Situation analysis and prospects for establishing a dairy goat breeding program in Tanzania

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Abstract

Dairy goats in Tanzania accounts for two percent of the 17 million goats in total. Toggenburg, Saanen, Norwegian, Anglo Nubian and French alpine are dominant exotic dairy breeds distributed in all regions of Tanzania but abundance in Manyara, Morogoro, Arusha and Kilimanjaro regions. Both public and private organizations have played in importing and distribution the exotic breeds in the country. For example, the collaboration between in Sokoine University of Agriculture (SUA) and Norwegian University of Life Sciences (NMBU) participated importing the Norwegian goat breed. The FARM Africa (Food and Agricultural Research Management) and HPI (Heifer Project International) responsible for Toggenburg and Saanen dairy breeds. The support with dairy goats has proven to be rather effective in improving food security and livelihood of people who owned them. Long term benefits of the goats can be realized if breeding principles are well considered e.g. reliable source of replacement breeding stock. As a step towards achieving that, a Strength, Weakness, Opportunity and Threats (SWOT) analysis of a dairy goat breeding program in Tanzania today were analysed in this paper. The analysis revealed potential possibilities for establishing sustainable dairy goat breeding program in the country. However, poor and unreliable records were the main hindrances for sustainable genetic improvement of goats in the country. Alternatively, this paper propose a simplified breeding plan that benefits from progress made elsewhere through occasional semen import for AI in one breeding nucleus herd in the country, multiplied by another unit/centre for distribution to clients. Key roles and risks of private and public institutions participating in implementing the breeding plan are highlighted.

Keywords: *breeding scheme, current situation, dairy, goats*

Introduction

In Tanzania, goats are popular and a large population of indigenous Small East African (SEA) goats is kept under extensive management systems (MLF 2015). Imported breeds are also available and kept by rural families. They account for about 2% of the about 17 million goats available in the country. Arusha, Morogoro, Manyara, and Kilimanjaro are the regions with highest numbers of dairy goats. Toggenburg, Saanen, Norwegian, French alpine and Anglo Nubian are the often mentioned dairy breeds found in Tanzania mainland and on the islands of Zanzibar.

Non-governmental organizations (NGOs) and community-based projects with integration of dairy goats have contributed to supply dairy goats among farmers in Tanzania. Norwegian dairy goats (called Norwegian

white (NW)-goats) were imported to Tanzania in 1983 as part of on institutional cooperation (SUA and NMBU) (Mtenga et al 2002). FARM Africa (Food and Agricultural Research Management) and HPI (Heifer Project International) have imported and distributed dairy goats in the country especially the Toggenburg and Saanen breeds (Chenyambuga et al 2014; FARM Africa 2006; HPI 2006). Furthermore, community based Organizations (CBOs) have played similar roles. The support with dairy goats has proved to be quite effective in improving food security and livelihood of people owning them (Amati & Parkins 2011; Eik et al 2008). Better long term benefits of the improved goats can be realized if reliable sources of replacement stocks exist. As a step towards achieving a sustainable supply of quality dairy goats, SUA and NMBU experimented on -farm recording system for dairy goats involving 62 farmers in Mgeta, Tanzania (Kifaro et al 2012). Aimed at understanding the Strength, Weakness, Opportunity and Threats (SWOT) of developing a dairy goat breeding program in Tanzania. Based on the SWOT analysis, a simplified breeding plan was proposed that benefits from progress made elsewhere through occasional semen import for AI in one breeding nucleus herd in the country. Key roles and risks of private and government institutions participating in implementing the goat breeding plan are highlighted.

Material and methods

A review of dairy goat breeding practices in both Tanzania and Norway was conducted. Norway represented countries with well-functioning dairy goat breeding programs. In Tanzania, data from 62 households' dairy goat control herds in Mgeta during a three years period from 2012 to 2014 was analyzed. The information on parentage identities (ID of individual, sire, and dam, birth date, sex, milk-yield/day, growth performance, mortality, head dynamics (number born, died, sold, slaughtered), mating (buck ID and date) and health (e.g. type of disease and measures taken) were the information available from the dairy goat recording trial in Mgeta. The current study analyzed individual identities (ID), parentage (buck and doe IDs), and birth date, sex, and milk yield/day parameters. Each farmer was trained in record keeping such as weekly and monthly milk and body weight measurements. In order to undertake the work, farmers received recording sheets, milk recording cylinders and weighing scales (Kifaro et al 2012).

To understand the dataset structure is an important step towards genetic evaluation. Simple statistics in Excel computer program was used to summarize the number of recorded information between 2012 and 2014. In addition, both published and unpublished information on dairy goats, information on available resources necessary for animal breeding program in public institutions, in particular the Tanzania Livestock Research Institute (TALIRI) and SUA, as well as from the private sector organizations engaged in livestock related activities, and milk processing companies, were used as important resources for the SWOT analysis.

