A Comparative Study of Urban and Rural Dairy Management Systems in Sudan

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ABSTRACT

Sudan is one of the poorest countries in the world, situated in the north-eastern Africa, with a nature ranging from desert in the north to tropical rainforest in the south. The majority of the population, of over 36 million people, is settled in central urban areas, resulting in great demands of food supply, including dairy products. The objectives of the present paper was to, by help of interviews and observations, study Sudanese cattle dairy production systems near Khartoum and in the Agalyeen area, Gezira state, with respects to breeds, general management, water regime and feeding of cows and calves.

The study showed a great variety in management systems, ranging from modern large-scale to small-scale rural systems, keeping exotic, crossbred or indigenous cattle. Water and feeding regimes varied from poor to well adjusted to the potential production level of the animals.

In a future perspective, mainly the small-scale systems have large potential for improvements leading to increased milk production as well as ameliorated living conditions for people in the area.

SAMMANFATTNING

Sudan, som ligger i nordöstra Afrika, är ett av världens fattigaste länder. Naturtypen övergår från öken i norr till tropisk regnskog i söder. Majoriteten av de 36 miljoner invånarna bor i centrala, urbana områden, vilket resulterar i stora behov av livsmedel, inklusive mjölkprodukter. Målet med det föreliggande arbetet var att, med intervjuer och observationer, undersöka den nötkreatursbaserade mjölkproduktionen i Sudan, i Khartoums närhet och i Agalyeenområdet, Gezira state, avseende rasval, djurhållning, vatten och utfodring av kor och kalvar.

Denna studie visade stor variation avseende djurhållningssystem, från moderna storskaliga till småskaliga landsbygdslokaliserade system, med exotiska, inhemska eller korsningsdjur. Vatten- och utfodringsformer varierade från väl avpassade till bristfälliga i förhållande till djurens produktionskapacitet.

I ett framtidsperspektiv kan konstateras att, framför allt den småskaliga landsbygdslokaliserade produktionen har stora möjligheter att utvecklas till att så väl öka produktionen som förbättra levnadsstandarden för människorna i området.

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INTRODUCTION

The Sudan

Sudan is, to the surface, the largest country in Africa and it has a population of more than 36 million people (UN, 2004). It is one of the poorest countries in the world, due to long term conflicts concerning the governing of the country and civil war. Sudan is situated in the north-eastern part of Africa and the nature ranges from the Sahara desert in the north to tropical rain forest in the south. The majority of the population lives in the central part of the country, mainly in and around the capital (Landguiden, 2005). Considerable numbers also live in the southern, western and eastern parts of Sudan (Malik, 2005).

Large parts of the population, especially in rural areas, are farmers and depend on livestock for a living. According to tradition owning livestock equals wealth and it has not only economical but also a social value, including a role in religious rituals.

Animals kept in Sudan are mainly cattle, goats, sheep, poultry and camels; but also, for draught power, donkeys and some horses (FAO, 2005). Cows, but also goats are the most important species involved in milk production; together they provide nearly 90% of the output.

Objectives

General objectives

This study was conducted in order to investigate the management of dairy cattle under Sudanese conditions, with focus on health care and productivity. The main objective was to study different cattle based milk production systems in rural and urban areas of central Sudan.

Specific objectives

The Sudanese dairy production systems were studied with respect to:

- Cattle breeds
- General management
- Water regime
- Fodder and feeding of cows and calves
- Milk production

BACKGROUND

Area description

Khartoum, the capital of Sudan, consists of three towns; Khartoum, Khartoum north (Bahry) and Omdurman. These three towns are situated along the riverbanks where the White and Blue Nile merge to form the common Nile. The city, with its annual average rainfall of 161 millimetres during July-September (U.S. Library of Congress, 2006), is situated in the arid and semiarid tropics (CGIAR, 1994). The average minimum and maximum temperatures range from 16-31°C in January to 28-43°C in May (Climate Zone, 2006). This zone is not suitable for cropping why this area is very dependent on the water supplied by the Nile (Malik, 2005). The population of greater Khartoum (all three towns) is estimated to be 6 million people (Landguiden, 2005); and thus this urban area has a great demand of foods, including animal products.

The village Abu Elkelik is situated an hour drive from Khartoum, in the rural Agalyeen area, Gezira state (see fig 1) (Malik, 2005), in the arid and semi-arid tropics (CGIAR, 1994). By irrigation canals, leading water from the Nile, cropping is possible. The area is one of the most important agricultural areas in Sudan and it is common with mixed crop-livestock farming in the Gezira state.

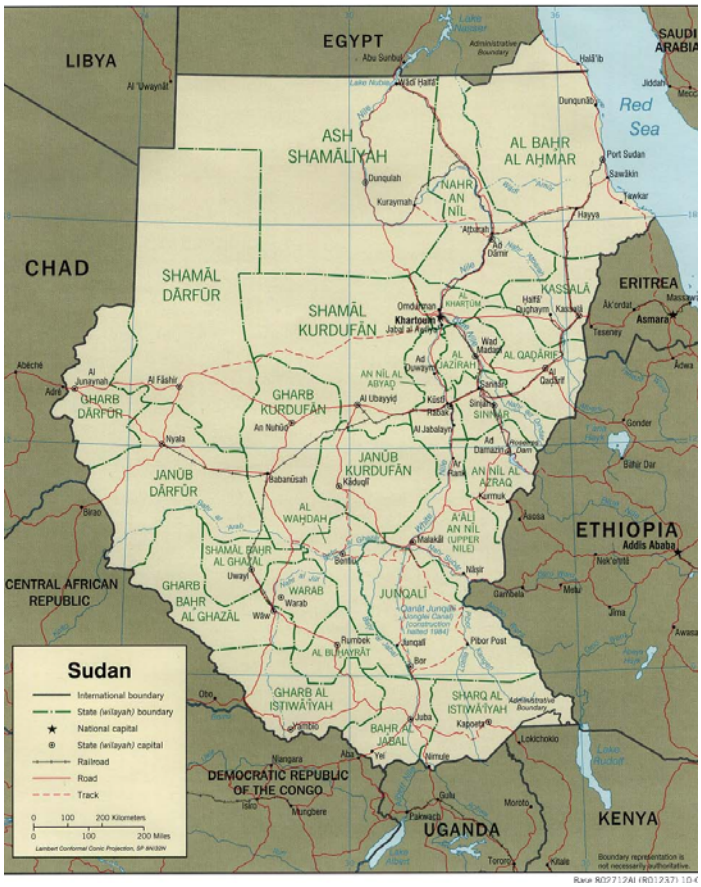

Fig 1. Map of Sudan

Cattle breeds and breeding

Cattle of the world originate from two distinct species; the *Bos taurus* (non-humped, referred to as European type) and the *B indicus* (humped, referred to as Zebu type or indigenous cattle) (McDowell, 1972). Most indigenous types are the results of natural selection due to climatic factors as well as breeding by man.

The local breeds found in Sudan belong to the group of North Sudan Zebu (McDowell, 1972; Sudanimals, 2006). Examples are Butana, Kenana and Baggara; multipurpose breeds that are used for milk and meat production as well as draught power (Payne & Hodges, 1997). The Butana cow is considered to be the best milk producer of the Sudanese zebu breeds (Sudanimals, 2006). See Fig 2.

