University of Natural Resources and Applied Life Sciences, Vienna

Division of Livestock Sciences

Head: Univ. Prof. Dr. Christoph Winckler

Institutional arrangements and breeding strategies of Ankole cattle keepers

Investigation of options of setting up a community based breeding programme for crossbred cattle where Ankole is an important component

Master thesis

Submitted by

Florian A. Peloschek

Supervisor: Dr. Maria Wurzinger

Examiner: Univ. Prof. Dr. Johann Sölkner

Vienna, October 2009

Acknowledgments

I would like to thank my family and my friends for the support and guidance they provided me through my entire life and in particular in the last five years during my studies at the University of Natural Resources and Applied Life Sciences, Vienna.

I am grateful to my friends in Uganda for hosting and supporting me during my stays in their marvellous home country.

I would like to express my gratitude to my supervisor, Dr. Maria Wurzinger, for answering all my questions patiently. Giving me the possibility of working independently were the moving spirit and motivation to succeed in doing the survey in Uganda.

I also want to acknowledge Univ. Prof. Dr. Johann Sölkner for the supervision of my master thesis, his attendance during the first week of my fieldtrip and being a great travel mate.

Very, very special thanks go to Esau Galukande MSc and Henry Mulindwa MSc for their invaluable support, numerous advices and amicable assistance. Dr. Grace Asiimwe has been greatly supporting my field work in Kiruhura district.

For generous financial and logistical support I want to thank University of Natural Resources and Applied Life Sciences (Vienna), International Livestock Research Institute (Nairobi), Faculty of Agriculture at Makerere University (Kampala), National Animal Genetic Resources Centre and Data Bank (Entebbe) and National Agricultural Research Organisation (Kampala).

Finally I owe special gratitude to the Bahima cattle keepers in Kiruhura district, Uganda, for sharing their knowledge both about the way things are, and their hopes for way things should be.

Summary

Livestock is a major source of income in rural communities; the rising demand for livestock products is requesting more efficient breeding strategies. In the formerly extensively and traditionally grazed and managed rangelands of South Western Uganda, a production system is emerging where cattle breeders keep two separate herds, a purebred Ankole herd and a herd of Ankole crossbred. Different institutional frameworks in Uganda, e.g. government institutions, national agricultural research organisations, cattle breeders' communities, provide possibilities to launch breeding programmes. Missing participative integration of livestock keepers has troubled the success of many well intended breeding programmes in these countries. The thesis aims on better understanding the mechanisms of breeding as carried out by individual farmers as well as by communities. Data collection occurred with a semi-structured interview including a progeny history and was carried out in Kiruhura district in South Western Uganda. The interviews were transcript and entered into an 'Atlas.ti'-database for analysis. Friesian-Ankole crossbreds are not only kept for income generation through higher milk yield and therefore better marketing possibilities, furthermore a wide range of modern and new management system has been introduced together with the exotic cattle. Nevertheless the problem of adaptation to the environment is recognised and of relevance in breeding decision making. The Bahima pastoralists in Kiruhura district have a strong relationship to their Ankole cattle and their crossbred cattle, highlighting the importance of local, indigenous breeds forming the cultural basis of pastoralists in rural livelihoods. The Ankole cattle breeders of Kiruhura district developed flourishing strategies based on their indigenous knowledge which should be preserved and established in any planed breeding programme. The thesis indicates that farmers have preference for breeds with high milk and meat production Furthermore it identified that the knowledge flow on animal husbandry, particularly on breeding strategies and progeny history, in families and communities is commonly functioning. The challenge is to develop a new, adapted breed based on Ankole and any exotic breed by establishing a crossbreeding scheme that allows on-farm rearing to reduce replacement costs.

Key words: Ankole, Ankole x Holstein Friesian, crossbreeding, institutional arrangements, Bahima agro-pastoralists, indigenous knowledge, knowledge transfer

Zusammenfassung

Nutztierzucht und -haltung ist eine wichtige Einnahmequelle in Ostafrika. Die steigende Nachfrage nach tierischen Erzeugnissen erfordert effizientere Zuchtstrategien, welche die komplexen Beziehungen zwischen Ökosystemen und den landwirtschaftlichen und kulturellen Praktiken der Landwirte berücksichtigen. Die vorliegende Diplomarbeit untersucht die Handhabung und Umsetzung der Zuchtstrategien durch Bahima Pastoralisten. Im ehemals extensiv beweideten Buschland im Südwesten Ugandas entwickelte sich ein Produktionssystem, in dem die Rinderzüchter jeweils zwei Herden, eine reinrassige Ankole Herde und eine Herde mit eingekreuzten europäischen Hochleistungsrindern halten. Unterschiedliche institutionelle Rahmenbedingungen wie nationale Agrarforschungseinrichtungen sowie private Organisationen von Viehzüchtern bieten gute Möglichkeiten, Zuchtprogramme durch Integration der Rinderhalter erfolgreich umzusetzen. Gerade die fehlende Einbeziehung der Bauern bei der Entwicklung von Zuchtprogrammen in Afrika hat die Rentabilität derer geschmälert. Die Datenerhebung, durchgeführt in Kiruhura District im Südwesten Ugandas, erfolgte mit halbstrukturierten Interviews einschließlich einer Erhebung der Nachkommenschaft der Rinder. Die aufgezeichneten Interviews wurden in eine Atlas.ti-Datenbank für die Analyse integriert. Die durch Kreuzung von Ankole Rindern mit europäischen Hochleistungsrindern entstehende Milchrasse verbessert die Einkommenssituation durch höhere Milchleistung. Von Relevanz für das Treffen von Zuchtentscheidungen ist auch die Anpassungsfähigkeit der Rinder an die tropischen Umweltbedingungen. Die Bahima im Kiruhura District haben eine enge Beziehung zu ihren Nutztieren, die einheimische Rasse spielt in Bezug auf die Kultur und Einkommenssicherung eine wichtige Rolle. Die Züchter des Kiruhura District entwickeln ihre Zuchtstrategien auf Grund ihres indigenen Wissens, dieses soll in einem Zuchtprogramm berücksichtigt und integriert werden. Die Diplomarbeit zeigt auf, dass die Landwirte eine Vorliebe für Rassen mit hoher Milch- und Fleischproduktion entwickelt haben. Die traditionelle Weitergabe von Wissen über Tierzucht und -haltung wird in den Familien und Gemeinden gepflegt und ist ein wichtiger Bestandteil der Bahima Kultur. Um eine nachhaltige Entwicklung zu gewährleisten, stellt sich die Herausforderung der Schaffung eines Zuchtprogramms, das die indigenen Ankole Rinder sowie das lokale Wissen der Bahima Viehzüchter integriert und Leistungssteigerung und Anpassung an tropische Umweltbedingungen berücksichtigt.

Table of contents

Index of figures

Index of tables

1 Introduction and research question

The demand for livestock products has rapidly grown since the 1980s. The Uganda Investment Authority (UIA) (s.a.) published on its homepage data about the growth of the livestock population and the production quantities. These figures give a good impression on the need to intensify the production in order to keep up with the high demand for livestock products in Uganda, where the indigenous breeds account for over 95% of the national herd (UIA s.a):

Tab 1: Cattle population in Uganda, total heads of cattle from 1997 – 2001.

Year	Cattle
1997	5.460.000
1998	5.651.000
1999	5.820.000
2000	5.966.000
2001	6.144.000

(Source: UIA, own table 2009)

Tab 2: Production quantities for milk (million litres) and meat (million tons) in Uganda, from 1992 – 2001.

output	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Milk	510.6	548.0	531.6	551.2	571.5	592.7	614.8	637.8	661.8	900.0
Beef	79.1	81.5	77.5	79.9	82.4	85.0	87.7	90.4	93.3	133.0

(Source: UIA, own table 2009)

The increasing demand is stimulating production techniques to become economically more effective (FAO 2007a). A statement by Köhler-Rollefson (1997) incorporates the occurring difficulties in developing countries: “Various methods for managing livestock genetic resources have been developed, but each strategy has its own set of problems, especially when considered in resource-poor developing countries.” Immense changes in African livestock production systems are ongoing, especially for the pastoral systems, due to population growth, modernization and institutional transformation and governmental policies (FAO 2007a, Millar et al. 2006, Kugonza 2008).

Traditional knowledge of Ankole cattle keepers is an important driving force in breeding decision making as it is in any other cattle keeper society. Especially in Africa the community is a source of knowing and knowledge production. Understanding this indigenous knowledge and its organizational background may be an important step towards successful livestock management in harsh environments (Millar et al. 2006). Utilization of traditional breeding practices for improvement of indigenous breeds and crossbreds can be less infrastructure and cost causing for managing animal genetic resources (Kahi et al. 2005).

Major transformations have occurred in the last decades in the Ugandan Ankole production system. Extensive grazing has become more difficult because of new land policies, which favour fencing off of large tracts of land which have been communally grazed in previous years. To achieve higher milk yields crossbreeding with Holstein Friesian cattle is taking place at fast rate, reducing the number of purebred Ankole cattle (Galukande et al. 2008).

“Currently, most smallholders practise systems of upgrading indigenous breeds to higher exotic grades without following a defined breeding programme. This process has resulted in problems, which can be ascribed to lack of adaptation to tropical stresses of poor nutrition, disease challenge and heat stress (Kahi et al. 2000).” With crossbreeding indigenous cows with exotic bulls a dramatic increase in productivity has been achieved in most cases in the F1 generation, nevertheless repeated backcrossing to exotic bulls often have resulted into adaptation problems for the subsequent generations. Indigenous cattle possess essential genetic resources and properties for reproduction and survival in the subtropical and tropical environments; therefore it is important to preserve these for the future (Syrstad et al. 1998).

1.1 Research outline

The aim of the thesis is to analyze published papers and conduct a field survey to assemble information and data to respond to the following subchapters. The occurring results are analysed referring to the objective, purpose and research question too.

1.1.1 Objective of thesis

The goal of this Masters project is to better understand the mechanisms of breeding as carried out by individual farmers as well as by communities, especially the traditional, current and may be emerging institutional arrangements.

1.1.2 Purpose of thesis

Investigating the breeding mechanism of Ankole cattle keepers can help to strengthen endeavours to assist breeding activities. Institutionalized traditional arrangements and cultural breeding practices should be embedded in breeding programmes to sustain their efforts. Selection criteria also base on indigenous, traditional and inherit knowledge. Breeds in developing countries as in developed countries are products of specific ecological conditions and socio-cultural background of the cattle breeders. There is a dependence on cultural values and emotions that are attached to breeding decisions. Ankole cattle keepers and Ankole cattle are living in a strong developed relationship which is defined as “cattle-complex” through anthropologists (Klima 1970). There are versatile socio-economic and cultural roles of Ankole cattle that might have been underscored by earlier studies. Milk, meat and living animals have a broader significance among cattle keepers than just an economic worth. Breeding objectives developed on an economic bias need a social relevance to become ecological sound and gain more acceptances within Ankole cattle keepers’ societies. Because of the missing systematic documentation like herd books, the investigations will highlight importance of the traditional, oral knowledge transfer. Occurring results can have a positive influence on integrating traditional practices and technologies into procedures of animal health and production.

1.1.3 Research question

The analysis of traditional arrangements of exchanging Ankole cattle within the breeders’ communities will be explored in this thesis; an emphasis will be placed on investigating eventually occurring differences in breeding strategies between breeding of pure bred Ankole or cross-breeds on the same farm. Ankole cattle

keepers have a unique knowledge of this breed; therefore it should effectively be incorporated into improvement of breeding schemes.

The thesis focuses not only *how* breeding decisions are resolved and *how* breeding is done by the cattle keepers, it also centres *why* these breeding strategies are realized. Investigation conducted within this thesis therefore will explore traditional ways of decision making in animal breeding and finally propose options for a community based breeding programme.

2 Literature review

In this section published literature on the subject is reviewed and results compared. The section opens with an overview of breeding strategies in developing countries, a description of the Ankole cattle and the ethnic group Bahima, Ankole cattle breeders. Definitions of institutional arrangements are given and an outline on traditional arrangements and indigenous knowledge in animal breeding is provided. Finally the field tools are presented.

2.1 Breeding strategies for cattle in developing countries

A popular belief among extension workers and development consultants for many decades was that indigenous tropical animal genetic resources are unproductive and inferior to exotic breeds and as a consequence, crossbreeding and replacement were severely promoted (Köhler-Rollefson 2001). “The characterisation of indigenous breeds has often been neglected, as has their improvement (Conroy 2005).” Nevertheless local, indigenous breeds form the basis of cultural identity and are supplemental to sustaining rural livelihoods (Ayantunde et al. 2007). In developing countries most livestock, including cattle, are kept in traditional management systems, where the breeders rely upon their breeding stock. Identifying genetically superior animals through the experience and expertise of the cattle keepers should not be underrated. Difficulties in employing modern methods of livestock genetic improvement arise through illiteracy and slow acceptance rates of education systems (Kahi et al. 2005). Livestock in rural communities is a major source of income, the rising demand for livestock products is requesting more efficient breeding strategies. Within breed selection and the use of crossbreeding strategies are commonly used in these communities (Kosgey et al. 2006, Kahi et al. 2005). For improving the livelihoods of poor livestock keepers, facilitating the productivity of such livestock is one of the major means (Mwachero et al. 2005). Adaptation regarding breeding priorities and strategies were identified in several studies (Homan et al. 2008). Indigenous knowledge, production system and breeding preferences of smallholders breeding practices reflect their broader objectives (Bebe et al. 2003). Breed improvement programmes tend towards market driven traits as increase of milk yield

disregarding other livestock functions and constraints (Ouma et al. 2004). The breeding stock of the livestock keepers is replaced within their own herds often (Wurzinger et al. 2006, Mwachero et al. 2005).

Sölkner at al. (1998) define community based breeding programs as village breeding programmes: “Village breeding programmes are carried out by communities of smallholder farmers (villagers), often at subsistence level. The availability of feed for the animals is far from optimal with large seasonal variations and variations between years (e.g., droughts and floods in the tropics, summer and winter in extreme mountain regions of Asia). The pressure from diseases may be high (tropical regions). The level of organisation is low, hierarchical structures with good flow of information between levels of the hierarchy cannot always be assumed to work. Data recording in the sense used by animal breeders in the developed countries will often be missing.”