Dairy goat breeding program practices in Norway

During at least the last four decades, Norwegian goat farmers have participated in a comprehensive recording and breeding scheme for Norwegian Landrace Goats. To develop an efficient selection program, while at the same time conserving indigenous breeds are two main objectives for the on-going work (Ådnøy 2014). The program includes 31000 dairy goats in 340 herds producing 19 million liters of milk per year (Blichfeldt 2013; SSB 2016). Most of the milk is used to make traditional brown whey cheeses, the popular "Gudbrandsdalsost". In recent years, a rennet coagulated white spreadable cheese "Snøfrisk" (Snow Fresh) has also become popular. Ninety percent of the dairy goat farmers participate in the goat recording scheme operated by the Farmers Dairy Cooperative (TINE) in Norway. Specialists at the Norwegian association of sheep and goat breeders (NSG) estimate breeding values for all goats participating in the scheme. A total of eight traits: daily milk yield, milks' content (%) of DM (dry matter), CP (crude protein), fat, lactose, in addition to udder/teat conformation, milking speed, free fatty acid content, and occurrence of mastitis are included in the breeding goals. To avoid overproduction of milk, farmers must adhere to a quota system. According to SSB 2014, for years Norway has experienced a stable high milk production reaching 20000 tons per year, which is equivalent to the current market demand for goats' milk. Figure 1 shows development of milk content.

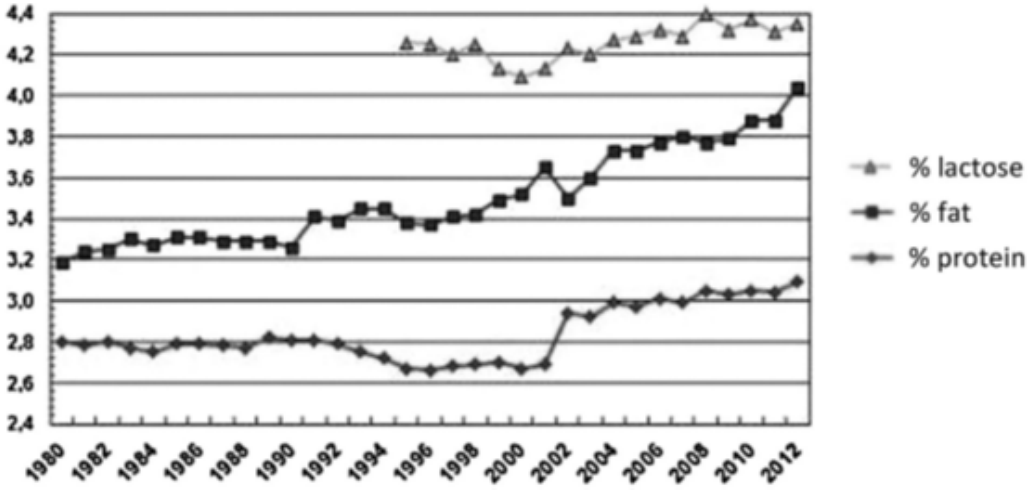

Figure 1. Percentage content of protein, fat and lactose in Norwegian Dairy Goat Recording Scheme 1980-2012 (Tine 2013).

In the recording scheme, annually farmers are required to record does' milk yield five times and milk contents three times. In addition, all individuals are registered in a pedigree for their parentage information. Test bucks were selected based on a "buck circle strategy" until 2005 when the practice ended due to the risk of transmitting diseases between herds (Ådnøy et al 2000; Blichfeldt 2013). Farmers are now encouraged to test best buck kids within own herd and use semen for introducing new genes and for comparison of production level of daughters of own test bucks and AI bucks. This is possible since farmers have large herds and keep adequate records.

Both performance recording and selection for replacement bucks is done at farm level. Farmers' organizations control what should happen and continue to happen at the farm level. Infrastructures necessary for goat recording and performance evaluation from farm to the institutional level is well articulated. For example, animal ID in Europe is the first link and is unique to all animals in the country (Blichfeldt 2013). Moreover, both farmers and scientists are quick to learn and apply emerging technologies such as use of electronic tagging, AI, and genome based breeding (i.e. including information obtained through DNA analysis in breeding) (Ådnøy 2014). To keep genetic variation high and increase milk quality, Norway has imported some semen from other countries. For example, between 2007 and 2011, French Alpine semen was imported and made available to farmers (Ådnøy 2014).

Every year, semen from elite bucks is stored for possible future use (Blichfeldt 2013). In addition, genotypes from special populations, i.e. wild goats, are secured in the same manner. By doing so, it is possible to safeguard biodiversity and adapt the breeding goals if needed. For the last decades, farmers keep dairy goats for milk only and surplus goat kids are often disposed of after delivery without utilizing the meat. Due to the climate and small farms, the agricultural sector receives governmental support (Ådnøy 2014), which is not the case for most developing countries including Tanzania. In summary, the long-term successful breeding program for goats in Norway may be attributed to several factors such as presence of enough expertise in the field of animal breeding and genetics, high level of income and education among farmers, strong governmental support and a spirit of collaboration among farmers and institutions working along the dairy goats breeding program.