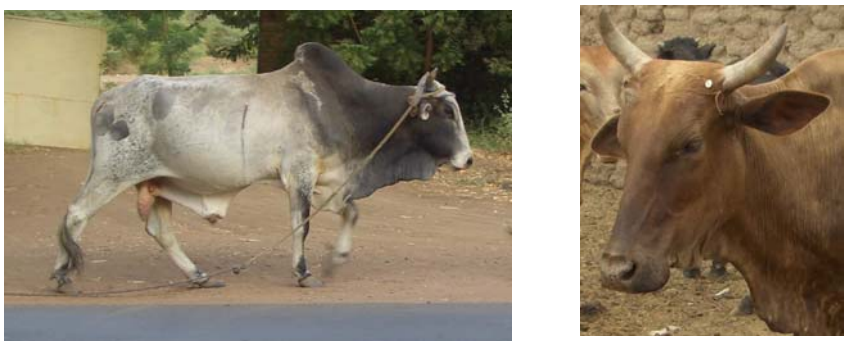

Fig 2. Kenana bull and Butana cow

The Holstein Friesian (HF) cattle originate in Europe. Breeding has made this black-and-white dairy cow the highest milk producing bovine breed in the world (Oklahoma State University, 2000).

The milk production in the Sudanese indigenous cattle breeds Kenana and Butana (*B. indicus*) was found to be lower than that of Holstein Friesian cattle (*B. taurus)*, even under the same climatic conditions (average lactation milk yield adjusted to 305 days: 1405 ± 695 kg compared to 4784 ± 81 kg in Holstein Friesian) (Ageeb & Hillers, 2000b; Ageeb & Hayes, 2000a). Low productivity (total lactation milk yield: 1597 kg) was also shown in another study concerning the Kenana breed (Wilson *et al.*, 1987). However, the same authors (1987) suggest that with improved management, feeding and breeding, the Kenana breed has a high potential as a milk producer under tropical climatic conditions.

Crosses between *B. taurus* and *B. indicus* are generally superior to local types of cattle in terms of production and reproduction (McDowell, 1985). However, the milk production of the first generation of crosses exceeds that of the two following, though it is still higher than for the indigenous breeds. McDowell here also suggests that, due to difficulties in management and feeding in the tropics, breeding should rather aim at improving productivity from low to intermediate than by providing genetic potential for high productivity since that is difficult to support both economically and practically.

General management, water and feeding

Climatic stress

The climate of the tropics affects livestock and other animals in many ways (Payne & Wilson, 1999). The higher temperatures in the tropics have a direct effect on the body temperature. To keep this within the normal range, the animal can use two major ways: Decreasing metabolism and so diminish heat production within the body, respectively increasing heat loss to the environment. The metabolic heat production depends on digestive activity, production level and muscular work. Heat loss is mainly by evaporation through the skin or respiratory tract and increased peripheral circulation. Radiation of heat can not be done since the temperatures, at least during daytime, is near or higher than the body temperature. Zebu breeds have been shown to be less sensitive to heat stress than *B. taurus* breeds (Srikandakumar & Johnson, 2004). On the other hand, camels, during water deprivation, are shown to be able to use a rise in body temperature of several degrees to save water (Schmidt-Nielsen *et al.*, 1956). A similar pattern has also been shown for goats (Baker, 1989; Olsson & Dahlborn, 1989), but regarding cattle there is no evidence that they can use this mechanism. However, McDowell (1972) suggests that also cattle among other species may tend to let body temperature rise slightly to aid heat loss by conduction.

The greater ability to tolerate heat stress in indigenous tropical cattle breeds is thought to be related mainly to lower metabolic rate and more appropriate properties of the skin (Hansen, 2004), like suitable architecture of the hair coat, skin pigmentation and higher numbers of sweat glands than temperate breeds. Zebu breeds also have large amounts of excess skin (Oklahoma State University, 2000). Most animals of exotic origin can adapt to some extent to the climatic stress, depending on their ability to use the mechanisms described. Good management (protection from the sun, good quality feeding and water, protection against disease) is also crucial to these animals if they are to function in the tropics.

Some studies have been carried out to evaluate the genetic and environmental effect on productivity and reproduction of Holstein-Friesian cattle in central Sudan (Ageeb & Hayes, 2000a; Ageeb & Hayes, 2000b). The milk production was found to be comparable to that achieved by Holstein-Friesians in temperate regions, as long as a high quality management was achieved. The climatic stress, however, was found to affect the breeding, resulting in increased calving intervals and calf mortality. To decrease these effects, the authors suggest that breeding should be limited to the cooler months of the year (January-March), thereby avoiding parturition in the hottest time of the year. The negative effects of year-round breeding are also discussed by Sudanimals (2006).

Feeding and water

The quality of the forage is often poor in arid and semiarid zones as plants are less digestible, and the growth of the forage is slow except for in the rainy season (Payne & Wilson, 1999). Generally plants on pasture contain low levels of nutrients and high amounts of lignin. Grazing behaviour is also affected as shown by daytime grazing being diminished in hot and dry areas compared to cooler

climates. However, this can be compensated by night time grazing, if there is enough forage available on the pasture and if it is safe for the livestock. When possible for the farmer, supplementary feeding is another way to increase the feed intake and to compensate for low pasture quality.

Higher environmental temperatures require higher water intake, since the water is needed for the ability to loose heat (Payne & Wilson, 1999). If the temperature of the drinking water is lower than that of the body, excessive heat will be lost by direct cooling at drinking. Animals in a tropical climate maintain the normal body temperature for example by decreasing production (indirectly by decreasing digestive metabolism) and exercise, increasing sweating and panting, excreting urine and faeces at body temperature, and seeking shadow.

Indigenous tropical breeds of livestock are better than eotic in using other ways of temperature regulation than increasing water intake. The indigenous breeds are adapted to the environment through lower metabolic rate ad production.

The water intake is related to the feed intake as the forage in the arid and semiarid areas has a high proportion of dry matter during a large part of the year and the water requirement will thereby increase. Water deprivation may lead to a lower feed intake and thus indirectly to decreased production. Low or decreased milk production is also a direct effect of water deprivation.

Growth

Both birth weight and growth rate of *B. indicus* cattle is lower than that of *B. taurus* cattle (Payne & Wilson, 1999). It is however relatively unknown how the growth is affected by heat stress; though the authors reason that it is probably slower than under temperate conditions since energy intake is lower.

Production

As described above, the low productivity of animals in tropical areas is due to many factors (Payne & Wilson, 1999). Indigenous livestock produce less than many other breeds, since adaptation to the climatic stress have been more important than production. The authors suggest that introduction of exotic breeds into the tropics can result in raised productivity, but good management is crucial to make the animals adapt and function in this climate. Another way is to use crossbreeds, which have been shown to be more resistant to the higher temperatures than pure exotic breeds and producing better than the local ones.

Disease control and veterinary services in Sudan

To be profitable, animal production requires good management of healthy animals (Payne & Wilson, 1999). Health depends on proper feeding and access to enough water of good quality as well as protection against environmental factors (such as heat) and health hazards. On the other hand, an animal in good condition is more resistant to disease than a weak one, why the health status, to a considerable extent, depends on the other three.

Disease prevention has to be adjusted to the management system and the disease pattern in the herd (Payne & Wilson, 1999). The ways available to protect

livestock from infectious diseases are by increasing the host's defence and by preventing the animals from meeting the contagion. Through breeding regimes, animals have become more tolerant or even resistant to some diseases. An example of this is the resistance of some indigenous cattle breeds to negative effects due tick infestation.

Generally, by providing good hygienic conditions, the disease pressure can be diminished (Payne & Wilson, 1999). By proper management of the grazing environment, many parasitic diseases can be controlled. In a housed environment, other ways of spreading diseases has to be taken into consideration. Many animals then have close contact in a limited area. The walls and floors may harbour infectious agents, why they should be of such a material that they can be disinfected. Other ways of controlling diseases are by vaccination, vector control (e.g. dipping) and for young animals by securing colostral immunity.