2.1.1 Pastoralists activities and objectives

Breeding strategies among pastoral societies all over the world and between livestock species are different (FAO 2001a). A general definition of breeding activities in the subtropics and tropics is given by Valle Zarate (1995): “Breeding activities are aimed to support small subsistence farmers to develop cost- and resource-saving production methods and to become more market-oriented, in order to provide for their families and stay on the land. Animal products should be produced efficiently, taking account on specific environmental conditions with severe climatic and feed restrictions and seasonal fluctuations, as well as minimum investment opportunities.”

Over numerous centuries, African pastoralists developed specific breeding objectives, adapted to the harsh environments and intractable livelihoods. Yet these circumstances are not simply variable at all (Sölkner et al. 1998). Furthermore the classifications of the traditionally long-term developed breeding objectives differ significantly between farmers and scientist (Köhler-Rollefson 1997). Breeding objectives and breeding plans have often been developed and realized through researchers for village breeding programmes (Sölkner et al. 1998). Pastoralist breeding practices follow a broad range of objectives: Milk yield merged with adaptability to tropical diseases and local fodder resources, non-market benefits (e.g.

insurance and means of savings) combine with physical appearance (Bebe et al. 2003).

Embedded in breeding traits are also non-market and sociocultural functions of cattle in developing countries, hence these functions are lacking in economic values. Breeding programmes often highly value one breeding trait: improved milk production, which is attained by crossbreeding with exotic dairy breeds. However for pastoralists in East Africa this trait does not seem of high-ranking importance compared to other breeding traits (Ouma et al. 2007). A study in Kenya (Bebe at al. 2003) investigating in smallholders' dairy system breeding practices came to the conclusion, that pastoralists make decisions on multiple objectives, including non-market production and sociocultural functions. Wollny (2003) states: "Traditionally, mating decisions are based on ancestral performance rather than progeny testing."

Ankole cattle breeders indicate multiple breeding trait preferences, ranging from cultural heritage symbol, fitness traits and marketability of livestock products to the ability to cope the rough environmental conditions (Ndumu et al. 2008). For defining breeding objectives participatory evaluation processes delivered prosperous results, adapted to on site conditions (Ndumu et al. 2008, Wurzinger et al. 2006). Ankole cattle keepers in south western Uganda run a production system with a pure bred Ankole herd and a Friesian-Ankole crossbred herd. The Friesian-Ankole are kept for income generation through higher milk yield and therefore better marketing possibilities. The Ankole are kept because of a traditional motivation and the adaptability to the harsh environment (Galukande et al. 2008).

2.1.2 Crossbreeding cattle for milk production in the tropics

"Within-breed selection (which animals to choose as parents) and crossbreeding (which breed combinations) are classical approaches for genetic improvement (Kahi et al. 2005)". Galukande et al. (2009) reviewed fifty studies concerning crossbreeding in the tropics and underlined "that where management is good, there is an improvement in performance among crossbreds with increasing bos taurus genes, with 50% and 75% performing better than all other levels of crossing." The improvements of the crossbreeds are highlighted with earlier calving, producing more milk and having longer lactations and shorter calving intervals than the indigenous stock (Galukande et al. 2009). Three broad crossbreeding strategies are classified on

these categories: formation of synthetic or composite populations, establishment of a stable crossbreeding system (rotational crossing or criss-crossing) and breed replacement and grading up (Cunningham et al. 1987). Synthetic breeds can be made up by inter se mating from two or more indigenous or already crossbred breeds. The simplest form is developed with two parental breeds crossed to produce the F1 generation and than continue with selecting the best performing F1 to produce the F2 and subsequent generations. “Developing a synthetic breed is a long-term process that needs many resources, a large number of animals, detailed recording and analytical facilities (Kahi et al. 2005).”

Rotational crossbreeding is simplest established by using two pure bred males of each breed in alternate generations. The first generation will be an F1, however the subsequent generations will after a few breeding cycles a population with a two-third gene complement from one parental breed and a one-third gene complement from the other parental breed. Grading up is a widespread tactic in the tropics, were typically indigenous cows are mounted by an exotic bull. Nevertheless this is in fact a population replacement strategy because within four generations more than ninety percent of the indigenous genotype can be replaced (Galukande et al. 2009, Cunningham et al. 1987).

Genetic improvement by selection is an attractive alternative to importation of genetic material. Many temperate breeds achieved by selection impressive results in increasing productivity, improving the dairy potential of tropical cattle by the same method should be considered too (Syrstad et al. 1998).

2.1.3 Launch of genetic improvement in the Tropics

Different institutional frameworks and organisational players provide possibilities to launch breeding programmes, ranging from government institutions, national agricultural research organisations to cattle breeders (Rewe et al. 2008). Missing participative integration of livestock keepers has troubled the success of many well intended breeding programmes in these countries (Sölkner et al. 1998).

Genetic improvement can simple be generated in a small fraction of the population referred to as the nucleus, where recording and evaluation can be done easier when resources are scarce as in developing countries (Kosgey et al. 2006). The main advantage of a nucleus is described by Kosgey et al. (2006): “Recording is not

needed for the remainder of the population. The genetic progress is disseminated to the commercial population through use of males and/or semen (where artificial insemination is feasible) originating from the nucleus." There are two possibilities for nucleus breeding programmes, open or closed: „In a closed nucleus, there is no upward migration of animals from the lower tiers to the nucleus, and all recording is confined to the nucleus. On the other hand, an open nucleus allows animals of high merit to be migrated up for breeding in the nucleus. Only females of high merit, and not males, from lower tiers are allowed to migrate up for breeding in the nucleus (Kosgey et al. 2006)." For implementing a breeding scheme based on a nucleus it is necessary to consider the interaction between nucleus and cattle breeders for the migration of animals, especially the open nucleus scheme with the possible larger population involved can lead to an increase of costs for improving the infrastructure (Kosgey et al. 2006). Some degree of recording of animals in the open nucleus scheme to ensure the flow of genes between the breeders and the nucleus herd is compulsory (Kahi et al. 2005).

Infrastructure, socio-economic and socio-political limitations in developing countries hamper the implementation of recording schemes established in developed countries. Community-based breeding programs could be a solution; nonetheless their success depends mainly on the incorporation of farmers and, not to be neglected, strong collaboration with government and other development partners. A system as an open nucleus breeding programme can encourage farmers to participate through integrating their resources and reducing overhead costs (Kahi et al. 2005). Sölkner et al. (1998) suggest regional centres of breeding, forming the base of open nucleus systems, as leverage for efficient improvement of breeds.

2.2 The Ankole cattle and the Bahima cattle keepers

In Uganda, the Ankole is the prevalent type of cattle, found in the western, central and south western parts of the country (Nakimbugwe et al. 2003). These cattle are valuable for milk, ghee and meat production, and satisfy many cultural functions such as funeral, marriage or religious sacrifice (Nakimbugwe et al. 2003, Wurzinger et al. 2006).

The Sanga group of cattle are indigenous to the central and eastern regions of Africa including the Ankole group of cattle: Bahima cattle, Bashi cattle, Kigezi cattle, Ruzizi cattle and Watusi cattle (Rege et al. 1999). The horns, which are the most conspicuous and one of the most highly regarded features of these animals, are very long, measuring over 100 cm. Ankole cattle can weight 300 – 500 kg at maturity, an average bull measures 145 cm and an average cow measures 129 cm at withers.

The boundaries between agriculture and pastoralism are fluid and changing as an answer to the environmental, political and social changes (Loftsdottír 2001). Ankole cattle are kept under various production systems: pastoralism, agro-pastoralism and crop-livestock mixed farming (Kugonza 2008). If Ankole cattle keepers acquire cattle from other herds, the most common ways are dowry presents and inheritance, like in other traditional cattle-breeder societies in Africa (Mwachero et al. 2005, Köhler-Rollefson 1997 & 2001). Ankole cattle are progressively more and more crossbred with competitive breeds e.g. Friesian cattle (Wurzinger at al. 2006).

Fig. 1: Ankole bull
(Source: Florian Peloschek 2009)

The reproduction of Ankole cows is precisely described by Kugonza (2008), age at sexual maturity ranges between 12 - 36 months for both male and female Ankole cattle, average age at first calving ranges between 24 and 45 months, the calving interval for Ankole cows ranges between 12 and 18 months. The average lactation length significantly differed between the various production systems, lactation length was 5.5 months for the crop-livestock, 6.3 months for agro-pastoral and 7.4 months in pastoral areas. Across the country, the overall mean was 7.2 months.

Wurzinger et al. (2006) explained reproduction parameters for Ankole cattle: “According to farmers, the number of calves born per cow in a lifetime is extremely

high, with an average of 6 to 9. Also, the age of cows at disposal is high. On average, bulls are between 26 and 34 months old when they are first used for mating, but ages up to 54 months were mentioned by farmers. Bulls are kept in the herd between 4 and 7 years before they are replaced by a younger bull." Because of the relatively long stay of the mating bulls in the pure bred Ankole cattle herd or crossbred cattle herd, inbreeding can easily occur.

Fig. 2: Ankole cow
(Source: Florian Peloschek 2009)

The Ankole region south west of Kampala and Lake Victoria consists mainly of bush savannah and is primarily used as grazing land for cattle by the Banyankole people (Reichhart 2007). Banyankole society is divided into a high-ranked social class of pastoralists, the Bahima[1], and a lower-ranked caste of crop farmers, the Bairu. The Banyankole belong to the Bantu speakers, their language is called Runyankole. Dowry gifts, the paying of a bride price, are in the Bahima tribe of high concern. The bride price is paid in form of cows which have at least one calving and in-half heifers to ensure that the received animals are fertile (Reichhart 2007). Bulls are usually not accepted as dowry gifts (Nakimbugwe et al. 2003). The relatives of the bridegroom, sometimes the bridegroom himself, visit the herd of the in-laws and choose an earlier specified number of cattle (Nitza et al. 1998).

In the last decenniums the Bahima Ankole production system has transformed, pastoralists favour fencing off their land to secure pasture for their herds (Galukande et al. 2008). Kugonza (2008) describes ownership patterns and acquisition of Ankole

[1] Bahima is the plural term, Muhima is the singular term.

cattle. The Owner of an Ankole cattle herd in south western Uganda is usually the household head, mainly men. The major method of attaining Ankole cows in this ethnic group is inheritance, while purchase and dowry gifts although important are minimal. Purchase is the most common method used to acquire the breeding bull, followed by raising the bull in the own herd and acquiring it as a gift. Cows are mainly acquired as gifts, followed by inheritance and purchase.

In south western Niger pastoralist and agro-pastoralist society's acquisition of cattle from other herds occurs mainly through inheritance, purchase, caretaking arrangements and absentee owners (Ayantunde et al. 2007). Similar ways for exchanging animals have been described for Ankole cattle keepers in south western Uganda (Nakimbugwe et al. 2003). The possibility of manipulating the gene pool of a herd consisting of purebred Ankole or crossbred Friesian-Ankole with this methods of acquiring new animals (life-cycle stages e.g. marriage) will be explored through the field research. A study conducted in Sudan reflects that the cattle breeders replace their indigenous breeding bulls mostly of their herds offspring, crossbred bulls were mostly bought on markets (Musa et al. 2006).

2.3 Institutional arrangements and indigenous knowledge

It is not the author's intention to restrict the definition of institutional arrangements to one valid standard, but for the purpose of this thesis institutional arrangements are regarded as customs and traditions moderated by prevailing belief systems and values. What is practised within a community is regulated by its institutional arrangements, based on the indigenous knowledge of the community members. Institutional arrangements are both stable and dynamic.

The Mindset of Ankole cattle keepers is influenced by a set of beliefs, which is embedded in an institutional context which shapes behaviour and interaction within the breeder's social network (Macadam et al. 2003). Institutional arrangements are strongly affected by the competence of people belonging to them (Wenger 2000, as cited in: Macadam et al. 2003).

Figure 3 is visualizing the influences on Bahima cattle breeders' mindset.

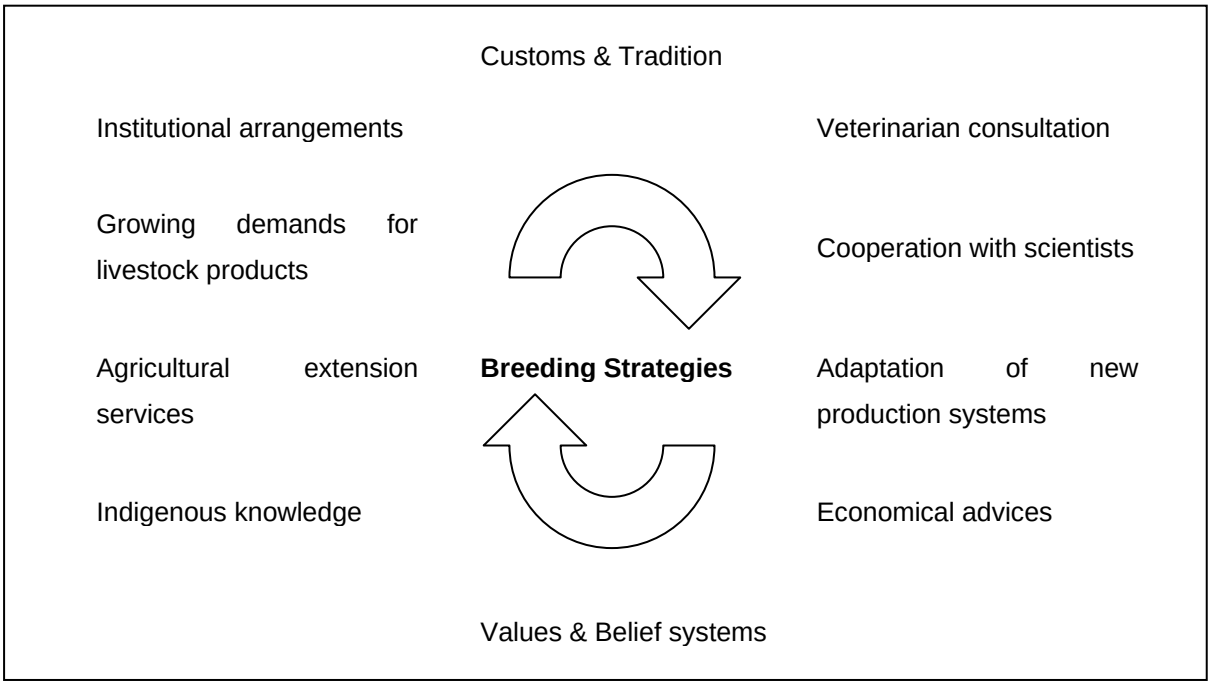

Fig. 3: Influences on Bahima cattle breeders' mindset
(Source: own illustration 2009)

A precise definition on indigenous knowledge, in the literature often termed as local knowledge, is given by the Knowledge and Learning Center, Africa Region, World Bank (1998): "The literature on indigenous knowledge does not provide a single definition of the concept. Nevertheless, several traits distinguish indigenous knowledge broadly from other knowledge. Indigenous knowledge is unique to a particular culture and society. It is the basis for local decision-making in agriculture, health, natural resource management and other activities. Indigenous knowledge is embedded in community practices, institutions, relationships and rituals. It is essentially tacit knowledge that is not easily codifiable."