Dairy goat breeding program practices in Tanzania

Goat breeding in Tanzania is still in infancy stage and the herd sizes are often very small – five goats per farmer as opposed to around 100 in Norway. This makes on-farm selection difficult unless a cooperative breeding program is employed (Nziku et al 2016). Governmental support is also insufficient, making collaborative efforts and implementation of long term projects more difficult.

Several attempts have been made to establish goat genetic improvement programs in Tanzania. In the 1980s, the Tanzania Livestock Research Organization (TALIRO) established an important base for animal breeding that included an intensive recording system, and introduction of improved goat breeds for both milk and meat (TALIRO 1980). The Toggenburg and Saanen breeds were the selected breeds for milk while the Kamorai and Boar goats were imported for meat improvement. Unfortunately, these efforts did not sustain

after the program ended in 1992. Today, the dairy goat sector in Tanzania is active mainly because of the community development projects tailored to dairy goats (RIPAT 2015; EPINAV 2011; FARM Africa 2006; HPI 2006). These projects come with different technology packages and themes regarding dairy goats, which include feeding, marketing, breeding, disease control, capacity building, malnutrition alleviation and the like. It seems these and previous similar projects had less focus on maintaining genetic potential of the exotic goats than impact on famers.

For the last five years, a dairy goat breeding project was implemented by SUA and NMBU in collaboration with 62 dairy goat farmers in Mgeta (EPINAV 2011). The analyses of registered basic and milk yield per day data from dairy goat recording in the project are shown in Figure 2 and 3. Results show a complex data set that is difficult to use for genetic improvement. There was no uniformity in the counted numbers of recorded information and a lot of missing cells for information like the parent IDs. Buck (sire) ID was least registered. Parentage information is a basic requirement in conducting modern breeding (El-Kassaby et al 2011). The estimation of additive genetic relationship depends on parentage information, something which seemed to be a challenge in Mgeta. Mgeta is considered a reliable place for goat breeding in Tanzania. The complexity observed suggest that at this point in time, and under the given circumstances, it is difficult to operate an on-farm dairy goat breeding program in Tanzania. Still the information gathered in the project is an important indicator that future breeding of goats in the country can be decided.

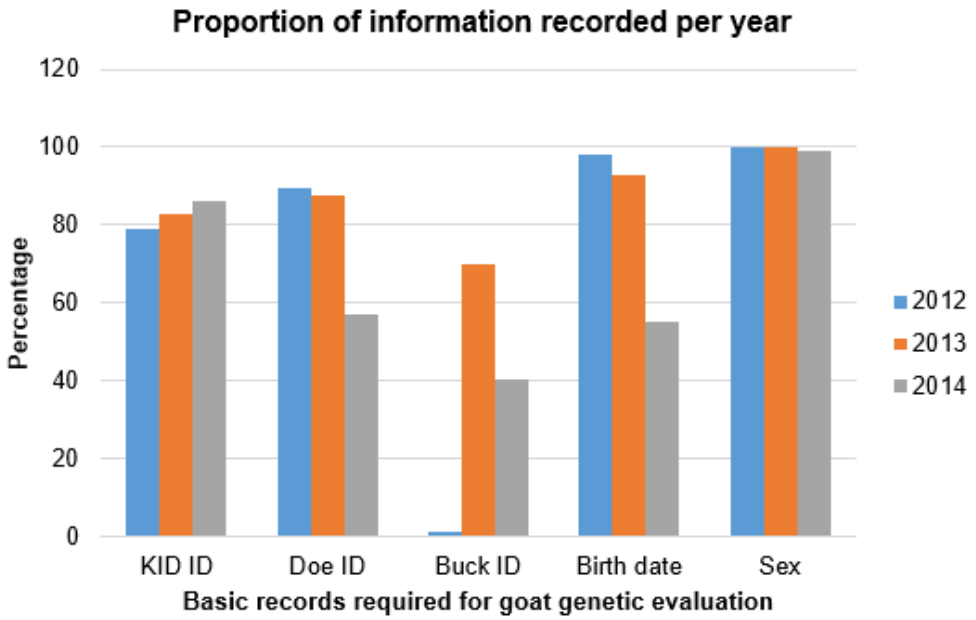

Figure 2. Basic information from dairy goat recording in Mgeta, Tanzania 2012-2014. Proportion of registered identities (ID) for the newborn kids, does and bucks,
birth date and sex. The total count of registered information in 2012, 2013 and 2014 was 687, 1353 and 446. (The Kid ID may reoccur
as Doe ID or Buck ID several times if they become parents of offspring in subsequent generations). *ID= identity*

Figure 3. shows the uneven flow of milk yield information between the different months and years. For example more records were obtained in 2013 than in 2014. This could be due to efficiency of the assistants involved in data collection or number of does available for recording during a specific period. Lack of reliable and availability of on-farm data for genetic evaluation is common in developing countries (FAO 2010; Gamborg and Sandøe 2005). Most farmers in Mgeta are poor with limited formal education, and daily they are engaged in several activities including cropping, grazing, water and firewood fetching to mention a few (Asheim et al 2015). These activities may limit their capacity to participate in a long-term goat breeding program.