In Sudan, the veterinary graduates per year are approximately 325 (Malik, 2005). Very few Sudanese veterinarians have conducted their veterinary studies in foreign countries. There are approximately 10 practitioners employed by the government working in each of the 26 Sudanese states. Other practicing veterinarians work in the private sector; mainly in and around Khartoum and in western Sudan (Darfur and Kurdofan). The availability of veterinarians in Sudan is very good in urban areas, but in rural areas it is poor and this limitation is one of the major complaints by those in the rural population that keep livestock.

The costs for veterinary services are generally low for the animal owners (Malik, 2005). When consulting a governmental veterinarian, the animal owner has to pay only for the medicines and the cost for these is relatively low. As a comparison, the cost for 50 ml of oxytetracycline is 400 SD (Sudanese Dinars) which equals 1,65 USD. One litre of milk bought at a market costs approximately 100 SD and of this, 50 SD reaches the farmer. Also the cost for a consultation by a private veterinarian is low. Unfortunately, the understanding among animal owners is limited regarding the advantages of consulting a veterinarian about sick animals, why many of them choose to treat the cases by themselves or not at all. Medicines are available for anyone to buy from pharmacies in the cities, and in rural areas from every common market. No prescription is needed, nor is any education required for those selling the drugs. The knowledge about medicines and their use is low, especially in rural areas. Available drugs are often too old and stored in unsuitable ways, and the treatment is often performed improperly, e.g. wrong drug for the purpose, dosage too low or wrong route of administration.

In rural areas, where the access to practicing veterinarians is limited due to lack of infrastructure or security risks, e.g. in war zones, many organizations educate community animal health workers, CAWHs, in primary animal health care (Malik, 2005). The CAWHs can diagnose and treat simple cases and refer to veterinarians if needed. Sometimes the CAWHs cannot handle a case properly, but generally the situation is better with them present than without them.

METHODS

Selection of herds

Commercial (producing milk for sale) cattle dairy herds, representing both large urban and smaller rural farms, were selected. The management systems chosen were ranging from completely closed and modern to grazing-based traditional systems. All farms are listed in Table 1.

In central Sudan, farms were visited in Kuku (east of the Blue Nile), Rudwan area (west of main Nile), Baggair (west of Blue Nile) and Karfuri (east of main Nile), all these situated in urban areas near Khartoum. The rural area was represented by farms in the village of Abu Elkelik (Gezira state).

The bovine breeds included in this study were both local and exotic breeds as well as their crosses.

Data collection

Data on livestock management and health was collected from the selected dairy production farms in the late half of September 2005, at the end of the rainy season.

A targeted data collection was carried out in the selected areas since a random sampling of data was not possible for logistical and cultural reasons. Invitations were necessary to achieve access to farms. These invitations were generally received by personal contact with veterinarians working at the University of Khartoum or through veterinary students. Due to the time and resources available for the study, only a limited number of farms could be visited.

Data from the farms were collected by one person (the author, 6th year Swedish veterinary student) through interviews and by making observations. The interviews were based on a questionnaire (see Appendix 1) with main questions followed by more specific, and conducted by help of an interpreter. The person interviewed was a member of the staff on each farm. Collection of data was done by recording (using a dictaphone) aond/or taking notes, as well as taking photograhs. Observations were done when visiting the farms, to receive information not likely to be gained from the interviews.

Systems and grouping

The farms were subjectively divided into groups according to management factors. The division into groups is also shown in table 1.

- Group I: Modern, large scale dairy production systems that are completely closed, efficiently run with a relatively high productivity and using a large amount of exotic breeds (n=2).
- Group II: Relatively intensive and modern, more or less closed, small scale dairy production systems with varying productivity (n=5).
- Group III: Open, traditional mixed crop-livestock production systems (n=13).

A closed system describes a system where the animals have no other individual contacts than with the animals and persons inside the farm. An open system refers

to a grazing-system with a limited control of contacts with other herds (including other species of animals) and other human beings than the staff.

Herd size

The herd size was estimated in numbers of heads in each heard, including both adult productive animals and heifers and calves for recruitment.

Data analysis

Based on interview results and observations by the interviewer, the groups were compared with respect to water access and feeding regime, including suckling for calves. Evaluations of general hygiene and management were mainly based on subjective observations.

Table 1- Farms visited for data collection

Location	Farm ID	Group	Herd size	Breeds	Grouping system
Azaheir		I	620	Exotic (HF)	Several groups [1]
Karfuri		I	250	Cross (high % exotic)	8 groups: Lact. cows, dry cows, heifers, calves (in age groups)
Kuku	1	II	30	Local (Kenana)	3 groups: Lact. cows, dry cows, heifers and calves
	2	II	70	Cross (high % exotic)	Lact. cows, dry cows, heifers (3 age groups), calves
Rudwan	1	II	66	Cross	2 groups: Calves up till weaning and older animals
	2	II	55	Cross	2 groups: Calves up till weaning and older animals
	3	II	42	Cross	2 groups: Calves up till weaning and older animals
Abu Elkelik	A	III	60	Local and cross	3 groups: Calves up till weaning, heifers and adults
	B	III	50	Local and cross	2 groups: Calves up till weaning and older animals
	C	III	23	Local and cross	2 groups: Calves up till weaning and older animals
	D	III	29	Local and cross	2 groups: Calves up till weaning and older animals
	E	III	9	Local and cross	2 groups: Calves up till weaning and older animals
	F	III	48	Local and cross	2 groups: Calves up till weaning and older animals
	G	III	14	Local and cross	2 groups: Calves up till weaning and older animals
	H	III	40	Local and cross	2 groups: Calves up till weaning and older animals
	I	III	38	Local	2 groups: Calves up till weaning and older animals
	J	III	9	Local and cross	2 groups: Calves up till weaning and older animals
	K	III	33	Local and cross	2 groups: Calves up till weaning and older animals
	L	III	12	Local and cross	2 groups: Calves up till weaning and older animals
	M	III	12	Local and cross	2 groups: Calves up till weaning and older animals

[1] Lactating cows (8 groups); dry cows; sick/treated cows; heifers (6 age groups); fattening bulls (2 groups); breeding bulls; calves (sep stall).

RESULTS

The interviews

The main questions could be posed, but they were not always followed by the more detailed discussion, mainly due to time limitations, linguistic confusion and support by different, sometimes several, interpreters. The persons interviewed at the farms varied from farm veterinarians to one of the workers. Most, but not all interviews could be recorded by use of a dictaphone.

General description

Group I (modern large scale systems)

In Azaheir, the animals were kept in a loose housing system, in a solid building with high walls on three sides, concrete floors and a roof. Between every second pen there were high walls and no contact. Straw was used only for the young calves and all calves were kept in a separate building. There were some stalls in all pens; however the numbers seemed to be less than the numbers of animals. Some animals were lying down outside the stalls. In front of the pens there were exercise yards (solid floor, no roof, iron fences around) where animals were kept when the pens were cleaned. The exercise yards were separate for each pen, but the animals could get in contact with each other through the fences. The cows were milked 2-3 times per day by machine milking in a parlour system. (See fig 3)

In Karfuri, the animals were kept on the ground. Roofs for shadow were present in all pens. Pens were separated by iron fences, allowing contact between neighbouring groups. The group of lactating animals was separate from other groups. Milking was done manually twice per day in a solid building. (See fig 3.)

The production was estimated to be 15-23 litres of milk per day/cow. In the case of Azaheir the production is recalculated from 305 days of lactation since they reported a total lactation milk yield of 5000-7000 litres per cow. The milk was sold on the farm, directly after milking. Azaheir had milk tanks with a cooling system for the milk. Only cattle were kept on the farms of group I. The animals generally appeared healthy and in good body condition.

