1 GENERAL INTRODUCTION

1.1 Background and aim of the study

The multifaceted role of livestock in combating rural poverty and enhancing food security in terms of quality and quantity makes it an indispensable tool in development. Increasing the availability of nutrients, especially animal protein, is one of the strategies out of poverty and malnutrition prevailing in many developing countries. The per capita availability of livestock products in Uganda is 40 litres of milk and 5.6 kg of meat, a pathetic level compared to the FAO recommendations of 200 litres and 50 kg, respectively (FAO, 1974-1977).

At the political level, Uganda has responded to this problem by making animal breeding an important component of its Poverty Eradication Action Plan (PEAP), which is a comprehensive development framework (MAAIF/MFPED, 2000). The National Animal Genetic Resources Centre and Databank (NAGRC), a body corporate under the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) with the mandate to oversee animal breeding activities in the country, is trying to streamline cattle breeding programmes in the country. The legal basis of its operation is a law entitled “The Animal Breeding Act” (Nakimbugwe et al., 2002). Uganda is one of the few developing countries which have recognised the importance of livestock breeding up to this level.

In response to the agro-ecological diversity, suitable for different types and breeds of cattle, NAGRC has plans and/or operates countrywide, several large cattle breeding stock farms with different types of breeds (Holstein-Friesian, Jersey, Simmental, Ankole, Nganda, Short horn Zebu, Boran). These farms are expected to act as nuclei in open nucleus schemes, where superior animals are multiplied at a central farm (nucleus), distributed to farmers, and the best animals from the farmers are brought back to the central farm for further breeding. The best bulls are recruited for semen production in the bull stud. Their germplasm is distributed via artificial insemination, a technique well developed and used in Uganda.

Breeds developed in the temperate regions of Europe and North America (called “exotic breeds” in tropical countries) have the potential of producing milk at a much higher level than local breeds. This is a well recognized fact, thus pure breeding and cross breeding with such animals, especially of the Holstein-Friesian breed, has been carried out in many tropical countries (CIDA, 1992; CUNNINGHAM et al., 1987; KAHI et al., 2004b; MAAIF, 1997a). Many programmes, systematic or based on individual entrepreneurship, have failed due to lack of adaptation of exotic breeds to tropical conditions resulting in poor performance and low survivability of imported or even crossbred animals. Nonetheless, exotic breeds do relatively well in particular agro-ecological niches of Uganda where the climate is moderate (temperatures not exceeding 30°C) and as long as the disease pressure from, e.g., East

Coast Fever (ECF) is controlled by regular immunisation, tick control or treatment. Under such conditions, Holstein-Friesian cows produce 5 to10 times more milk than local breeds at a sustainable level. This provides an option to substantially increase production of animal protein and individual incomes of farmers while keeping the pressure on agricultural land reasonably low. Such a scenario has led to the development and increasing adoption of a special “cut and carry” (zero grazing) system for smallholder farmers combining agriculture and livestock production in the highly prolific areas close to markets. Holstein-Friesian is the most popular exotic/temperate dairy breed among such production systems focused on high milk producing animals. Preference for this breed is reflected in NAGRC’s semen sale records, which show higher sales of Holstein-Friesian semen than any other breed (NAGRC, 2004).

Acquiring independence from semen imports from Europe and North America plus evaluating the potential of bulls under local conditions, that is, developing a “tropicalised” type of Holstein-Friesian with the help of an optimal breeding scheme using the available resources and with active participation of farmers is a realistic development goal.