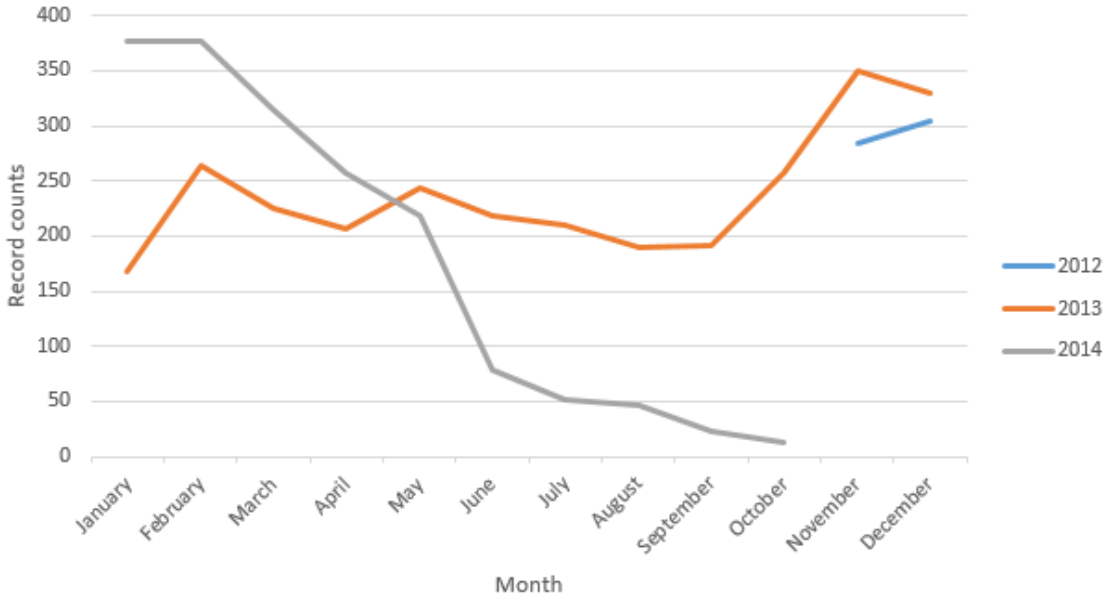

Figure 3. Counts of registered milk yield information from dairy goat recording in Mgeta, Tanzania 2012-2014. Total milk yield records in 2012,
2013 and 2014 were 656, 2850 and 1755. Milk yield records were supposed to be measured four times in a month by farmers.

In Mgeta better recording could be expected if fewer traits and number of recording times were done, information transfer process shortened (from farmers to data base/server) as opposed to the four registration gathering steps (farmers > agriculture extension agent > research assistant coding data in excel computer program > project leader keeps data files > data users/researchers) adopted in this study. The system may have high risk of human error and delay in getting information available for use. Electronic tools (e.g. cellphone) for data entry and transfer from farmers to the server could help. More importantly motivation factors of farmers, and others involved, to continue recording should been identified.

Conclusions from results in Figure 2 and 3:

· On-farm recording is challenging, hence limits dairy goats selection program in Tanzania.

· Farmers are self-motivated to keep dairy goats, but less on recording; hence identification of motivating factors becomes even more necessary.

· To develop reliable sources to supply quality dairy goats in the country is required.

Based on this background, this paper proposes an alternative breeding strategy to increase potential for milk yield while keeping inbreeding low in the Norwegian goats' population in Tanzania. The novel strategy is to rely on the selection of dairy traits which depends on progeny test based on recording of performance of daughters in Norway, while some traits like survival, color, and body conformation, shape of udder, temperament could be selected for in Tanzania.