Indigenous knowledge plays a major role in the use, improvement and conservation of a breed (Kugonza 2008). Sociological research has established that pastoralist manipulate the genetic composition of their livestock with their traditional knowledge (Köhler-Rollefson 2001). For any planed implementation or preparation of a breeding system these existing structures for transfer of knowledge and information should be used (Sölkner et al. 1998). In traditional pastoralist communities, animals are habitually symbols and indicators of the social status of the owner. This sociocultural

significance of an animal must be understood to realize the networks among the community members for exchanging their livestock (Köhler-Rollefson 1997).

Traditional rangeland management and seasonal herd movements of Borana Pastoralists in Ethiopia have been described as a convertible institutional arrangement by Homan et al. (2008), exploring the adaptive strategies for improved exploitation of natural resources.

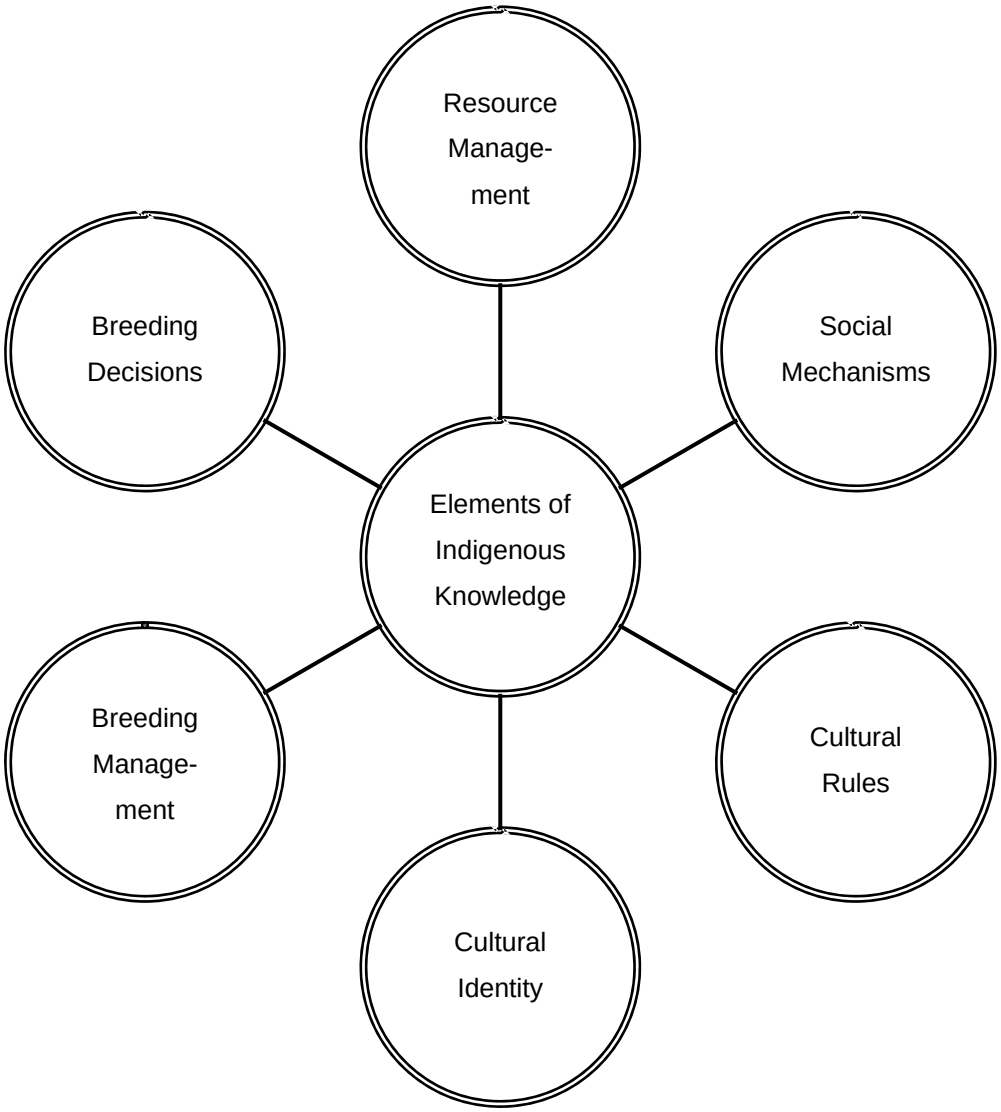

Fig. 4: Elements of indigenous knowledge
(Source: own illustration 2009)

Figure 4 is visualizing which influences are emerging on indigenous knowledge in traditional cattle keeper societies.

The dynamic interaction between indigenous people and their animals and the importance of this knowledge system is described by Philipsson et al. (2006b):

“Domestic animal diversity is ecologically and culturally embedded. Therefore, the knowledge of local people extends beyond the breeds themselves to the complex web of interactions between the animals and the environments in which they are kept, including the beliefs and cultures of the communities that keep them. For example, because of the need to make best uses of the erratic and unpredictable rains and to avoid inter-community hostilities (rustling) and disease-prone areas, pastoral management systems, where indigenous breeds dominate, are flexible and dynamic. The flexibility and dynamism enables the people to respond quickly to changing conditions and complex systems of reciprocal favours and obligations. It also provides equity-sharing instruments that characterise the management systems which are often sanctioned by elaborate rituals and ceremonies. This knowledge system is crucial, not only in understanding the history and nature of existing diversity in animal populations, but also as a basis for developing strategies for its continued maintenance and sustainable exploitation (e.g. niche markets) in a way that accommodates the lifestyles, aspirations and livelihoods of the keepers.”

Manifesting of ownership is sometimes applied within pastoralist societies through various identification modes (e.g. branding and ear notching); an indication for traditional indigenous knowledge established trough social relationships (Mbuku et al. 2006; Loftsdottír 2001). For centuries and over quite a few generations these simple methods helped breeders to maintain and adapt local breeds sustainable (Kahi et al. 2005). A statement by Sölkner et al. (1998) explains the within community arrangement of livestock keepers and their difficulties with foreign interfering: “Village communities may have different perceptions and priorities. Having lived from generation to generation with what an outsider may regard as a problem, a community may not understand the necessity of any form of intervention. Communities have different sets of cultural and social values by which to judge, appraise and decide.”

2.4 Field tools

The following subchapters give a short description of the applied tools, based on a literature review. Detailed information about the application of the survey methods during the field research is explained in Chapter 3.

For gathering relevant information, well proven field tools are used in the survey. The participatory approach is enabled with a semi-structured interview including a progeny history. Conroy (2005) enunciates basic principles for participatory methods:

- Conduct the survey in a relaxed way.
- Use different tools for gathering information to cross-check the findings.
- Do not collect information that is not relevant, even if it sounds interesting.
- The time of all dialogue partners is precious, do not waste it.

Involving local groups through indigenous institutions or external programmes is specified as collective action. Meinzen-Dick et al. (2004) give the following description on collective action: ”What most definitions have in common is that collective action requires the involvement of a group of people, it requires a shared interest within the group, and it involves some kind of common action that works in pursuit of that shared interest.” The mentioned group of people in the statement above are the Ankole cattle keepers in south western Uganda. Collective action is a phenomenon that can be identified trough various methods of investigation and best results can be achieved with participative approaches and methods (Meinzen-Dick et al. 2004). The FAO Informal Working Group on Participatory Approaches & Methods (2009) defines participation in development as a sustainable process which has to continue after the withdrawal of a programme or a project. This can be achieved if in particular local institutional arrangements are strengthened.

2.4.1 Progeny history

“Progeny histories are essentially livestock genealogies, which describe the fate of all offspring of a given female animal. They provide quantitative data on the fate of the animals that have left the herd or flock. This includes information on voluntary off take, such as numbers of animals sold, for what reason sold, slaughtered for food or used for other purposes, as well as animals that have died as a result of disease, drought or other causes (Iles 1994).” In a Study conducted by Iles (1994) in Samburu District, Kenya pastoralists provided all required information voluntary and enjoyed talking to the interviewers. Progeny histories provide date over an extended period of time (approximately five to ten years), in comparison to the short time frame of single interview techniques. A progeny history delivers best results with more important,

valued species as cattle. Furthermore large livestock histories are easier to remember because of more occurring single births (Iles 1994).

The technique of progeny history analysis is moderately time consuming, nevertheless it allows the research team to acquire raw qualitative data on herd off-take, abortion rate and herd mortality rate (FAO 2000). In this study information about acquiring cattle and the period of utalization in breeding of bulls was collected with this field tool.

2.4.2 Semi-structured interview

"Semi-structured interviewing does not involve a formal questionnaire, but instead makes use of a flexible interview guide to help ensure that the interviews stay focused on the relevant issues, while remaining conversational enough to allow participants to introduce and discuss issues that they deem relevant (Rietbergen-McCracken et al. 1998)." Semi-structured interviews can be concluded with an individual or with a few key informants or with a group. Especially to follow up on a topic raised by other field tools it is a very convenient method. It is advisable to prepare a checklist, detailed or only a broad outline is depending of the personal interviewing skills of the interviewer, besides the fact, that the interview should take place in a relaxed and friendly atmosphere (FAO 2001b).

Organizing tips for conducting successful semi-structured interviews are given by Theis at al. (1991):

- The interview team should consist of two or four people of different disciplines.
- Begin with the traditional greeting and state that you are here to learn.
- Begin the questioning by referring to someone or something visible.
- Conduct the interview informally and mix questions with discussion.
- Be open-minded and objective.
- Let each team member finish their line of questioning (don't interrupt).
- Carefully lead up to sensitive questions.
- Assign one note taker (but rotate).
- Pay attention to nonverbal cues.
- Avoid leading questions and value judgements.

- Avoid questions that can be answered by “yes” or “no”.
- Individual interviews should be no longer than 45 minutes.
- Group interviews should be no longer than two hours.

3 Materials and methods

This section of the thesis report gives a detailed explanation of the study area, the survey procedure, the data collection and the data analysis.

3.1 Study area

Fig. 5: Map of Uganda
(Source: UN Cartographic Section 2009)

Data collection was carried out in Kiruhura district in South Western Uganda from 31st March to 2nd May 2009. This district forms part of the Ugandan cattle corridor, where traditionally people have moved with their animals in search of water and pasture (Wurzinger et al. 2006). Kiruhura district was created in January 2006 when Mbarara district was split in two almost equally seized districts, Kiruhura in the east

and Mbarara in the west. Geographical information or current maps are not available yet (Reichhart 2007).

A description of Kiruhura district is given by Reichhart (2007): “Kiruhura consists of large grazing areas, most of them neatly fenced with barbed wire or natural shrubs or both. Where no pasture management is practised the land is covered by dense bushes. At first sight, the land does not seem to de densely populated. However one has to keep in mind that huge areas of pasture are needed to feed one’s cattle as rangeland in semi- arid areas is not too productive. In this area animal pressure increasingly becomes a problem leading to overgrazing and land degradation. The cattle distribution is reported to be highest in Mbarara- and Ntungamo districts; therefore including Kiruhura district. These areas can also be described by fair to high soil productivity with mean annual rainfall ranging from 900 to 1,500 mm. The temperature varies between 17 and 27 °C. The natural pastures are of moderate to low nutritive value (Samaanya et al. 2002).” Especially during the dry seasons overgrazing and land degradation are seriously affecting the pastures (Mulindwa et al 2009).

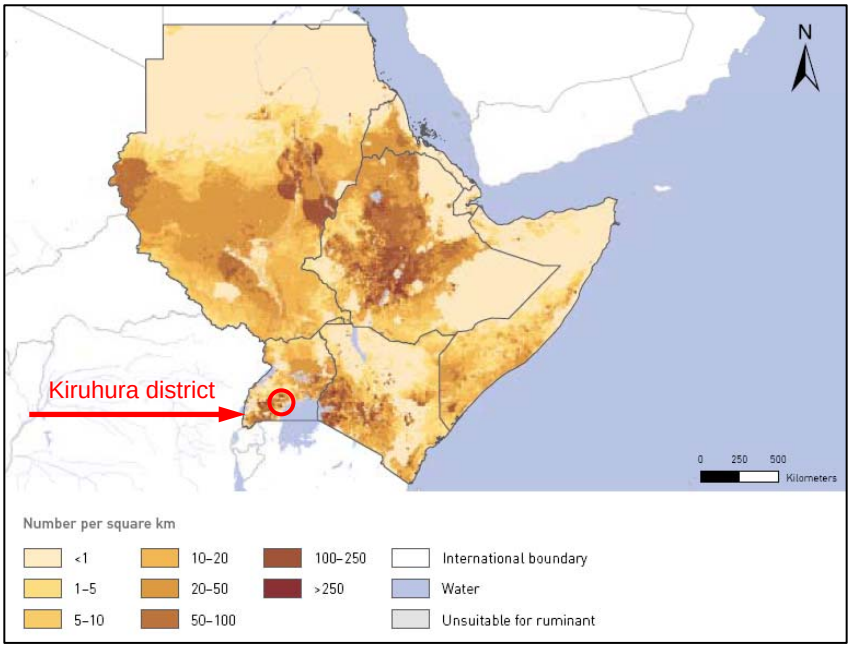

Fig. 6: Modelled cattle density in the horn of Africa
(Source: FAO 2007b, modified)

A livestock distribution map of the FAO (2007b) models the density of cattle in the horn of Africa, visualizing the high number of cattle in the Ugandan cattle corridor. Cattle density and other socio-economic, environmental and satellite data are

illustrating the importance of livestock contributing to the livelihoods (Rogers at al. 2006).

