual-purpose cow pea has been executed in Nigeria (Kristanjanson et al, 2002; Dangbegnon et al., 2011; Ugbe et al., 2011). No information is provided on handling, characteristics and feed value of the cowpea fodder. As all the fodder will be harvested in a short period conservation will be required. Some practical general info on hay making is given in Appendix 4 (paragraph A.4.6.3).

An overview of the main Agro-industrial by-products present in Nigeria is presented in Table 6.1-3. The products with TDN 70% or higher and 10% cp or higher can be used as concentrates. Some others (rice hulls, bagasse) are mere stomach fill, or providers of fiber for animals not consuming any fibrous materials.

Table 6.1-3 Agro-industrial by-products present in Nigeria and some feed (TDN, cp) analyses results

By product	**dm**	**TDN**	**cp**
	%	**kg TDN/kg dm**	**%**
Cotton seed cake	90	0,80; 0,77	46; 48
Banana peels	8-25	0,75; 0,60	8; 8-11
Spent Brewers grain sorghum	35	0,72; 0,85	24; 32
Rice polishing	90	0,90	14
Rice bran	90	0,56; 0;70; 0,72	11; 12; 14
Rice hulls	90	0,13; 0,24	3; 3,8
Sugarcane bagasse	90	0,36	1
Sugarcane molasses	75	0,62; 0,70; 0,75	0; 7; 10
Maize bran	90	0,76; 0,76	10; 11
Wheat bran	90	0,64; 0,66; 0,70; 0,76	16; 18; 18

For further info feed value of feeds and feed requirement for cattle see e.g.: Ayantude et al. (eds), 2005; Köster, 2010; Moran, 2005.

The daily intake by an animal is limited by the volume of its stomachs and the time needed for chewing and digestion. The lower the digestibility of feed, the longer it will stay in the rumen, reducing the amount the cow can eat and hence her production. Of feed with a low feed value of which the animal need to eat a lot for getting enough energy and protein, the animal cannot eat much of it (starvation diet). Even when offered a lot, the animal will starve on pastures in the dry season with plenty of grass, but which is stemmy and almost leafless grass.

6.2 Feeding Systems and Grazing (time)

The feeding systems observed ranged from the Fulani grazing system, to zero grazing observed on large scale dairy farms with crossbreed and European dairy cattle. In Table 6.2-1 their main characteristics and differences are highlighted.

Table 6.2-1 Comparison of free grazing and zero grazing of cattle

	Free grazing with herdsman, night paddock or night-enclosure	**Zero grazing also called cut and carry**
Herding	yes	no
Water dry season	animal has to be brought to watering point. Limited opportunity for drinking	mechanized permanent water supply, or daily collection and transport of water to the stable
Water rainy season	(almost) enough, dew, rain, water with forage	mechanized permanent water supply, or daily collection and transport of water to the stable
Forage which can be grazed	yes, on farm or communal land	no
Forage which has to be cut	no	yes, on farm or communal land
Daily hours for feed intake	restricted grazing time, only day-time herding, often too few hours for optimal feed intake	Day and night feed intake possible
Energy spent on obtaining water and feed by cattle	In dry season often excessive walking necessary. At the cost of milk production and body condition	No or very low energy expenditure. Optimal for milk and beef production
Damage to sward by trampling/puddling when soil water saturated	medium risk, damage locally	no damage risk
Crop residues feeding	possible	easy
Mineral supplement	at night, rain protection	rain protection
Urea supplement	difficult	easy, with drinking water or spraying on forage
Concentrate supplement	easy	easy
Dung collection	relatively easy from night paddock or enclosure	easy collection of day- and night - dung
Urine nitrogen	N deposited on pasture during day grazing	N with dung in stable, will depending on conditions partly stay in manure
Tick borne diseases	high exposure, tick control by hand difficult	very low or no exposure, ticks can be controlled by hand
Claw problems	normal risk	high risk
Specific durable system investments (excluding water, mineral, shade, and manure provisions)	none, or night enclosure	enclosure or stable

For an optimal feed intake cows can be best fed, or have feed available, during all 24 hours of the day. They need time for intake and rumination. It is especially so in the case of medium to poor quality feed. In Europe often zero grazing stables are lit during the night to stimulate the dairy cows to a larger feed intake than in unlit stables. An African example is the common practice of night grazing in the West African Sahel, especially at the end of the dry season

(Breman et al. 1978; Ayantunde, 1998). Benefits of increased grazing time, are increased forage intake, resulting in increased condition, milk production and live weight gains.

During the consultancy it was noted that the herd with lactating cows and their calves left the night paddock at 09.00 in the morning. The herd went on walking and grazing until reaching water at 12.30. Of the total 210 minutes, about 110 had been spent 'grazing' - in fact searching, while moving, for the widely spaced single edible leaf of grass and edible crop residue left over. Some 100 minutes were spent on walking. An estimate of the distance covered that morning was 6-7 km. Stomach fill was not achieved and thus any incentive for rumination absent. In the afternoon the herd probably returned between 17.00 and 18.00. This represented a short 8-9 hour day of "grazing", with intake far below maintenance level and walking a distance of about 13 km. It resulted in mortality of many calves during this period, drying off of their dams, and even dying of adult cattle. Considering the complete scarcity of feed to graze in the field, the short grazing time (9 hrs/day) did not matter probably. But when there is feed to graze it seems a constraint on production.

6.3 Feed during the Dry Season

As highlighted in Paragraph 6.1 the quality of the available feed in the dry season, stemmy grass and wilted and/or dried weeds and stemmy crop residues on cropland, is of a very low quality. Generally even too low for maintenance (of weight and condition).

Some alleviation is possible by saving or conserving excess forage present during the rainy season as: standing hay, silage, or hay, though the feed value of this feed is lower than at the time of growth in the rainy season. A better possibility is the planting of shrubs, preferably leguminous, of which the leaves stay green in the dry season. And of course though more costly the poor feed can be supplemented with concentrates or industrial by-products having a high feed value.

More info on dry season feed and feed conservation is provided in Appendix 4.

6.4 Key Finding/Insights

Presently the Fulani herds are during large parts of the year receiving feed with a low to very low feed value, both with respect to TDN and cp content. This results in very low milk production and high mortality rates. The dry season in particular is a very critical period when not only the quality of the feed but even its quantity is too low.

Research, extension and implementation of the use of improved forages is internationally seen lagging far behind in Nigeria, undoubtedly for a large part due to severe understaffing. E.g. not one staff member on forages and fodder crops is presently appointed or active at ILRI-Ibadan.

Locally produced concentrates and agro-industrial by-products are available. Though practically completely used as feed for poultry and pigs.

Probably most Fulani herds are grazing less than 10 hours per day. And often part of their "grazing time" has to be spent just walking to cover the distance to a location with water for drinking.

6.5 Recommendations

R6.5-1 ***Promotion of improved forages***

Presently there is practically no research, extension and implementation of the use of improved forages (Shiwoya and Tsado, 2011). By the lack of a sufficient number of trained personal in Nigeria, initially international action will be required. For instance training by international expert(s) in a workshop and/or a FAO project with Nigerian counterparts, and/or extension of the staff at ILRI coupled to national cooperation.

R6.5-2 ***Selection and testing of promising new forage and fodder species and cultivars***

Immediate desk study coupled with expert judgment to select some 20-30 species for testing and demonstration at different grazing reserves and large scale dairy farms.

R6.5-3 ***Grassland husbandry and N fertilization***

Optimal management of the areas on which grasses or legumes were established serving as feed reserve for the dry season. Nitrogen fertilization of grass promoting longer growth into the dry season and earlier start of growth with the first rains at the end of the dry season.

R6.5-4 ***Use of irrigation to maintain growth of quality feed in the dry season***

Several large scale dairy farms in Kwara State are optimally situated near river water to use for dry season irrigation. A first demonstration can be implemented there. Subsequently surveys can be made of some grazing reserves to identify areas suited for irrigation. (Either or not in combination with cultivation of vegetables and crops).

R6.5-5 ***Viability of concentrate use by Fulani*** In fact this recommendation is covered by recommendations R3.2-1 and R3.2-2, which will not be repeated here.

R6.5-6 ***Promotion of grazing time for herds of 11 or more hours per day***

Feed intake by cows for milk production is dependent on the number of hours per day with access to feed, as will be the feed intake of all cattle. Presently several herds are less than 10 hours per day in the field for grazing, this is shorter than the hours with daylight. Early and late grazing has the advantage that these are the coolest hours of the day. In some areas in addition to daylight grazing night grazing is practiced to maximize feed intake.

7 Water: Requirement, Quantity, Quality, Distance

7.1 Key Findings/Insights

Water is the most crucial factor in the survival and production of animals. Availability of water for animals is generally not a factor of concern during the wet season. But in the dry season it can become a critical factor. Several farmers have to move their cattle during the dry season to another location, or need to bring them daily to watering points. Watering cattle during such periods can be a handicap. In particular in zero grazing systems it can become a problem how and where to get daily a large quantity of water.

It is clear that the water requirement is influenced by many factors, such as exposure to sunshine or availability of shade, type of feed, type of breed, feed intake, production level, etc. There is a large variation in water requirement between breeds, as exemplified by the following. Some local beef breeds, in extensive tropical production situations, can go for three days without water. In the Ethiopian Rift Valley, watering Borana cattle once every three days had little effect on mortality, calving rate, or the weight of two-year old steers, although calf live weight was greater with daily watering. But in these regions water scarcity for lactating cows can result in serious weight loss. The same is true for local breeds in other semi-arid regions, such as for instance the Sahel. Cattle of *Bos indicus* or *Bos indicus*-infused breeds drink less water under hot conditions than do *Bos taurus* breeds. Cattle of local breeds adapted to dry areas will re-hydrate quickly without suffering from water intoxication. Cattle from most other breeds should be prevented from drinking too much water too quickly, if they have been deprived from water for more than a day.

Another point can be that during a drought much of the water is salty. If it contains more than 10 g total soluble salts per liter it is unpalatable for humans and unsuitable for cattle. They will reduce their voluntary feed intake and productivity will suffer. Water should be of sufficient quality, amongst others a pH between 5.5 – 8.5. Most water quality problems come from contamination with bacteria, acidity or excessive sulphates.

Dairy cattle, in particular during lactation, need to be watered every day. In fact cows given the opportunity will drink about 14 times every day. Cows prefer to eat, drink, eat, drink, in an alternating pattern. They also like to drink immediately after being milked. The optimum water intake requirement for dairy cattle can be estimated with the following equation. Water intake (l/d) = 15,99 + 1,58 * dm intake (kg/d) + 0,9 * (milk production l/d + 0,05 * sodium intake g/d) + 1,2 * weekly minimum temperature in degrees Celsius. The moisture in feed is not included in this formula as a factor of influence on the water requirement. Another factor is if the cow can find shade, and is not exposed to full sunshine during the day. According to the formula a lactating cow of 250 kg live weight, with an intake of 6,25 kg dm/d, not receiving salt (NaCL

supplementation), producing 6 l milk per day, and staying in an environment with a weekly minimum temperature of 18 ^{0}C, requires 53 liters water daily for optimum water provision.

Stated in a general way: a lactating dairy cow in the tropics needs 30-100 liters of water per day. The water requirement of lactating cows depends on their milk production. A general rule is that for every liter of milk the cow needs 2 - 2,5 liters more water above its basic water requirement. So the daily water requirement of a lactating cow is higher than that of the other cattle in the herd. They all have a basic water requirement of 20 – 40 l water per day.

The distance to a watering point is very crucial for lactating cows. Does this distance exceed 1 km then the energy spent on walking will be at the cost of the milk production and/or condition of the cow. Stated in a simplified way, the reduction of the milk production is at least 10% per km walking by the cow in hilly country, and about 10% per 4 km walking in flat terrain, probably coupled with condition and some weight loss of the cow as well.

7.2 Recommendations

R7.2-1 ***Water quality***

Check the water quality of boreholes as soon as possible. To secure that it is of adequate quality, before making further investments. Check the water quality of surface water at critical times: in the dry season for saltiness, bacteria, level of dissolved solids (problems likely if dissolved solids > 3,000 ppm); in the wet season in locations with erosion run off for dissolved solids.

R7.2-2 ***Water availability and distance to water***

More watering points during grazing, and easy access to water in the night paddock will promote milk production and the condition of the cattle. If cows have to walk daily more than 1 km to water this will reduce the milk yield.

R7.2-3 ***Water and young calves***

Access to water in the night paddock will allow dams with young calves to stay in the night paddock, when feed for the dam is provided. This is recommended. As in situations that the provision of water is coupled to the grazing of the herd, when only this leads to a watering point, then the dam and her new born calf have to walk in the open sunshine. Depending on the situation this exposure can be for a short or long time. Anyway better to be avoided for new born calves.

R8.2-3 ***Water and remote sensing***

Remote sensing, facilitating three-dimensional relief inventories and mapping, can be used for selection of sites for ponds to store run-off water to provide water to cattle in the dry season.

8 Mineral and Salt Supplementation

8.1 Key Findings/Insights

"The content in plant tissue of a deficient plant nutrient will be lower than normal. It can drop below the level of minerals required in feed for animals (essential elements are called nutrients for plants, and are called minerals in animal nutrition). In Sub Saharan Africa soil deficiencies of P (widely occurring), of S (seldom occurring, if at all with aerial deposition of S from volcanic activity), and of microelements such as B, Cu, Mo and Zn have been recognized by agronomists. But the information gathered on crops is incomplete and not always relevant for livestock. Potential deficiencies have been reviewed, no acute mineral deficiencies occur, though probably P is marginal for cattle in many situations (Schillhorn van Veen, and Loeffler, 1990).

This is further demonstrated for tropical grasses in Table 8.1-1, and for tropical legumes in Table 8.2-2.

Table 8.2-1 Some aspects of plant nutrients in unfertilized grass forage

(adapted from: Boonman, 1997. p. 57; Mueller et al., 2003. p.230; 't Mannetje, 2001. p.33)

	grass, nutrients in dm	**dairy cow, requirement in dm feed**	**grass 5 ton dm/yr (yield at 60 day interval, 1 year) total nutrients**	**excreted and returned by grazing cattle (about 2,2 TLU/ha)**	
				faeces	**urine**
	%	%	kg/ha/yr	kg/ha/yr	
N [1)]	1	1,6	50	13	26
P	0,25	0,36	12,5 (30 P2O5)	8,3 (20 P2O5)	0
K	3	0,44	150 (180 K2O)	17 (20 K20)	122 (145K2O)
Ca	0,39	0,43	20		
Mg	0,25	0,12	13		
S	0,28	0,1	14		

[1)] N is classified as a plant nutrient; in animal nutrition N is not classified as a mineral, it is converted to and indicated as crude protein.

Table 8.2-2 Mineral content of some tropical legumes species and average of "all" forbs [D'Mello and Devendra (eds.), 1995. p.36, 60]

	P	Ca	Mg	Na	Cu	Co
	g/kg dm				mg/kg dm	
Desmodium intortum	1,1-7,4	4,6-14,1	2,3-2,8	-	-	-
Pueraria phaseoloides	1,0-6,5	3,6-17,2	3,0	0,1-0,4	-	-
Vigna unguiculata	1,8-4,2	13,3-20,6	-	-	11,3	0,67
Average "all" forbs	2,6	10,1	4,0	0,7	10	0,07
Glyricidia sepium wet season	1,2-1,6	7,5-16,9	0,8-1,6	0,2-4,7	-	-
Glyricidia sepium dry season	0,9-1,5	9,5-15,6	0,5-1,5	0,2-1,7	-	-
Requirement	1,8-3,2	1,9-4,0	1,9	0,8-1,2	7-10	0,11

Grass is deficient in P with respect to the mineral requirement of cattle, whereas legumes seem marginal in this respect.