Since genetic changes are usually permanent in nature, thorough planning of animal breeding programmes is important to avoid making changes in the wrong direction. Implementation of these programmes is also long term in nature so valuable time and resources should not be wasted due to poor planning. A detailed analysis of a potential intervention and predicting its outcome using computer simulation or numerical analysis of models that describe the system is essential. Models which may be deterministic or stochastic (probabilistic) offer a cost effective way of linking different components of a system, both biological and socio-economic, so that their interactions can be investigated, predictions made and hypotheses (i.e. What if ? scenarios) tested before interventions on the real system are attempted. In respect of a genetic plan, for example, the optimal number of female offspring per bull must be evaluated against the number of bulls that may be tested via the performance of the offspring. The selection intensity among tested bulls and the resulting rate of inbreeding have to be considered. Biological coefficients like the average number of lactations of a cow or the time period for which a bull is used are needed as well as factors like recording costs, the costs of operating a nucleus at different sizes or the price of a straw of semen produced are decisive for the efficiency of a system.

This study is part of NAGRC’s conceited effort in setting up an optimal breeding scheme for the Holstein-Friesian population. The study covered part of the Lake Victoria Crescent region in Uganda. This region lies in the central milk shed area which produces 34% of all milk production in the country (MAAIF, 1993). It has also an on-going Herd/Milk Recording Scheme which provided much of the data that was used in this study. The region has predominantly two dairy production systems: zero grazing and fenced dairying systems run mainly by smallholder farmers, a target group for this study. NAGRC's centrally located Njeru stock farm, which has been earmarked to spearhead the improvement of the Holstein-Friesian breed, is to serve as the central nucleus for the proposed programme.

The overall objective of this study is to develop a sustainable dairy cattle improvement programme for increased milk production so as to improve on the nutritional status and income of farmers.

The specific objectives are to:

i) estimate reproductive biological coefficients for the Holstein-Friesian, essential among other things, for designing of breeding programmes and in decision making at various levels (national, farm etc.).

ii) evaluate a range of open nucleus schemes (genetical) for the Holstein-Friesian cattle population in Uganda with the aim of implementing the most optimal one in terms of profitability and sustainability.

GIBBON (2004) observes that the continuing failure to bring farmers into the planning process is usually detrimental to sustainability of programmes. Hence, the operational plan (modus operandi) is to be worked out with stakeholders as a way of reinforcing their participation and ownership of the programme.

1.2 Justification

Uganda government's broad policy goal for the livestock sector is to attain sustainable food production of animal origin for both domestic and export markets, and hence increase the incomes of the rural poor households (MWEBAZE, 2004). The importance of such a goal is supported by WALSHE (1990) who reports that the World Bank's Operations Evaluation Department (OED) is of the view that sustained increases in farm productivity, especially in smallholder agriculture, cannot be attained without attention to livestock development.

The per capita milk consumption in Uganda, though still low, is on an increase as evidenced by a 40% increase within a five year period (1997-2001). Of all protein rich food commodities, perhaps the largest gains in production have been made in milk where production has virtually doubled since the early 1990s. This development can be attributed to the increasing demand brought about by an increase in the population and the improving standards of living. Much of this demand, strikingly, has been met by the increased number of cattle among smallholder farmers rather than by an increase in the yield per cow (MWEBAZE, 2004; SPOSATO, 1998).

With a 2.97% population growth rate (aneki.com, 2004) and a population mean density twice that of Kenya and thrice that of Tanzania (BOURN and BLENCH, 1999), the number of animals cannot be increased indefinitely; there is a limit dictated by available land and other production resources. Improving productivity per animal through improved management and exploiting their genetic potential is often one of the few possibilities of increasing farm income and getting farmers out of the poverty trap (DE HAAN, 2004). This is true for the Ugandan dairy industry which is overwhelmingly based on smallholder farmers whose major and often only source of regular income is from sale of milk. Dairy cows, especially the Holstein-Friesian breed, have proved to be instrumental in the fight against poverty, especially, among NGOs (e.g., Send a Cow, Heifer Project International) who target vulnerable groups in society. This approach is supported by GALLOWAY (2003) who is of the opinion that encouraging milk production on the small farms is a way of empowering the disadvantaged, especially women.