Farmers from the following villages participated: Kikatsi, Ekimono, Rushenyi, Kyabagyeni, Kyabagyoni, Kayonza, Kachumbiro, Akatongole, Kanyabihara, Ruburara, Akengoma, Akashenshero, Kakyeera, Nyarutegura Nkongoro. The villages are located in the Sub counties Kikatsi, Kenshunga, Masha, Rubaya, Nyakashashara and Sanga, which are situated in the Counties Nyabushozi, Isingiro South and Kashari.

All interviewed farmers live a sedentary life as agro-pastoralist. Cultivation of bananas, beans and maize is carried out for additional food for home consumption, and the surplus is sold to gain additional income.

Fig. 7: Grazing site in Kiruhura district with crossbred cattle
(Source: Florian Peloschek 2009)

3.2 Survey methodology and data collection

The survey is conducted with a participatory approach using methods and tools to facilitate a more equitable and demand-driven participatory development process (FAO 2009). The involvement of Ankole cattle keepers into the study was mainly by providing information to the enumerators.

Data was collected through a semi-structured questionnaire used as a guideline for gathering information from cattle keepers. An emphasis was put on the fact, if the institutional arrangements are stable or dynamic, especially to comprehend the meaning of the term ‘competence’ of keepers of pure bred Ankole and crossbreeds cattle. Stable institutional arrangements may damp down the development of new breeding strategies, while dynamic institutional arrangements can encourage changes. The methods of replacement of purebred Ankole or crossbred Friesian-Ankole breeding bulls might be similar. The enquiry conducted during the field research therefore included questions for investigating this ways of substitution and the relevant linkages among the cattle keepers’ communities are investigated.

This guideline is attached as Annex 1. It included among others a section progeny history to provide data on the fate of exemplary chosen cows and bulls, social economic and education background of the farmer, questions regarding herd structure, relationship among farmers and knowledge transfer. The interviews were conducted at the cattle herd, or in the farm house, or at village centres or at a restaurant, allowing the interviewer and the interviewee enough possibilities for dynamic and productive discussion. This allowed obtaining the goal of the survey: to gather information on attitudes and beliefs of cattle keeper, focusing their breeding strategies, on changes in them over time and differences within their society. In the questionnaire open-ended questions only were used. Open-ended questions allow the respondent to express their thoughts and feelings in their own words and provide an inside into different perspectives on one question asked. To keep the information during the interview flowing and avoid disruptions, it is helpful to asks probes and remarks when using open-ended questions (Weisberg et al. 1996).

Data collection was accomplished in a series of face-to-face interviews conducted by the author and a translator using a pre-tested questionnaire as a guideline either in English or in the local language, depending on the literacy level of the farmer. In case of interrogating and discussing with the eight pastoralists at the village centre the dialogue switched into a group discussion with the steadily growing audience. Three local veterinarians acted as translators of the questionnaire and officiated as contact persons to the farmers. All interviews were recorded in full length, using a digital voice recorder WS-310M Olympus. The interviewer maintained some practical aspects of interviewing as a general checklist for managing and recording the interview. This included an interview schedule for preparing the interview, opening

the interview with a short general rapport on the study and closing the interview politely, and a well harmonized sequence and a verified type of questions. The recording of the responses for easier analysis with electronic equipment involves skills in working with recorders. Communication and listening skills also needs preparation and training. Therefore the interviewer tested with the help of the supervisor the questionnaire and equipment before the field research was conducted (Punch 2007). After the pretest, the questionnaire was finally adapted with new and revised questions and modified to the conditions of handling an interview situation in the field. Information was also obtained on socio-economic data about the household. After closing the interview and turning off the recorder, some farmers communicated remarkable information which was written down by hand on the data sheet. The duration of one interview was in average forty minutes. Eighteen farmers of an ongoing research project, run by the International Livestock Research Institute (ILRI) Nairobi, University for Applied Life Sciences and Natural Resources (BOKU) Vienna, National Animal Genetic Resources Centre and Data Bank (NAGRC & DB) Entebbe, were among the farmers interviewed. An additional twenty farmers were identified by support of local veterinarians. The selection criteria for these farmers were keeping pure bred Ankole cattle only or recently begun crossbreeding.

Fig. 8: Farm visit: Interviewer (left), farmer (middle), translator (right)
(Source: Florian Peloschek 2009)

3.3 Data analysis

The interviews were downloaded to a laptop, transcript and entered into a database for later analysis. Thirty four interviews out of thirty eight were used for the data analysis, four interviews accomplished while the pre-test were not included into the data analysis. All interviews were transcribed with the software programme ‘f4’, version 2.1, 2004/05, during the fieldtrip in Kiruhura district, Uganda. The transcript was then transferred as primary document (P1: Data4Atlas.ti.rtf) to the software programme ‘Atlas.ti’, version 5.2, 2006, for analysing the qualitative data, later on in Vienna, Austria. This programme allows the user to systematically analyze with codes and quotations to sort the received information. Forty eight codes were selected to classify one thousand three hundred ninety eight quotations (see Annex 3).

4 Results

Through answering the questions during the data collection the Bahima cattle breeders explained their traditional ways of breeding, how they become acquainted with exotic cattle breeds and the influences of modernization. The farmers gave an enormous amount of their knowledge. In the following subchapters the received information is summarized and reviewed.

4.1 Herd size and breed composition

From the thirty four farmers who participated in this study the majority of twenty seven keep their cattle in two or more herds. Only seven farmers keep their cattle in one herd. One farmer keeps five herds (P 1: Data4Atlas.ti.rtf: 528-528), three farmers keep four herds (P 1: Data4Atlas.ti.rtf: 926-926, 1464-1464, 1743-1743) and three farmers keep three herds (P 1: Data4Atlas.ti.rtf: 853-853, 1033-1033, 1338-1338).

Four farmers keep purebred Ankole cattle only (P 1: Data4Atlas.ti.rtf: 1140-1140, 3325-3325, 3420-3420, 3509-3509), the other thirty farmers keep also crossbreds. These, locally called “Crosses”, are Ankole-Friesian cross-breds mainly, one farmer has Ankole-Boran crossbreds (P 1: Data4Atlas.ti.rtf: 855 -855), and another farmer does crossbreeding with Brown Swiss (P 1: Data4Atlas.ti.rtf: 1344-1344).

Five farmers herd their Ankole cattle and cross-breds together, because they have just started to do crossbreeding and want to separate their herds later (P 1: Data4Atlas.ti.rtf: 3004-3004, 3014-3014, 3117-3117, 3224-3224, 3236-3238).

Six farmers recounted that they have more head of cattle than three years ago. Contrarily most of the farmers recently sold cattle. The reasons differ widely between to sell cattle of to fulfil economic demands (P 1: Data4Atlas.ti.rtf: 16 -16) or to balance the number of animals to the amount of available pasture (P 1: Data4Atlas.ti.rtf: 752 -752). Others made major investments in the farm like buying additional land for grazing (P 1: Data4Atlas.ti.rtf: 1239-1239) or cleared the bush land on their farms (P 1: Data4Atlas.ti.rtf: 1662-1662).

The number of cattle owned varies within a wide range, from twenty (P 1: Data4Atlas.ti.rtf: 2342-2342) to four hundred eighty (P 1: Data4Atlas.ti.rtf: 536-536).

4.2 Advantages of different cattle breeds

The cultural relevance of keeping Ankole play a major role for nineteen farmers and are an important reason for keeping them. As main advantage of Ankole cattle thirteen farmers mentioned the resistance to diseases and nine farmers referred to adaptation to draughts and acclimatization to the harsh conditions of the environment.

The benefit of crossbred cattle for thirty farmers is income generation. Through higher milk production to serve the economic demands and commercial purposes crosses are more favoured.

The question, which cattle breed they would like to keep in the future, was answered by four farmers only, they would prefer to keep the pure bred Ankole (P 1: Data4Atlas.ti.rtf: 2251-2251, 2348-2348, 2453-2453, 2669-2671).

4.3 Origin of breeding bulls and period of utalization in the herds

If the farmers separate their herds according to the different breeds they keep, they customarily have more bulls in their herd. For each Ankole herd or crossbred herd eleven farmers have at least one mature bull in use. Rearing a male calve from the own herd or raising a young bull from another herd to replace the leading bull is a strategy ensued by twelve cattle breeders. In fact rearing a bull does not obligatory pursue the aim of raising the next leading bull for the herd, because these bulls can leave the herd at the age of reaching maturity by the traditional ways of exchange. Replacing the old bull with a young bull that was reared within the herd happens normally before the daughters of the young bull reach maturity age (P 1: Data4Atlas.ti.rtf: 2909-2909, 3024-3024). Hence this is described by a farmer, who keeps a bull until he produced his fourth generation and after that is replaced (P 1: Data4Atlas.ti.rtf: 1253-1253).

Thirty-one farmers stated that bulls usually are brought in from another farm.

The allocated period which a bull is used for breeding in a herd differs widely, from one and a half year (P 1: Data4Atlas.ti.rtf: 37 -37) to a severe duration of fifteen years (P 1: Data4Atlas.ti.rtf: 2196-2196). The bull that stayed for such a long period in the

herd was prevented from mating his daughters by the herdsmen (P 1: Data4Atlas.ti.rtf: 2206-2206).

Three farmers with one herd keep their bull for three or four years (P 1: Data4Atlas.ti.rtf: 1152-1152, 3437-3438, 3524-3525) another one up to five years, if it produces many female calves (P 1: Data4Atlas.ti.rtf: 3340-3341)

Fifteen farmers use a pure bred Ankole bull or pure bred Friesian bull or crossbred bull for the same period for breeding. The time span of keeping the breeding bull in the herd differs between the breeds for other farmers. Seven keep Ankole bulls longer. The justification of a cattle keeper for keeping pure bred Ankole bulls longer is because the crossbred bulls reach the age of sexual maturity earlier, therefore unwanted mating can occur earlier (P 1: Data4Atlas.ti.rtf: 548-548). A similar point of view has one more farmer, who exchanges the bull in the crossbred herd every year (P 1: Data4Atlas.ti.rtf: 2158-2158).

Crossbred bulls are maintained longer in the herd of four farmers. One farmer explained that the product of inbreeding among the crossbreds is not so bad than the result of inbreeding among Ankole, so the bull in use for the crossbred can stay longer (P 1: Data4Atlas.ti.rtf: 663-663). Another one reasoned that he just has not got another good bull to replace the old one (P 1: Data4Atlas.ti.rtf: 1376-1376).

A cattle breeder stated that he is waiting to see the quality of the daughter from his bulls, before he decides over maintaining this animal or selling it off (P 1: Data4Atlas.ti.rtf: 768-768).

Three farmers do not keep bulls in their crossbred herd; instead they use artificial insemination (P 1: Data4Atlas.ti.rtf: 869-869, 900-905, 1466-1466).

4.4 Crossbreeding, cattle acquisition and disposal

The farmers of the ILRI-BOKU-NAGRC&DB research project started earlier with crossbreeding than the other farmers, who were contacted and interviewed in addition for this survey.

Two farmers brought crossbred cattle one year ago (P 1: Data4Atlas.ti.rtf: 3240-3240) and one and a half year ago (P 1: Data4Atlas.ti.rtf.: 2358-2358). One cattle keeper, who started in 1978, was among the first who started crossbreeding in Kiruhura District (P 1: Data4Atlas.ti.rtf: 1057-1057). Two farmers began already in the 1980’s (P 1: Data4Atlas.ti.rtf: 871 -871, 1583-1583). Regarding the given replies over

a longer period, fourteen farmers out of all cattle breeders started crossbreeding before the year 2000; eleven farmers began with crossbreeding in the last five years. The majority of twenty two farmers got the information about crossbreeding from relatives, friends and neighbours. Through visiting farms of cattle keepers who started earlier with crossbreeding they realized the profitable selling of the higher milk yield and copied this farming strategy for their own farms. Two farmers received training by a non governmental organization (P 1: Data4Atlas.ti.rtf: 772-772, 1494-1494) and three farmers got familiar with crossbreeding through government programs and government stock farms (P 1: Data4Atlas.ti.rtf: 226-226, 952-952, 1059-1059).

Fifteen of the pastoralists started crossbreeding by bringing a pure bred Friesian or Ankole-Friesian crossbred bull into their Ankole herd. One farmer got a crossbred heifer from within his community as his first crossbred (P 1: Data4Atlas.ti.rtf: 435-435). Thirteen farmers also acquired crossbred cows and heifers to build up a crossbred herd. Once the cattle keepers uphold a crossbred herd, they obtain crossbred cattle from other herds to increase the productiveness of their herd and ensure the higher milk yield of the crossbred cows. As an alternative thirteen farmers narrated that they only buy bulls and do not get heifers or cows from outside. One cattle keeper told that the crossbred cows are too expensive (P 1: Data4Atlas.ti.rtf: 3244-3244), another one explained that he is afraid of loosing cattle born on other farms, because they are not as well adapted too the environment as his own (P 1: Data4Atlas.ti.rtf: 2077-2079).