Prospects of dairy goat breeding program in Tanzania

In most developing countries including Tanzania, the private sector is the main employer generating viable income opportunities to poor people (FAO 2007). The private sectors in this case includes individual farmers or associations, companies (cropping and livestock keeping, milk processors and marketing) and the public sectors as research and academic institutions, for example, TALIRI and SUA. Together, they can mainstream the dairy goat breeding program activities into the general agricultural policies of the country. The new strategy builds on the concept of Public Private Partnerships (PPP) policy in Tanzania (URT 2009). The milestones of the proposed breeding strategy consist of four principles, each with unique responsibilities (Fig. 4) as follows:

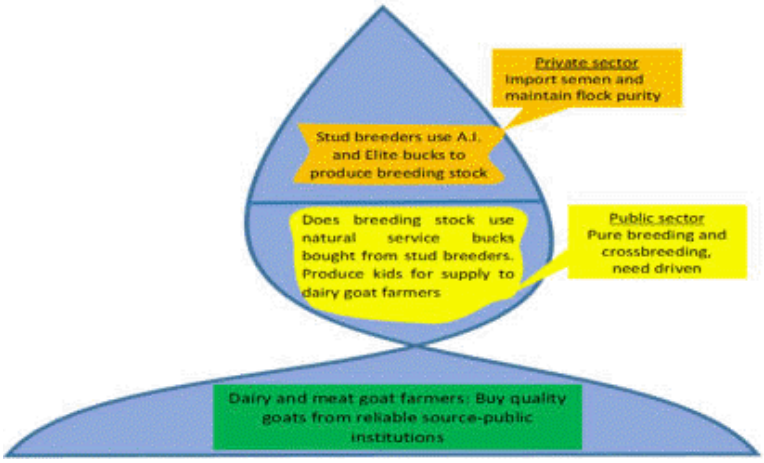

Figure 4. Proposed dairy goat breeding pyramid with a nucleus breeding herd under private sector. Imported semen is only used in
such a herd and only the offspring are sold out to farmers/associations through public institutions in Tanzania.

Nucleus breeding herd (stud breeders) under private sector

The nucleus herd should have at least 100 does year round. All male weaned kids should join a bachelor group (a group with only male goats) to avoid unplanned mating in the nucleus herd. The plan is to use AI and possibly elite bucks for mating. For doe side: 30% replacement per year coming from young female kids in the nucleus herd with AI sire and or elite buck. Breeding goal for selection should consider adaptability traits under Tanzanian conditions. Quality young bucks female shall be sold/taken to public institution e.g. TALIRI where replacement and multiplication process will take place before selling to farmers. Government subsidy to farmers is encouraged even at this stage for buying quality breeding stock. If the strategy is well managed it could results in a huge impact in genetic improvement of dairy goats in Tanzania, and therefore contribute to the rural economy that the majority of livelihood depends (WB 2011). The private sector may benefit in this business through constant supply of quality genetic materials and use of expertise in goats to and from government institutions. It is expected that all parts involved in such a program economically will benefit through selling live goats, and or products and meat.

Specific responsibilities for the nucleus breeding unit:

· Buy semen of the dairy goat breed.

· Control breeding in the nucleus herd/stud breeders.

· Record parentage information, sex, growth, milk yield and mortality.

· Supply quality goats to public institutions e.g. TALIRI proposed in this case.

· Collaborate with the public institutions by sharing information regarding dairy goats.

Motivation of private farm

· Income from selling quality breeding stock: around 150,000 Tanzanian shillings ~ 68.7 USD per weaner kid of 4-7 months old (Nziku et al 2016).

· Recognition from local and international parts involved in dairy goat sector.

· Collaborations with scientist in the animal field.

· The involvement of institutions (academic, research and church missionaries) and individuals as development partners from local and international would be motivated by doing good things for Tanzanians.

Public institution

The TALIRI-West Kilimanjaro is a public Livestock Research Center which has been mandated to coordinate small ruminant research in Tanzania (MLF 2015). The center owns about 5723 ha of land – a resource important for livestock research purpose. In addition the center is equipped with experimental goat barns, personnel working at the center (PhD, MSc, Diploma, and Certificate holders), sheep and goats of different genotypes are kept for different purposes including conservation.

Specific responsibilities of the institution can be:

· Link dairy goat farmers and other stakeholders to nucleus breeding herd.

· Facilitate formation and strengthen dairy goat farmers' associations.

· Receive and process applications for dairy goats from farmers/dairy goat farmers' association.

· Collaborate with academic institutions through local and foreign student visitors for research purposes. The emphasis for this institution should be to involve students and young scientists in most of the planned agriculture field activities, hoping that they will take the lead in dairy goat improvement in near future.

· Conduct research and share the results on various aspects of dairy goats in the country.

· Collaborate with milk processors and marketing companies on the use of milk collected and quality records.

· Collaborate with the nucleus herd staff to participate in agriculture shows in the country as one way to spread information about the goat breed.

· Should play a role in providing necessary training to farmers on various aspects related to dairy goat keeping (breeding, feeding, disease control, and marketing).

· Should conduct research to answer the question of how many dairy goat breeds are needed in Tanzania and whether pure or crosses (100%, 75%, >50%) are best suited depending on environment. Environments are not uniform. Highlands, low lands, dry and humid areas, diseases, feed availability, and production systems vary throughout the country.