Fig 3. Loose housing, Azaheir; milking parlour system,Azaheir; main group, Karfuri

Group II (relatively modern systems)

In this group there was diversity between the farms. Common for them was their urban location, their production of milk for sale and that milking was done manually twice per day. The milk yield ranged from 5 to 11 litres per day/cow. Milk was sold directly after milking on or nearby the farms.

At all farms, the groups were housed in pens on the ground, surrounded by either mud walls or iron fences and with access to roofs for shadow. Some of the farms only kept cattle and some also kept several other species, in those cases all animals were kept together. The body condition of animals in group II was generally good, except for the calves at some farms. (See fig 4.)

Three of the herds belong to the Rudwan project which consists of about 260 herds, all situated close together in a semi-desert area. This project is run by an Islamic organisation providing the participating farmers with veterinary care and free medicines.

Fig 4. Main group, Rudwan 1; main group, Kuku 1

Group III (traditional systems)

This group consists of the herds in the village Abu Elkelik. The animals were kept traditionally, in a crop-livestock farming system, and by use of very few modern technical aids. Milking was done manually twice per day and the milk yield ranged from 5 to 9 litres/day and cow. Nearly all the milk produced in the village was taken by car to be sold in Khartoum.

The majority of the pens were surrounded by walls made of mud while some did not have any walls but kept the animals tied to the ground instead. The ground was soil, which during the visit was very dry. On the ground there were dry faeces and lots of wood and trash like plastic and scrap iron. Some pens were provided with shading roofs, especially for the calves. (See fig 5.)

Fig 5. Housing of animals in group III, Abu Elkelik

All dairy animals of Abu Elkelik were in contact with a wide range of animals, both their own species and others. No groups of animals were isolated. In the village there were cattle, goats, sheep, dogs, chickens and donkeys.

The body condition of the animals in group III ranged from poor to average. Especially the calves appeared small for their estimated age and the growth rate was generally slow according to ages reported by the farmers.

Detailed description

In Table 2, interview results concerning feeding, water regime, dry period and postnatal care are presented with further details given in marked comments following the table.

Table 2 – Interview results. "Q" refers to questions from the questionnaire (appendix 1).

	Groups (No of herds)		
Question (Q)	**I (n=2)**	**II (n=5)**	**III (n=13)**
Pasture routines – Q 3	No pasture	No pasture	Pastures are used See *comment a*
Water – Q 4	Tap water; *ad lib* for animals > 4 d of age	Tap water *ad lib*: -All animals: 4/5 -Postweaning: 2/5. Calves: Twice/day at milking time. (See fig 6.)	Water from canal during pasture for most animals, Calves 2-5 times/day. See *comment b*
Feeding out of pasture (post weaning animals) – Q 5	Relatively well adjusted and controlled. See *comment c*	Variation. Satisfactory for basic needs. See *comment d*	Some supplementary feeding. See *comment e*
Dry period – Q 9	2-2,5 months	Dry period (3 days-2 months): 4/5 No dry period: 1/5	Ranging from no dry period to 8 months before delivery
Postnatal care – Q 11-13	Somewhat isolated groups with individual care. See *comment f*	No isolated groups. Varying feeding, suckling and health care. See *comment g*	No isolated groups, restricted feeding and suckling after first days. See *comment h*

Comment a– Pastures in Group III

All animals in the main groups (post weaning) were let on pasture (1-)2 times/day when the herds often mixed. Three of the 13 farmers did also let the calves out on pasture (once a day) but separate from adults. The pastures were the fields with crop residues after harvest. The farmers valued the quality of the pasture differently; good (1/13), not very good now (too dry, 5/13), good except for plants near the canal that could cause disease (2/13), and value depending on season (4/13).

During the visit, though it was just after the rainy season, the pasture areas were generally quite dry and the amount of available grass was poor, due to sparse raining. Some were greener than others but it was never really green other than beside the canals.

Comment b – Access to water in Group III

Adult group

Animals after weaning (animals on pasture) drank freely from the irrigation canals during grazing hours. Two farmers reported one additional drinking occasion (out of pasture time) and one of these only let the animals on pasture in the morning. (See fig 6.)

Calves

- Two of the three farmers who let their calves on pasture said that the calves only had access to water then. The third farmer (one pasture period per day) took the calves once to the canal during other hours.
- No pasture, taking calves to the canal to drink x2 (n=3/13)
- No pasture, taking calves to the canal to drink x2-3 (n=1/13)
- No pasture, taking calves to the canal to drink x4-5 (n=1/13)
- No pasture, water given in troughs (either from the canal or tank, or both) (n=3/13). One of these explicitly said availability was *ad lib*.
- No answer (n=1/13)

Quality

Comments given by the farmers about the quality of the water:

- Not healthy or potentially causing disease (n=5/13)
- Good or very good quality (n=3/13)
- The plants near the canal may cause disease (n=2/13)
- The tank water better than the canal water (n=1/13)
- The canal water is cold and therefore better than water from the tank (n=1/13)
- No comment (n=2/13)

Comment c - Feeding in Group I

Azaheir

All feeding was done in stone troughs along the sides outside the pens, reachable at all times.

Roughages

Nut hay (October – April also dry alfalfa) fed 2 times/day:

- Lactating cows given 40% of the dry matter intake (DMI) as roughages
- Dry cows in late pregnancy were also given dry straw (for vitamin D)
- Heifers had *ad lib* access

Concentrates

- Lactating cows: 60% of the DMI were concentrates. These were fed 4 times/day, amount adjusted to production and reproductive status
- Dry cows: 5 kg/day, last 2 weeks of pregnancy increased to 7 kg/day
- Heifers <6 months: 2,5 kg/day
- Heifers 6-9 months: 3 kg/day

- Heifers 12 months-250 kg body weight (BW): 4 kg/day
- Heifers 250 kg BW-2 months pregnant: No concentrates
- Heifers 2-7 months pregnant: 5 kg/day
- Heifers from 8 months pregnant: 7kg/day

Karfuri

Roughages

Sorghum straw was fed 2 times/day in big troughs around the pens, the amount seemed sufficient. (See fig 6.)

Concentrates

All lactating cows were given the same amount (4 kg x2/day) in stone troughs in the milking stall just before the milking. Dry cows were given concentrates but of a different composition. Their troughs were not seen at the visit, why probably either smaller common troughs were brought to the animals or the troughs around the pens were used.

Comment d – Feeding in Group II

Roughages

Roughages (mainly sorghum) were fed on the ground 1-2 times/day. (See fig 6.)

Concentrates

- The concentrates were for example wheat bran, nut cake, molasses and urea, with addition of salt and calcium. Feeding of concentrates:
- To all animals but amount varying with group (n=2/5).
- To all animals in common troughs = free competition (n=3/5, those with one main group of animals)
- Feeding of dry cows ranged from only roughages to the same combinations as for the other animals.

Comment e – Feeding in Group III

Roughages

Roughages (in addition to pasture) were plants cut in the fields; during the visit it seemed to be mainly sorghum. The roughages were fed on the ground at feeding (=milking) time. During the visit, remaining roughages were only seen in few pens.

- Roughages were provided for the cows in the pen (n=2/13, one of these is the one only using the pasture in the morning)
- No roughages given in the pen (n=3/13)
- Roughages given in the pen during the dry season (n=6/13)

Concentrates

Concentrates were generally made from wheat bran and oil cake. Adult animals were fed individually in sacks around the nose (strapped around the neck), and calves were generally fed in troughs. (See fig 6.)