Grass is deficient in Ca with respect to the mineral requirement of cattle, whereas the Ca content in legumes is sufficient.

The contents of the other minerals indicate that they are generally sufficient to meet the requirements of cattle, though they can also be too low. This risk is prevalent after some years of zero grazing when plant nutrients are withdrawn from the soil, unless these are returned to the soil with manure and/or inorganic fertilizers.

The macro nutrients required by cattle are the same as those required by plants: N, P, K, S, Ca, and Mg. Except that animals require chlorine (Cl) also as a macronutrient, whereas it is a micronutrient for plants. Cl is usually supplied as common salt, NaCl (Dierolf et al., 2001. p.56).

The sodium (Na) is required at a level of 1 – 1,5 g/kg dm. It can be applied as common salt. Under certain conditions it can increase the feed intake of cattle.

8.2 Recommendations

R8.2-1 *Supplementation of Phosphorus*

Phosphorus is crucial for cattle and in particular for the fertility of heifers and cows. It is recommended to check P levels in the blood of some animals, to ascertain if this is satisfactory or not. Apart from that in unfertilized soils P is general a critical element for plants. Lack of P

will limit root development and will result in lack of sufficient water for optimal plant growth even in soils with sufficient moisture at depths of 20-40 cm below surface. Compared to grass soil-P is more critical for legumes, thus P fertilization will also promote legume growth. Of mineral P supplemented to cattle about 70% will be excreted with the manure, and in this way cattle can be used as fertilizer-spreader. Unless the soil has a high P-fertility level the supplementation of P always stimulates plant growth. Initially it can be noted through the longer green and lusher pasture near points frequented regularly by the cattle for drinking or any other reason. After some years the whole pasture will benefit as most patches will have received one or more cattle droppings over the years.

R8.2-2 ***Zero grazing and minerals***

With zero grazing grass or any other feed is harvested and fed in a stable. The urine and feces excreted in the stable by the animals are often not returned to the field where the feed was harvested. After some years this can lead to plant nutrient deficiency in that field. Often this starts with K deficiency. So it is recommended in case of zero grazing to check at least every other year the soil fertility of all plant nutrients. And to apply fertilizers of the elements of which the level becomes marginal.

9 Manure and ISFM

9.1 Key Findings/Insights

Manure is an important factor in agriculture, the more so in regions where no or very limited quantities of chemical fertilizers are used. This is the case in most of the regions where Fulani cattle graze.

A night paddock in these regions has the advantage that all “night feces and urine” are excreted by the animals on its limited surface. The soil fertility of this paddock increases considerably, and it can be used for growing crops or forages, after another night paddock has been selected. The plant nutrients taken up and collected by the cattle during their day grazing are transported and concentrated in the night paddock. This in fact at the cost of the grazing area from which the plant nutrients are “mined”. In this way the rangeland soil fertility can be depleted, and its forage production decrease and its forage species degrade to short lived annuals. In short manure has its advantages but certainly also its shortcomings.

Depending on the soil pool of plant nutrients (minerals, organic matter) chemical fertilizer will be necessary for all plant nutrients for a sustainable system. Only N is an exception in case use is made of legumes for fixation of N from the air by Rhizobium bacteria.

The quality of the manure, its plant nutrient content, can vary widely. It is dependent among other: on the feed quality (plant nutrient content) the fate of the nutrients ingested by the cattle (ingested plant nutrients incorporated in milk, or muscles and fat, or excreted); and the fate of the feces and urine after excretion (left in the field, collected and protected from rain, composted with other materials).

Examples of very rich and poor manure are presented in Table 9.1-1

Table 9.1-1 Composition of very rich and poor manure

	Manure	
	very rich	**poor**
	g / kg dm	
inert material dirt	250	240
plant nutrients (N,P,K,S,Ca,Mg,etc.)	100	40
organic matter	650	720
organic C	380	420
Total N	25	6
C/N quotient	15,2	70
	Fraction of Total N	
N directly available	10%	0%
N liberated within 3-5 months	45%	negative, withdrawing available soil N
N liberated after one year	45%	20%

9.2 Recommendations

R9.2-1 *Manure and Integrated Soil Fertility Management (ISFM)*

Fortunately there is some cooperation between crop farmers and herders on some win-win points. In some cases herds are night “stabled” on arable fields, which then receive the droppings and urine of the herd. Farmers and herders should be made aware of ISFM. Which in this case entails: that from an ISFM point of view keeping of cattle for production of manure is justified, if inorganic fertilizer is applied to the field from which the feed is derived for the cattle. When manure from cattle remains in the location where they stay overnight, the field which is grazed during daytime needs to receive inorganic fertilizer. Even when manure is returned or dropped in the field which was grazed, less nutrients are returned to this field. Namely part of the plant nutrients taken up with grazing are incorporated in the milk and body of the cattle. With respect to P supplementation, this amply compensates the withdrawal of P by the cattle. So R8.2-1 is in line with the ISFM principle.

10 Producers Manhours, Way of Life, Innovation

10.1 Key Questions/Insights

No efforts have been made to estimate the labor requirements of the different production systems considered. Even at first sight the differences are striking. A semi-settled large Fulani family (comprising several households or families) with large herds, lives a completely different life when compared to a large-scale dairy farmer with several employees.

The Fulani's manage the cattle in their way. During the daytime they herd their cattle for grazing. At dusk, they bring the herd(s) to the paddock for a nights-rest and milk it in the morning before the grazing and searching for natural sources of water for them.

The large-scale farmer with cattle in a stable brings harvested feed to the animals, provides water all day round through a mechanized system, milking twice a day, and taking care of and managing cattle, employees, milking parlor, water system, machinery, etc.

The manhours spent per head are possibly quite low in the Fulani system; and high in the large scale dairy farms (unless wages are very low and grass is cut manually for the cattle). The manhours available in a Fulani system are apparently much higher than the manhours spent on the herds of a large scale dairy farm. The manhours available on a well-managed large scale dairy farm will have little difference from the manhours spent.

Can the general economic evaluation be applied to the Fulani labor? How can this be quantified? Labor spent, or labor available? In general economic terminology, a situation is defined as 'hidden unemployment' when much more manhours are available than the actual manhours spent, with little or no opportunities for other work. An economic term is "the opportunity cost of labor". Is this terminology justified for the Fulani system and way of life?

10.2 Recommendations

R10.2-1 ***Intensification of milk production by Fulani is coupled to an increasing workload***

The intensification of milk production will mean more work for Fulani household members viz feeding concentrates, more milking hours, more watering of the lactating cows, intensified calf rearing and care for the crossbreeds. Monitoring how these tasks are divided in the households is an important aspect of DDP.

R10.2-1 ***Labor and intensification of milk production on large scale dairy farms***

Monitoring of the effects of increased production on the management and the number of employees is an important topic.

11 Economic Activity and Employment Opportunities stimulated by MCCs

11.1 Key Findings/Insights

Establishment of a MCC triggers employment and economic activity. In several ways:

- Management, administration and maintenance of the MCC;
- Shop keeping activities for sales of veterinary drugs, concentrates;
- Employment of personal for producer support on animal and feed husbandry;
- Maintenance of access roads to the MCC;
- Milk delivery transport activities;
- Increased regular cash income of producers.

11.2 Recommendations

R11.2-1 ***Observations on the social and economic impact of a MCC***

For the establishment of more MCCs it is important to have info on their impact.

12 Record Keeping at MCCs and Interpretation

12.1 Key Findings/Insights

Records are kept of daily milk quantity and quality delivery of each producer (group), of sales of veterinary drugs and of concentrates to each producer (group), and possibly of other matters like animal diseases and veterinary assistance.

12.2 Recommendations

R12.2-1 ***Compiling records, estimation and interpretation of the number of producers, herds, milking cows, lactating cows delivering milk each month, and quantity and quality of milk delivered.***

Insight can be obtained if the establishment of a MCC effects the number of producers and head of cattle in the area around the MCC. In case this number increases considerably it may provoke undesired side effects. On several other points records and their interpretation can facilitate important insights. See the recommendations below in this paragraph.

R12.2-2 ***Compiling and interpretation of monthly records of milk delivery quantity per producer and purchase of concentrates***

At the moment no concentrates are used records provide a dry season base production. Probably next year some producers will buy and use concentrates others not. Interpretation of the records will provide info on the economics of concentrate use.

Further interpretation of these records may provide the milk income data per producer from her/his milk. Possibly for some producers this can be worked out further: per household; per person; per lactating cow; per total no. of cows (dry and lactating); per cattle head (averaged over the herd); etc.

R12.2-3 ***Compiling and interpretation of monthly records of purchases of veterinary drugs and/or concentrates per producer and purchase of concentrates***

Interpretation of these records will show monthly variations, differences between producers (groups).

R12.2-4 ***In general a manifold of interpretations is possible from well kept records***

13 The DDP Project in Communities - Cattle Herders and Crop Farmers, Land Use, Carrying Capacity, Water, Certificate of Occupancy

13.1 Key Findings/Insights

The unilateral attention of FCW and NLDP of their support to the Fulani, and their resulting benefits, may create some mixed feeling with Yoruba farmers, getting less attention and support from commercial firms and local government; an obvious side effect of the "10%" goal. Presently water from the borehole established for the cattle is also used as drinking water both by Fulani and Yoruba.

The mutual interests of herders and farmers on several points and competition on other points need attention. Its complexity is beyond DDP capacity and goal but possibly some actions can contribute to improve the communal feeling of the two groups, though there will be always a risk that some DDP actions may trigger more tension between the two groups.

13.2 Recommendations

R13.2-1 ***Land use inventory and background***

In the communities there are certain (unwritten) historic traditional agreements on land use. An inventory should be made of present land use, to obtain some insight in how much land is available for grazing through the year: ranch, fallow, crop residues after the harvest. Remote sensing, followed by discussion with herders and croppers will enable "physical" inventory, information on social traditional aspects, and on mutual agreements and tensions (Akinyede, 2009). A question remains, if an inventory will trigger unwanted effects, and if it is a contra-productive activity which should not be done.

R13.2-2 ***Inventory of herds and cattle number***

Insight in the herd composition and number of cattle is needed as a base for recommendations on animal husbandry.

R13.2-3 ***Carrying capacity feed situation***

Based on feed availability estimates from the land uses inventory and on the information about herds and number of cattle insight can be obtained if the grazing situation is sustainable (under-grazing, or in balance) or not (overgrazing). Remote sensing can provide an important

tool for these evaluations (Meer van de, et al. 2002; Okhimamhe, 2002; Olaleye, et al. 2009; Ojigi, 2006).

R13.2-4 *Effects of DDP on the relation between the communities of cattle herders and crop farmers.*

A decision has to be made to which degree attention should be given by the DDP to the relation between cattle herders and crop farmers, and if pro-active actions will be initiated to normalize or improve this relation.

R13.2-5 *Initiatives by DDP aiming at improvement of the relation between cattle herders and crop framers*

- Efforts can be made to organize meetings with the Fulani and Yoruba to find mutual wishes and benefits.
- Possibilities may be water provision for cattle of Fulani and for irrigation of high value crops (tomatoes) of Yoruba, either from communal water sources or from separate sources. Attention points are: ownership and maintenance of water installations; water management, responsibilities, distribution; payment for water or regulations to prevent excessive use and spoilage; water rights.
- There are croppers who have acquired some cattle, and there are herder-families who have started to grow some vegetables and/or crops. This offers a chance for joint training of the two groups. In which a topic as the best handling and processing of cattle feces to good manure or compost, and its best use for vegetable or crop cultivation will be new and of avail to both.
- Further promotion and support of cropping by herders and keeping some cattle by croppers.
- Attention to and (advisory) support of acquiring lease-titles (certificate of occupancy). This is also a topic of mutual interest and of conflict between the two groups, each wanting to acquire the certificates. It can be coupled to land redistribution aiming at win-win solutions. A topic which requires experienced expertise and much preliminary reconnaissance of the actual situation and conflicting interests.

14 Reduction of Cattle Mortality by DDP, Sustainability

14.1 Key Findings/Insights

Mortality in a Fulani herd in Nigeria can be as high as 28% of the herd (Areghore, 2005). An average calf mortality of 35% and 23% respectively is reported for 500 indigenous herds in Tanzania with dips not working and dips working coupled with an adult mortality of 6% and 3% respectively (Brandt et al., 2001. p.521). A high mortality of European breeds imported on large-scale dairy farms was reported in Nigeria while on fieldtrips in 2011. On two farms visited the number of animals went down to a mere 100 in the six years after importation of 300 Holstein-Friesians. The animals suffered from and were weakened by heat-stress and their subsequent death was due to various diseases such as FMD which was lethal for the weakened heat stressed animals. It is clear from the above that high mortality is a rule and not an exception. It is therefore an essential factor to be considered in each tropical dairy farming system.

With the efforts of DDP cattle mortality will be reduced by: better water provision, more veterinary support from technical assistants linked to the MCC; easy availability of the proper drugs at the MCC; the increased attention to tsetse control; and concentrate use.

14.2 Recommendations

R14.2-1 ***Effectuation of DDP will promote that the increase of the number of cattle will be at an accelerated rate. Based on this are the following four recommendations:***

R14.2-1a ***Monitoring of the number of cattle***

The importance of insight into this has to be explained to the Fulani, in case they are not already convinced of this.

R14.2-1b ***Monitoring the mortality of cattle***

The importance of insight into this has to be explained to the Fulani, in case they are not already convinced of this.

R14.2-1c ***Promotion of the sale of cattle by the Fulani, see R2.2-3***

Keeping unproductive cattle (mature steers, non-reproductive cows) will be at the cost of the productive cattle (calves, heifers, immature steers, cows, selected bulls). Is a mindset change needed with respect to not keeping and not feeding unproductive animals any longer than

necessary; or are these animals generally sold already? If not the focus for a mindset change should be possibly on the presently young generation (in age and/or openness for change).

R14.2-1d *Checks on, monitoring of, the feed situation, sustainability*

Is there enough feed, land for grazing (overgrazing). The vicious circle of overgrazing may be speeded up by the “10%” goal. However as remarked in R8-2.1: a desired side effect of the “10%” goal may be some recovery of degraded grazing land by cattle feces containing more P, as cattle is supplemented with concentrates, P and minerals. The recovery will be a slow process possibly some first signs, e.g. a gradual change in vegetation, may be visible after 3 years. Use can be made of Remote Sensing, as noted in R13.2-3.

R14.2-2 *Land use planning, nature conservation, sustainability, fertilizers*

Increase of dairy production and increase of cattle numbers might lead to expansion of grazing land by deforestation or developing wet lands. Land use planning should limit unbridled opening for agricultural expansion of these “natural” environments. In many situations when considering expansion or increase of agricultural production, a choice can be made between promoting fertilizer use on cultivated land, or opening new land.

15 DDP: Time Frame, First Accomplishments, Activities in 2012

15.1 Timeframe, MoU between FCW and FMA&RD

The NDEI LoL-USAID project executed in 2004-2006 focused on support to and assistance with innovation for peri-urban smallholder livestock producers around Abuja. After the 25 months project was completed successfully its conclusion was that it would require a minimum of 5 years of uninterrupted project implementation to put in place a sustainable dairy program in Abuja in particular, and Nigeria in general.

A successful Swiss supported program introducing dairy production by smallholders in Tanzania expanded over 25 years up to the phase of complete independent sustainability after gradual transfer to farmer cooperatives with national government support.