Motivation

· Income from selling quality breeding stock: around 150,000 Tanzanian shillings ~ 68.7 USD per weaner kid of 4-7 months old (Nziku et al 2016). Also, income from selling goat milk approx... 1000 Tanzania Shillings per liter. ~ 0.5 USD.

· Information about the dairy goat breed made more available and possible to trace.

· Opportunities for more research regarding goat breeds, e.g. pure breeding and or crosses.

· Learning opportunities of researchers (AI, breeding plan, and evaluation of genetic parameters).

· Availability of experimental units (animals in the country for research reasons).

Farmers / associations

The primary breeding goal at farm level is to increase milk supply while developing farmers' attitude to recording and to increase economy of rural families through sale of milk and meat. The farmers' associations are important as they have a strong influence on policy and research (Umeh and Odom 2011). They also bring farmers and other stakeholders together to share experiences about dairy goat breeding practices, have a voice on prices of milk or milk production, prices of live goats, assist in input supply and manage buck rotation.

Dairy goat farmers / associations in the country should make it possible to tap the dairy goat genetic resource from reliable sources under private sector through public institutions. Use of public institutions is important to have proper documentation and know distribution of the resources in the country for future monitoring of performance and reporting. More befits from goats and their products e.g. milk can be guaranteed if value addition is considered. Factories for cow milk processing is common, these may stand a better chance to add value goat milk from farmers around. Alternatively, the association can install cooling tanks and factories near to their premises for goat milk processing this is significant as under rural settings where storage of products like milk could be a challenge and in most cases is sold as raw. Adding value to products means more money at sale.

In this context, farmers are responsible for:

· Acquiring the dairy goats and replacement bucks from the nucleus breeding herd through the public institutions.

· Milk the goats and sell surplus milk e.g. to processors through farmers' association in their localities.

· Keep simple records (e.g. registering the newborn goats including their parents and mortality information, milk yield once per month).

· Involve their school children at home in goat breeding practices, hoping that they will develop interest in agriculture aspects and attitude for self-reliance.

· Encourage buck rotation technique so that the progeny are evenly distributed in the area (Ådnøy et al 2000).

· Organize acquisition of livestock inputs for selling to members to enhance easy supply of inputs

Motivation

. Reliable source of quality replacement stock.

. High producing goats.

. Possible to get subsidies.

. Accumulation of capital of the associations for their better performance

Milk processing and marketing companies – Private

Cow milk processing factories are many, but almost no factory processes goat milk in Tanzania. These factories stand a better chance if they work closely with dairy goat farmers and get more milk to process.

Their main roles could be:

· Buying surplus milk from farmers.

· Process the milk and market.

· Establish milk collection centers where they keep track of milk supplied, e.g. source, quantity, and quality. Such records will help breeders in making various decisions related to future improvement of the dairy goats.

The central government

The central government through the Ministry of Livestock and Fisheries (MLF) is also an important partner in this regard such that they have to:

· Formulate good policy for livestock farmers.

· Provide subsidies e.g. buying semen or bucks, livestock inputs e.g. veterinary drugs because most of the farmers in the country are of low economy and practicing low inputs farming systems.

· Capacity building of relevant staff on different livestock technologies e.g. AI.

· Establish small ruminant semen collection center in Tanzania.

· Institute and monitor a working dairy goat extension service in areas where dairy goats are being raised.

Motivation

. Poverty alleviation rural families of Tanzania.

. Information for planning/budgeting.

. Criteria for subsidy to farmers planning.

. A practically working dairy goat breeding in the country

SWOT summary as for 2015 in developing dairy goat breeding program in Tanzania

Main strengths: Farmers are motivated to keep dairy goats and goat milk is becoming popular. There is a good policy for livestock development in the country. A government unit responsible for small ruminants' research in the country is present. Enough land and natural feed resources are available. Academic institutions teaching both agriculture & livestock at Certificate, Diploma, and Degree level are available. The private sector which exists is ready to participate in dairy goat development for the farmers.

Main weaknesses: Insufficient financial and logistical support from the government. Most farmers lack good skills for recording. Lack of an outstanding breeding association that belongs to farmers, lack of feasible dairy goats recording system under small scale farmers' conditions, lack of well-defined breeding goals for dairy goats and other livestock, lack of cooling tanks, milk processing facilities and lack of financial returns for farmers.

Main opportunities: Information about why other countries (Norway, for example) have succeeded in dairy goat breeding program is available (Ådnøy 2014; Dagnachew and Ådnøy 2014; Skeie 2014; Blichfeldt 2013; Meuwissen et al 2013; Paulenz et al 2005; Ådnøy et al 2000). There are high possibilities of starting testing of bucks locally, provided that data for genetic evaluation are available. Tanzania has good international relationship with other countries. Private sector keeping pure dairy goat flocks e.g. the NW-goat breed at Mulbadaw farm LTD in Tanzania exists. The established PPP policy in Tanzania (URT 2009). Progeny tested bucks' semen can be imported to Tanzania as an immediate solution.