The pastoralists trade cattle to finance any occurring economic activity (P 1: Data4Atlas.ti.rtf: 0239-0241, 4225-445, 1267-1267) or to get rid of unproductive animals which have *overstayed* (P 1: Data4Atlas.ti.rtf: 0346-0346, 966-966). There are no livestock markets in Kiruhura district. They were closed as a measure to control the spread of contagious diseases like Foot and Mouth disease (P 1: Data4Atlas.ti.rtf: 2816-2816, 2933-2933).The buyers come to the farm and acquire the cattle direct from them (P 1: Data4Atlas.ti.rtf: 0354-0354, 683-683, 1979-1979). Crossbreds, in general heifers and young cows, who are sold for breeding from on farmer to another reach a higher price than any cattle sold for slaughter (P 1: Data4Atlas.ti.rtf: 970-970, 1686-1686). Crossbreds sold for slaughter furthermore make more profit than pure bred Ankole, because of their bigger size (P 1: Data4Atlas.ti.rtf: 1069-1069). Selling off the biggest cow in the herd for achieving the

better price is for one farmer the right choice, because he wants to get the maximum amount of money possible (P 1: Data4Atlas.ti.rtf: 1158-1158). A different farmer explained that in dry seasons when the pasture is depleted and the stocking rate is too high he sells, based on the size, the smaller animals (P 1: Data4Atlas.ti.rtf: 1500-1502). The closure of cattle markets in the area has resulted in poor returns from sale of stock one of the farmers lamented (P 1: Data4Atlas.ti.rtf: 3446-3446).

4.5 Arrangements for bull exchange

The cattle keepers' exchange bulls for different reasons. The exchanging happen primary to avoid inbreeding (P 1: Data4Atlas.ti.rtf: 61-61, 758-758, 1785-1785, 1866-1866, 2583-2584), for maintaining relationships among the community and for fostering friendships (P 1: Data4Atlas.ti.rtf: 2929, 3041-3042).

If farmers give or receive an animal, they will return a heifer, a cow or a bull back, but not immediately, any time span is possible (P 1: Data4Atlas.ti.rtf:249-249,681-681, 2929-2929, 3349-3349). Seven cattle breeders told that it makes no difference to them if they exchange pure bred Ankole or crossbred cattle. The ways of exchanging follow the two traditional rules of giving and receiving in a certain period of time and returning an animal of the same quality as the given one (P 1: Data4Atlas.ti.rtf: 788-788).

Exchanging is not done with strangers, to avoid the risk of easily spreading diseases (P 1: Data4Atlas.ti.rtf: 562-562).

Contrarily twelve farmers do not exchange. Three of them insist on buying bulls, heifers and cows to get the best available animals for their herds (P 1: Data4Atlas.ti.rtf: 1273-1273, 2275-2275) or they prefer to sell their cattle to increase their income instead of giving them away for free (P 1: Data4Atlas.ti.rtf: 1386-1386, 2275-2275). Two farmers explained that the exchanging and introducing of a bull into another herd will make the animal 'wild'. They experienced that these bulls leave the herd for every female cow for mating they sense and bring back diseases from another herd (P 1: Data4Atlas.ti.rtf: 798-798, 1506-1506). A statement of a farmer reflects his strong personal and religious thinking and has no sexist background: "A bull is like (a) wife, they are not for sharing (P 1: Data4Atlas.ti.rtf: 3444-3444)".

Twenty two farmers denied to take care of cattle of absentee owners, ten cattle keepers use the animals of not present relatives for breeding within their herd.

4.6 Criteria for choosing breeding bulls and dowry gifts

The most important criteria for choosing a bull for breeding is the physical appearance and the milk yield of the dam. Fourteen farmers differ between pure bred Ankole and crossbreds in these two categories. For Ankole cattle the beauty of the animal, the physical appearance regarding white horns, colour of the coat and the size of the animal, are important. A crossbred bull has mainly to produce females with a high milk production. Seventeen cattle breeders prioritize the physical appearance of a bull; eleven favour the milk production and there fore seek information on the milk yield of the bull's dam.

Two farmers replied that they ask for records of cattle they want to acquire, if there are animals with records available (P1: Data4Atlas.ti.rtf: 1439-1439, 1448-1449, 1544-1544).

Asked if the farmers favour Ankole or crossbred heifers and cows as dowry gifts, eight of them mentioned pure bred Ankole and eight prefer crossbred cattle. Four cattle keepers do not make a difference; they would like to receive both. A farmer's wife, the mother of a daughter, who is due to get married, insists on Ankole since they can persist better under the prevalent environmental conditions. She is afraid that the crossbred would die easily and she wants to keep the cattle that are replacing their child as long as possible in the herd (P1: Data4Atlas.ti.rtf: 2866-2866). One farmer claimed that as gift you always have to give a good animal (P1: Data4Atlas.ti.rtf: 149-149).

Following a book report (Nitza et al 1998), it was usual that in former times the leading bull was slaughtered when the household head died. This custom is not practiced any more; twelve farmers explained that today the bull is sold off instead. Slaughtering a bull as mealtime for the funeral meal is still done, but therefore not the best animal is killed (P1: Data4Atlas.ti.rtf: 1323-1323). An explanation for the giving out of a good bull was given by a pastoralist: "The man is the owner of the home and the bull is the owner of the herd. So this two belong together. So they will call the bull after the owner, like Henry's bull. So when the owner dies, they still will call the name for the bull. So that is why they remove it (P1: Data4Atlas.ti.rtf: 2983-2983)." The selling of the bull brought economical benefits for two farmers. The first one used the profit made through the sale for buying a coffin for his father's funeral (P1:

Data4Atlas.ti.rtf: 3280-3282). The second told that when his grandfather died they sold the bull and shared the profit among each other (P1: Data4Atlas.ti.rtf: 3569-3569).

4.7 Avoiding inbreeding in the herd

All pastoralists who participated in this study know the risks of inbreeding. As a solution to avoid bulls to mount their daughters' four farmers separate the heifers away from the main herd (P 1: Data4Atlas.ti.rtf: 126-126, 382-383, 710-711, 1303-1303). Twenty one farmers explained they remove the bull from the herd and get a new one. Two farmers narrated that they choose among the two possibilities: they separate if they have enough land for a second herd or they remove the bull from the herd (P 1: Data4Atlas.ti.rtf: 2848-2848, 3290-3290). The bull can be sold to a trader or exchanged with another cattle keeper (P 1: Data4Atlas.ti.rtf: 820-820). Five farmers try to prevent the bulls to mount their daughters while they stay in the herd (P 1: Data4Atlas.ti.rtf: 1579-1579, 2206-2206, 2410-2410, 2515-2515, 2735-2735).

4.8 Progeny history of individual cattle

Always amusing for the farmers was one question always asked while interrogating them: "What is the name of your favourite cow?" Nonetheless every pastoralist in Kiruhura District has a favourite cow. Cattle breeders with more then one breed in their herds even have a preferred cow of each breed (P1: Data4Atlas.ti.rtf: 570-572, 1597-1597). In general the farmers sell off unproductive cows at a definite age (P1: Data4Atlas.ti.rtf: 3549-3549), however eleven farmers insisted on keeping their favoured animals until these die of infirmity. The majority of twenty eight favourite cows were born within the herd of their owners; only six cows were born on other farms. The reason for choosing an animal as his preferred cow is well described by a statement given by a farmer: "It produces milk, it is a good cow, structure it is beautiful. Then I grew it up (P1: Data4Atlas.ti.rtf: 3454-3454)."

The offspring of the favourite cow can be recounted by all farmers easily. The female calves are usually used for breeding in the own herd, only a few are given away to friends (P1: Data4Atlas.ti.rtf: 263-264) or as dowry gifts (P1: Data4Atlas.ti.rtf: 367-

367). Six farmers kept male calves from there favoured cow in their herds, for breeding within the herd or to rear them for exchanging or selling off later (P1: Data4Atlas.ti.rtf: 471-471, 1176-1176, 1408-1408, 2493-2493, 2711-2711, 2945-2945). One of the pastoralists castrated the male offspring before selling them (P1: Data4Atlas.ti.rtf: 1605-1605). The risk of inbreeding is a serious problem and the reason behind not to maintain the male calves in the herd stated another farmer (P1: Data4Atlas.ti.rtf: 1799-1799).

The sire of the favourite cow is well remembered by all cattle keepers, who raised their preferred animal themselves. For the six favoured cows mentioned above as born on another farm, the sire is not unknown at all to the farmers. Two of them mentioned that they know the sires because their favourite cows were born in the herds of close friends (P1: Data4Atlas.ti.rtf: 702-705, 3551-3551). Twenty sires were born in herds on other farms and bought by the cattle keepers. Three farmers narrated that the sire of the favourite cow was a gift in the traditional way of exchange (P1: Data4Atlas.ti.rtf: 2193-1294, 2298-2299, 2720-2721). The advantages of these bulls (P1: Data4Atlas.ti.rtf: 104-104, 483-483, 588-589) and the value of the offspring (P1: Data4Atlas.ti.rtf: 102-102, 955-988, 1612-1613) are still kept in good reminiscence and without difficulty recalled from memory by the cattle keepers. The advantages were described as physical appearance of the bull and the offspring (P1: Data4Atlas.ti.rtf: 2198-2189, 3373-3373) and the high milk production (P1: Data4Atlas.ti.rtf: 1902-1902, 3070-3070, 3278-3278). As an example for important characteristics of a bull one interviewee portrayed a bull with following testimony: “First it produced good offspring, secondly it stayed with the herd, grazed with them, lead them, went to watering with them. Thirdly, it was secure; no other bull would come to his herd (P1: Data4Atlas.ti.rtf: 2840-2840).”

Also disadvantages are remembered; a pastoralist reflected that he removed the sire of the favourite cow because he produced only male offspring (P1: Data4Atlas.ti.rtf: 2957-2957).

Similar to the sire all cattle breeders can retain information about the dam of the favourite cow. One farmer even considered the line of his favoured cow as the best in his herd (P1: Data4Atlas.ti.rtf: 594-594).

4.9 Knowledge transfer in the cattle keeper's society

Eighteen of the interviewees stated that they know all their cattle well enough to provide detailed information about their progeny. One farmer explained he can tell back to the tenth generation in his herd (P1: Data4Atlas.ti.rtf: 2517-2517), two others reported that the knowledge about the ancestors of their Ankole cattle goes back far more than for the crossbred cattle they keep (P1: Data4Atlas.ti.rtf: 1714-1716, 2965-2965).

Twenty eight farmers pass on the knowledge about the progeny of their cattle and cattle breeding in general to their families, especially their children. Five cattle breeders complained that it became difficult to train their children because of school attendance (P1: Data4Atlas.ti.rtf: 282-282, 1625-1625, 2852-2852, 2967-2967, 3294-3294). One pastoralist even testified that with his death the knowledge will be lost because of the lack of interest from the school attending successors (P1: Data4Atlas.ti.rtf: 715-715). Though on the whole the information is forwarded to the children, and the declaration from a farmer's wife explains it concisely: "You can not separate a Muhima from his cows (P1: Data4Atlas.ti.rtf: 1718-1718)."

The cattle keepers narrated that they plan to split their herds among their successors and pass on a share to all children. Some divide their property into fair shares (P1: Data4Atlas.ti.rtf: 2311-2311), others divide it not equally, depending the number of animals handed over on their personal relationship to the heirs (P1: Data4Atlas.ti.rtf: 2523-2523).

Sharing information, discussing breeding matters and exchanging knowledge are widely common among the cattle breeders. Twenty four stated they share and discuss breeding matters with family and friends, twenty five explained they exchange their experiences within their community and nineteen clarified that they also confer with farmers outside their community. Nonetheless a farmer explained that sharing of cattle relevant information with the children became difficult since the life style of the children has changed through their school attendance (P1: Data4Atlas.ti.rtf: 2313-2313). Another interviewee narrated that he has to convince his family if he wants to sell a cattle because of the strong relationship developed between the family and the animal. Therefore they are included in decision making process of cattle sale but not in cattle acquaintance (P1: Data4Atlas.ti.rtf:2973-2973).

Highlighting the relevance of cattle in the Bahima society is the explanation of a farmer: ”They talk about cattle, nothing else, wherever they are (P1: Data4Atlas.ti.rtf: 3563-3563).” A farmer noticed however that the tradition of exchanging knowledge among the farmers’ communities is fading out (P1: Data4Atlas.ti.rtf: 717-717).

4.10 Sociological and household data

The age of the cattle keepers differ widely from twenty nine to sixty eight years. All farmers narrated that they grew up with cattle and started with activities like herding and milking at child age (P1: Data4Atlas.ti.rtf: 3492-3492). Usually they inherited the farm after their fathers passed away. One farmer therefore had to overtake when he was ten years old (P1: Data4Atlas.ti.rtf: 1123-1123), another one at the age of eleven (P1: Data4Atlas.ti.rtf: 1325-1327).

Six farmers do not want to get retired and hand over the farms to their successors at a certain age. Fourteen cattle keepers strongly agreed with the idea of passing on the farms to their children at an age when they can still provide advice to them. The successors nevertheless are involved into farm activities by taking over particular responsibilities while their fathers still manage the farm (P1: Data4Atlas.ti.rtf: 836-836, 1930-1930). Two farmers highlighted their role as advisers and trainers of their sons (P1: Data4Atlas.ti.rtf: 511-511, 836-836). An occurring problem is that the children and grandchildren are not living on the farm anymore. Well educated children are working in the cities and so that the father can not get retired (P1: Data4Atlas.ti.rtf: 1125-1125, 1331-1331).

Only ten out of thirty four farmers have not attended school or any other way of education. The majority of the pastoralists have received some form of education at varying levels. Nine farmers visited school at primary level, eleven farmers at secondary level and four farmers received education at tertiary level. However all cattle breeders interviewed send their children, and sometimes also their younger siblings, to school and if possible to university too. In one case only the male children are send to school, while the daughters get no education at all (P1: Data4Atlas.ti.rtf: 3577-3577). All household members at the age of compulsory education never the less are involved in the farming activities after their classes.