It is clear that a successful switch of the Fulani to commercial milk production, will require many years of intensified attention, extension and support. A good fundament for this switch to commercial milk production is the five year stretch of the DDP, as formulated in 2010 in the MoU between FCW and FMA&RD.

15.2 First Accomplishments of DDP after its Start in 2010

FCW started to collect milk in June 2010 from large scale dairies at Shonga, Kwara State.

A plan for a MCC at Fasola, Oyo State, with cooperation from Fulani producers was developed by NLDP and FCW. Two assistants were appointed and trained by FCW. They subsequently trained the Fulani amongst other on milking-hygiene. Milk delivery and collection started in December 2011.

A more detailed time schedule and overview of activities and accomplishments is presented in Appendix 5.

15.3 DDP Activities in 2012

In 2012 the establishment will be completed, and operation started, of 6 MCCs (4 in Oyo State and 2 in FCT).

The DDP baseline report will be completed in March 2012. Based on this, a stakeholder's workshop as well as a core partners meeting will be held in the 2nd quarter of 2012 to create a

wide platform for DDP of high-level stakeholders to discuss the DDP, exchange ideas and make improvements on planned actions.

It is expected that by November 2012 a lot of field experience will have been gained, successes scored, first lessons learned and constraints identified. All these will serve as a base for defining DDP plans for 2013. Possibly improvement and consolidation of the activities started in Oyo State and FCT will take prominence in 2013, providing a solid base for expansion of DDP to other States in 2014, though it is also possible that expansion of DDP in other States will be started already in 2013.

A more detailed time schedule and overview of activities in 2012 is presented in Appendix 5.

16 Roles and Responsibilities of Core Partners/Implementers

The responsibilities in the DDP project have been divided and are assigned to the three core partners as follows (Anonymus, 2010; Anonymous, 2011a; Anonymus, 2011b):

FCW:

- daily receiving, control and timely periodic payment of milk at the MCC;
- development of the infrastructures like MCC's;
- daily management and maintenance of the MCC;
- intermediation in the sale of veterinary drugs at the MCC;
- basic extension assistance to producers
- a leading role in development of potential dairy crossbreeding schemes

NLDP (FMA&RD) has the final responsibility of several activities which are the task of Federal and/or State governments and/or Local governments:

- establishing grazing reserves in regions delivering to MCC's for settling Fulani pastoralists;
- financing and construction of infrastructure of grazing reserves, feeder roads, water dams, boreholes and other structures;
- land lease-titles (Certificate of Occupancy);
- infrastructure in areas outside grazing reserves delivering milk to MCCs which are part of the DDP;
- delivering efficient communal veterinary services in the MCC's clusters like various vaccination campaigns, eradication of tsetse flies;
- a leading role in development of potential dairy crossbreeding schemes

IFDC: has the responsibility of assisting in matters not covered explicitly by FCW and NLDP. These are matters which require specific expertise to work out practical questions which have been foreseen or which come up during the execution of DDP. The first example of this is the preparation of a baseline document for the DDP, for which experts had to be contracted.

An overview of potential questions on which IFDC will be required to provide expertise is presented in Chapter 17.

As an integral part of the 2SCALE project BoP Inc will be actively involved to in DDP (Anonymous, 2011b). This with respect to develop inclusive business models:

- Provision of business development services (market research, consumer insights, design business case).
- Proposal of a model to include base-of-the-pyramid customers and local stakeholders in the demand chain.
- Support in the design of scaling this inclusive business model both at the production as well as the consumer side.

Farmers and local agro-dealers in partnering agribusiness clusters will be the main beneficiaries of the pilot as programmed for DDP collaboration with the 2SCALE project (Anonymous, 2011b). As the cluster formation is a bottom-up approach, they will have a role to play in:

- Supplying good quality milk to the MCC.
- Willingness to settle down and integrating livestock activities and crop activities.
- Willingness to intensify their livestock production system by improved breeding, feeding and disease control.
- Willingness of the crop farmers to become also dairy farmers (keeping dairy animals for integration in their crop system and supply of milk)

17 Specific Points on which IFDC Can Take Responsibility

In the Chapters 2 through 14 “Key Findings/Insights” and “Recommendations” have been presented. What are the most crucial recommendations that need first and possibly immediate attention? Those that can be solved with little effort within a short time? Those that effect social stability, between herders and croppers? Those that lead to sustainability, or those that create prospects for considerable economic gains?

Optimally attention should be given to all the recommendations. But this is clearly impossible. Thus a selection has to be made which recommendations deserve priority. This selection has to be an ongoing activity, as the urgency to address certain points will fluctuate over time, and new thus far hidden attention points will come up, and some attention points will be solved or disappear.

Below a subjective selection of recommendations for the first months of activities is listed. The list is partly based on the criteria: a) does the recommendation address a side effect of the strive for the “10%” goal; b) is there a risk that when no attention is given to the recommendation that unwanted side effects are irreversible; c) will focus on the recommendation lead to the detection or creation of beneficial side effects of the strive for the “10%” goal.

1. The DDP baseline document. This provides amongst others:

- an overview of present dairy activities in Nigeria;
- the quantified estimates milk and beef production of different production systems;
- options how to achieve the "10%" goal by FCW;
- the feed situation in Nigeria and possible improvements;
- plans for the first innovations and demonstrations for semi-settled Fulani in grazing reserves and on large scale dairy farms;
- alternative potential dairy crossbreeding schemes.

2. Organization of a stakeholder's workshop with core and none - core partners.

3. Organization of a meeting with core partners.

4. Provide expertise in the economic and technological evaluation and reconnaissance of different concentrate options in Nigeria.

5. Provide expertise in evaluating the willingness and possibilities of changes in the traditional way of the Fulani's viz.:

- to change the practice of not using any concentrates;
- to change the practice of keeping too many unproductive animals in their herds at the cost of productive animals and at the cost of environmental degradation by overgrazing.

6. Installation and demonstration of new improved forage grasses and legumes and fodder crops in semi-settled Fulani environments in Oyo State and in FCT, and on a large scale dairy farm in Kwara State (see Appendix 6).

7. Provide expertise and propose win-win solutions on gender questions if any indirect side effects of the "10%" goal arises on the position of women, for example the payment of concentrates and veterinary drugs. Should these be paid for from the milk money (traditionally for the women) or should it be charged to the men, owners of the animals, in view of increased animal survival?

8. Provide expertise on how to develop more mutual communal ways of living together for Fulani herders and Yoruba croppers.

9. Land redistribution and land lease titles, striving for possible win-win solutions for herders and croppers.

10. Obtaining maximum information out of MCC records on Fulani animal husbandry and economics.

11. Evaluating different economic options of dairy coupled with beef for Fulani and large scale dairy framers.

12. Investigations and/or rough calculations on the profitability of fertilizer use on natural range and on established plantings (“pastures”, protected areas) of improved forage species.

13. Expertise for long term decisions.

The core partners have to make a choice which of the above points or other points to address. IFDC can retrieve and assign expertise to facilitate a discussion and decision making on the priority selection of the recommendations. Some urgent recommendations have to be addressed by experts, others lend themselves as topic for MSc or PhD dissertations.

18 Conclusion

FCW aims to collect 60 million liters of milk per year, 10% of its milk powder import, as fresh milk from Nigerian milk producers by 2016. Initial efforts to collect milk from indigenous Fulani cattle, herded by semi-settled Fulani have been successful. Milk is daily delivered from different herds to the newly established FCW Milk Collection Center (MCC) situated at Bale Fulani settlement near Fasola town, Oyo State. After cooling to 4°C, the milk is transported to the FCW processing plant in Lagos. The plan of DDP at this pilot stage is to replicate this system in other selected states. In this way it is hoped that the 10% target will be met.

But to effectively achieve this goal, the authors are of the opinion that the milk yield of the lactating cows in the herds has to be raised to ensure an increased delivery of milk, otherwise too many MCCs will have to be established and too large distances have to be covered daily for the transportation of the milk.

Milk production can be substantially raised by introducing concentrates into feeding and by introducing crossbreed cattle into the herds. A minimum of 13,000 crossbreed cows are needed for this and these cows are not available. Breeding of these cows will take too much time considering the 2016 deadline.

Consequently the little increase of the basal 0.75 l/d/lactating cow by supplement feeding of concentrates, which doubles the milk production of the cows, is the only possible alternative. The 10% target can be met without crossbreed cattle, using 220,000 grazing Fulani cows, and supplementing 45,000 ton of concentrates per year. To collect this milk it is estimated that 51 MCCs are required. The 10% target can also be achieved by using 5,000 crossbreed cows (to replace 57,500 Fulani cows) and 162,500 Fulani cows, and supplementing 34,000 ton concentrates per year. To collect this milk 43 MCCs are required.

It will require a change in the mindset of the Fulani, to daily spend money buying concentrates as supplement feed for their lactating cows. But the use of concentrates will not only raise the milk yield, it will also lead to a considerable reduction of the mortality of calves and dams. And in this way to an increase of the herd, allowing more sales of animals.

As discussed earlier, there are many other side effects, which could come up in the strive to achieve the 10% goal. A good example is the tension and conflicts between Fulani herders and Yoruba croppers over land and water. Several of these points need serious attention. And for as long as these side effects are taken care of, the 10% goal can have many beneficial win-win effects for all people and communities involved.

Appendices

Appendix 1

Milk and Beef Production and Gross Revenue of Cattle Production Systems in Nigeria

(Based on literature search, expert guestimates, calculations)

The aim of the Dairy Development Project (DDP) by FrieslandCampina WAMCO (FCW) is to source by 2016 in Nigeria 10% of FCW sales. To achieve this goal first an overview has been made of different production systems (actual and potential) in Nigeria, and their annual milk and beef production. Based on this further steps will be taken, in fact the first milk collection from Fulani herds started already in November 2011.

Table A1-1. Characterization and production levels of individual cattle and herds (100 cows + other cattle) in Nigeria, considered for 7 different production system. [1)]

For the production calculations of the 7 systems herds have been assumed of 100 cows and related cattle (calves, heifers, steers and bulls or AI). Total head of cattle in each herds is around 300. (Note the number of families considered of each production system. E.g. for the crop-dairy smallholder 10 to 20 families, in other words 5 to10 cows per smallholder family.)

	Fulani nomadic	**Fulani grazing reserve**	**Fulani semi settled**	**Fulani settled**	**Crop-dairy smallholder**	**Large Scale dairy**	**Dairy smallholder**
No. of families	1	1	1	1	**10 - 20**	1	**5 - 10**
No. of dependants							
l/d/cow presently	0.75	0.75	1.5	5	8	15	10
Calf mortality %	35	30	20	20	20	15	20
Milk ton/yr not considering mortality ton/yr	12.5	12.5	28.6	77.1	144.0	360	180

	Fulani nomadic	Fulani grazing reserve	Fulani semi settled	Fulani settled	Crop-dairy smallholder	Large Scale dairy	Dairy smallholder
Milk ton/yr considering. mortality corr., ton/yr	10.9	11.3	26.3	72.5	136.8	311	171
Live weight not considering mortalityton/yr	12.5	12.5	15.8	17.2	23.3	32.0	23.3
Live weight gain, considering mortality, ton/yr	4.9	6.0	9.5	11.9	17.9	23.9	17.9
Milk value (60N/l) N/yr [2)]	0.65 E6	0,68 E6	1.6 E6	4.4 E6	8.2 E6	18.7 E6	10.3 E6
Lv.wt. value (500N/l)N/yr[2)]	2.45 E6	3.00 E6	4.8 E6	6.0 E6	9.0 E6	12.0 E6	9.0 E6
Gross cattle (dairy+beef) production/family N/yr [2)]	3.10 E6	3.68 E6	6.4 E6	10.4 E6	0.9 E6 up to 1.7 E6	30.7 E6	1.9 E6 up to 3.9 E6

[1)] Table 1 is a condensed version of Table 2 below.

The objective of the Table is to get some insight into the cattle production in Nigeria, some emphases on milk production. Seven production systems have been distinguished. Geographically all located in the "Tall Grass Savanna" ot "Guinea Savanna" in the Central East-West belt of Nigeria. Cattle production is for 95% dominated by herds of the Fulani, for the largest part a nomadic system, particularly in the Northern drier part of the Tall Grass savanna, where this transcends into the Short Grass savanna.

There are little or no quantitative data on the production systems. By lack of better guestimates have been made based on international and Nigerian literature and expert judgment.

[2)] 1 N = 1 Naira = 0.005 Euro

The milk production 5 l/d of the "Fulani settled" system is only possible thanks to the concentrate feeding. My other calculations show that this practice is marginally economical, and probably/certainly will not be practiced by Fulani.

The milk production 8 l/d of the "crop-dairy smallholder system is only possible thanks to concentrate feeding and a proportion of crossbreds in this herd. Both these presumptions are not realistic for the present phase of dairy in Nigeria.

The milk production 15 l/d of the "large scale dairy" system is presently not achieved by large dairy holdings in Nigeria. At the moment these are not or marginally profitable, to my knowledge.

REMARKS with respect to the assumptions and method used for the production estimates in Table A1-2.

First calculations have been made for a dynamic steady state herd not considering mortality (in other words, the mortality is zero). The calculations are made for 100 cows in each of the production systems. The number of bulls is 15, only on the large scale dairy AI is being used. Added to cows and bulls are young animals (calves, heifers and steers), their number based on the steady state corresponding to the characteristics of the production system, as presented in Table 2. Bulls and cows are assumed to have constant live weight. For the live weight production calculations only the young animals are considered. Live weight of the calves starts at conception, 0 kg. Live weight increases up till the animals reach maturity. After that they are no longer part of the steady state system. Maturity is reached for heifers at the age of first calving. E.g. age at first calving is 3.5 yr than the time to reach maturity live weight is 3,5 years The same number of years has been taken for the steers to reach maturity. The weight of the calves/heifers/steers at different ages have been estimated and are presented in Table 3. These weights have been used in the calculations instead of growth rates kg lv.wt./d/young animal.

After these first calculations a calculation is made considering mortality. This is done by a reduction of the production without mortality, by the mortality linked to the production system under consideration.