Main threats: Challenges related to AI service including expenses, change of policies, and technical knowhow on the Tanzania side. In addition, consumer preference for goat milk, disease outbreak and change of weather. Participating government institutions like TALIRI may not have enough funds to participate sustainably in the proposed program. Threats to diversity need to be noted as one of the possible effect in the long run.

Conclusions

- The potential of dairy goats under small scale farming systems in Tanzania have stimulated both local, regional, and international developmental partners to join force against poverty through dairy goat supply to rural families.
- Farmers and other key beneficiaries along the dairy goats' market chain in Tanzania could benefit more if they collaborate and participate to their best level to work along with the proposed breeding strategy.
- Capacity building of staff from public institutions on small ruminant e.g. for AI technology is highly required.

- Faster genetic progress for dairy goats in Tanzania can be tapped from foreign running breeding program while continuing to develop own capacity to run dairy goat breeding program.

Needful research

Develop possible and reliable recording system under small scale farming settings.

Establish small ruminant semen collection center in Tanzania is also a good proposition.

References

Ådnøy T 2014 The dairy goat industry in Norway: Challenges in a historical perspective. Review. Small Ruminant Research 122: 4–9.

Ådnøy T, Nævdal I and Svendsen M 2000 In: Gruner, L., Chabert, Y. (Eds.). Buck circles for dairy goat breeding in Norway (Circles des books pourl'amélioration génétique des chèvres laitières en Norvège). Institut del'Elevage/INRA, p. 1047.

Amati C and Parkins, J R 2011 Improved goat breeding and mixed crop farming in East Africa: A literature review. Nairobi, Kenya: ILRI. http://hdl.handle.net/10568/27874 . 06.04.2016.

Asheim L J, Nziku Z C, Eik L O, Mwaseba D and Kifaro G C 2015 Climate change adaptation in vulnerable crop and livestock production systems in Mgeta, Tanzania. Sustainable use of grassland resources for forage production, biodiversity and environmental protection. Conference paper: *XXIII International grassland Congress IGC 2015*. 20-24/11/2015. New Delhi India.

Bathgate R, Mace N, Heasman K, Evans G, Maxwell W M and de Graaf S P 2013 Birth of kids after artificial insemination with sex-sorted, frozen-thawed goat spermatozoa. Reproduction in Domestic Animals 48(6):893-8. doi: 10.1111/rda.12182.

Blichfeldt T 2013 Breeding for goats milk quality in Norway. Goat milk quality. Regional IGA Conference 2013 in Tromsø, Norway.

Chenyambuga S W, Jackson M, Ndemanisho E E and Komwihangilo D M 2014 Profitability and contribution of small-scale dairy goat production to income of smallholder farmers in Babati and Kongwa districts, Tanzania. Livestock Research for Rural Development. Volume 26, Article #27. Retrieved March 12, 2016, from http://www.lrrd.org/lrrd26/2/chen26027.html

Eik L O, Kifaro G C, Kiango S M, Nordhagen Ø M, Safari J and Mtenga L A 2008 Productivity of goats and their contribution to household food security in high potential areas of East Africa: A case of Mgeta, Tanzania. *African Journal of Food, Agriculture, Nutrition and Development* 8, 278-290.

Eklundh C 2013 The use of artificial insemination in dairy farms in urban/peri-urban Kampala, Uganda-a study of knowledge, attitude and practices. Degree project, Veterinary Program, Uppsala, Sweden, 2013. http://epsilon.slu.se. ISSN 1652-8697.

El-Kassaby Y A, Cappa E P, Liewlaksaneeyanawin C, Klápště J and Lstibůrek M 2011 Breeding without Breeding: Is a complete pedigree necessary for efficient breeding? PLoS ONE 6(10): e25737. doi:10.1371/journal.pone.0025737.

EPINAV 2011 Enhancing Pro-poor Innovation in Natural Resources and Agricultural Value Chains. EPINAV Tanzania. http://www.suanet.ac.tz/epinav/. . 06.04.2016

Escareño L, Salinas-Gonzalez H, Wurzinger M, Iñiguez L, Sölkner J and Meza-Herrera C 2012 Dairy goat production systems. Status quo, perspectives and challenges. Tropical Animal Health Production. 45:17–34.

FAO 2010 Breeding strategies for sustainable management of animal genetic resources. FAO Animal Production and Health Guidelines. No. 3. Rome, Italy. p 65. FAO (Food and Agriculture Organization) (2007) Private sector development and partnership strategy policy. Enabling the rural poor to overcome poverty. Palombi, Rome (Italy). http://www.ifad.org/pub/policy/private/e.pdf. 10.2.2016.

FAOSTAT 2012 http://faostat.fao.org/site/569/DesktopDefault.aspx ? PageID0569#ancor. Accessed 08/10/2015.