The source of livelihood is for all farmers the income they gain from their cattle. One cattle keeper also produces crops on his land like cassava and beans (P1:

Data4Atlas.ti.rtf: 3219-3219), two farmers have banana plantations for increasing their profits (P1: Data4Atlas.ti.rtf: 739-739, 1335-1335). Two more keep goats for commercial purposes (P1: Data4Atlas.ti.rtf: 2444-2444, 3112-3112) and two achieve a higher income with salaries from non farm activities (P1: Data4Atlas.ti.rtf: 923-923, 1829-1829).

5 Discussion

The purpose of the discussion is to explain, analyze, and compare results and interpret them in the broader context set forth in the introduction and the literature review. Outcomes from results are used to identify the similarities and inhomogeneities in this chapter.

5.1 Bahima pastoralists' breeding strategies

Structure and composition of the herds have changed on the farms over the last years. Galukande et al. (2008) described the production system in south western Uganda; the findings of the study are in line with it: Ankole cattle keepers run a production system with a pure bred Ankole herd and a Friesian-Ankole crossbred herd. The results show that the Friesian-Ankole crossbreds are not only kept for income generation through higher milk yield and therefore better marketing possibilities, furthermore a wide range of modern and new management system has been introduced together with the exotic cattle for crossbreeding. The construction of valley tanks for water harvesting, off fencing of private property and the construction of specialized structures to restrain animals for routine spraying and drenching are examples for that. Farmers construct these valley tanks because they acknowledged the struggle of the Ankole-Friesian crosses during the draughts. The animals are not well adapted to the harsh climate and can not walk long distances with out water.

5.1.1 Advantages of different cattle breeds

The farmers of Kiruhura District choose the cattle breeds they keep through specific criteria. Attention is given by the pastoralists to the results of their crossbreeding activities. Breeding traits concerning milk yield and seize of the animals are important, nevertheless the problem of adaptation to the environment is recognised and of relevance in breeding decision making. The diverse advantages of Ankole cattle and crossbreds were already highlighted by different studies from Kugonza (2008), Galukande et al. (2008), Reichhart (2007), Ndumu (2007) and Wurzinger et al. (2006). The advantages of the Ankole which include resistance to diseases,

adaptation to draughts, acclimatization to environment, are still well known. As stated in Chapter 4.2, the cultural relevance of keeping Ankole play a major role for nineteen farmers and are an important reason for keeping them. But they have become less important because of strong believe in modernization and the emerging income generation for the farmers' family. Although Ankole cattle play an important role as the traditional symbols of their wealth, on their own they are not productive enough to sustain pastoralist families under the new settled farming system. The study indicates that this might be the reason, why many farmers have preference for breeds with high milk and meat production. Only few farmer, four out of thirty four, still prefer Ankole cattle and explained their wish of herding only them, none the less that aspiration is undermined through striving after economic success.

5.1.2 Crossbreeding, cattle acquisition and disposal

The Bahima cattle breeders acquire breeding bulls still from other farms through purchase, as described by Kugonza (2008) as most common method. The results also correspond with Kugonza (2008) on rearing a male calve from the own herd until maturity age. The cattle keepers integrated in this study give a self raised bull time to grow up and wait for his first offspring to estimate his breed value. Musa et al. (2006) state that indigenous bulls are mainly replaced from within the herd, crossbred bulls are bought from outside, the Bahima pastoralist pursuit a similar strategy. To prevent inbreeding and to increase the productiveness of their herds, farmers already developed a preference for buying good breeding bulls from stock farms, like the NAGRC & DB stock farm Ruhengyere in Kikatsi Sub county, or from successful farmers keeping crossbred animals. The traditional way of bull acquisition through exchanging within the wide range of the community therefore might get less important in the future. The average duration of keeping a breeding bull in the herd is between three and four years, comparable to the findings of Wurzinger et al. (2006). The majority of the pastoralists interviewed in this survey use their bulls for an equal time span for breeding. There is no difference for them between a pure bred and a crossbred bull, if one is reaching puberty age it is used for breeding.

Crossbreeding with exotic cattle is fast becoming an important cattle improvement strategy among the keepers of Ankole cattle. This option is attractive because productivity of the animals can be increased this way in only one generation. This

enables the farmers to benefit from the current increase demand for livestock products like milk and from sell of breeding stock. Syrstad et al. (1998) point out that crossbreeding can induce the risk of thinning the genetic diversity. Galukande et al. (2009) and Cunningham et al. (1987) warn of a population replacement strategy eliminating indigenous cattle. At present the Bahima pastoralist are not participating in any planed and evaluated breeding scheme; never the less, as note by Sölkner et al (1998) and Kahi et al. (2005), regarding the origin and progeny has supported the cattle breeders doing their choices over centuries and has to be installed in any breeding recommendations or programmes.

Besides the point that recording of cattle a necessity in a breeding programme involving a open or closed nucleus (Kahi et al. 2005, Kosgey et al. 2006), the market value of a cow is increased if the farmer keeps record about it. The records kept in the moment, and these are rare, at the most only include the milk yield of the cow. The collection of the data for the records is not a nationwide standardised procedure, nor is the record sheet. In the moment it is mainly done by the farmers who participate in the ongoing ILRI-BOKU-NAGRC&DB research project.

5.2 Institutional arrangements and indigenous knowledge

The Bahima pastoralists in Kiruhura district have a strong relationship to their Ankole cattle and their crossbred cattle, which is growing since childhood, because of the involvement of the children and successors beside their compulsory education into the farming activities. The relationship is still maintained even if the children go to school and receive higher education, it persists. Ayantunde et al. (2007) highlight the importance of local, indigenous breeds for the cultural basis of pastoralists and their sustaining role in rural livelihoods, a statement that can be hold true for the Bahima too.

One traditional custom has already changed: According to Nitza et al. (1998) it was usual to slaughter the leading bull of the herd after the household head had died. Interviewed farmers additionally narrated that the culling also occurred when the bull has not overstayed in the herd and was still young and of good breed value. The explanation given by the interviewees was that the leading bull is related to his owner by other farmers through naming it after the owner. As a result, if the owner dies the bull can not be renamed or possessed by any other person. Nowadays the

pastoralists, in awareness of the bulls' quality for breeding, prefer to sell the bull, realizing the market value of an excellent bull. The tradition was adapted to the situation today because of the high demand after bulls for breeding without getting lost totally. The relationship of a bull and his owner is not less important than years ago, the bull still has to leave the herd, but instead of slaughtering him the farmers prefer the profit from the sale. The institutional arrangements of the Bahima seem to be dynamic, embedded in the interactions within the breeders' social network, a strong influence also discussed by Macadam et al. (2003).

5.2.1 Arrangements for bull exchange and dowry gifts

The survey determined that important institutional arrangements within the Ankole cattle keeper society for acquiring new animals and substituting cattle for the herds are dowry gifts and exchanging of bull, according to the results from Reichart (2007). They are the mechanism used over centuries to avoid the sire to mate their offspring and they were successful in creating the Ankole breed and maintaining its advantages for a long period. As explained in Chapter 4.6, the farmers who participated in this study make in general no difference between pure breeds and crossbreeds as dowry gifts, an example for how a traditional arrangement is valued by a society and used for fulfilling its function without being a hindrance for modernization.

Two simple strategies can be recommended to avoid inbreeding in the pure bred Ankole herds. The traditional ways of exchanging cattle occur mainly within the communities and are not done with strangers. For a better substitution of high quality breeding cattle the institutional arrangements could be released towards farmers from outside the community. Separations of heifers from the herds were the sire is kept for further breeding can only be accomplished by owners of enough land.

5.2.2 Knowledge transfer in the cattle keeper's society

Farming systems like pastoralism in eastern Africa have developed from complex relationships between ecosystems, habitat, organism and the agricultural and cultural practices of farmers (Arce et al. 2007). Knowledge boundaries are shifting,

knowledge generation is a flexible and dynamic process. All around the world societies and cultures accumulate and understand knowledge according to their indigenous and traditional value codes (Sillitoe 2007). Kugonza (2008) too highlighted the important role if indigenous knowledge for the improvement and conservation of a breed. The Ankole cattle breeders of Kiruhura district developed flourishing strategies which should be preserved and established in any planed breeding programme, because they simply have the cultural support. It is easier to develop new strategies if attention is given to the proved experiences and skills of an existing system than implementing something brand new. Indigenous knowledge is crucial for implementing sustainable agriculture as an important mile stone in achieving sustainable development (Cleveland et al. 2007).

Sölkner et al. (1998) analyzed the importance of existing structures for knowledge transfer and foreign interfering. The study in Kiruhura district identified that the knowledge flow on animal husbandry, particularly on breeding strategies and progeny history, in families and communities is commonly functioning. However outside the communities there are hardly any possibilities for the cattle breeders to exchange their ideas and thoughts, even news and gossip. New practices and methods of farm management are introduced slower because of the missing networking possibilities over wider distances and to other communities. The farmers who participated in this survey but not in the ILRI-BOKU-NAGRC&DB research project, do not have the same access to information about cattle breeding as the other ones, working together with scientists over a long period.

The survey as well highlights that the cattle breeders are encouraged to adapt new strategies in animal breeding and farm management. Cattle keepers introduce new animals into their herds and new techniques to their farm for improving the output of their production system. Therefore they seek for information about new techniques and possibilities to exchange knowledge and ideas.

The Bahima people are strongly engaged into local politics and administration up to district level, participating at a community meeting is appreciated by most of them, therefore the traditional exchange of indigenous knowledge is not really threatened to fade out. Moreover this will support the Bahima communities to overcome the infrastructure, socioeconomic and socio-political limitations in developing countries as explained by Kahi et al. (2005).

In Chapter 4.10 the levels of education from the farmers and their families are summarized, indicating that sending of the cattle breeders' children, and sometimes also their younger siblings, to school and if possible to university, will increase the level of education and therefore the willingness to accept modification strategies and experience on variation of the institutional arrangements and breeding strategies. That is another influence emerging trough modernization, probably supporting pastoralists to overcome the difficulties described by Kahi et al. (2005). Homan et al. (2008) noted: "Documenting and analyzing the pastoralists indigenous knowledge allows to understand their perception of changes of their local environment and potentially conflicting interests, and to identify technical and organizational elements that can help them cope with variable rangeland resources and socio-economic challenges." Beyond all questions the sinking level of illiteracy facilitates documenting by integrating farmers into the indigenous knowledge recording process.

6 Recommendations for implementing a breeding program

Determinants of success and failure of local livestock breeding programmes in the tropics have been reviewed by Sölkner et al. (1998) and Kosgey at al. (2006), therefore this issue is not reconsidered in this thesis.

As earlier defined in section 2.1.1., a community breeding program will only be successful while regarding indigenous knowledge and animal genetic resources. “The design of any efficient breeding programme relies on research results and practical experiences (Philipsson et al. 2006a)”. Loss of traditional knowledge might also lead to loosing Ankole cattle as specific breed, some significant matters to be considered while designing and implementing a community based breeding programme are the practical experiences of the farmers.

6.1 Steps for designing a community-based breeding program

To satisfy the increasing demands for livestock products and to enhance food security, the realisation of animal improvement for increased productivity and food availability is necessary. This can be accomplished with the efficient exploitation of genetic diversity among and within indigenous breeds in developing countries. ”The most productive and adapted animals for each environment must be identified for breeding purposes. Only then will it be viable to increase food production without further expansion of animal numbers with subsequent effects of land degradation (Philipsson et al. 2006a).”

Genetic improvement programmes follow an important feature, which is accumulation of effects of selection over a time span. This genetic principle applies to the same species worldwide; the methods of application are variable and need to be adapted towards the various circumstances (Philipsson et al. 2006a).

For sure it is quite challenging to develop a programme which facilitates multi-purpose use of animals and long-term benefits to farmers; nevertheless it is of high priority to consider on environmental conditions, the production system and the socio-cultural background of the cattle breeders. Breeding programmes in the hands of farmers’ cooperatives, often with government support have, throughout the world,

been successful for several livestock species (Ahuya et al. 2005). Kahi et al. (2005) recommend considering three key factors as important while developing a community based farmers association:

- Composition of the organization
- Functions of the organization
- Capacity and limitations of the organization

Köhler-Rollefson (2001) listed several practical steps towards implementing a community-based breeding programme, all the same can best be achieved with equal contribution of involved farmers and researchers:

- Survey for breeding institutions
- Analysis of limiting factors
- Setting of objectives
- Awareness generation
- Formation of an independent local institution
- Training and capacity building
- Overcoming constraints
- Impact assessment

For implementing the above mentioned steps into action, which should be converted one after the other, information is already available from the scientific ILRI-BOKU-NAGRC&DB research project. If attention is directed on the institutional arrangements and breeding strategies of the pastoralists, the implementation of a breeding programme will be successful and sustainable. Homan et al. (2008) outlined a procedure analysing the pastoralists' indigenous institutions on natural resource management and changes in the institutional settings: Community meetings with delegated elders are organised, as socio-scientific tool visualizing Venn diagrams demonstrate the actual institutional arrangements comparing them to the situation a defined time span ago. After identifying all institutions with relevance to natural resource management during the respective period of time, highlighted differences are discussed in the group. The discussions help the pastoralists to reflect the institutional situation.

The design of the breeding scheme relies on one significant decision, precisely deciding on what breeding strategies is chosen. Five major options are proposed by Philipsson et al. (2006a):

I. Crossbreeding indigenous breeds with temperate breeds without artificial insemination.
II. Improving indigenous breeds.
III. Progressively substituting the breed with another indigenous breed.
IV. Crossbreeding indigenous breeds with temperate breeds using artificial insemination.
V. Forming a composite (synthetic) breed.

It is necessary to consider that the choice of strategy is dependent on many different ecological, economical, socio-cultural factors, making the pronouncement of the strategy very specific to each situation.

In the case of the Bahima and their Ankole and crossbred cattle, option I is in common use, so it makes sense to stick to this decision instead of choosing another option immediately. Option II, improving indigenous breeds, can be realized on government stock farms and commercial farms, and later on introduced to the smallholder cattle keepers. Option III is irrelevant because there is no other indigenous breed in east Africa, which can be better used for milk and meat production as the Ankole cattle in South Western Uganda. Option IV and V, artificial insemination and developing a new breed, is with the lack of infrastructure and communication channels at the moment nationwide the most challenging possibility.