The general objective of Uganda's livestock development strategy as implied in the Plan for Modernisation of Agriculture (PMA) is to increase yield per animal and enhance productivity through use of improved animal breeds and adopting proper management practices. PMA is a holistic, strategic framework for eradicating poverty through multi-sectoral interventions, aimed at enabling the people to improve their livelihoods in a sustainable manner (MAAIF/MFPED, 2000).

Because gains in breeding programmes are cumulative and for perpetuity, other forms of investment in livestock production can hardly rival with it in regard to sustainability. For example, injection of cattle with bovine somatotropin (growth hormone) will increase milk production by 10 to 20 percent. This is quite impressive, especially if the cost of treatment is low. However, the improvement will be realized only as long as the cows continue to be injected. If, on the other hand, milk production is increased by breeding, the differential, though not spectacular, will be maintained without further treatment and is expressed in thousands or millions of animals, hence making genetic improvement programmes one of the most powerful and cheapest means of increasing the efficiency of animal production. In the long term, breeding may provide the most secure option for sustainable livestock improvement (PONZONI, 1992; ATKINS, 1988; WIENER, 1994; WOLLNY, 1995).

ERASMUS and WYK (1995) report that interest in genetic improvement of livestock in South African countries has escalated over the past years because of the increasing comprehension that it is more cost effective to improve genotypes than most environments. The economic and financial realities facing livestock production have led to a conception of changing genotypes to suit environments rather than changing environments to suit unadapted genotypes.

In Uganda, introduction of more productive exotic breeds, since the early 1960s, was a result of disappointment with the slow progress encountered with selection among the indigenous cattle (MAHADEVAN and MARPLES, 1970). However, these efforts geared towards increasing production per animal have been wanting notwithstanding the fact that some few farmers have benefited from such interventions (MAAIF, 1997). DE HAAN (2004) is certain that the poor results of massive importations of mostly female Holstein stock, from US and Europe to East Africa and Latin America were due to poor adaptation of exotic breeds to the local conditions. Changing the environment to suit these breeds has not only become economically prohibitive, but also highly unstable and a risk to food security (ERASMUS et al., 1995).

CUNNINGHAM (1992) is of the view that such infelicitous results are due to not giving enough attention in advance to the design of breeding programmes and to the evaluation of their chances of success within the existing environment and infrastructure. The fiascos associated with the direct transfer of breeding technology from the Western World to developing countries are well known. Importation of live animals has proved to be inappropriate. Studies on production and life expectancy of live Holsteins imported into Venezuala, a country which lies in the same climatical belt as Uganda, show that 81.3% of calves born from these animals died before one year of age, and the number of calvings recorded for these animals during their lifetime in the herd was only 1.2 (VACCARO et.al., 1983). Importation of such adult animals is perhaps the worst scenario, for they have not been able to build up any acquired immunity to local diseases (HODGES, 1990a). Use of imported semen, which is now a focus of most breed improvement programmes, has proved to be no panacea in the quest for appropriate genotypes. DE HAAN (2004) admonishes that the quality of genetic material on offer in developing countries is often not suitable for the producer and even less so for the smallholder. Most of this semen comes from sires from temperate climates, ignoring the Genotype X Environment interactions which define to a large extent the phenotypic outcome. Although the resultant F1 crosses by use of this semen on indigenous breeds tend to meet the farmer’s needs better, maintaining such discontinuous breeding programmes require structures that usually do not exist in these countries (OLLIVIER, et al., 2000). However, a study conducted in Central Uganda on the performance of Friesians by MARPLES and TRAIL (1967) and TRAIL and MARPLES (1968) indicated that the breed is not adversely affected by climate rather the major limitation to production of the breed is poor management. Genetic improvement should, therefore, go hand in hand with improvement in management. The challenge to stakeholders in dairy cattle breeding is to make a choice on the course of action that would enable the Holstein-Friesian breed, their favourite dairy breed or genotype, fit into their production systems in a sustainable manner.