- Concentrates given to the lactating cows (n=13/13)
- Concentrates to all cattle; lactating cows fed more than the others (n=2/13)
- Concentrates given during the last part of pregnancy (15 days-1 month) (n=4/13)
- No concentrates to dry cows (n=6/13)

Feeding of heifers was not specified, but since they do not produce milk it could be interpreted as they also were dry.

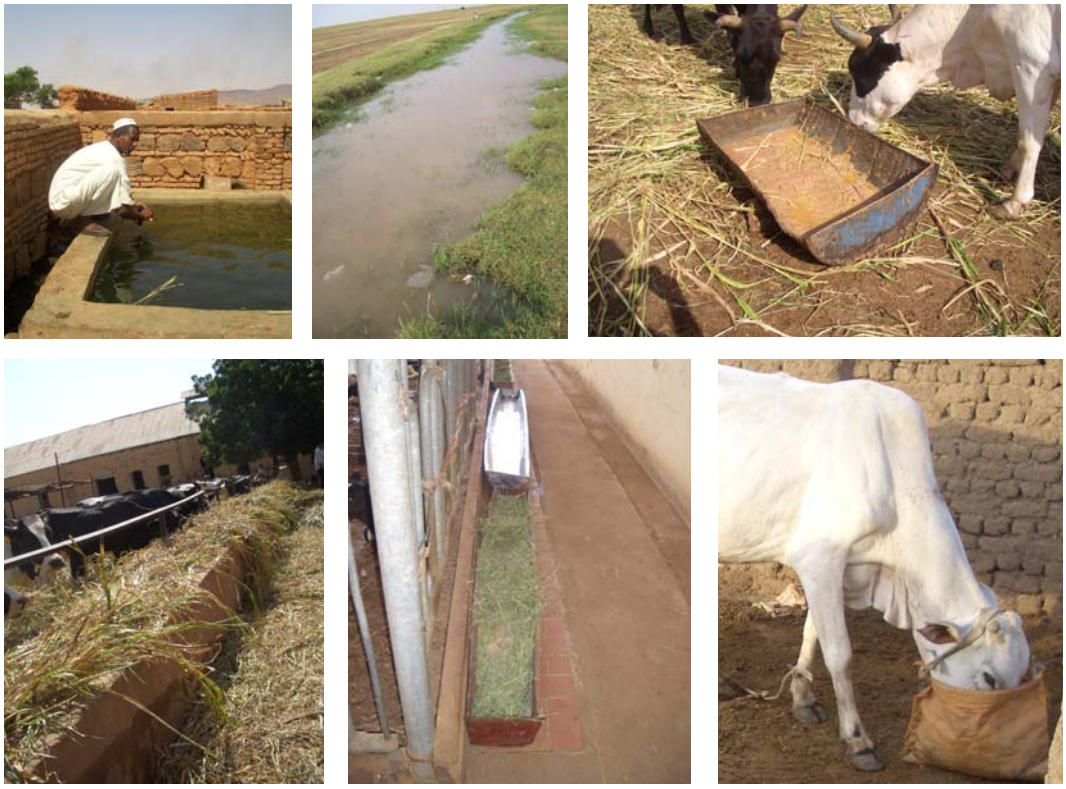

Fig 6. (From the top and left) Water trough, Rudwan 3 (group II); Irrigation canal, Abu Elkelik (group III); feeding trough for concentrates, Rudwan 1 (group II), feeding of roughages, Karfuri (group I), feeding of calves, Azaheir (group I); feeding of concentrates, Ebu Elkelik (group III)

Comment f –Post natal care of calves in Group I

Azaheir

Separate stall for calving and another for calves.

- Calves <2 weeks of age were kept alone in single pens (see fig 7)
- Calves 2 weeks - 45 days of age were kept in small groups
- From 45 days bulls and heifers were separated:
    - Bulls 45 days – 2 months of age were kept in larger groups
    - Heifers 45 days – 3 months of age were kept in larger groups

In the single pens there was sorghum enough to make good bedding. Also in the groups of older calves in the same house some bedding was present. The pens had good hygienic conditions. The troughs with their contents and the water appeared clean.

Milk fed to calves:

- 0-3 days: Colostrum 3 times/day.
- 4-7 days: Whole milk 2 times/day. Water *ad lib*.
- 2nd week – weaning (= 3 months for heifers, 2 months for bulls): Mixture of whole milk and milk replacement 2 times/day. Roughages and concentrates *ad lib*. Water *ad lib*.

Karfuri

- 0-5 days: Kept with the mother in the pen where they were born. Free suckling
- 6 days – weaning (3 months): Moved to the calves' pen with access to roughages, concentrates and water. They were fed milk individually (10% of BW/day, divided into two meals) (see fig 7).

Mortality

Calf mortality was about 5% at Azaheir; Karfuri reported that in the dry season, up to 90% of the calves may die due to diarrhoea.

Comment g - Post natal care of calves in Group II

Herd	Comment
Kuku 1	With the dam, free to suckle *ad lib* the first 1-2 months of life, longer if they seemed weak. Later moved to the pen for heifers with access to concentrates and roughages. Let to suckle after milking.
Kuku 2	Separated from the dam 2-3 hours after delivery, then let to suckle twice a day. The first week depending only on suckling. After this fed roughages and concentrates in the calves' pen. Let to suckle a little after milking.
Rudwan 1	The first days with the dam all night. Daytime kept separate in the calves' pen. Roughages and concentrates from two months of age, before this depending on milk only. Suckling 15 minutes once per day after milking.
Rudwan 2	With the dam all night, daytime in the calves' pen. Let in to the cows at milking time. Fed (only from suckling) milk until 1,5 months of age and then only concentrates and roughages.
Rudwan 3	After birth, vaccinated and separated from the dam. With the dam all night during the first two months. After this fed concentrates and roughages.

Calf mortality: No or few calves die. (See fig 7.)

Comment h – Postnatal care of calves in Group III

Milk feeding

Calves were separated from their mothers after 2-24 hours. Eight farmers reported that they made sure that the calf suckled before separating it from the mother. Suckling was at milking time, generally twice per day. The calves were first let to suckle a minute before milking, to ease milk let-down, and then after milking. Two farmers considered it to be bad for the calf to suckle under the sun when the weather is hot, why their calves were separated under these circumstances. This means that these calves suckle only once per day (in the morning) during the hottest time of the year.

Six of the 13 farmers reported that more milk from the cow was left for the calf during the first period of life (meaning no milking of the dam for the first 1-15 days, leaving all the milk in the morning for 3 days or leaving one quarter for the calf). Two farmers reduced suckling after two months or when the calf started to eat roughages and concentrates. (See fig 7.)

Other feeding

- Concentrates to calves (n=10/13)
- All animals given concentrates, probably including the calves (n=2/13)
- No concentrates (n=1/13)
- Some roughages for the calves (n=9/13)
- No roughages (n=1/13)
- Not specified whether they do or not (n=3/13)

Weaning

- Weaning at drying (n=6/13)
- Tries to prevent the calf from suckling after 7 months (n=1/13)
- Sometimes at drying and sometimes before (n=1/13)

After weaning the calves generally go with the adult animals to pasture.

Mortality

Reported calf mortality ranged from 0-57%.

Fig 7. (From top and left) Calf in single pen, Azaheir (group I); calves' pen, Karfuri (group I); calves' pen, Kuku 2 (group II); calves, Abu Elkelik (group III); calves pen, Abu Elkelik (group III); milking process, Abu Elkelik (group III).