Table A1-2. Characterization and production levels of individual cattle and herds (100 cows + other cattle) in Nigeria. Based on literature search, expert guestimates, calculations by Heko W. Köster; hekow.koster@gmail.com. February. 2012. [1)]

	Fulani nomadic	Fulani grazing reserve	Fulani semi settled	Fulani settled	Crop-dairy smallholder	Large Scale dairy	Dairy smallholder
No. of families [2)]	1	1	1	1 n.p.	10 – 20 n.p.	1	5 – 10 n.p.
Land title [3)]				y	y	y	y
Land area ha [4)]							
Native cattle	y	y	y	y	y		
Crossbred cattle				y	y	y	y
European breed						y	
Artificial Insemination [5)]				p	(cy) p	y	(cy) p
Av. Adult cow lv.wt kg	250	250	275	300	350	400	350
Av. Calf at birth lv.wt kg	15	15	17	20	25	37	25
Av. Calf of 1 yr lv.wt. kg	50	50	70	90	130	175	130
Calving interval month	24	24	21	21	18	15	18
Age at 1stcalving yr	4	4	3.5	3.5	3	2.5	3
Calf mortality % [6)]	35 (9)	30 (7.5)	20 (5)	20 (4)	20 (3)	15 (1.5)	20 (3)
Adult mortality %	7 (3.5)	6 (3)	6 (3)	4 (2)	4 (2)	6 (5)	4 (2)
Mortality milk reduction %	12.5	10.5	8	6	5	6.5	5
l/d/cow presently [7)]	0.75*	0.75*	0.75	n.p.	n.p.	10	n.p.
l/d/cow potential [7)]	2	2	1.5*	2-10	2-15 8*	10-25 15*	2-15 10*
Lactationperiod days [8)]	333 *	333 *	333 *	300 *	270 *	300 *	270 *
Total no. of cows	100	100	100	100	100	100	100
Lactating cows/yr [9)]	50	50	57	57	67	80	67
Total head cattle [10)]	315	315	315	315	301	300	301
Milk ton/yr [11)]	12.5	12.5	28.6	77.1	144.0	360	180
M. mortality corr. ton/yr [12)]	10.9	11.3	26.3	72.5	136.8	311	171
Live weight ton/yr [13)]	12.5	12.5	15.8	17.2	23.3	32.0	23.3
L.w.mortality corr.ton/yr [14)]	4.9	6.0	9.5	11.9	17.9	23.9	17.9
Milk value (see Table 1)							
Lv.wt. value (see Table 1)							
Range	y	y	y	y			
Crop stubble	y	y	y	y	y		
Crop residue	y	y	y	y	y		
Improved pasture		(y)		(y)	y	y	y
Fodder crops					y	y	y
Zerograzing					p	p	p
Silage					p	y	p
Hay					p	y	p
Fertilizer					y	y	p
Salt							
Mineral licks							
Concentrates			(cy) p	(cy) p	(cy) p	y	(cy) p

	Fulani nomadic	Fulani grazing reserve	Fulani semi settled	Fulani settled	Crop-dairy smallholder	Large Scale dairy	Dairy smallholder
Urea lick blocks							
Milk replacer							
Water distance <500m [15)]				y	y	y	y
Medicines/drugs							
Veterinarian							
Fencing/barrier		y		y	y	y	y
Stable/shed						y	
Animal traction							
Tractor, etc.					p	y	p
Labor							

[1)] The objective of the Table is to get some insight into the cattle production in Nigeria, some emphases on milk production. Seven production systems have been distinguished. Geographically all located in the "Tall Grass Savanna" ot "Guinea Savanna" in the Central East-West belt of Nigeria. Cattle production is for 95% dominated by herds of the Fulani, for the largest part a nomadic system, particularly in the Northern drier part of the Tall Grass savanna, where this transcends into the Short Grass savanna.

There are little or no quantitative data on the production systems. By lack of better guestimates have been made based on literature and expert judgment.

[2)] As the quantitative comparison of the production systems is based on a herd, centered around 100 cows as a permanent characteristic. The number of families is indicated which in the respective production system are likely to own together 100 cows. For Fulani and for the large scale dairies this is probably one family, for smallholders 5 – 100 families.

Cells of the Table with "n.p.", indicate that this system is not in existence in Nigeria.

[3)] In the Table cells have been left open in case the object is not present in the corresponding production system. A "y" is put in the cell when it is present

[4)] No attempt have been made to estimate area of land

[5)] A "p" in a cell indicates that in the future, the object is possibly included in the corresponding production system.

A "(cy)" in a cell indicates that the object has been assumed to be present for the calculations of the corresponding production system

[6)] Mortality of both calf and adult (cow in this case) effect the milk production. The figure placed in between brackets is the percentage value by which the milk production is reduced. The sum of these figures is total milk yield reduction due to the death/mortality of calves and cows. The total milk yield reduction has been put in the next row below.

[7)] In all systems calves are either suckling milk from their dam or it's being fed to them. Figures in the Table refer to the yearly milk production of a lactating cow, to drawn milk only, so not included is the milk suckled by or fed to the calf. Cells of the Table with "n.p.", indicate that this system is not in existence in Nigeria. Figures marked with an asterix * will be used for calculations of milk and lv.wt. production.

[8)] Fulani milking periods generally can be much longer with at the end very low milk yields per day. In the Table the period is shortened which is compensated by a higher milk production per day.

[9)] Herd production calculations, and the number of lactating cows, are based on 100 cows in the herd of each of the different systems.

[10] The sex and age composition of the herds is different and characteristic for each system. Details are given in the text. With respect to live weight calculations the same weights are taken for male and female animals.

[11] (Herd) Milk production calculations per year are based on: figures marked with an asteryx in the Table, drawn liter milk/d/(lactating)cow; the lactation period, and the number of lactating cows per year.

[12] (Herd) Milk production corrected for mortality, which shows the estimated actual milk production.

[13] (Herd) Live weight production is first calculated over a period equal to the period between calving and maturity, i.e. age at first calving. This is subsequently averaged to herd production per year. In each system calves receive milk from the dam.

Only growing animals are considered. That is from zero, the fertilized egg/embryo, via new born calf to the weight of the mature animal, adult cow. An overview of the live weights of animals of the different production systems and of different age are presented in the Table 3 below. With respect to live weight calculations the same weights are taken for male and female animals. It is assumed that mature cows and bulls in the herd do not change in weight.

[14] (Herd) live weight production corrected for mortality, the estimated actual lv.wt. production.

[15] A lactating cow should spend the least energy possible on walking. E.g. when the walking distance to obtain water is in excess of 1 km, the milk production is reduced by 10% per extra 4 km in flat terrain, and in hilly country by 10% per extra km.

Etc.: Animal/ha; Liter/ha; kg lv.wt/ha; Manday/liter; Manday/kg lv.wt.; Total Farm costs; Naira/liter milk; Naira/kg lv.wt

Table A1-3. Live weight of young animals at different ages in 7 different production systems

Age		**Fulani**			**a) Crop-dairy b) Dairy smallholder**	**Large scale dairy**
		a) Nomadic b) Grazing res.	**Semi settled**	**Settled**		
yr	month	lv.wt. kg /animal				
0	0	15	17	20	25	37
1	12	50	70	90	130	175
1 3/12	15					210
1,5	18				200	
1 9/12			110	135		
2	24	110			250	
2,5	30					400
3	36	180			350	
3,5			275	300		
4	48	250				

Some other derived info, not relevant for the milk and live weight production calculations

Herd composition and herd production estimate based on a herd with 100 cows - without taking in consideration the loss of animals due to mortality

- The nomadic and the grazing reserve Fulani herd totals then: 315 head of cattle, comprising 50 lactating cows, 50 calves which are born and grow, 50 dry cows, 150 young animals (heifers and steers) which grow or in other words gain live weight, and 15 bulls.
- The semi-settled and the settled Fulani herd comprises then: 300 head of cattle, with 57 lactating cows, 57 calves which are born and grow, 43 dry cows, and 143 young animals (1 year old calves need another 2.5years to reach maturity. 2.5yr x 57 calves/yr = 143, the heifers and steers) which grow or in other words gain live weight, and 15 bulls.
- The crop-dairy smallholder herd and the dairy smallholder herd then comprise: 301head of cattle, with 67 lactating cows, 67 calves which are born and grow, 33 dry cows, 134 young animals (1 year old calves need another 2 years to reach maturity. 2 yr x 67 calves/yr = 134, the heifers and steers) which grow or in other words gain live weight, and AI replacing the bulls.
- The large scale dairy herd then comprises (a manifold of): 300 head of cattle, with 80 lactating cows, 80 calves which are born and grow, 20 dry cows, 120 young animals (1 year old calves need another 1.5years to reach maturity. 1.5yr x 80 calves/yr = 120, the heifers and steers) which grow or in other words gain live weight, and AI replacing the bulls.

Fulani herd 100 cows

Number of head and herd composition is assumed to be the same for the nomadic system and the grazing reserve Fulani system. Grazing reserve mortality goes down, but the production level remains the same, not considering herd mortality.

Fulani system semi-settled, with concentrate feeding, some increase of lv.wt. gain, and milk production, and a further decrease of mortality.

Fulani settled system, a large production increase is obtained when concentrates are fed and e.g. 50% of the herd animals are cross-breed cattle.

Fulani herd 100 cows, nomadic system and grazing reserve system

Calving interval 2 yr
First calving at 4 yr
Bulls 10% of cows and heifers
lactating cows 50
calves 50

dry cows 50
Young animals 150 born the last 3 years and all kept up to maturity at 4 years (75 heifers and 75 steers)
bulls 15
Total head of cattle 315

Production of herd per year not corrected for mortality

Milk production

Calving interval 24 months. Fraction of total number of cows that is lactating (or calving) in one year is 12/24 = 0,5. Number of lactating cows per year is 0,5 x 100 cows = 50 cows.

Total milk production: lactating cows 50 x 1 l/d/cow x 250 days = 12,500 l/yr/herd = 12.5 ton milk/yr/herd

Live weight production

The cattle reach maturity live weight at 4 years of age in this system. Further growth of the animals beyond maturity is neglected.

Fulani herd 100 cows, nomadic system and grazing reserve system.

Calving interval 2 yr
First calving at 4 yr
Bulls 10% of cows and heifers
lactating cows 50
calves 50
dry cows 50
Young animals 150 born the last 3 years and all kept up to maturity at 4 years (75 heifers and 75 steers)
bulls 15
Total head of cattle 315

Production of herd per year not corrected for mortality

Milk production/yr/herd

Calving interval 18 months. Fraction of total number of cows that is lactating (or calving) in one year is 12/18 = 0,666. Number of lactating cows per year is 0,66 x 100 cows = 67 cows.

Total milk production: lactating cows 67 x 8 l/d/cow x 270 days = 144,000 l/yr/herd = 144 ton milk/yr/herd

Live weight production/yr/herd

The live weight or beef production equals the weight of the new born calves at the age of 1 year, 66 calves of 130 kg = 8,580 kg. Plus the lv.wt. gain of the calves born the last 3 years (now young animals with an age range 1 – 3 years), which are mature at 4 years of age, 3x50 = 150 animals.

Animal of 1 yr 50 kg, of 4 yr 250 kg (=TLU) lv.wt. Thus av. growth of the young animals is (250 – 50 kg)/3 yr = 67 kg lv.wt./yr

150 animals x 66.6 kg = 10,000 kg

Total lv.wt. production: 2,500 kg + 10,000 kg =12.5 ton lw.wt./yr/herd

Total lv.wt. production: (2,500 kg minus 35%) + (10,000 kg minus 7%) = 1,625 kg + 9,300 kg = 10.9 ton lw.wt./yr/herd

Appendix 2

Number of MCCs, Lack of Time for Crossbreeding

The aim of the Dairy Development Project (DDP) by FrieslandCampina WAMCO (FCW) is to source 10% of FCW milk powder import as fresh milk from Nigerian milk producers by 2016. In 2010, milk products sales by FCW was approximately equivalent to 550 E6 liter milk (1E6 = 1 million) in Nigeria. The 10% will be achieved in the order of 60 E6 liter of milk per year.

To this end, a Dairy Development Project (DDP) of a five-year duration was initiated with the signing of an MoU between FCW and FMA&RD in April 2011. Here the goals, activities and responsibilities of each partner are outlined in broad terms.

The plan is for FCW to collect milk from a Milk Collection Centers (MCCs) near the producers. The milk has to be brought by the producers to the MCC, and must arrive there within 3 hours after milking commences. This system is currently operational and functions effectively at the first MCC established in December 2011 in Fasola, Oyo State. The milk is transported to the MCC in a small van. At the MCC the milk is cooled down to 4 ^{0}C in a tank of 5.000 to 10.000 l, depending on the local milk supply. A total of approximately 40 MCCs is planned within a radius of 200 km from the FCW milk processing plant at Lagos and the MILCOPAN plant in Kaduna. Some years ago MCCs were established in FCT by National Livestock Development Project (NLDP). These over the years, were operating with varying degree of success. NLDP is now incorporating these MCCs into the DDP project.

At the MCC in Fasola milk is obtained from some 20 herds, which are milked at a distance from the MCC not exceeding a 2 hours drive for delivery. Based on the milk received in the dry season 550 l/d and in the wet season 1,200 l/d it can be estimated that milk is received from a total of 4,500 cows (dry + lactating). The area in which the cows graze is used for cropping including fallowing and “unused” grazed secondary vegetation. The climate is favorable with a 4-6 months dry season. Up North, the climate has a more pronounced dry season, less grazing part of the year, and with likely less cropping and a larger fraction of the land which can be used for grazing. Assuming that these factors compensate each other, then the same number of cows as in Fasola is present within a 2 hour driving distance from an MCC. So based on the driving distance milk delivery to an MCC is possible in an area grazed by Fulani herds with in total 4,500 cows (dry + lactating).

FCW is planning to establish a total of 40 MCCs for the 10%, i.e. 60 E6 l/yr in varying capacities of between 5,000 to 10,000 l/d/MCC. The largest MCC can store the wet season production of 10,000 l/d, which can be delivered daily during the 7 months wet season, followed by a 5 months dry season with a production of 5,000 l/d. Within a complete year the largest MCC can

store an average of 8.000 l/d which is equal to 2.9 E6 l/yr. In a situation where only the largest MCCs are used, then a total of 60 E6 / 2.90 E6 = 21 MCCs are required for 60 E6 l/yr. There will also be MCCs with a capacity of 5,000 l/d as it currently exists in Fasola. Neglecting these, the minimum number of MCCs will be 21.

In sum, 60 E6 liter/yr has to be collected. The minimum number of MCCs needed to achieve this are 21. The planned number of MCCs is 40 while the total number of cows delivering to one MCC (within 2 hours drive) is about 4,500 cows.

In Table A2-1 is calculated for the different production systems how much MCCs with 4,500 cows/MCC are needed to store the 60 E6 l/yr.

Table A2-1 The minimum number of Milk Collection Centers (10,000 l/d capacity) needed to Collect 60 E6 l/yr (or 0.16 E6 l/d), for different production systems.

(In a situation where the milk is collected from a total of 4,500 cows from herds within 2 hours drive from the MCC)

Production system	Production level of lactating cow	l/yr/cow [1)]	Total no. of cows for 60E6 l/yr	No. of cows, crossbreed or European dairy breeds	Minimum no. of MCCs [2) 3)]	l/d/MCC [2)]
Fulani nomadic, Fulani-herd no concentrates use	0.75 l/d/cow	109	0.55 E6	0	122	1,347
Fulani grazing reserve, semi-settled, Fulani-herd no concentrates use	0.75 l/d/cow	113	0.53 E6	0	117	1,405
Fulani grazing reserve, semi-settled, Fulani-herd, use of concentrates	1.5 l/d/cow	263	0.23 E6	0	51	3,223
Fulani semi-settled, mixed herd 93%Fulani cattle and 7% crossbreeds	(2.2 l/d/cow)	333	0.18 E6	12,600	40	4,110
Fulani settled, mixed-herd 80% Fulani cattle and 20% crossbreeds	3.0 l/d/cow	552	0.11 E6	22,000	24	6,849
Fulani settled, mixed-herd 20% Fulani cattle and 80% crossbreeds	8.0 l/d/cow	1420	0.04 E6	32,000	(9[3)] >20	< 10.000
Large scale dairy, crossbreeds and European breed; use of concentrates [4)]	10.0 l/d/cow	2073	0.029 E6	29,000	(6) >20	< 10.000
Large scale dairy, crossbreeds and European breed; use of concentrates [4)]	12.0 l/d/cow	2488	0,024 E6	24,000	(5) >20	< 10.000
Large scale dairy, crossbreeds and European breed; use of concentrates [4)]	15.0 l/d/cow	3110	0.019 E6	19,000	(4) >20	< 10.000
Total no. of cows in Nigeria, estimates			5 E6	< 5,000 ?		

[1)] Average production per cow in a herd, considering lactating cows, dry cows, mortality of calves and cows in the herd. Detailed calculations of the milk production default values/guestimates have been presented in another document.

[2)] The largest MCC can contain 10.000 l. For 60 E6 l/yr a minimum of 21 MCCs is required.

3) In between brackets the minimum collection points with each 4,500 cows. More than one large collection tank needed for each of these collection points.