SMITH (1988) is of the opinion that countries in Southern Africa should develop and identify their own breeding objectives, testing schemes and breeding stock based on their own commercial conditions rather than taking blueprints from elsewhere. In reference to South African countries, NYATHI (1995) points out that the ever increasing costs of production in commercial livestock enterprises and the frequent droughts that decimate the grazing resource base both indicate the relevance of the need to develop livestock types that can perpetuate the species under conditions of reduced available grazing and feed resources.

This reality was one of the major justifications for formulating Uganda's first-ever Animal Breeding Policy which recommends spelling out well-defined principles for selection, crossbreeding and introduction of purebreeds in accordance with agro-ecological conditions and prevalent management levels. The general strategy in animal breeding should focus on optimisation of the genetic potential according to production factors, the needs of the market, the ecological environment and future development (WOLLNY, 1995).

In low input-output systems, the sustainability of animal breeding efforts to improve animal productivity becomes a dominant factor (WOLLNY, 1995), hence the need for selection to be within the adaptive environment and under sustainable management conditions (VALLE ZÁRATE, 1996). In Uganda, there is a need to develop suitable genotypes for the different production systems. During the diagnostic survey carried out in 1999, under the Livestock Systems Research Programme (LSRP), farmers explicitly pointed out the lack of productive adapted genotypes for their production systems as a major hindrance to livestock production. The diagnostic survey, a component of the Farming Systems Approach in which the farmer is the core and motor of all activities, was conducted by a multidisciplinary team which identified priority areas of research through a process of stakeholder consultation and field diagnosis. Its objective was to describe and understand the production systems (what, where, when, why, who, how?); identify, prioritize and analyse major problems; and explore potential solutions/interventions (LSRP, 1999a).

Studies of selection within established exotic breeds, under climatic and resource constraints similar to those encountered where they are intended to perform have shown that such breeding programmes are sustainable (KAHI et al., 2004b). REGE (1995) points out the key to genetic improvement of livestock as being dependent on access to genetic variation and effective methods for exploiting this variation. There is enough variation within the Holstein-Friesian population in Uganda given that the importation of the breed into the country dates way back to 1962. The 1970s and 80s saw further importations of live animals from the Netherlands, Germany, Canada, Zimbabwe, and Kenya. This has been compounded with massive importations of semen from all over the world, notably, from the USA, Denmark, Sweden, South Africa, New Zealand, and Kenya (MAAIF, 1997). The planned selection within the Holstein-Friesian population in Uganda is to capitalize on this variation. Since improvements accruing from genetic selection are gradual, selection done in the country will allow the required necessary changes in feeding and management to be assimilated slowly and steadily.

Smallholdings are a ground reality and systems need to be tailored to work with that reality (CHAND, 2004). WOLLNY (1995) proposes the use of simple nucleus schemes in such systems. A study by BONDOC and SMITH (1993a) has shown that the establishment of two-tier open nucleus breeding systems (rather than unstructured populations) maximises genetic improvement, reduces inbreeding rate, and reduces the total cost of recording in smallholder dairy cattle production systems. An open nucleus will integrate farmers' resources, reduce overhead costs, and encourage more farmer participation. It was from such studies and analysis that the Animal Breeding Policy based its recommendation for the use of open nucleus breeding schemes in the genetic improvement of livestock in Uganda. Consonance of livestock farmers with this recommendation is implied in farmers having participated in drawing up the Animal Breeding Policy. Furthermore, farmers who participated in the LSRP diagnostic survey proposed the availing of more locally produced Holstein-Friesian semen as a means of improving the adaptability of this breed (LSRP, 1999b, NAKIMBUGWE, 2000b).

It is, therefore, NAGRC's responsibility to set up a Holstein-Friesian breeding programme which will avail appropriate genotypes of this breed to the two the production systems where it is popular, namely, zero grazing and fenced dairying. HAMMOND (2001) points out that there is high potential for genetic improvement in breed populations of developing countries if only breeding programmes were well planned, executed and sustained.