DISCUSSION

Livestock play important roles in human life, in the tropics as well as elsewhere. They are especially essential in semiarid and arid areas, since they there provide a wealth resource to the farmers (FAO, 2006). In mixed crop-livestock farming systems, the land used for growing crops in the wet season can, after harvest, be grazed by the livestock (Sudanimals, 2006). In the dry part of the year, farmers in these areas have no other income than what they can get from their animals in terms of milk, meat and skins, both for subsistence and commercial use. By using livestock as draught power, the land available for cropping can be considerably increased. Improved crop production can give more income for the family, as well as potentially increasing the storages for the dry season of vegetable foods for humans as well as fodder for the livestock.

Cattle are one of the most important species of livestock in the world, due to their ability to provide milk, meat and draught power (Payne & Wilson, 1999). The high nutritional value of milk is considerable to humans particularly in poor communities. As a highly palatable source of protein, energy, vitamins and calcium, it makes a significant difference in the diet for especially women of reproductive age and children (Gebre-Medhin, 1996). To the farmers, milk production constitutes a continuous source of income, while the livestock can be used for other purposes (draught power, producing calves etc) at the same time.

The productivity of an animal depends on genetic potential as well as nutrition and management, including protection against disease. The latter comprises dipping, vaccination and preventing the animals from meeting the infectious agent, for example by keeping the herds closed.

Genetic potential for milk production

The average level of performance of *Bos indicus* cattle is generally lower than that of *B. taurus* cattle (McDowell, 1972). The choice of breed for dairy production must be related to management system and available nutrition (Payne & Wilson, 1999). One policy is to use indigenous breeds that, although with low productivity, are well adapted to the environment. Another is to use imported breeds with high productivity genes and a third way is to use crossbreeds. When the management skills and educational skills are low, the usage of indigenous cattle is most likely to succeed, but even then it is possible to slowly upgrade the potential by selective breeding. If temperate-types of breeds are imported, either selection for adaptability to the climate, or improvements of management to reduce the adverse effects put on them, have to be conducted.

The average production of 9 490 kg ECM per lactation in Swedish Holstein Friesian cattle can be mentioned to give an example of the potential productivity of *B. taurus* cattle in temperate regions (Svensk mjölk, 2004). A study of Holstein Friesian cattle in Sudan showed a total lactation milk yield of 5117 ± 123 kg or to 4784 ± 81 kg adjusted to 305 days of lactation (Ageeb & Hayes, 2000a). In that study, Ageeb & Hayes compared the data for Holstein Friesians in Sudan with other tropical regions and showed that *B. taurus* breeds can produce well under stressful climatic conditions, but not as well as in temperate zones.

The average lactation milk yield in the Sudanese local cattle breeds Kenana and Butana (*B. indicus*) was found to be 1405 ± 695 kg adjusted to 305 days (Ageeb & Hillers, 2000b). Low productivity (total lactation milk yield: 1597 kg) was also shown in another study concerning the Kenana breed (Wilson *et al.*, 1987). However, the authors suggested that with improvements on management, feeding and breeding, the Kenana breed has a lot of potential as a milk producer under hard climatic conditions. Studies showing the production potential of local *B. indicus* breeds in the tropics under optimal management conditions could not be found.

Group I (modern large scale systems)

Compared to production levels mentioned above, the productivity of group I, with an average of 15-23 litres/day, is relatively good, especially on Azaheir farm. It is however lower than would be expected in temperate regions so the genetic potential is not fully exploited. Climatic stress is probably one factor in this; others could be high disease pressure and low nutrient content in the fodder. Some preventive actions against disease are conducted in this group, especially in Azaheir.

Group II (relatively modern systems)

The crossbreeds used in group II have different proportions of exotic breed, but their genetic potential of production is probably higher than the production reported by the farmers during the interviews. The appearance of the animals being in relatively good body condition indicates that nutrition and management are sufficient to cover the basal needs, but with improved conditions, the milk yields would probably increase.

Group III (traditional systems)

Even though there were very little control of the breeding in group III, the production capacity by the cows is probably much higher than the level reported by the farmers. In this system, the growth of calves is expected to be slow, leading to high age at first calving. This is a clear loss for the animal owners since the heifers cost to keep even though they do not produce anything. The multifactorial background to the low productivity in group III includes poor nutrition, lack of water and water hygiene, and climatic stress in combination with little protection against sun and heat, and very little preventive actions against disease transmission.

Feeding

All food are built from the same components: Water, nitrogenous compounds, carbohydrates, lipids, vitamins and minerals (Payne & Wilson, 1999). The amount of water in the fodder varies with type. There are plants that have such large water content that some species, for example goats, can manage their entire water need only by eating these plants under water deprived circumstances. However, the dry matter content of plants is generally high in semiarid and arid areas.

The carbohydrates consist of sugars (sugars and starch) and structural carbohydrates (hemicelluloses, celluloses and lignin), and they are the main

energy source in the ruminant food intake. With age, a plant's contents of structural carbohydrates increases and the digestibility decreases.

Mineral deficiencies are not uncommon in arid and semiarid areas. Abdelrahman *et al.* (1998) investigated the mineral balance in grazing dairy cattle in western Sudan and found low serum levels of copper, phosphorus, calcium and sodium.

Group I (modern large scale systems)

Knowledge about feeding seemed to be rather good in group I. Feeding of roughages was done in troughs around the pens, thereby avoiding consumption from the ground as in groups II and III. This is important from a hygienic perspective and thus in prevention of spreading diseases.

At Azaheir farm, lactating cows were divided into 8 groups according to performance, which makes it possible to adjust the feeding and thus optimize the production. On the Karfuri farm, all lactating cows were given the same amount of concentrates. This feeding was done in the milking house in individual troughs, why it should be possible to accomplish individual feeding. All ages of animals in group I were fed both roughages and concentrates. Dry cows, heifers of different ages and calves were all kept in separate groups with adjusted feeding.

The success of the feeding regime in group I can be estimated by the impression of body condition and related to production. Animals in this group generally were in good body condition, suggesting that the feeding was enough to cover basal needs. The reported milk yields indicate that the feeding adapted to production level at Azaheir farm works rather well, but the lower productivity at Karfuri could probably be increased by improved adjustments of the feeding.

Group II (relatively modern systems)

Many infectious agents are spread by a faecal-oral route and good hygienic standards are therefore necessary (McDowell, 1972). The feeding of roughages on the ground in groups II and III is therefore identified as a risk factor for transmission of diseases. This includes internal parasites as well as many other disease causing agents.

In the present study, feeding times ranged from once to twice per day, of which the effect can only be estimated knowing the amount of roughages per feeding occasion. However, feeding roughages only once per day could lead to a greater hunger, and thereby a more intensive competition at feeding time.

In this group, concentrates were fed in common troughs. In the farms with separated groups for heifers of different ages and dry cows, the amounts were adapted to stage in life. In other farms, all animals post weaning competed for the fodder. As a consequence of this it is likely that animals requiring a higher amount of concentrates (i.e. late pregnant and lactating cows as well as sick animals) will not get enough. This is not only a health issue for the cows that have to use their body reserves to cover basal needs and in addition for milk production, but also an economic loss for the farmer. Productivity could be increased if the animals with the greatest needs also could get larger rations and

high quality fodder. However, the present regime is of some benefit to the heifers and late pregnant females.

Group III (traditional systems)

The feeding of group III was highly based on grazing. The quality of the pastures differs between seasons (Payne & Wilson, 1999). During the dry season, the amount is generally limited and the quality poor in arid and semiarid areas. The energy content is probably lower than in many other fodder types. One of the effect of high ambient temperatures is that feed intake decreases. This has to be compensated by additional feeding or by grazing during less hot hours of the day, i.e. during the night, to reach sufficient dry matter intake. The cattle in group III were kept in pens at night, and since little additional feeding was given, at least in the wetter season, the fed intake of these animals was probably not optimal.