[4)] Milk production per cow, depending on amount of concentrates fed (ratio concentrate price, milk price) and level of farm management.

Table A2-1shows:

- that Fulani cattle even with the use of concentrates will require at least 122 MCCs each with 4,500 milking cows, for delivery of 60 E6 l/yr. This is much more than the planned 40 MCCs.
- the production of 60 E6 l/yr collected in 40 MCCs can only be achieved with 7% crossbreed cows in a "Fulani+crossbreed" herd and with use of concentrates. For this, a total of 180,000 cows are required, out of which at least 12,600 are crossbreed cows.
- by increasing the number of crossbreeds to 32,000 the total number of cows can be reduced to 40,000 cows.
- lactating crossbreed cows will require about 5 kg concentrate per day for their milk production of 10 l/d/cow. The quantity of concentrates needed will depend on the quantity and feed value of the grass consumed during grazing, distance to drinking water, etc.
- a larger low milk producing herd is not just a disadvantage for the milk-beef producer. A larger herd with low milk producing cows will produce more live weight or beef at less concentrate cost.
- additional calculations are needed to determine what is more economic. A large herd of Fulani cattle with low milk production per cow and no concentrate feeding, or a small herd Fulani + crossbreed cows with concentrate feeding and a high milk production per cow.

To determine the difference in beef production of these herds, different scenario's should be considered including one in which milk is not collected from low producing cows, as collection of their milk is not economic or worth considering by FCW.

- the attention of the DDP project should also be directed at the large scale dairy farms in Nigeria. This is because they are a source of improved dairy breed cattle, and they display a very different approach to dairy farming from the Fulani system. A joint effort towards achieving more milk production will be a good opportunity for both parties offering DDP the opportunity to demonstrate several innovations (calf rearing, new forage species, irrigation, etc.). Their role as a source of contribution to the 60 E6 l/d milk collections by FCW is important but not certain especially because over time, they may prefer to do the profitable processing of milk by and for themselves in which case they many withdraw their contribution to the FCW DDP goal. Under certain conditions however, a joint venture with FCW may overcome this.
- Table A2-1 does not show what is written in the text, namely that Table A2-1 is based on many assumptions. So the calculated results presented are just meant to give a rough idea of the order of magnitude, and to give a gross indication of the trends coupled with dairy intensification.

To obtain one crossbreed lactating cow requires at least 3, 5-4 years (AI, followed by 9 months pregnancy, birth of calf, followed by age at first calving 33-39 months). Presently the number of crossbreed and pure European-dairy breed cows is a maximum of 4,000. Between March 2012 and January 2016 are 46 months, 2 months less than 4 years. This implies that having 13,000 lactating crossbreed cows by 2016 is not possible from the crossbreeds and pure European dairy breed cows currently present in Nigeria. An unrealistic optimistic maximum number would be around 4,000 assuming all cows come into heat during the next months and that AI is done with pre-identified semen which guarantees that 90% of the born calves will be female.

The conclusion is that the milk produced by Fulani herds delivering to 40 MCCs will be insufficient to achieve the "10%" goal by 2016. There remain three simple options to achieving this goal by 2016:

Option 1:

Establishing more than 40 MCCs. For pure Fulani herds the calculated number is 51 MCCs (see Table A2.1-1)

Option 2:

To obtain milk both from the large scale dairy's operating in Nigeria, and the Fulani.

Assume a total of 5,000 crossbreed cows in large scale dairies. These produce 50 x 311 ton milk/yr (see Table A2-1) = 15 E6 l/yr a minimum of 5 MCCs is required for this. The 45 E6 l/yr remaining will be produced by the Fulani system with concentrates.

172,500 Fulani cows and 38 MCCs is required for this. The estimated number of MCCs for this option is 43.

Option 3:

The third option to achieve the "10%" goal would be to import pregnant crossbreed heifers. This however seems too costly and will not be considered.

In considering the first two options, it should be noted that both are possible without any crossbreeding program.

Appendix 3

Land, Number of Cows, and Quantity of Concentrates for the "10%" Goal by 2016

- Land is the base of herding cattle. The cattle needed for the "10%" goal is presently grazing on: grazing land, crop residues left on arable land after harvest, arable land fallowed. So not more land is required (not considering present overstocking of much land, and the feed scarcity in the dry season).
- Land lease-titles, official name "Certificate of Occupancy". It is necessary that all traditional grazing land is registered with certificates. This will create more social and pastoral stability. Allowing better planning of and investing in grazing and cropping.

Other requirements follow below (the presented numbers are based on estimates discussed and presented in Appendix1).

Option 1 (Fulani system, concentrate, no crossbreed cows)

Number of MCCs: around 51

Number of Fulani cows: 230.000

Number of crossbreed cows: 0

Concentrates: 45,000 ton/yr.

Namely 115,000 of the cows get concentrates (lactating cows + pregnant cows 1 month before parturition) year round 1 kg concentrate/d/cow; all 50.000 calves less than 3 months old, during the 6 month dry season 250 g concentrate/d/calf.

Water: will not be considered here.

Personal for 51 MCCs: will not be considered here.

Personal for extension/veterinary care, and other support to producers: will not be considered here.

Option 2 (Fulani system, concentrate, no crossbreed cows + large scale dairy, no Fulani cattle, only crossbreed cows)

Number of MCCs: 43

Grand total of the two systems both used for option 2.

Number of crossbreed cows: 5,000

Number of Fulani cows: 172,500

Total number of cows: 177,500

Concentrates: 34,400 ton/yr.

Details of the two systems in option 2:

a) milk produced with Fulani plus concentrate system

Number of crossbreed cows: 0

Number of Fulani cows: 172,500

Concentrates: 32,000 ton/yr. Namely 86,250 of the cows get concentrates (lactating cows + pregnant cows 1 month before parturition) year round 1 kg concentrate/d/cow; some 10,000 calves less than 3 months old, during the 6 month dry season 250 g concentrate/d/calf.

b) milk produced with the large scale dairy farm system

Number of crossbreed cows: 5,000

Number of Fulani cows: 0

Concentrates: 12,400 ton/yr. Namely all 5,000 cows get concentrates average year round 4 kg concentrate/d/cow; all calves, heifers and steers total number around 7,000 get an average of 2 kg concentrate/d/animal.

Water: will not be considered here.

Personal for 43 MCCs: will not be considered here.

Personal for extension/veterinary care, and other support to producers: will not be considered here.

Details of the two systems in option 2:

a) milk produced with Fulani plus concentrate system

Number of crossbreed cows: 0

Number of Fulani cows: 172,500

Concentrates: 32,000 ton/yr. Namely 86,250 of the cows get concentrates (lactating cows + pregnant cows 1 month before parturition) year round 1 kg concentrate/d/cow; some 10,000 calves less than 3 months old, during the 6 month dry season 250 g concentrate/d/calf.

b) milk produced with the large scale dairy farm system

Number of crossbreed cows: 5,000

Number of Fulani cows: 0

Concentrates: 12,400 ton/yr. Namely all 5,000 cows get concentrates average year round 4 kg concentrate/d/cow; all calves, heifers and steers total number around 7,000 get an average of 2 kg concentrate/d/animal.

Remark. With respect to the volumes of concentrate calculated above, it can be noted that the estimate of feed, or concentrate, used for poultry production in Nigeria is in the range of 300.000 – 600.000 ton/yr (FAO. 2006. Poultry sector country review, Nigeria).

A note on Calf Milk Replacer (CRM)

Studies in 1989, 1994 and 2006 revealed that indigenous cows (zebu cows, as the White Fulani and other breeds in Nigeria) produced significantly more milk for their calves and human consumption under partial suckling and hand milking (Yilma, et al 2006. Livestock research for Rural Development. Vol. 18, no 5. www.lrrd.org/lrrd18/5/yilm18071.htm). The use of milk replacer can be only beneficial if given to calves in addition to partial suckling. This as the last stimulates milk let down and longer milking periods. In other words CRM to increase milk yields from lactating indigenous cattle is counterproductive.

Appendix 4

Feed Sources in Nigeria

In Nigeria improved pastures have not been established except on Government and University, experimental, teaching and demonstration farms. Consequently cattle depend on natural grasslands that are nutritionally poor during a large part of the year, crop residues, and/or on provision of costly concentrate feeds. Possibly in some exceptional cases urea supplementation can be used as a source of crude protein.

In the following paragraphs the mentioned sources of feed will be discussed separately.

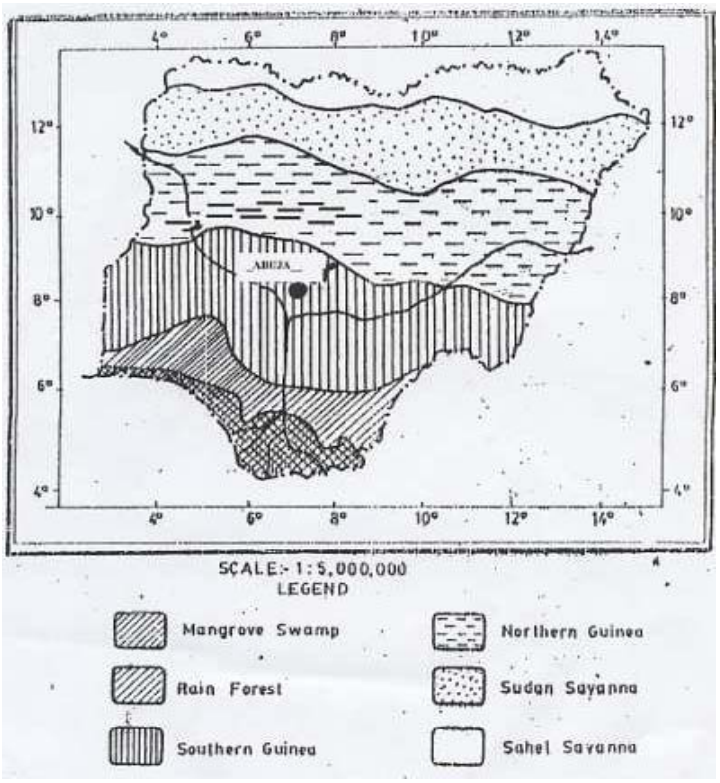
A4.1 Natural Range in Nigeria

The underlying paragraph is based mainly on FAO's "Country pasture/forage resource profile of Nigeria" (Aregheore, E.M. 2005).

About 90% of Nigeria is or has been covered by natural range (including deforested areas, now dominated "naturally" by grasses). Two major zones can be distinguished (see Figure 1):

- In the North the short grass, or Sudan savanna belt, covering about 35% of the country;
- In the central zone the Guinea savanna belt, covering about 50% of the country. This zone can be further subdivided in the Northern and Southern Guinea savanna (see Table A4.1-1);

Figure A4.1-1 Major Agro-Ecological Zones of Nigeria



Source: Agishi 1984

The natural range can be present for over many years in the drier zones, or it can be in a first stage of development on land recently fallowed after its cultivation.

The vegetation of the natural range is determined by grasses; legume-forbs are almost completely absent. The productivity and feed value vary greatly according to: season, stage of growth, grass species, water relations and nature of the soil.

During the early wet season quality is high, cp levels up to 9%. Halfway the wet season the quantity is high, but the quality is going down (young leaves with a good quality, stems and older leaves quality medium to poor). Then with the onset of the dry season the quality deteriorates, with protein levels going down to 2-5% cp. The quantity is becoming insufficient for the livestock present, a problem which is aggravated further by widespread burning of natural range.

In the savannas there are some shrubs/trees of which the leaves are green year round. Many are well known by herdsmen and smallholders, who cut down their branches in the dry season for stock feeding. Also the fruits of some form a feed resource during the dry season.

Table A41-1 Main grazing/cropping zones in Nigeria, covering about 90% of the country

Vegetation zone	Some main natural grasses	Precipitation	Dry season	Productivity	Area
		mm/yr	months	ton dm/ha/yr	km^2
Short grass savanna or Sudan savanna. Quick growing annuals, easily reseeding	Perennial and annual grasses Cenchrus spp. Foxtail, Buffel grass Aristida spp. Andropogon spp: Gamba grass Browse shrubs	500 – 1.300	6 – 8	1,9 – 2,6	320.000
Northern Guinea savanna Open woodland	Hyparrhenia spp: Jaragua Digitaria spp.: Pangola Andropogon spp.: Gamba grass	1.300 – 1.600	5 – 7	2,7 – 3,5	250.000
Southern Guinea savanna Tree savanna	Pennisetum spp.: Elephant grass Andropogon spp.: Gamba grass Panicum spp.: Guinea grass	1.600 – 2.000	4 – 6	3,5 – 4,2	200.000

Bordering to the main zones discussed above, two minor vegetation zones can be distinguished which are locally of some importance to grazing-livestock:

- The marginal savanna or Sahel savanna in the far North-East of Nigeria. It is characterized by a dry season of 9 - 10 months. Its scarce vegetation is mainly grazed by camels. In the South some natural range on roadsides and fallow land, dispersed in the coastal forest zones.

A4.2 Weeds and Grasses on Cropland

Weeds and grasses present on cropland can be “grazed” after the harvest of the crop it provides some feed in the dry season. Their quantity will be small, and their quality will deteriorate within one or two months of the dry season. Then its feed value, 0.3-0.5 kg TDN/kg d.m. and cp <5% will be below maintenance (see also Table 6.1-1). Cattle will lose weight, milk production decreases, and several calves will die.

A4.3 Crop Residues

The residues of most crops can be used as feed, though their quality (TDN and cp) is generally very low, and is insufficient for cattle to maintain weight and a reasonable condition. Regrettably this is the case for the residues of grain crops as maize, sorghum, millet and rice.

Sweet potato vines, cassava leaves, bananas leaves and stem, leaves of bean plants and sugarcane tops can be of mediocre feed value immediately upon harvest, only when the leaves are still green.

The big problem with the use of crop residues as feed is that the material comes available in a short harvest period in a large quantity, and that its generally low feed value will deteriorate fast.

A4.4 Concentrates and Agro-industrial By-Products

Concentrates and agro-industrial by-products are used in the tropics only in innovative forage based feeding systems to supplement energy and/or cp.

Examples of globally common used concentrates and their feed value are presented in Table A4.4-1. Of these, cassava tubers are the most likely to be used in Nigeria.

Table A4.4-1 Four globally common concentrates and some feed (TDN, cp) analyses results

Concentrate	**dm**	**TDN**	**Cp**
	%	kg TDN/kg dm	%
Cassava (tuber)	90	0,8	3
Maize (grain)	90	0;85; 0,86; 0,88; 0.9	9; 9; 10; 11
Soybeans	90	0,87; 0,9	26; 32
Sweet potato (tuber)	90	0,8	5

Examples of agro-industrial by-products which are present in Nigeria have been listed in **Table** A4.4-2 together with their feed value.

Table A4.4-2 Agro-industrial by-products present in Nigeria and some global feed (TDN, cp) analyses results

By product	**Dm**	**TDN**	**Cp**
	%	**kg TDN/kg dm**	**%**
Seed cotton meal (cake)	90	0,80; 0,77	46; 48
Banana peels *	8-25	0,75; 0,60	8; 8-11
Spent Brewers grain sorghum	35	0,72; 0,85	24; 32
Rice polishing	90	0,90	14
Rice bran	90	0,56; 0;70; 0,72	11; 12; 14
Rice hulls	90	0,13; 0,24	3; 3,8
Sugarcane bagasse	90	0,36	1
Sugarcane molasses	75	0,62; 0,70; 0,75	0; 7; 10
Maize bran	90	0,76; 0,76	10; 11
Wheat bran	90	0,64; 0,66; 0,70; 0,76	16; 18; 18

A4.5 Urea Supplementation

When the feed of cattle is low in protein this can be overcome by supplementation of urea, but only when the feed contains sufficient energy (> 0,75 kg TDN/kg dm). This is not the case with the feed from crop leaves, crop residues and forages. Urea supplementation is common with feeding of molasses, it can be done too when roots or chips from cassava or sweet potato are supplemented.