Syrstad et el. (1998) stated: “Reliable progeny testing requires that the daughters of the various bulls have been producing under similar conditions. Efficient use of progeny testing requires a large breeding unit, careful planning, extensive recording, and good organization.” As the above mentioned preconditions for progeny testing are not available in Kiruhura district in the moment, orally transmitted progeny history of cattle is a strong symbol of the tight relationship of the cattle owner and their animals and furthermore helpful tool for breeding decision making.

For maintaining pastoralists indigenous Knowledge, the ‘Endogenous Livestock Development’ approach should be considered. “Incorporation of indigenous knowledge into research and development facilities appropriate technology

development, and helps faster and more effective adaptation to complex and dynamic processes. The Endogenous Livestock Development network aims at mobilizing exactly these pastoralist' own strengths, skills and resources" (Homann et al. 2008). The Endogenous Livestock Development aspires to strengthen livestock development by building institutions, developing livestock policies, delivering improved service and extension to livestock keepers and support lobbying and networking among stakeholders with a participatory approach. This is done through documentation, validation and operationalisation and pastoralist should be engaged into a joint learning structure for enhancing their capacity to become accustomed to shifting environmental, political and social conditions (Homann et al. 2008).

6.2 Conclusion

The necessity is to develop a new, adapted breed based on Ankole and any exotic breed. Importance has to be given on the traits resistance to diseases, adaptation to draughts and acclimatization to environment. Milk production, growth and calving easiness are important too, but should not be overestimated. The short time advantages vs. long time results affect sustainability. It is of high relevance to strengthen awareness among all stakeholders to create an adopted breed instead of a high-producing breed that can not do well under tropical conditions.

Considering the reviewed publications by Galukande et al. (2009), Rewe et al (2008), Kosgey et al. (2006), Kahi et al. (2005) and Sölkner et al. (1998) an open nucleus breeding scheme to develop a synthetic breed could be the most successful alternative for the production environment of Kiruhura district in south western Uganda.

Khombe (2002) described a group breeding scheme set up as a joint venture between cattle breeders and private investors, keeping a nucleus herd. To intend collaboration between farmers and private investors in Uganda the possibility of a joint venture should be discussed seriously.

Kahi et al. (2000) discuss the challenge to establish a crossbreeding scheme that allows on-farm rearing to reduce replacement costs. To raise a female crossbred calf from the own herd means that the farmer has to wait up to two, two and a half year to see the results of his endeavours. That period of herding cattle before choosing

between keeping and giving them away contrary to the costs is a matter of course to be concerned.

There is need to establish an organization for developing a breeding program, owned by farmers. During a workshop in Kikatsi village on the 30th March 2009 for the pastoralists of the ongoing ILRI-BOKU-NAGRC&DB research project, the cattle keepers spontaneously founded a village community to strengthen their efforts in milk recording. These farmers set a good example of cooperativeness, for voluntary work and acceptation of an office in a community organization, which are widespread in Uganda. This willingness to accept responsibility and assume an obligation should be imbedded into a breeding scheme.

As record keeping at the moment is not a standardised procedure, the development of recording programme is an important step. An independent sampling is required at a regular interval by a neutral person appointed by farmers. This person should be a local veterinarian, simply because of speaking the local language, experiences in scientific procedures and, of high importance for the cattle breeders, offering additional veterinarian services while visiting the farms.

For a successful implementation of a breeding association all relevant stakeholders must be involved. As an example, in Kiruhura district these are cattle breeders; local authorities at parish, village, sub county, county and district level; the veterinarians form the sub counties Kikatsi, Kenshunga, Masha, Rubaya, Nyakashashara and Sanga; official substitution from members of the Uganda Government and Uganda Parliament; and participation of national and international research institutions. The existing interrelationships of the different groups of people can generally be described as a spirit of friendship and collaboration. But there is need to deepen co-operation between farmers from different villages, between researchers and government officials, between district and national authorities for a sustainable realisation of animal improvement.

As a first step farming communities and steering committees could be established, scientists and government officials could assist as development partners (Kahi et al 2005). Secondly commonly developed and selected breeding objectives for improving livestock production have to identified and constituted.

A working group consisting of farmers, veterinarians and researcher should develop tools for recording, performance, evaluation, selection and mating at sub county level

(Kahi et al 2005), taking institutional arrangements, indigenous knowledge transfer and traditional breeding practices into consideration. Different outcome of these sub county working groups could be discussed together with authorities at district level and reduced to a common denominator. The district level working group members could act as a steering committee and for example discuss issue and find solutions how to contact more farmers of the sub counties. At district level all data should be collected and transmitted to a national research institution like NAGRC & DB for district- and nationwide evaluation and data analysis. The outcome of the data analysis could be discussed by a national working group and revised by international scientific research institutions. This is necessary to ensure that political influences are limited and the latest scientific achievements are incorporated.
Occurring results have to be explained to all participating farmers at a return workshop at sub county level and a meeting of farmers' community representatives at county and district level. The success of a breeding program depends of interaction with the farmers and their communities, therefore these return workshops for presenting and discussing all research results to the village level, are of high relevance.

Indigenous breeds like the Ankole cattle in East Africa posses important qualities for present and future generations of Bahima pastoralist. The conservation of an indigenous breed should never be neglected, neither in Uganda nor in any other region of the world.

7 References

Ahuya C. O., Okeyo A. M., Mwangi-Njuru, Peacok C. (2005): Developmental challenges and opportunities in the goat industry: The Kenyan experience. *Small Ruminant Research* **60**, 197-206.

Arce A., Fisher E. (2007): Creating natural knowledge: Agriculture, Science and Experiments. . In: Sillitoe P. (2007): Local science vs. global science: approaches to indigenous knowledge in international development. Berghahn Books, New York – Oxford. 175-186.

Ayantunde A., Kango M., Hiernaux P., Udo H. & Tabo R. (2007): Herders' Perceptions on Ruminant Livestock Breeds and Breeding Management in Southwestern Niger. *Human Ecology* **35**, 139-49.

Bebe B.O., Udo H.M.J., Rowlands G.J., Thorpe W. (2003): Smallholder dairy systems in the Kenya highlands: breed preferences and breeding practices. *Livestock Production Science* **82**, 117-27.

Cleveland D.A., Soleri D. (2007): Farmer knowledge and scientist knowledge in sustainable agricultural development: ontology, epistemology and praxis. In: Sillitoe P. (2007): Local science vs. global science: approaches to indigenous knowledge in international development. Berghahn Books, New York – Oxford. 209-224.

Conroy C. (2005): *Participatory livestock research*. ITDG Publishing, Bourton-on-Dunsmore.

Cunningham E.P. and Syrstad O. (1987): Crossbreeding bos indicus and bos taurus for milk production in the Tropics. *FAO Animal Production and Health paper* **68**, Rome.

FAO (2009): Participation in development, sharing our resources. Informal Working Group on Participatory Approaches & Methods. Online at: http://www.fao.org/participation/default.htm (06.01.2009)

FAO (2007a): The state of the worlds animal genetic resources for food and agriculture. Edited by Rischkowsky B., FAO, Rome.

FAO (2007b): Gridded livestock of the world. Edited by Wint, W. & Robinson Th., FAO, Rome.

FAO (2001a): Pastoralism in the new millenium. *FAO Animal Production and Health paper* **150**, Rome.

FAO (2001b): Field Level Handbook, Socio-economic and Gender Analysis (SEAGA) Programme, Gender and Development Service. Edited by Wilde V., FAO, Rome.

FAO (2000): Animal Health Manual 10, Manual on Participatory Epidemiology, Method for the collection of action-oriented epidemiological intelligence. Edited by Mariner J., FAO, Rome.

Galukande E., Mulindwa H., Wurzinger M., Mwai A.O., Sölkner J. (2009): Crossbreeding cattle for milk production in the Tropics: Achievements, challenges and opportunities. *In Press.*

Galukande E., Mulindwa H., Wurzinger M., Mwai A.O., Sölkner J. (2008): On-far comparison of Milk production and body condition of purebred Ankole and crossbred Friesian-Ankole cattle in south western Uganda. In: Tielkes E. (2008): Competition for resources in a changing world: new drive for rural development. Book of abstracts, Deutscher Tropentag 2008, Universität Hohenheim,Stuttgart. s.p.

Homann S., Rischkowsky B., Steinbach J., Kirk M., Mathias E. (2008): Towards Endogenous Livestock Development: Borana Pastoralists' Responses to Environmental and Institutional Changes. *Human Ecology* **36**, 503-20.

Iles K. (1994): The progeny history data collection technique: a case study from Samburu District, Kenya. *Participatory Learning and Action, RRA Notes* **20**, 71-77.

Kahi A.K., Rewe T.O., Kosgey I.S. (2005): Sustainable community-based organizations for the genetic improvement of livestock in developing countries. *Outlook on Agriculture* **34**, 261-70.

Kahi A.K., Nitter G., Thorpe W., Galla C.F. (2000): Crossbreeding for dairy production in the lowland tropics of Kenya. II. Prediction of performance of alternative crossbreeding strategies. *Livestock Production Science* **63**, 55-63.

Khombe C.T. (2002): Genetic improvement of indigenous cattle breeds in Zimbabwe: A case study of the Mashona Group Breeding Scheme. Online at: http://agtr.ilri.cgiar.org/casestudy/khombe/khombe.htm (04.09.2009)

Klima G.J. (1970): The Barabaig: East African cattle herders. Holt, Rinehart and Winston, USA. In: Nakimbugwe H.N., Muchunguzi Ch. (2003): The role of livestock and breeding: Community presentations Bahima, Uganda. In: Köhler-Rollefson I., Wanyama J. (2003): The Karen Commitment. Proceedings of a Conference of Indigenous Livestock Breeding Communities on Animal Genetic Resources Karen. 34-40.

Köhler-Rollefson I. (2001): Community-Based management of animal genetic resources – with special reference to pastoralists. In: FAO (2003): Community-based management of animal genetic resources. Proceedings of the workshop held in Mbanane, Swaziland. FAO, Rome. 14-26.

Köhler-Rollefson I. (1997): Indigenous practices of animal genetic resource management and their relevance for the conservation of domestic animal diversity in developing countries. *Journal of Animal Breeding and Genetics* **114**, 231-8.

Kosgey, I. S., Baker, R. L., Udo, H. M. J., Van Arendonk, J. A. M. (2006): Successes and failures of small ruminant breeding programmes in the tropics: a review. *Small Ruminant Research,* **61,** 13-28.

Kugonza D.R. (2008): Genetic diversity, husbandry, selection criteria and verification of kinship assignemnt of Ankole cattle populations in Uganda. Faculty of Agriculture, Makerere University, Kampala.

Loftsdottír K. (2001): Where my cord in burried: WoDaaBe Use and conceptualization of Land. *Journal of Political Ecology* **8**, 1-24.

Macadam B., Drinan J., Inall N., McKenzie B. (2003): The inter-relationship between capacity building and institutional arrangements, and the implications for extension and adult education. Online at: http://www.regional.org.au/au/apen/2003/refereed/046macadamb.htm. (19.12.2008)

Mbuku S.M., Kosgey I.S., Kahi A.K. (2006): Identification Systems and Selection Criteria of Pastoral Goat Keepers in Northern Kenya-Implications for a Breeding Programme. In: Asch F., Becker M. (2006):. Conference on International Agricultural Research for Development, Deutscher Tropentag 2006, University of Bonn. 511.

Meinzen-Dick, R., DiGregorio M., McCarthy N. (2004): Methods for studying collective action in rural development. *Agricultural Systems* **82**, 197-214.

Millar D., Haverkort B. (2006): African knowledges and sciences: Exploring the ways of knowing in Sub-Saharan Africa. In: Millar D., Kendie S., Apusigah A., Haverkort B. (2005):. African knowledges and siences: Understanding and supporting the ways of knowing in Sub-Saharan Africa. Compas, Leusden. 11-17.

Mulindwa H., Galukande E., Wurzinger M., Mwai A.O., Sölkner J. (2009): Modelling of long term pasture production and estimation of carrying capacity of Ankole pastoral production system in South Western Uganda. *Livestock Research for Rural Development* **21**. Online at: http://www.lrrd.org/lrrd21/9/muli21157.htm (06.09.2009)

Musa L.M-A., Peters K.J., Ahmed M-K. A. (2006): On farm characterization of Butana and Kenana cattle breed production systems in Sudan. *Livestock Research for Rural Development* **18**. Online at: http://www.cipav.org.co/lrrd/lrrd18/12/musa18177.htm (05.12.2008)

Mwacharo J., Drucker A. (2005): Production Objectives and Management Strategies of Livestock Keepers in South-East Kenya: Implications for a Breeding Programme. *Tropical Animal Health and Production* **37**, 635-652.

Nakimbugwe H.N., Muchunguzi Ch. (2003): The role of livestock and breeding: Community presentations Bahima, Uganda. In: Köhler-Rollefson I., Wanyama J. (2003): The Karen Commitment. Proceedings of a Conference of Indigenous Livestock Breeding Communities on Animal Genetic Resources Karen. 34-40.

Ndumu D.B., Baumung R., Wurzinger M., Drucker A.G., Okeyo A.M., Semambo D., Sölkner J. (2008): Performance and fitness traits versus phenotypic appearance in the African Ankole Longhorn cattle: A novel approach to identify selection criteria for indigenous breeds. *Livestock Science* **113**, 234-242.

Ndumu D.B. (2007): Genotypes, morphology, selection criteria and production aspects of the Ankole Longhorn cattle in the African Great Lakes region. Department of Sustainable Agricultural Systems, Universität für Bodenkultur, Wien.

Nitza R., Mbaga-Niwampa (1998): Peoples and cultures of Uganda. Second edition. Fountain publishers, Kampala. 168.

Ouma E., Abdulai A., Drucker A. (2007): Measuring heterogeneous preferences for cattle traits among cattle-keeping households in East Africa. *American Journal of Agricultural Economics* **89**, 1005-1019.