Even though the interviews were carried out during the wetter season, the pastures were relatively poor and dry due to lack of sufficient rain. These poor pastures will be much worse in the dry season, requiring even more additional feeding by the farmers.

All farmers in group III reported that additional feeding of concentrates was done, at least to lactating cows. The concentrates were fed individually, which is positive. However, not all farmers fed concentrates to all animals, and, as discussed above, additional feeding is crucial for an adequate dry matter and energy intake. Therefore, it is likely that heifers, since they are growing, but also dry cows, are not fed enough. Feeding in common troughs would give these groups of animals a chance to reach the fodder, but consequently the lactating cows would get less. The best solution would be, if the farmer's economy could support it, to feed concentrates individually to all animals, not only the cows.

Roughages were fed only to a limited extent during the investigated time of year and only some of the farmers reported any dry season additional feeding. Looking at the pasture quality and body condition of the animals, this was not enough. If the feeding could be ameliorated and energy intake increased, the animals would be in a better nutritional state, be more resistant to disease and produce better.

Pre weaning calves

Immunoglobulins in colostrum fed to newborn calves are absorbed through the intestinal mucosa and give the calf so called passive immunity from the mother (Vann *et al.*, 1995; Sangild & Schmidt, 1997; Svensson, 2005). The absorption is better when early fed and with large amounts, why Svensson suggests that colostrum should be available for the calf within four hours after birth to an amount of at least 15% of BW. After the first 24 hours rarely any antibodies pass the mucosa (Sangild & Schmidt, 1997; Svensson, 2005). Svensson also describes that calves with good passive immunity are healthier, grow faster and produce better as cows. After approximately 2 months, the calf has built up its own immune system and produces its own immunoglobulins. Weaning is in Sweden recommended at 2-3 months of age.

Holstein calves allowed to suckle their dams *ad lib* during the first 6 weeks of life acquired higher weight gain, compared to calves fed milk replacer in buckets (Bar-Peled *et al.*, 1997). The suckling calves also had a lower age at first conception and a tendency of higher milk production during the first lactation. Coulibaly & Nialibouly (1998) have shown that *ad lib* suckling zebu calves grow faster than those having a restricted suckling regime. That study also discusses that suckled zebu cows have potentially higher milk production than cows milked in the absence of their calves.

It is recommended that calves are fed roughages and concentrates already the first week of life, to stimulate the forestomach development (Svensson, 2005).

Group I (modern large scale systems)

The calves at Azaheir farm were separated directly after birth, put in single pens in a separate building and fed individually in buckets. Here it was a highly controlled environment for the calves, ensuring access to enough colostrum and later, milk, for each animal. From a few days of age water, roughages and concentrates were available. The handling of calves in this system was very similar to the way calves are cared for in Sweden. With large numbers of animals and concentrated calving, as at Azaheir, it is possible to have calves in group systems and yet not mix animals of largely different ages. This is working well with respect to disease control but also limiting the competition for food.

At Karfuri farm, calves were kept together with the cow for the first five days of life. One positive aspect of this is the absorption of immunoglobulins from colostrum, which was shown to be higher if the dam was present (Pettersson *et al.*, 2001). The authors also discuss the risk that too little colostrum is suckled if the calf is left alone with the dam without additional manual feeding of colostrum. This problem is mainly thought to be caused by the size of the udder and placement of teats in Swedish dairy cows. Since the cows at Karfuri highly resemble pure Holstein Friesian cows, it is possible that problems receiving adequate passive transfer of antibodies could be an issue even there.

After the first five days, the calves were separated and put in a pen for pre weaning calves. They were fed milk individually in buckets, ensuring that each animal received its share. The calves also had access to water, roughages and concentrates. Diarrhoea in the dry season leading to high calf mortality was a problem at this farm. Since the ground was soil, infectious agents may remain in the permanent pen and thus put a high disease pressure on new calves introduced into the herd. The problems could be caused by a combination of failure of passive transfer, high disease pressure in the pen for calves and mixing of calves at different ages.

Group II (relatively modern systems)

In this group, calves were left with the dam until varying ages: 1-2 months at one farm to some hours-a night at the others. After separation, access to suckling was provided at some farms in varying patterns, from twice/day at milking to all night with the dam for a couple of months. The farmers reported that feeding of roughages and concentrates started at a few weeks-two months of age, but since

all calves were kept together, restriction of feed intake by younger calves is probably caused by competition.

On some farms, the calves do not have any access to water, except at milking time when they are let in the main pen with the rest of the animals. It is likely that the calves at this time prefer to devote themselves to suckling and making contact with their mothers rather than to drink water.

Feeding (concentrates and roughages) were reported to start relatively late at many of these farms. Since all calves were kept together in a pen, where also the fodder was given, it is likely that the restriction of fodder to the young calves only was a result of competition.

Calves in this group generally looked thin. The numbers of calves kept together was large and all calves, pre weaning, were kept in the same pen. The pens were on soil and, in some herds, with walls of mud, allowing infectious agents to persist in the environment. Poor growth and health problems in these animals are probably caused by restricted suckling in combination with scanty feeding, poor access to water in some cases and high disease pressure.

Group III (traditional systems)

The suckling regimes in group III included separation from the dam after some hours up to one day. After this, suckling was restricted to twice a day, at milking time. Most farmers left more milk for the calf; i.e. extracted less from the cow, for some time after birth but that period could be as short as one or a few days.

Some of the farmers were convinced that it was dangerous for the calves to suckle under the hottest sun and their calves were prevented from suckling during the middle of the day in the hottest season. This means that some calves, although very young, were only let to suckle once a day.

In addition to suckling, calves were fed roughages, through grazing or supplied in the pen, and/or concentrates. Most farmers took the calves at separate occasions, or during grazing, to the irrigation canals to drink. In some cases water (mainly from the canal) was brought to the calves in the pen and given in troughs.

The general condition and health of the calves in group III was rather poor as they appeared thin and probably grew slowly. That was an expected outcome, based on the suckling, feeding and watering regimes for these animals. As an additional factor, the disease pressure is probably high due to lack of separation between groups of animals and through the use of permanent pens directly on the soil surrounded by mud walls.

Water

For maintenance of life, water is most crucial (Payne & Wilson, 1999). It is needed for many metabolic processes and it has an important role in the regulation of body temperature. The need of water increases with growth (incuding pregnancy), production of milk, increased metabolism (physical exercise) and environmental constraints. Cattle generally require access to free water at all

times, but *Bos indicus* cattle generally manage well on less than *B. taurus*. This means that *B. indicus* must employ other regulatory mechanisms than water evaporation to avoid dangerously high bdy temperatures.

Access to water also influences the intake and digestibility of the fodder. In a situation with water deprivation, e.g. in arid and semiarid areas, dry matter intake will decrease, at the same time as the forages generally have a low water content. To digest this dry forage the water intake need to be increased. Animals with *ad lib* availability to water drink small quantities frequently with short intervals. Drinking water should preferably be cold, in order to ease heat regulation in a hot climate.

The water sources, availability and hygiene, varied between the groups in the study.

Group I (modern large scale systems)

All animals in this group (above 4 days of age) had *ad lib* access to water of good quality and relatively good hygiene. This may be especially important since these animals, with a large proportion of exotic blood, are more sensitive to water deprivation than indigenous cattle.

Group II (relatively modern systems)

The adult cattle and heifers in this group also have *ad lib* availability to good quality water of reasonable hygienic quality. The most important issue in this group is that the calves on two of the farms did not have any access to water, except at milking time.