A4.6 Forage Conservation

A4.6.1 General

The decision to conserve forages or not is first of all dependent on the situation. Is it more economical or not, than to have a decrease of animal production in the dry season. Animals in a reasonable condition can use their body reserves to come through a period of low quality and possibly low quantity of feed. Cattle of 1 year will make up for weight and growth loss by compensatory growth once they have access again to abundant feed in the rainy season. Only for lactating cows, forage conservation is a proposition to be considered.

Several perennial shrub legumes such as Gliricidia, Calliandra and Leucaena will stay green, and show some growth through the dry season. Their wet season growth is very well suited to be reserved for the dry season. Other feed sources have to be at hand during the dry season. For this a choice can be made between options of forage conservation not requiring high financial investments, which will be presented in the following paragraphs.

A4.6.2 Standing Hay (not requiring any constructed storage facility)

Standing Hay is obtained by not using growing forage or crop residues during the rainy season, and by leaving their biomass on the field, which can then be used during the dry season. Most forage deteriorates before it is used to a degree that the quality of this feed will be hardly sufficient as maintenance-feed for cattle. In this respect Napier and sugarcane lose the least of their quality. Several perennial herbaceous legumes retain most of their leaves during the first 2-3 months of the dry season, e.g. several Stylosanthes, Centrosema, Canavalia species. Decay of part of their leaves will occur with moisture from dew and occasional light rains in the dry season.

A4.6.3 Hay Making (requiring storage of the hay, or at least protection from rain)

The saying goes that one should make hay when the sun shines, but that is difficult before the end of the rainy season, when there can be still sufficient forage of reasonable quality. This forage is cut and left in the field to dry. It has to be turned over at least once for thorough

drying. Depending on the quantity per surface area, its stemmyness and on the weather conditions at least one or two full days of sunshine are needed to obtain good dry hay.

Even with favourable weather conditions losses of total dry matter can be as high as 30%, due to respiration, leaching of soluble compounds, and mechanical losses by dropping of leaves or their tender parts. The losses are greatest of the most nutritive parts and compounds of the forage. With increasing length of the time needed for the cut forage to dry, the losses increase, the quality decreases, and sward regrowth is delayed. Hay with more than 20% moisture will deteriorate during its storage.

Hay of tropical grass contains less than 0,50 kg TDN/kg dm and less than 4% cp in general. Simplified hay bailing is possible in the following way (Onim et al., >1985). A wooden bailing box measuring 85x55 cm and 45 cm deep is used. Sisal twine strings are laid length- and crosswise in the box. On top of this the dried hay is put, which is being compressed by a man jumping on it. When the box is full each of the strings is pulled around the bail and tied together. A well pressed bail weighs around 20 kg, and can be stored up to its use. Fine forage material needs more strings than coarse material with stems.

But hay should be dried to 12-15% moisture before bailing in a humid environment. Or it will deteriorate from mould and other microbes. This also can occur when stored dry under cover, as the bales will absorb moisture to the level of the ambient humidity (Sotomayor, 20002). In tropical climates with a pronounced dry season during which cassava is harvested, hay can be made of the foliage. When done with caution and under optimal weather conditions, the feed quality can be maintained (Wanapat et al., 1997; Snijders et al., 2008).

A4.6.4 Silage Making (requiring either storage and protection from rain, or used plastic bags)

Silage making in the tropics is beset with great difficulties, because tropical grasses are: stemmy and therefore difficult to compress to exclude air; low in water soluble carbohydrates; and of low initial quality. This leads to heavy losses and poor quality silage. Some improvements are possible by: chopping the material for better compaction; adding acids or sugars (molasses). Another possibility is to use and chop fodder crops such as sorghum and maize (or additions of chopped sugarcane), with high sugar contents. Unavoidable dry matter losses will be at least 20%, even with addition of molasses, and the losses will be the greatest of the most nutritive parts and compounds of the forage, as compared to the almost indestructible crude fibre. Silage will thus have a much lower feed quality than the “mother” forage.

More recently, research in Zimbabwe and Israel, focused on possibilities for smallholders in the tropics to ensile forage. A possibility is offered by used plastic garbage bags (90-100 micron thickness), or fertilizer/maize bags (125 micron thickness) both large enough to carry 50 kg. Forage is chopped by hand with large knives to pieces of about 5 cm, air is manually pressed partially out of the bag, which is closed airtight. The last prevents the loss of liquid and volatile

silage-acids in a more efficient way than bunker or pit silages. The forage has not to be chopped to pieces of less than 5 cm, and its compression can be less. The filled plastic bags are easy to handle and to carry to the cows. The more sturdy fertilizer bags can be used twice (Titterton et al., 2002).

A4.7 Improved Forage Species

Some pasture of improved forage species were observed in grazing reserves. On 100 ha in total Gamba grass (Andropogon gayanus) and Setaria (Setaria sphacelata) have been established as standing hay during the dry season. Stemmy grasses which has a low feed value in the dry season, but providing a lot of rather unpalatable dry matter. ILRI introduced and established in cooperation with NAPRI in the 1990s more recent improved species, amongst other the legumes tropical kudzu (*Pueraria phaseolides*) and the tree/shrub Leucaena (*Leucaena leucocephala*).

In general with respect to profiting from international recent developments Nigeria is presently in the phase of “Problems and Prospects”, in accordance with the sub-title of a 2011 publication, in which it is remarked “Inadequate number of forage scientists to conduct necessary research” and in which it is stressed “the need for assessment of both exotic and indigenous species through field trials” (Shiwoya and Tsado, 2011). This can be certainly a focus point for DDP activities in cooperation with interested local milk producers.

Appendix 5

DDP Accomplishments in 2010-2011 and Activities in 2012

Accomplishments from drafting in 2010 of the MoU between FCW and FMA&RD to December 2011

June 2010

The development of a project plan by FCW and NLDP for further development of large scale dairies at Shonga, Kwara State coupled with milk collection by FCW.

August 2010

FCW's commencement of milk collection from MCCs at Shonga its processing plant at Lagos. The milk is supplied by 4 large scale dairy farms. Pasteurization of milk. Lesson learned: no market for pasteurized milk in Nigeria. The continuation of milk collection by FCW.

February 2011

Developing plan for an MCC in Oyo State by FCW and NLDP and first orientations about possible cooperation with the Fulani's.

March, April 2011

The employment of 2 assistants (John Adekunle and Samson Akinade) to work with delivering producers at the Fasola MCC in Oyo State

April 2011

Signing of an MoU between FCW and FMA&RD

May 2011

NLDP starts its search for Fulani's interested in delivering milk to an MCC and the registration of the Fulani's.

July 2011

Training of assistants John Adekunle and Samson Akinade (FCW assistants) and Shaibu Maidugu NLDP assistant in Vietnam on milk hygiene, basic veterinary care, etc

October and November 2011

Investigative visits of IFDC consultant John de Wolff and IFDC technical assistant Kobi Ikpo to core partners (FCW and NLDP) and several other non-core partners linked to DPP and the dairy sector (see Appendix 7 "Persons Contacted"; and Appendix 8 "List of Visits". A concept DDP baseline report was drafted by Unfortunately John de Wolff had to terminate his assignment prematurely due to sudden serious medical problems. A follow up by a new IFDC consultant was planned for early January-February 2012, but had to be postponed to late January 2012 for security reasons.

December 2011

Milk delivery by Fulani to the MCC at Fasola

Detailed overview of proposed activities for 2012

1. Innovation for Fulani in 2012. Sale of fresh milk after (long distance) transport by producers to MCC

It is expected that the successful commencement and smooth milk delivery operations by the Fulani's to the MCC at Fasola, Oyo will continue throughout the year. Though it has to be pointed out that the first three months were in the dry season with easy to pass dirt roads. It is hoped that the delivery time of maximally three hours can also be met in the wet season, when road conditions deteriorate.

2. The DDP-March 2012 baseline report

Investigative visits of IFDC consultant Heko W. Köster and IFDC technical assistant Kobi Ikpo to core partners (FCW and NLDP) and several other non-core partners linked to DPP and the dairy sector (see Appendix 7 "Persons Contacted"; and Appendix 8 "List of Visits". A concept DDP The DDP baseline report will be completed in March 2012. Based on this, a stakeholder's workshop as well as a core partners meeting will be held in the 2nd quarter of 2012 to create a wide platform for DDP of high-level stakeholders to discuss the DDP, exchange ideas and make improvements on planned actions.

3. Improvements of roads in the year 2012 in areas where milk is transported and delivered by producers and also collected and transported by FCW

4. Innovation for the Fulani's in 2012 viz the use of concentrates for milking cows, and for calves in the dry season too.

A next step hoped for is the use of concentrates by the Fulani. To achieve this, a change of mind set with regards to investing money on a daily basis on the cattle is a first step that must be done. How to approach this? (see: par. 11.4 point 12; and par. 11.6).

5. Expansion of the number of MCCs in Oyo State and FCT in 2012

Three more MCCs will be established and commence operations in Oyo State and another two in the FCT.

6. Training of 15-20 technicians (feed, animal husbandry, veterinary basics) for extension to producers delivering at MCCs

7. Establishing 50-100 meter deep water boreholes with solar energy water pumps

8. Erecting water dams for ponding water

9. The evaluation of 2012 DDP activities, developments and progress and defining DDP targets for 2013

It is expected that by November 2012 a lot of experience will have been gained, successes scored, first lessons learned and constraints identified. This provides a base to define in December 2012, DDP plans for 2013.

Appendix 6

Innovations and Demonstration Farm(s), First Ideas and Actions

The aim of the Dairy Development Project (DDP) by FrieslandCampina WAMCO (FCW) is to source by 2016 in Nigeria 10% of FCW sales. Part of the project focusses on innovations and demonstrations aiming at higher and more economic milk production in Nigeria. Below are some first thoughts on innovation and demonstration.

1. Innovations

With respect to innovations the following levels or phases can be distinguished.

Innovations which are being implemented at farm level.

In case of the Fulani near MCCs (in grazing reserves; and semi-settled):

- Hygiene with respect to milking hygiene, collection at farm level and farm gate delivery.
- Correct use of veterinary care and products.
- Improvements of the water provision for all cattle, or only for lactating cows.

In case of the large scale dairy farms:

- all the above indicated for Fulani and the use of concentrates are already implemented and have been common practice for some decades.
- silage making of fodder maize.
- special calf rearing.
- AI

Innovations which have been tested locally, proven to be economic, but which have to be tested at farm level.

In case of the Fulani (in grazing reserves; and semi-settled): none at this stage (in grazing reserves 100 ha with improved grass has been established as dry season reserve, “standing hay”).

In case of large scale dairy farms: to my knowledge not any one at this stage.

Innovations which have been tested globally but not locally, proven to be sometimes economic, which have to be tested at farm level with respect to economics and ways of implementation.

In case of the Fulani (in grazing reserves; and semi-settled):

- use of concentrates for all heifers and cows, or only for lactating cows
- use of crossbreeds
- increasing number of daily grazing hours requiring longer herding time (earlier milking, earlier breakfast for the herders, preferably take-away breakfast for in the field during herding).
- calf rearing
- milk replacer
- better forage grasses
- forage legumes
- forage crops
- standing hay
- cassava supplementation
- cassava urea supplementation
- other concentrates
- hay
- silage

In case of large scale dairy farms, all the above innovations indicated for Fulani are applicable. Several of these are already common practice, as indicated above.

The innovations which need (further) testing at large scale dairy farms are:

- better forage grasses
- use of high N-fertilizer dressings on forage grasses (400 kg N/ha/yr)
- pasture establishment with improved forage grasses and fertilizer
- harvesting these forage grasses (mechanized or manually) and feeding them in the stable
- harvesting these forage grasses by the cattle (so called grazing)
- improved fodder crop types (sweet sorghum) and cultivars
- use of irrigation on these pastures during dry spells and in the dry season
- crop feed integration
- cassava leaves/branches silage
- cassava urea supplementation

2. Demonstration farm, or demonstration through selected animals in semi-settled herds, or demonstrations on farms

General objective of a demonstration farm is to show new profitable innovations which can be implemented on farms in accordance with the management level of the farmers. And considering the required conditions with respect to the farm, land, credit, safety, etc.

Generally speaking a demonstration farm requires a lot of preparation: site selection, recruitment of farm-manager, establishment of infrastructure, etc. Depending on the needed efforts and/or land from the producer (Fulani family or dairy farmer) a contract has to be made. Stating: the aim of the demonstration; the way of its execution; the obligations of, and the provisions and support by DDP; and the obligations and rewards of the producer.

For the Fulani the above mentioned prerequisites for most innovations are far from optimal. And most innovations have still to be tested. For the moment innovations can be demonstrated during their testing, on some animals within herds of semi-settled Fulani families. Possibly some innovations in combination/cooperation with smallholder crop farmers,

For the large scale dairy farms several innovations can be tested, and at the same time be demonstrated.

3. Demonstration actions

It is proposed to select innovations (which still need to be further tested) which lend themselves for test-implementation and demonstration starting May 2012. The first demonstrations will be implemented in May 2012 in two grazing reserves, and on one large scale dairy farm.

Appendix 7

Prices of Inputs and Outputs

Feedstuffs, concentrates, mineral (mixes)

Product	**Price**
Cassava chips	N25/kg
Cotton Seed Cake	N44-N88
Maize bran	N22
Cassava fresh roots	N6/kg
Cassava meal	N80/kg

Milk, etc.

Average purchase price per liter 2008: Average purchase price per liter 2009: Average purchase price per liter 2010:	32 53 N53		Average selling price per liter 2008: 159 Average selling price per liter 2009: 159 Average selling price per liter 2010: 157
Raw Milk Processed Milk sold at: Raw milk	N60/ltr N150/ltr N50/ltr	Trip reports 2011 pg 9 middle Trip reports 2011 pg 9 middle Trip reports 2011 pg 17 middle	
Processed milk sold at:	N310 to retailers N450-500 to customers	Trip reports 2011 pg 10 bottom	
1 ltr Yogurt	N250/ltr	Trip reports 2011 pg 19 middle	

Animals for slaughter; cross breeds for dairy

Product	Price
Imported pregnant dairy heifer	$3500 USD
Imported pure bred animals	N500,000
A bull 140kg	N70,000.00
Crossbreds	N1000/kg live weight

Land rent

Product	Price	Remarks
1 ha	N1.3million(average total cost)	
600 ha (25 year lease)	50.000 N/yr whole farm	
Land rent	N2,000/annum	Size of land unknown

Transportation

Product	Price	Info Source
Transportation cost per ltr of milk	N7.2/ltr	DDP Report pg 11 bottom. See paragraph 2.3 of present DDP Baseline report.