FARM-Africa 2006 Annual Review 2005/2006. FARM-Africa (Food and Agricultural Research Management-Africa), London, UK, 24 pp.

Ferraz J B S, Eler J P and Rezende F M 2012 Impact of using artificial insemination on the multiplication of high genetic merit beef cattle in Brazil. Animal Reproduction 9(3):133-138. http://www.iga-goatworld.com/uploads/6/1/6/2/6162024/gmq-abstracts.pdf.

Gamborg C and Sandøe P 2005 Sustainability in farm animal breeding: A review. Livestock Production Science. 92(3):221-231.

HPI 2006 Heifer International 2006 Project Profiles. Heifer Project International (HPI), Little Rock, USA, 76 pp.

Kifaro G C, Eik L O, Mtenga L A, Mushi D, Safaril E J, Kassuku A A, Kimbiti E N, Maeda- Machang'u A D, Kanuya N L, Muhikambele V R M, Ndemanisho E and Ulvund M J 2007 The Potential use of artificial insemination in sustainable breeding of dairy doats in developing countries: A case study of Norwegian dairy goats' in Tanzania. Tanzania Journal of Agricultural Sciences.8 (1): 19 – 24.

Kifaro G C, Msalya G, Nziku Z C, Ndemanisho E E, Kimbita E N, Mushi D E, Max R A and Mtenga L A 2012 Status of Norwegian dairy goats in two districts of Morogoro region at the start of an up-scaling project. Oral presentation, 1st Annual Conference of the EPINAV Programme, Morogoro, Tanzania, 18 – 19 December 2012.

Meuwissen T, Hayes B, and Goddard M 2013 Accelerating improvement of livestock with genomic selection. Annual Review. Animal Bioscience. (1): 221-237.

MLF (Ministry of Livestock and Fisheries) 2015 Government budget speech 2015/2016. http://www.mifugouvuvi.go.tz/budget-speech-20122013/.

Moser J S, Schroder H S, Heeter C, Moran T P and Lee Y H 2011 Mind your errors: Evidence for a neural mechanism linking growth mindset to adaptive post-error adjustments. Psychological Science, 2011, [Epub ahead of print]. DOI: 10.1002/mnfr.201100262.

Mtenga A L, Muhikambele V R M, Kifaro G C and Ndemanisho E E 2002 Goat production in Tanzania: an overview. Helping smallholder keepers enhance their livelihoods: Improving management of smallholder owned sheep and goats by utilizing local resources. Proceedings of the second DFID livestock production programme link project (R7798) workshop for smallholder keepers. Sokoine University of agriculture (SUA), Morogoro, Tanzania. 8-10 January, 2002. Natural resources international Ltd, Aylesford, kent, Uk. ISBN 09539274-4-x.

Nasar Md A, Rahman A, Bin Abdullah R and Wan Khadijah Wan E 2008 A Review of Reproductive Biotechnologies and Their Application in Goat. Biotechnology, 7: 371-384.

Nkungu D R, Kifaro G C and Mtenga L A 1993 Performance of dairy goats in Mgeta Morogoro, Tanzania. Eds Lebbie S H B. Rey B and Irungu E K. In: Small Ruminant Research and Development in Africa. Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7-11 December 1992. ILCA (International Livestock Centre for Africa)/CTA (Technical Centre for Agricultural and Rural Co-operation). ILCA, Addis Ababa, Ethiopia. 268 pp.

Nziku Z C, Kifaro G C, Eik L O, Steine T and Ådnøy T 2016 Reasons for keeping dairy goats in Tanzania, and possible goals for a sustainable breeding program. *Animal Production Science*. http://dx.doi.org/10.1071/AN15423.

RIPAT (Rural Initiatives for Participatory Agricultural Transformation) 2015 RIPAT Mission. http://www.ripat.org/home/ 06.04.2016.

SSB 2014 Statistics Norway. https://www.ssb.no 16.2.2016.

TALIRO (Tanzania Livestock Research Organization) 1980 Tanzania Livestock Research Act No.2.1980. Government Printers: Dar-es-Salaam, Tanzania.

Tine 2013 Nøkkeltall for Geitkontrollen 2012 https://medlem.tine.no/trm/tp/Artikkelside?key=16399 (12.2.2016).

Umeh G N and Odom C N 2011 Role and Constraints of Youth Associations in Agricultural and Rural Development: Evidence from Aguata L.G.A. of Anambra State, Nigeria. World Journal of Agricultural Sciences 7 (5): 515-519.

URT (United Republic of Tanzania) 2009 National Public Private Partnership (PPP) Policy Dar es Salaam Government printers. . 10 pp.

WB (World Bank) 2011 Tanzania: Poverty, Growth, and Public Transfers Options for a National Productive Safety Net Program. Social Protection Unit, Africa Region, Washington D.C. Report No. 64620-TZ.

Received 27 March 2017; Accepted 3 November 2017; Published 1 December 2017

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