Group III (traditional systems)

The poor quality of the water in the irrigation canals, used as the main source of drinking water for animals in group III, and also the restricted availability, does probably affect the health, welfare and production of these animals. The shores of the canals were the greenest parts of the pastures, which of course increased the amount of grazing there. Where cattle graze, they also defecate leading to a high pressure of for example internal parasites. Less than half of the farmers in group III considered the water quality to be poor or a potential cause of disease, and some farmers mentioned the risk of infection by grazing near the irrigation canals. The farmers, however, do not have much choice regarding the water source. They depend on the pastures, which are all near the canals, to be able to feed their animals.

The cattle of group III had limited access to protection against the heat and the direct sunlight which increase the demands for water as a result of increased evaporation. The fodder available for these animals during a large part of the year is of poor quality and dry, which will increase the water need even further. Under these conditions, the production, health and welfare of the animals can be expected to be poor. What makes these animals live and function under the circumstances is probably the fact that they are mainly indigenous cattle or crossbreeds with low percent exotic blood, being relatively resistant to climatic stress and water deprivation as well as some diseases.

Management and health

From one point of view, an animal can be considered healthy when maintaining acceptable production levels in the management systems in which it is kept (Payne & Wilson, 1999). It relates thus not only to being free from disease but also to adaptation to the surrounding conditions. Management is the way of balancing the condition of the host, the presence of infectious agents and the environmental constraints in order to maintain health. This balance is crucial since preventing disease is more economic and practical than curing. In the host, the critical points are nutritional status, immunity (achieved or genetic) and physical barriers like the skin and its hair. The infectious agents can be handled by the livestock holder mainly by keeping them away from the animals, using closed herds and isolated groups. It is often the environment that houses the infectious agent, why ways of influencing this mainly involve improving the hygiene in the pens, houses and pastures.

Group I (modern large scale systems)

The representatives of the two farms in group I both showed a relatively good knowledge about problems in large scale milk production. As the farms were kept closed, they could control many diseases that are problems in more extensive systems. At Azaheir, vaccinations and other preventive actions were taken in order to keep the animals healthy. However, the habit of treating all cows at drying with oxytetracyclines is maybe not recommendable. The Swedish veterinary association has a policy of restricted antibiotic usage, in order to avoid unwanted side-effects like resistance, eco-toxicological effects and rest substances in foods for human consumption (SVF, 1998). There are other ways to control e.g. mastitis but many of them might be difficult to apply to the circumstances in Sudan. The farmers may also have learned to use preventive antibiotic treatment by example from many European and American cattle holders. Hopefully, these treatments are no longer used in the future, either in Sudan or elsewhere.

Group II (relatively modern systems)

These farms were relatively closed, making it possible to control many diseases. In the Rudwan area many farms were built tight together, making the health situation difficult to control in case of a highly contagious and lethal disease reaching the area. The farmers generally kept their animals inside their pens, but bulls were sometimes shared with other herds and the animals were kept outside, potentially mixing, when the pens were cleaned. The biggest problem according to the farmers (both in group II and III) was the ticks spreading theileriosis, an endemic disease in these areas (Ahmed, 1997). Ticks can live in the mud walls and thus reach plenty of animals.

The first action to be taken in order to improve production and health of the animals in group II could be to ameliorate the care of the calves. Efforts helping the calves to get a good start in life will make them grow faster and be less susceptible to disease, resulting in stronger, healthier and better producing adults.

Group III (traditional systems)

The majority of the citizens in the area of Abu Elkelik are farmers for a living (SVCP, 2003). The traditional system is not only a way of living for the farmers; by combining cropping with livestock production they can extract capital even during the dry season. Hence the people are depending on their animals, and they obviously try to care for them the best way they know and can. However, economy, location and lack of knowledge raise limits that have to be crossed in order to improve production.

The way of keeping animals in group III, with no separation between groups, permanent pens directly on the soil, mixing of herds on pasture and poor watering and feeding regimes, cause many problems for the health of animals and thus productivity and income for the farmers. Many of these problems could be diminished by extension activities. Increased knowledge among farmers and CAHWs would help the farmers to develop their livestock holding without necessarily higher costs. By simple means and possibly some economic investments, production could be increased and pay back these investments through higher income.

The interviews

The person to be interviewed at each farm was planned to be of the same category, but that was not possible. As a foreign veterinary student I was welcomed and taken care of by the person highest in rank at the farm and it was often this person who answered the questions. Therefore, interviews were done as was suitable in each situation, meaning either with the owner, the foreman, the veterinarian at the farm or one of the workers.

The aim was to pose the main question followed by a discussion, but for several reasons that was not always possible. Time was often limited, why it was necessary to keep the visit short and the interviews could not be the two-way communication aimed for. As the interpreter used could not be the same person for all interviews, these were not done in the same way from time to time. Another factor reducing the reliability of the answers was the presence of several persons during an interview. The interpreters had often some previous knowledge about the farm, and also generally little experience of both interpreting and conducting interviews, which may have influenced the answers.

At the interviews, the aim was to both record and take notes. For practical reasons this was not done at all occasions. By using the recorder it could be possible to do a second translation and evaluate the quality of the answers and interpretation afterwards, however this was not done because of lack of opportunities with persons with good skills in both Arabic and English.

Answers given by the farmers probably referred to the time of the interview, since follow-up questions about other times of the year rarely could be posed. It is therefore important to remember that the situations discussed in this study is relevant to a certain period of this specific year, and that feeding, for example, may vary a lot between seasons and years.

FUTURE PERSPECTIVES

In the past, development projects aimed to improve productivity using large-scale dairy systems with imported high-grade cattle, but such systems often failed (FAO, 1994). Since the mid-nineties the work therefore has focused on smallholder systems to establish sustainable rural development (FAO, 1994; Pica-Ciamarra, 2005). That view is supported by the results of the present study, where the small-scale dairy management systems in Abu Elkelik, by help of fairly simple measures, have large potential for improvements, and could result in increased milk production for urban needs as well as ameliorated living conditions of the rural farmers.

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APPENDIX 1 – QUESTIONNAIRE

Location:
Owner:
Size of farm:

General management

1. What kinds of animals do you have and which breeds?

2. How do you group your animals? How many in each group, are they always kept in the same group, do you mix different ages, do you mix different kinds of animals? Do the different groups have any contact?

3. How and when do you let any of your animals on pasture? Which ones? Do you mix different groups of animals, different ages, different kinds of animals? What do you think about the quality of the pasture?

4. How do you give your animals water and how much and how often can they drink? What do you think about the quality?

5. What and where do you feed your animals on things other than pasture? How much and how many times per day (concentrates and roughages)? What do you think of the quality? Are all cattle/goats given the same amount?

6. Can you tell me about the breeding? Do you use natural breeding or AI? How soon after giving birth do they get pregnant again? Do all your goats/cows give birth in the same season or are they spread around the year?

7. How many times can a female give birth during a lifetime? What are the main reasons for culling?

8. Which are the main diseases affecting your animals and how are they treated? How often do you call for the veterinarian to come?

Management of pregnant animals

9. How do you keep the late pregnant females? Do they have a dry period before delivery and if so how long? Which are the main diseases in this group of animals and how are they treated?

10. Where do the cows/goats have their calves/kids? Are there ever any problems?

Management of newborn animals

11. How do you keep the newborn calves/kids? How and how soon after birth are they fed? Are they kept alone with their mother? Do they have any contact with other animals (same kinds, same ages, different ages, different kinds of animals)?

12. At what age are they separated from their mother and what do you feed them then?

13. Which diseases are most common in this group of animals? How many of them die?

Milking and its hygiene

14. How do you milk your cows/goats? How many times per day and where do you do it? What equipment and utensils are used (including material)? Describe the cleaning process.

15. How much milk do you get from one cow/goat?