Milk cost price

Product	Price
Fulani system	cost price per liter is N50
Zimbabwean farmers system	Between N80 and N120 per liter
Other large scale dairy farmers	N250 per liter

Appendix 8

Gross margins and Key Indicators of a Tanzanian Farm

Note: $1 USD = 159 Naira = 1,590 Tanzanian Shilling

Code	Description	2006	2007	2008	2009	2010
	Herd Development:					
hc01	Number of cows at begin	13	17	17	22	17
hc02	Number of bulls at beginning	0	0	0	0	0
hc03	Number of Young stock beginning	19	21	21	22	17
hc04	Number of cows at the end	17	17	22	17	19
hc05	Number of bulls at the end	0	0	0	0	0
hc06	Number of Young stock at the end	21	22	20	22	10
	Total animals at the end of the year	38	39	42	39	29
hc07	Value of the herd at the beginning (000)	5,800	7,200	7,500	8,800	6,800
hc08	Value of the herd at the end (000)	7,200	7,300	8,600	7,300	6,700
	Turn Over:					
gm01	Milk sales (000)	21,130	17,326	36,615	41,427	42,030
gm02	Value of milk for home (000)	689	716	938	1,164	2,456
gm03	Value of cattle sales (000)	958	1,141	5,300	4,455	14,750
gm04	Value of cattle purchases (000)	0	0	1,500	0	0
gm05	Increase or decrease in value (000)	1,400	100	1,100	-1,500	100
gm06	Total turn over (000)	24,177	19,283	42,454	45,546	59,136
	Variable Cost: (000)					
gm07	Total transport costs	2,114	2,650	3,975	4,789	3,250
gm08	Total labour costs	2,596	2,288	3,768	1,716	4,232
gm09	Total concentrate costs	8,984	9,297	12,844	15,732	15,314
gm10	Veterinary costs	270	325	665	791	227
gm11	Breeding and minerals	661	983	1,033	1,174	1,609
gm12	Pasture, fodder grass and hay costs	2,584	2,514	3,662	2,718	5,324
gm13	Marketing costs	2,157	2,183	4,367	4,,432	4,473
gm14	Other costs	573	630	804	1,317	906
gm15	Total costs	19,941	20,871	31,119	32,670	35,334
gm16	Gross Margin	4,236	-1,588	11,334	12,876	23,802
gm17	Gross Margin per Cow	282	-99	566	644	1,400
	Cost Price Calculation :					
cp01	Variable costs (000)	19,941	20,871	31,119	32,670	35,334
cp02	Minus cattle sales (000)	-958	-1,140	-5,300	-4,455	-14,750
cp03	Plus cattle purchase (000)	0		1,500	0	-
cp04	Minus herd increase (000)	-1,400	-100	-1,100	1,500	100
cp05	Net costs (000)	17,583	19,630	26,219	29,715	20,684
cp06	Total litters of milk produced (000)	48	34	66	57	46
cp07	Cost price per liter	365	574	398	523	446
	Key Indicators:					

Code	Description	2006	2007	2008	2009	2010
ki01	Transport costs per liter of milk	44	77	60	84	70
ki02	Labour costs per liter	54	67	57	30	91
ki03	Concentrate costs per liter	187	272	195	277	330
ki04	Veterinary costs per liter	6	10	10	14	5
ki05	Breeding cost per liter	14	29	16	21	35
ki06	Fodder + roughages per liter	54	73	56	48	115
ki07	Marketing costs per\liter	45	64	66	78	96
ki08	Other costs per liter	12	18	12	23	20
ki09	Gross costs per liter	414	610	472	574	761
ki10	Net costs per liter of milk	365	574	398	523	446
ki11	Average herd size during the year	35	37	40	41	29
ki12	Average number of cows	15	16	20	20	17
ki13	Percentage of cows in total herd	44	45	50	48	59
ki14	Percentage of cows in milk	89	79	81	85	75
ki15	Milk per cow per year	3,139	2,073	3,308	2,904	2,704
ki16	Total mortality rate	8	13	2	10	3
ki17	Age in months of first calving	28	33	41	45	29
ki18	Calving interval in days	445	655	644	444	588
ki19	Average selling price 1 liter	439	506	556	728	905
ki20	Average price of 1 kg of concentrate	156	134	160	177	202
ki21	Kg of concentrate per head per day	5	5	6	6	7
ki22	Number of man days in cow shed + sale milk	1,290	1,200	1,520	1,250	1,080
ki23	Number of man days for fodder/roughages	1,723	1,676	2,441	1,812	3,549
ki24	Milk per man-day	16	12	17	19	10

Appendix 9

Persons Contacted

S/N	NAME	POSITION	ORGANIZATION	LOCATION	CONTACT
1.	A.A. Voh (Jnr)	Director	National Animal Production Research Institute (NAPRI)	Zaria, Kaduna State	aavohjr2@yahoo.com 08036162962
2.	Abubakar Abdulahi	MD,	Brains & Strenght Agro-Chemical Dealer Shop, Tudun Fulani, Opp Imrat Plastic Industry	Minna, Niger State	bscng@yahoo.com 08036018669, 08097473647
3.	Adekunle O. John	QualityControl/Milk Collection	FrieslandCampina WAMCO Nigeria	Lagos State	Olayiwola.adekunle@frieslandcampina.com 08034222218
4.	Adeniyi O.	Zonal Manager	Oyo State Agricultural Development Programme. Zonal Headquarters, Oyo.	Oyo State	08035680162
5.	Adebowale E.A.	Visiting Professor	National Universities Commission	Abuja. FCT	eaadebowale@yahoo.com 08035522121
6..	Adedeji Bukola	Staff	Oyo State Veterinary Department	Ibadan, Oyo State	
7.	Akinade Adebayo Samson	Extension Services, DDP	FrieslandCampina WAMCO Nigeria	Lagos State	Adebayo.akinade@frieslandcapina.com 08024021616
8.	Aligana Mohammed	Head, Livestock/MD	National Livestock Development Project (NLDP) /MILCOPAL	Kaduna State	mohdgana@yahoo.com 08039705126
9.	Barje P.P.	Head, Dairy Research Programme	National Animal Production Research Institute (NAPRI)	Zaria, Kaduna State	ppbarje@gmail.com 08039683980, 08054411922
10.	Billing Kevin	Team Leader	GEMS Support for Meat & Leather Industry, Kano	Kano State	k.billing@gems1meatandleather.com 0810 329 5153
11.	Dr. Enessy	Head of Ruminants	National Livestock Development Project (NLDP)	Kaduna State	
12..	Dr. Kareem	Veterinary Doctor	Oyo State Veterinary Department	Ibadan, Oyo State	
13.	Dr. Oriade	Veterinary Doctor	Oyo State Veterinary Department	Ibadan, Oyo State	
14.	Gbassay Tarawali	Project manager, (CEDP)	Officer in charge IITA Onne	Rivers State	g.tarawali@cgiar.org 08037001497
15.	Gimba K.A.	Veterinary Doctor	Shonga Dairies Farm 10	Kwara State	08079753004
17.	Iheanacho Okike	Country Programme Manager, ILRI	International Livestock Research Institute (ILRI) IITA, Ibadan	Oyo state	i.oiki@cgiar.org 08036672991
18.	Idris, Musa	Interpreter	Fulani Settlement, Akele, Oyo West	Oyo State	07087527885
19.	Makam Biri	Head, Grazing Reserves/Stock Routes	National Livestock Development Project (NLDP)	Kaduna State	
20.	Mbuga Patrick	Head, Dairy Development	National Livestock Development Project	Kaduna State	

			(NLDP)		
21.	Mukasa Christopher	Ph.D Student on Dairy Development	Ahmadu Bello University, Zaria	Kaduna State	cmukasauk@gmail.com 08030976153
22.	Mamman Mohammad	Director General/Chief Executive	Nigerian Institute For Trypanosomiasis Research	Kaduna	mammanm@hotmail.com +234-062238074
23.	Ohue Lawrence Inegbenoise	Dairy Development Manager	FrieslandCampina WAMCO Nigeria	Lagos State	Lawrence.ohue@frieslandcampina.com 0803-402-1318
24.	Osue, Hajj Hudu O.	Asst Director, M&E	Nigerian Institute For Trypanosomiasis Research	Kaduna State	osueho@yahoo.com 08095230956
25.	Orita Osien	Head of Planning	National Livestock Development Project (NLDP)	Kaduna State	
26.	Retzlaff Paul	Chairman	Shonga Dairies Farm 10	Shonga, Kwara State	paulretzlaff@gmail.com 08058267939
28.	Reid Irvine	Chairman	Rosedale Daries	Shonga, Kwara State	shongafarmers@yahoo.co.uk 08058484226
	Ruma Bashir M.	Project Manager	National Livestock Development Project (NLDP)	Kaduna State	barume1@yahoo.com 08033111161
29.	Sabo Muhammed	Production Manager	Maizube Farms	Minna, Niger	sembenari@gmail.com 08036426818
30.	Sabuwa Muktar	Veterinary doctor	Nagari Farms	Keffi, Nassarawa State	docmukty.sabuwa@yahoo.com 08039370285
31.	Tafida Godfrey	Special Adviser to Governor of Taraba State on Agriculture	Taraba State Liaison Office (Current office of the former Project Manager/Coorperative Development Specialist, Land O lakes Nigeria Dairy Initiative NDEI)	FCT. Abuja	tafidawes@hotmail.com 08085684145
32.	Nyam Leo	Ag. Director	National Livestock Development Project (NLDP)	Kaduna State	
33.	Mambo,M	Coordinator (FMA&RD-FCT)	Livestock Improvement & Breeding Centre/ Grazing Reserve, Paikon Kore. Gwagwalada	FCT Abuja	08032476834, 08052080969
35.	Wase Lawal	Head, Livestock Marketing Dev.lpt	National Livestock Development Project	Kaduna State	

Appendix 10

List of Visits

S/N	DATE	ORGANIZATION	ADDRESS	CONTACTS
1.	26/10/2011	Agricultural Development Project (ADP), Zonal Headquarters, Oyo	Oyo State	08035680162
2.	2/11/2011	Ardo Abdulahis Farm, NLDP Milk Collection Center	Kaduna State	
3.	12/10/2011	Brains & Strength Agro Chemicals Dealer Shop,	Tudun Fulani, Opp Imrat Plastic Industry, Minna Niger State	bscng@yahoo.com 08036018669
4.	26/10/2011	FCW Milk Collection Center, Bale Village, Fulani Settlement.	Oyo State	Adebayo.akinade@frieslandcapina.com 08024021616
5.	14/10/2011	Federal Livestock Dept, Ministry of Agriculture	FCDA, Abuja	
6.	24/10/2011	Freisland Campina Wamco, Lagos.	Lagos State	Lawrence.ohue@frieslandcampina.com 0803-402-1318
7.	26/10/2011	Bale Village (Fulani Settlement)	Oyo State	Adebayo.akinade@frieslandcapina.com 08024021616
8.	26/10/2011	International Institute for Tropical Agriculture (IITA), Ibadan	Oyo State	g.tarawali@cgiar.org 08037001497
9.	2/11/2011	Kushie Milk Producers Cooperative Society	Kaduna Saye	
10.	12/10/2011	Maizube Dairy Farms	Minna, Niger	sembenari@gmail.com 08036426818
11.	2/11/2011	MILCOPAL, Kaduna	Kaduna State	mohdgana@yahoo.com 08039705126
12.	21/10/2011	Nagari Farms, Keffi	Nassarawa State	docmukty.sabawa@yahoo.com 08039370285
13.	13/10/2011	National Agric Show Ground	Nassarawa Express Road	
14.	19/10/2011	National Livestock Development Project (NLDP)	Post Office Road, Kaduna	Barume1@yahoo.com 08033111161
15.	1/11/2011	National Livestock Development Project (NLDP)	Kaduna State	Barume1@yahoo.com 08033111161
16.	3/11/2011	National Animal Production Research Institute, (NAPRI), Zaria	Kaduna State	Aavohjr2@yahoo.com 08036162962
17.	19/10/2011	Nigerian Institute for Trypanosomiasis Research (NITR)	Federal Ministry of science & Technology Surame Road, U/Rimi GRA, Kadauna	mammanm@hotmail.com +234-062238074
18.	25/10/2011	Oyo State Veterinary Department, Ibadan	Oyo State	
19.	15/10/2011-	Shonga Dairies, Patidzuru, Bokugi In Edu LGA	Shonga, Ilorin, Kwara	08132449741
20.	17/11/2011	Shonga Dairies	Shonga, Kwara State	paulretzlaff@gmail.com 08058267939
21.	21/10/2011	Paikon Kore, Grazing Reserve, Gwagwalada	FCT	08032476834
22.	4/02/2012	Taraba State Liaison Office (Current office of the former Project Manager/Cooperative Development Specialist for the Land O lakes Nigeria Dairy Initiative NDEI)	FCT	tafidawes@hotmail.com 08085684145
23.	6/02/2012	Freisland Campina Wamco, Lagos.	Lagos State	Lawrence.ohue@frieslandcampina.com 0803-402-1318
24.	7/02/2012	FCW Milk Collection Center, Bale Village, Fulani Settlement.	Oyo State	Adebayo.akinade@frieslandcapina.com 08024021616
25.	7/02/2012	International Livestock Research Institute, Ibadan	Oyo State	i.okike@cigiar.org 08036672991
26.	8/02/2012	FCW Milk Collection Center, Fulani Settlement, Akele Town. Oyo.	Oyo State	07087527885
27.	9/02/2012	Rosedale Dairy, Shonga farms	Kwara State	shongerfarmer@yahoo.co.uk 08058484226

Appendix 11

Literature Consulted

Adebowale, E.A. 1976. Studies on dry matter, energy, and protein utilization of three breeds of dairy cows at Ibadan. PhD Thesis. Department of Animal Science. University of Ibadan. Ibadan, Nigeria.

Agyemang, K., Clifford D.J., Little, D.A. 1993. An assessment of the biological and economic efficiency in conversion of milk to meat in N'Dama calves. Animal Production 56: 165-170.

Agyemang, K., Dogoo D.L., Makun H.J. 1998. Profitability of forage production in smallholder peri-urban dairy systems. Experimental Agriculture 34: 432-437.

Agyemang, K. 2000. Dairy development in West Africa. Result of research by ILRI and its partner (1978-1998). Market oriented smallholder dairy working document. No. 8 1-201.

Ahmed A.B. 2001. A stake-holder approach to tsetse fly control in central Nigeria. Journal of Agricultural Extension and Rural Development. 2 (8): 161-166.

Amogu, U. 2004. Emerging socio-economic, institutional and policy factors likely to influence future intensification of crop-livestock systems in Nigeria. pp. 282-295. In: Sustainable crop-livestock production in West Africa.

Anonymous, 2010. MoU for PPP Arangement on dairy value chain development in Nigeria (demand driven approach) between FMARD and FCW. pp. 7. Prepared by Legal Unit FMARD. Abuja, Nigeria.

Anonymous, 2011a. MoU between IFDC and Royal Friesland Campina (FC). (FC will partner with IFDC led consortium 2SCALE in initiatives in West Africa, with an initial focus on strengthening DDP in Nigeria with FCW). Accra, Ghana/Lagos, Nigeria.

Anonymous, 2011b. FCW Draft-Pilot program for collaboration with the IFDC led consortium 2SCALE initiatives in Nigeria. pp. 9. Accra, Ghana/Lagos, Nigeria.

Aregheore, E.M. 2005. Country pasture/forage resource profile of Nigeria (last minor editing in 2009). pp. 44. www.fao.org/ag/AGP/AGPC/doc/Counprof/nigeria/nigeria.htm

Attema, S. 2012. Personal Communication at Ibadan DDP Stakeholders Workshop, April 2012.

Ayantunde A.A. 1998. Influence of grazing regimes on cattle nutrition and performance and vegetation dynamics in Sahelian rangelands. pp. 179. PhD. Dissertation. WUR. Wageningen The Netherlands.

Ayantunde A.A., Fernandez-Rivera S., McGrabb C. (eds.). 2005. Coping with feed scarcity in smallholder livestock systems in developing countries. pp.306. Animal Sciences Group, WUR, Wageningen, the Netherlands; University of Reading, UK; ETH, Zurich, Switzerland; ILRI, Nairobi, Kenya.