Ouma E., Obare G., Abdulai A., Drucker A. (2004): Assessment of Farmer Preferences for Cattle Traits in Smallholder Cattle Production Systems of Kenya and Ethiopia. In: Peters K.J. (2004): Rural poverty reduction through research for development and transformation. Book of abstracts, Deutscher Tropentag 2004, Humboldt-Universität zu Berlin. s.p.

Philipsson J., Rege J.E.O., Okeyo A.M. (2006a): Sustainable breeding programmes for tropical farming systems. *Animal Genetics Training Resource, Version 2*, *Module* **3***,* online at: http://agtr.ilri.cgiar.org/Module/module3/Module3.htm (11.02.2009)

Philipsson J., Rege J.E.O., Okeyo A.M. (2006b): Sustainable breeding programmes for tropical farming systems. *Animal Genetics Training Resource, Version 2*, *Module* **2***,* online at: http://agtr.ilri.cgiar.org/Module/module2/Module2.htm (16.02.2009)

Punch K.F. (2007): Introduction to social research. Second Edition. Sage Publictions, Los Angeles. 320.

Rege, J.E.O., Tawah, C.L. (1999): The state of African cattle genetic resources: II. Geographical distribution, characteristics and uses of present-day breeds and strains. *Animal Genetic Resources Information*. **26,** 1-25. In: Ndumu D.B. (2007): Genotypes, morphology, selection criteria and production aspects of the Ankole Longhorn cattle in the African Great Lakes region. Department of Sustainable Agricultural Systems, Universität für Bodenkultur, Wien

Reichart U. (2007): Pastoral Nomadism and the process of Sedentarisation of the Bahima people in Uganda. Department of Sustainable Agricultural Systems, Universität für Bodenkultur, Wien

Rewe T., Herold P, Piepho H.P., Kahi A.K., Valle Zarate A. (2008): Institutional Framework and Farm Types Characterising the Kenya Boran Cattle Breeding Programme. In: Tielkes E. (2008): Competition for resources in a changing world: new drive for rural development. Deutscher Tropentag 2008, Universität Hohenheim,Stuttgart. 1-5.

Rietbergen-McCracken, J., Narayan D. (1998): Participation and social assessment tools and techniques [toolkit], World Bank, Washington, DC.

Rogers D., Emwanu Th., Robinson Th. (2006): Poverty mapping in Uganda using socio-economic, environmental and satellite data. PPLPI features 3, FAO, Rome.

Samanya J.P., Semambo D.K.N., Nakimbugwe H., Mubiru J.,Busuulwa H., Ndumu D. (2002): The farm Animal Genetic Resources Fact Sheet for Uganda.
In: Reichart U. (2007): Pastoral Nomadism and the process of Sedentarisation of the Bahima people in Uganda. Department of Sustainable Agricultural Systems, Universität für Bodenkultur, Wien

Sillitoe P. (2007): Local science vs. global science: an overview. In: Sillitoe P. (2007). Local science vs. global science: approaches to indigenous knowledge in international development. Berghahn Books, New York – Oxford. 1-19.

Sölkner J., Nakimbugwe H., Valle Zarate A. (1998): Analysis of determinants for success and failure of village breeding programmes. Proceedings of the 6th World Congress on Genetics Applied to Livestock Production Armidale. 273-280.

Syrstad O., Ruane J. (1998): Prospects and strategies for genetic improvement of the dairy potential of tropical cattle by selection. *Tropical Animal Health and Production*, **30**, 257-268.

Theis J., Grady H. M. (1991): Participatory Rapid Appraisal for Community Development: A Training Manual Based on Experiences in the Middle East and North Africa, Save the Children Federation and the International Institute for Environment and Development, London. In: Rietbergen-McCracken, J., Narayan D. (1998): Participation and social assessment tools and techniques [toolkit], World Bank, Washington, DC.

Uganda Investment Authority (UIA) (s.a.): Uganda's livestock industry. Online at: http://www.ugandainvest.com/livestock.pdf (25.06.2009)

United Nations Cartographic Section (2009): Map of Uganda. Online at: http://un.org/Depts/Cartographic/map/profile/uganda.pdf (16.01.2009)

Valle Zarate A.(1995): Breeding strategies for marginal regions in the tropics and subtropics. *Archives of Animal Breeding* **38**, 461-478.

Weisberg H.F., Krosnik J.A., Bowen B.D. (1996): An introduction to survey research, polling, and data analysis. Sage Publications, Thousand Oaks, California. 392.

Wenger E. (2000): Communities of Practice and Social Learning Systems. *Organization* **7**, 225-46.

Wollny C.B.A. (2003): The need to conserve farm animal genetic resources in Africa: should policy makers be concerned? *Ecological Economics* **45**, 341-351.

World Bank, Knowledge and Learning Center, Africa Region (1998):Indigenous knowledge for development. A framework for action. Online at: http://www.worldbank.org/afr/ik/ikrept.pdf (01.09.2009)

Wurzinger M., Ndumu D., Baumung R., Drucker A., Okeyo A.M., Semambo D.K., Byamungu N., Sölkner J. (2006): Comparison of production systems and selection criteria of Ankole cattle by breeders in Burundi, Rwanda, Tanzania and Uganda. *Tropical Animal Health and Production* **38**, 571-81.

8 Annex

8.1 Annex 1: Questionnaire & Progeny History

Following questions were used as a guideline for the semi-structured interviews:

How many herds do you own?
Which cattle do you keep?
Why do you keep Ankole cattle?
What are the advantages of Ankole cattle in comparison to other breeds?
Why do you keep cross-bred cattle?
What are the advantages of cross-bred cattle in comparison to other breeds?
Can you tell me the number of your cattle for each of your herds?
Do you have more or less cattle than three years ago?
Which breeds would you like to keep in the future?
How many bulls do you use in your herd for breeding?
Where are your bulls from?
When did you acquire each of them?
How long do you keep Ankole bulls in the herd for breeding?
How long do you keep cross-breed bulls in the herd for breeding?
When did you start with crossbreeding?
Did you start with crossbreeding yet?
Why did you start with crossbreeding?
How did you found out about it?
Who told you about it?
From where did you receive the cattle for crossbreeding (then)?
Where do you acquire the cross-breds (now)?
Do you buy cross-bred bulls, for what reason?
Do you buy pure-bred bulls, for what reason?
Do you buy cross-bred cows, for what reason?
Do you buy pure-bred cows, for what reason?
Do you sell or give away cross-breds?
Why do you sell or give away a cow? Why do you sell or give away a bull?
Do you exchange cattle for breeding?

If no: Why not?

If yes: Which ones? Why?

With whom would you exchange cattle for breeding?

What relationship is necessary for exchanging cattle for breeding?

Is this the same for Ankole and crossbred cattle?

If No: Why is it different for Ankole / crossbred cattle?

How do you sell your cattle?

How do you sell your cattle?

Do you sell your cattle on a public market?

Do you take care of cattle of absentee owners?

If yes: Do you use these cattle for breeding within your herd?

Do you rent out bulls to other herds?

What is the name of your favourite cow?

Can you show me your favourite cow?

Is it a pure bred Ankole or a crossbred?

Where did it come from?

How many calves has it given?

How many of them were males and what happened to them?

How many of them were females and what happened to them?

Will you further use her for breeding?

For how long will you keep them in you herd?

Who is her sire?

What is his name?

Is he still in the herd?

Where did it come from?

For how long is he in the herd?

Is he the sire of all your cattle?

What happened to his offspring?

What are the advantages of him?

What are the disadvantages of him?

Who is her dam?

What is her name?

Is she still in the herd?

Where did it come from?

How many calves has it given?

How many of them were males and what happened to them?
How many of them were females and what happened to them?
Are you using them for breeding in your own herd?
For how long will you keep them in you herd?
Has she sisters or brothers in the herd?
Does she mate with her father or with her brother?
If your bull is mating his daughters, what will you do?
If your bull is mating his sisters, what will you do?
What are you doing to prevent inbreeding?
For how many cattle in your herd can you tell about their progeny?
To whom do you pass on your knowledge in cattle breeding and about the progeny of your herd?
To whom will you pass on your herd?
Will the herd be split among your successors?
Do you discuss breeding matters with your wife or son?
With whom do you share your experiences in cattle breeding?
Would you share your experiences with farmers outside your community?
To you, what are the most important criteria for choosing a bull for breeding?
What should a cross-bred cow be like that you would give or receive as dowry gift?
What should a pure-bred cow be like that you would give or receive as dowry gift?
Following a book report, it was usual in former times that the leading bull was slaughtered when the household head died. Do you know something about this custom?
How old are you?
When did you overtake the farm?
Will you pass the farm to your successor and give up work at a certain age?
Did you attend school?
If yes: For how many years did you attend school?
How many members are there in your household?
How many members of the household go to school?
How many of your household members work as herders?
How many herdsmen do you employ?
What are your main sources of livelihood?

General information for internal evaluation and completion was recorded on a data sheet, containing following facts about the interview:

Date: Day____ / Month ____ / Year 2009 Record Code: _____ Duration: _____
Questionnaire Nr: _____ Enumerator: _____ Translator:_____
Farmer name: _____
Village: _____ District: _____
County: _____ Sub county: _____

Additional information given by the interviewee after switching off the recorder was hand noted on the data sheet for later consideration and, if necessary, assignment.

8.2 Annex 2: Interviews used for data analysis

This anonymous list of conducted interviews was used as key to differentiate between the two groups of farmers. The farmers from the Sub counties *Sanga* and *Nyakashashara* are not in the ILRI-BOKU-NAGRC&DB research project.

Nr.	Date	Village	Sub county	County	District
1	08-04-09	Kikatsi	Kikatsi	Nyabushozi	Kirihura
2	08-04-09	Kikatsi	Kikatsi	Nyabushozi	Kiruhura
3	09-04-09	Ekimono	Kikatsi	Nyabushozi	Kiruhura
4	09-04-09	Ekimono	Kikatsi	Nyabushozi	Kiruhura
5	09-04-09	Ekimono	Kikatsi	Nyabushozi	Kiruhura
6	10-04-09	Rushenyi	Kikatsi	Nyabushozi	Kiruhura
7	14-04-09	Kyabagyeni	Kenshunga	Nyabushozi	Kiruhura
8	14-04-09	Kyabagyeni	Kenshunga	Nyabushozi	Kiruhura
9	14-04-09	Kyabagyonyi	Kenshunga	Nyabushozi	Kiruhura
10	15-04-09	Kayonza	Kikatsi	Nyabushozi	Kiruhura
11	15-04-09	Kayonza	Kikatsi	Nyabushozi	Kiruhura
12	15-04-09	Kachumbiro	Kenshunga	Nyabushozi	Kiruhura
13	15-04-09	Akatongole	Kenshunga	Nyabushozi	Kiruhura
14	16-04-09	-	Masha	Isingiro South	Isingiro
15	17-04-09	Kanyabihara	Kenshunga	Nyabushozi	Kiruhura
16	17-04-09	Akatongole	Kenshunga	Nyabushozi	Kiruhura

17	20-04-09	Ruburara	Rubaya	Kashari	Mbarara
18	20-04-09	Akengoma	Nyakashashara	Nyabushozi	Kiruhura
19	22-04-09	Akashenshero	Nyakashashara	Nyabushozi	Kiruhura
20	22-04-09	Kakyeera	Nyakashashara	Nyabushozi	Kiruhura
21	22-04-09	Akashenshero	Nyakashashara	Nyabushozi	Kiruhura
22	22-04-09	Kakyeera	Nyakashashara	Nyabushozi	Kiruhura
23	22-04-09	Akashenshero	Nyakashashara	Nyabushozi	Kiruhura
24	22-04-09	Kakyeera	Nyakashashara	Nyabushozi	Kiruhura
25	22-04-09	Akashenshero	Nyakashashara	Nyabushozi	Kiruhura
26	22-04-09	Kakyeera	Nyakashashara	Nyabushozi	Kiruhura
27	28-04-09	Nyarutegura	Sanga	Nyabushozi	Kiruhura
28	28-04-09	Nyarutegura	Sanga	Nyabushozi	Kiruhura
29	28-04-09	Nyarutegura	Sanga	Nyabushozi	Kiruhura
30	28-04-09	Nkongoro	Sanga	Nyabushozi	Kiruhura
31	28-04-09	Nkongoro	Sanga	Nyabushozi	Kiruhura
32	28-04-09	Nkongoro	Sanga	Nyabushozi	Kiruhura
33	28-04-09	Nkongoro	Sanga	Nyabushozi	Kiruhura
34	28-04-09	Nkongoro	Sanga	Nyabushozi	Kiruhura

8.3 Annex 3: Codes used for analysis in Atlas.ti

HS_1_number herds

HS_2_cattle breeds

HS_3_benefit Ankole

HS_4_benefit Crosses

HS_5_number cattle

HS_6_breeds kept in future

BU_7_bulls in herd

BU_8_origin bulls

BU_9_bulls stay in herd

CB_10_start crossbreeding

CB_11_discovering crossbreeding

CB_12_source first crossbreds

CB_13_acquisition cattle

CB_14_sale cattle

RE_15_exchange cattle

RE_16_relationship exchange

RE_17_absentee owners

PFC_18_favourite cow

PFC_19_origin favourite cow

PFC_20_offspring favourite cow

PS_21_sire of favourite cow

PS_22_offspring sire

PD_23_dam of favourite cow

PD_24_offspring dam

IB_25_inbreeding

KT_26_percentage progeny known

KT_27_passing on knowledge

KT_28_pass on & split herd

KT_29_discuss breeding matters

KT_30_criteria breeding bull

KT_31_dowry gift

SD_32_age of farmer

SD_33_overtake farm

SD_34_retirement

SD_35_education farmer

SD_36_number household members

SD_37_education household members

SD_38_farm activities household members

SD_39_employing herdsmen

SD_40_source of livelihood

KT_41_sharing experiences within community

KT_42_sharing experiences outside community

HS_43_benefit Boran

BU_44_artificial insemination

HS_45_herd size +/-

KT_46_slaughter leading bull

HS_47_herd management

KT_48_record keeping

HS_49_benefit Jersey