Bafana B., Onyango P., Bosch S. van. 2012. Remote Sensing. Dossier. Spore no. 156: 13-19. http://spore.cta.int.

Barje P.P., Ehoche O.W., Eduvie L.O., Voh (Jr) A.A., Akpa G.N., Lamidi O.S. 2006. Effect of feeding differenet levels of whole cottonseed on performance of weaned calves. Nigerian Veterinary Journal 27 (3): 36-45.

Barje, P.P., Lufadeju, I.R., Muhammad, I.R., Malau-Aduli, A.E.O., and 9 other co-authors. 2001. Smallholder dairy production in the context of crop-livestock systems in the inland valleys of Nigeria II: characterization of dairy production systems in the inland valleys around Zaria. pp. 345-348. Proceedings of the 26th Annual Conference of the Nigerian Society for Animal Production. Volume 26.

Blench, R. 2004. Natural resource conflicts in North-Central Nigeria. A handbook and case studies. pp. 106. Mallam Dendo Ltd. Cambridge, UK.

Brand A., Noordhuizen J.P.T.M., Schukken Y.H. 2001. Herd health and production management in dairy practice. pp. 562. Wageningen Pers. Wageningen, The Netherlands.

Breman, H., Diallo. A., Traoré, G., Djitèye, M.M. 1978. The ecology of annual migrations of cattle in the Sahel. Pp. 592-595. In: Hyder nD.N. (ed.).1978. Proceedings of the 1st International Rangeland Congres, Denver, Colorado, USA.

Chapeta, S. 2006. Alive-Smallholder dairy development in Sub-Saharan-Africa. Alive discussion forum on the proposed draft policy note. Final report pp.57. Danish agricultural advisory centre.

Crum, S. 2000. Aerial photography and remote sensing. pp.8. Unioversity of Colorado. Boulder, USA. www.colorado.edu/geography/gcraft/notes/remote/remote.html

Dangbegnon C., Tarfa D.B., Mando A., Amapu I.Y., Ezui S.K., Ahmed B., Saleh M.K., Abu S.T. 2011. Improved maize-legume (also dual-purpose cowpea) production systems in Nigeria. pp. 88-95. In: Nederlof S., Wongstchowski M., Lee F. van der (eds.). 2011. Putting heads together; agricultural innovation platforms in practice. pp. 192. Bulletin 396. KIT publishers. Amsterdam, The Netherlands.

Euroconsult. 1989. Agricultural compendium – for rural development in the tropics and subtropics. pp. 740. Elsevier. Amsterdam. The Netherlands.

Falvey, L., Chantalakhana, C. (eds). 1999. Smallholder dairying in the tropics. pp. 462. ILRI. Nairobi, Kenya.

Köster H.W. 1968. (in Dutch). The fertilisation of 10 main forage grasses in the tropics. pp. 70. M.Sc. thesis. Wageningen-UR University. Wageningen. The Netherlands.

Köster H.W. 2010. Feed, animal and food production, land and fertilizer requirements of smallholders in the Great Lakes Region of Central Africa. pp.173. Report available at http://ifdc-catalist.org/rwanda.php

Kristjanson, P., Waters-Bayer, A., and others. 2010. Livestock's and women livelihoods: a review of the recent evidence. pp.34. Discussion paper no. 20. ILRI. Nairobi, Kenya. (Gender task and responsibility division in Nigeria, see p.11,18).

LoL. 2007. Nigeria dairy enterprise initiative (NDEI). A two year project. Final report. pp. 33. USAID (Jim Yazman) and Land O'Lakes (Godfrey Tafida). St. Paul, Minnesota, USA.

Lufadeju E.A. and Olayiwole M.B. 1987. Intake and digestibilityn of gamba (Andropogon gayanus) hay by cattle. pp. 7 -14. In: Little D.A. and Said A.N. (eds).1987. Utilization of agricultural by-products as livestock feed in Africa. Proceedings workshop. ILCA. Addis Ababa, Ethiopia.

Makkar, H.P.S., Sanchez M., Speedy, A.W. (eds). 2007. Feed supplementation blocks. Urea-molasses multinutrient blocks: simple and effective feed supplement technology for ruminant agriculture. pp. 248. FAO Animal production and health paper, no. 164.FAO. Rome, Italy.

Meer, B. van der, Nielsen, O.K., Omitogun, A.A. 2002. Determining the acreage infested with Imperata and Striga in the moist savanna of Nigeria. 4th Int. Conf. of AARSE. Abuja, Nigeria.

Moran J. 2005. Tropical dairy farming: feeding management for small holders dairy farmers in the humid tropics. p. 285. CSIRO publishing.

Ojigi L.M. 2006. Analysis of spatial variations of Abuja land use and land cover from image classification algorithms. ISPRS commission VII Mid-Term Symposium "From pixel to processes". ITC. Enschede, The Netherlands.

Okhimamhe, A.A. 2002. Multi-source Remote Sensing data for greenness mapping in the Savanna Region of Nigeria. 4th Int. Conf. of AARSE. Abuja, Nigeria.

Okhimamhe, A.A. 2003. ERS SAR interferometry for land cover mapping in a savanna area in Africa. International Journal of Remote Sensing. 24 (18): 3583-3594.

Olafadehan O.A. and Adewumi. 2008. Milk production and economic impact of strategic supplementation of prepartum Bunaji cows in the peri-urban areas of derived savanna of southwestern Nigeria. pp. 10. Livestock research for rural development, 20 (3). www.lrrd.org/

Olaleye J.b., Abiodun O.E., Igbokwe Q. 2009. Land use change and analysis using remotely sensed data in Lekki Peninsula area of Lagos, Nigeria. pp. 15. In: Surveyors key role in accelerated development. Eliat, Israel. https://www.fig.net/pub/fig2009/papers/ts08b/1

Onim J.F.M., Semenye P.P., Fitzhugh H.A., Mathuva M. >1985. Research on feed resources for small ruminants on small holder farms in Western Kenya. www.ilri.org/InfoServ/Webpub/Fulldocs/X4458e/x5548eOe.htm

Osotihemin, K.O., Tijani, A.A., Olukomogbon, E.O. 2006. An economic analysis of small scale dairy milk processing in Kogis State, Nigeria. pp.8. Livestock research for rural development, 18 (11).

Shiowoya, L. and Tsado, N. 2011.Forage and fodder crop production in Nigeria: problems and prospects. World Journal of Life Sciences and Medical Research: 1 (4): 88-93.

Torr S.J., Vale G.A., Morton J.F. Less is more: restricted application of pyrethroids for controlling tsetse. pp.1. www.bsas.org.uk/downloads/annlproc/Pdf2

Ugbe U.P. 2011. Cowpea (dual prurpose) and soybean in Nigeria. pp. 133-140. In: Nederlof S., Wongstchowski M., Lee F. van der (eds.). 2011. Putting heads together; agricultural innovation platforms in practice. pp. 192. Bulletin 396. KIT publishers. Amsterdam, The Netherlands.

Waters-Bayer A. 1985. Dairying by settled Fulani women in Central Nigewria ands some implications for dairy development. ODI Pastoral Development Network Paper 20c. Overseas Development Insitute. London. UK.

Wolff J. de, and Ikpo K. 2011. Dairy Development Program, Initial findings and recommendations. pp. 30. IFDC. Abuja, Nigeria.

Yahuza, M.L. 2001. Smallholder dairy production and marketing constraints in Nigeria. pp. 9. Chp. 19. In: Rangnekar and Thorpe (eds). 2001. Smallholder dairy production and marketing: opportunities and constraints. Proceedings of a South-South workshop held 13-16 March at National Dairy Development Board (NDDB). Anand, India.

Appendix 12

Literature of studies in Nigeria and/or by Nigerians

(some studies related to DDP, an extensive literature retrieval for DDP was not aimed at)

Adewuni M.K. Adeleye I.O.A., Omanjula A.B., Babayemi O.J. 1999. Evaluation of cassava forage andcowpea stover as dry season supplements to Bunaji cattle fed Andropogon gayanus hay. Tropical Animal Production Investigation. 2: 41-49.

Adesehinwa A.O.K., Okunola J.O., Adewuni M.K. 2004. Socio-economic characteristics of ruminant livestock farmers and their production constraints in some parts of south-western Nigeria. Livestock research for Rural Development: 16 (8): 1-9.

Ahmed A.B. 2001. A stake-holder approach to tsetse fly control in central Nigeria. Journal of Agricultural Extension and Rural Development. 2 (8): 161-166.

Akinyede J.O. 2009. Alumni interview: a fulfilled career: ITC's first PhD student ever. www.itc.nl/Pub/alumni/News_from_Alumni/Interview_with_alumnus_Dr_Joseph_Akinyede.html

Amogu, U. 2004. Emerging socio-economic, institutional and policy factors likely to influence future intensification of crop-livestock systems in Nigeria. pp. 282-295. In: Sustainable crop-livestock production in West Africa.

Anonymous, 2010. MoU for PPP Arangement on dairy value chain development in Nigeria (demand driven approach) between FMARD and FCW. pp. 7. Prepared by Legal Unit FMARD. Abuja, Nigeria.

Anonymous, 2011a. MoU between IFDC and Royal Friesland Campina (FC). (FC will partner with IFDC led consortium 2SCALE in initiatives in West Africa, with an initial focus on strengthening DDP in Nigeria with FCW). Accra, Ghana/Lagos, Nigeria.

Anonymous, 2011b. FCW Draft-Pilot program for collaboration with the IFDC led consortium 2SCALE initiatives in Nigeria. pp. 9. Accra, Ghana/Lagos, Nigeria.

Aregheore, E.M. 2005. Country pasture/forage resource profile of Nigeria (last minor editing in 2009). pp. 44. www.fao.org/ag/AGP/AGPC/doc/Counprof/nigeria/nigeria.htm

Attema, S. 2012. Personal Communication at Ibadan DDP Stakeholders Workshop, April 2012.

Ayantunde A.A. 1998. Influence of grazing regimes on cattle nutrition and performance, and vegetation dynamics in Sahelian rangelands. pp. 179. PhD. Dissertation. WUR. Wageningen The Netherlands.

Ayantunde A.A., Fernandez-Rivera S., McGrabb C. (eds.). 2005. Coping with feed scarcity in smallholder livestock systems in developing countries. pp.306. Animal Sciences Group, WUR, Wageningen, the Netherlands; University of Reading, UK; ETH, Zurich, Switzerland; ILRI, Nairobi, Kenya.

Barje, P.P., Lufadeju, I.R., Muhammad, I.R., Malau-Aduli, A.E.O., and 9 other co-authors. 2001. Smallholder dairy production in the context of crop-livestock systems in the inland valleys of Nigeria II: characterization of dairy production systems in the inland valleys around Zaria. pp. 345-348. Proceedings of the 26th Annual Conference of the Nigerian Society for Animal Production. Volume 26.

Barje P.P., Ehoche O.W., Eduvie L.O., Voh (Jr) A.A., Akpa G.N., Lamidi O.S. 2006. Effect of feeding differenet levels of whole cottonseed on performance of weaned calves. Nigerian Veterinary Journal 27 (3): 36-45.

Blench, R. 2004. Natural resource conflicts in North-Central Nigeria. A handbook and case studies. pp. 106. Mallam Dendo Ltd. Cambridge, UK.

Dangbegnon C., Tarfa D.B., Mando A., Amapu I.Y., Ezui S.K., Ahmed B., Saleh M.K., Abu S.T. 2011. Improved maize-legume (also dual-purpose cowpea) production systems in Nigeria. pp. 88-95. In: Nederlof S., Wongstchowski M., Lee F. van der (eds.). 2011. Putting heads together; agricultural innovation platforms in practice. pp. 192. Bulletin 396. KIT publishers. Amsterdam, The Netherlands.

Kristjanson P., Tarawali S., Okike I., Singh B.B., and others. 2001. Genetically improved dual-purpose cowpea: assessment of adoption and impact on dry savanna region of West Africa. ILRI Impact assessment series 9. ILRI. Nairobi, Kenya.

Kristjanson, P., Waters-Bayer, A., and others. 2010. Livestock's and women livelihoods: a review of the recent evidence. pp.34. Discussion paper no. 20. ILRI. Nairobi, Kenya. (Gender task and responsibility division in Nigeria, see p.11,18).

LoL. 2007. Nigeria dairy enterprise initiative (NDEI). A two year project. Final report. pp. 33. USAID (Jim Yazman) and Land O'Lakes (Godfrey Tafida). St. Paul, Minnesota, USA.

Lufadeju E.A. and Olayiwole M.B. 1987. Intake and digestibilityn of gamba (Andropogon gayanus) hay by cattle. pp. 7 -14. In: Little D.A. and Said A.N. (eds).1987. Utilization of agricultural by-products as livestock feed in Africa. Proceedings workshop. ILCA. Addis Ababa, Ethiopia.

Meer B. van der, Nielsen O.K., Omitogun A.A. 2002. Determining the acreage infested with Imperata and Striga in the moist savanna of Nigeria. 4th International Conference of AARSE. Abuja, Nigeria.

Okhimamhe, A.A. 2002. Multi-source Remote Sensing data for greenness mapping in the Savanna Region of Nigeria. 4th Int. Conf. of AARSE. Abuja, Nigeria.

Okhimamhe, A.A. 2003. ERS SAR interferometry for land cover mapping in a savanna area in Africa. International Journal of Remote Sensing. 24 (18): 3583-3594.

Olafadehan O.A. and Adewumi. 2008. Milk production and economic impact of strategic supplementation of prepartum Bunaji cows in the peri-urban areas of derived savanna of southwestern Nigeria. pp. 10. Livestock research for rural development, 20 (3). www.lrrd.org/

Olaleye J.b., Abiodun O.E., Igbokwe Q. 2009. Land use change and analysis using remotely sensed data in Lekki Peninsula area of Lagos, Nigeria. pp. 15. In: Surveyors key role in accelerated development. Eliat, Israel. https://www.fig.net/pub/fig2009/papers/ts08b/1

Ojigi L.M. 2006. Analysis of spatial variations of Abuja land use and land cover from image classification algorithms. ISPRS commission VII Mid-Term Symposium “From pixel to processes”. ITC. Enschede, The Netherlands.

Osotihemin, K.O., Tijani, A.A., Olukomogbon, E.O. 2006. An economic analysis of small scale dairy milk processing in Kogis State, Nigeria. pp.8. Livestock research for rural development, 18 (11).

Shiowoya, L. and Tsado, N. 2011.Forage and fodder crop production in Nigeria: problems and prospects. World Journal of Life Sciences and Medical Research: 1 (4): 88-93.

Ugbe U.P. 2011. Cowpea (dual-purpose) and soybean in Nigeria. pp. 133-140. In: Nederlof S., Wongstchowski M., Lee F. van der (eds.). 2011. Putting heads together; agricultural innovation platforms in practice. pp. 192. Bulletin 396. KIT publishers. Amsterdam, The Netherlands.

Waters-Bayer A. 1985. Dairying by settled Fulani women in Central Nigewria ands some implications for dairy development. ODI Pastoral Development Network Paper 20c. Overseas Development Insitute. London. UK.

Wolff J. de, and Ikpo K. 2011. Dairy Development Program, Initial findings and recommendations. pp. 30. IFDC. Abuja, Nigeria.

Yahuza, M.L. 2001. Smallholder dairy production and marketing constraints in Nigeria. pp. 9. Chp. 19. In: Rangnekar and Thorpe (eds). 2001. Smallholder dairy production and marketing: opportunities and constraints. Proceedings of a South-South workshop held 13-16 March at National Dairy Development Board (NDDB). Anand, India.