Feature Article

Livestock provide more than food in smallholder production systems of developing countries

Liveness Jessica Banda and Jonathan Tanganyika

Animal Science Department, Bunda College, Lilongwe University of Agriculture and Natural Resources, Lilongwe, Malawi

Implications

- Livestock serve as a form of savings, which can easily be liquidated into cash and provide many other benefits both directly and indirectly.
- Livestock are key to poverty alleviation and are an important development tool where benefits derived vary with the gender of beneficiaries.
- Livestock provide numerous benefits, which are both tangible and intangible, but they are not adequately valued.
- There is a need for more research to quantify and value various aspects through which livestock benefit communities in the developing world for efficient resource allocation.

Key words: assets, food, income, livelihoods, livestock

Introduction

Livestock play multiple and significant roles in the rural livelihoods of most developing countries where they provide both direct and indirect benefits to communities. Herrero et al. (2012) reported that livestock roles in the economies of developing countries are significant to millions of both producers and consumers that are often vulnerable and economically constrained. Livestock serve as a source of food, income, manure, traction, and transport as well as serve as financial aids and enhance social status among others. The various benefits of keeping livestock confirm that livestock form an integral and indispensable part of social life and sustenance of poor communities (Meissner et al., 2013).

According to Bettencourt et al. (2014), livestock uses can be classified as economic (source of cash income, means of saving accumulation and investment, and economic status), household use (feeding, transportation, fertilizer, and animal draught), sociocultural (social status, paying bridewealth, providing animals for communal feasts or sacrifices), and leisure (horse racing, cockfighting, bullfight, and hunting). In their review, Alonso et al. (2019) classified nonfood roles of livestock as economical (access to credit, draft power, transport, asset accumulation, household energy production, nonedible byproducts [hides, horns, fiber, etc.], and construction material); environmental (manure, nutrient recycling, landscape amenity, improving pastureland, and carbon sequestration); and social (psychosocial well-being, traditional foods, cultural events, ritual and religion, exercise, sport, and recreation). Therefore, there is evidence that livestock do not only directly produce food but also provide key nonfood roles to communities. Sometimes, the roles are quite complex and span across value chains, but documentation of such roles is scanty. It is the objective of this manuscript to highlight the key roles of livestock in smallholder production systems in developing countries.

Livestock production systems and productivity

The roles of livestock are directly linked to production systems used and subsequent productivity. Livestock management has been classified into different production systems, which often depend on agroecological zones and production practices. The production systems are generally in two categories—mixed and sole production systems. This is based on whether livestock production is mixed with other enterprises such as crops, or it is the sole activity on the farm. Ruthernberg (1980) defined a farming system as a population of farms with a similar structure and function with a likelihood to have similar production functions. McConnell and Dillon (1997) further defined an agricultural system as "an assemblage of components which are united by some form of interaction and interdependence and which operate within a prescribed boundary to achieve a specified agricultural objective on behalf of the beneficiaries of the system." The interactions and interdependence are evident in various production systems that have been classified. Farms that fall within the same production system tend to have broadly similar resources, pattern of productions, livelihood strategies, and challenges, and, therefore, similar development strategies and interventions apply to the farms. There are different livestock production systems that have been described

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and various names and classification criteria have been used. Some of the criteria used to classify the production systems are intensity of production, extent of integration of farm enterprises, animal–land relationship, and agroecological zones (Seré and Steinfield, 1996; Damron, 2009; McDermott et al., 2010). Production systems that prevail in most developing countries are those falling into mixed production systems. Mixed systems have varying levels of integration of livestock and crop farming with varying degrees of nutrient recycling between systems. Sole livestock systems in developing countries are generally associated with nomadism, which has gradually declined over the years likely due to urbanization, land availability, human population increase, and climate change challenges.

The productivity of livestock will depend on the production system involved. Although the systems prevailing in rural communities of most developing countries are distinct, they generally tend to be low input–low output systems. As such, benefits derived from these animals are largely based on the population sizes of the livestock than individual animal productivity. The communities do not necessarily focus primarily on the quantity of products such as milk, meat, and eggs produced but other benefits as perceived by communities. Hence, the systems tend to be less efficient and are associated with high mortality and low productivity. However, the breeds that thrive in these production systems have adapted to the systems and tend to be more disease tolerant or resistant. The animals are generally adapted to low feed and water availability as well as harsh environmental conditions.

The various roles and benefits of livestock discussed below vary depending on the production system in association with specific species and prevailing environmental factors. The actual value of livestock varies from community to community depending on cultural practices. For instance, on the one hand, large stock such as cattle, donkeys, mules, and camels are important for draft power in addition to being a source of income, meat, milk, and other byproducts. They are also a form of savings and provide prestige and other social values. On the other hand, small stocks such as poultry, goats, and sheep may easily be slaughtered for consumption besides other roles they play. There are also other species that may not be consumed or are valued differently by some societies because of religious beliefs and such species include pigs and sheep. Hence, their utilization and benefits also vary based on their religious value.

Gender roles in livestock production systems

There also tend to be variations in terms of benefits linked with gender depending on cultural norms regarding ownership and management responsibilities. Kristjanson et al. (2014) reported differences in how women benefit from livestock depending on gender roles. Njuki et al. (2011) reported that women are likely to be engaged in commodities that generate lower revenues sold in informal markets than men. Men on the other hand have a high likelihood to control high revenue-generating commodities that are generally sold in formal markets. This is further evidenced by Yisehak (2008) who reported that in smallholder systems of Ethiopia, men owned most of the livestock species and were responsible for sales of live animals and meat, whereas women owned chickens, and, if involved with large stocks, they were primarily involved with milk management (Figure 1).

Livestock in development programs

Livestock in rural communities are mainly kept under low input and low output production systems, where feeding, housing, health, and breeding management is minimal. As such, their productivity tends to be low. Furthermore, the breeds kept are those that are adapted to the often, harsh tropical environments that characterize most developing countries. This presents an unexploited potential in these animals, and many government and nongovernmental organizations recognize this potential and tend to include livestock in rural development programs. Livestock have also been described as having distinct pathways that could facilitate poverty reduction. Many NGOs use livestock as a development tool and attempt to do this along with the promotion of appropriate livestock management practices. Such interventions have contributed to the increase of populations of livestock over time in different regions (Figure 2). Figure 2 shows that the population trends of major livestock species where the distribution of the populations and their changes between 2013 and 2018 vary with region. Some regions have some species dominating, which could be related sociocultural practices and/or adaptation of the animals to the production environment. However, trends show that some species are increasing, whereas others are inconsistent except in Africa where several species have an average increase rate of about 2%. More species seem to thrive in Africa and South Asia compared with other regions.

Figure 1. Women involved in management of small stock (from left to right: restraining a goat and feeding poultry with one dairy cow in the background).

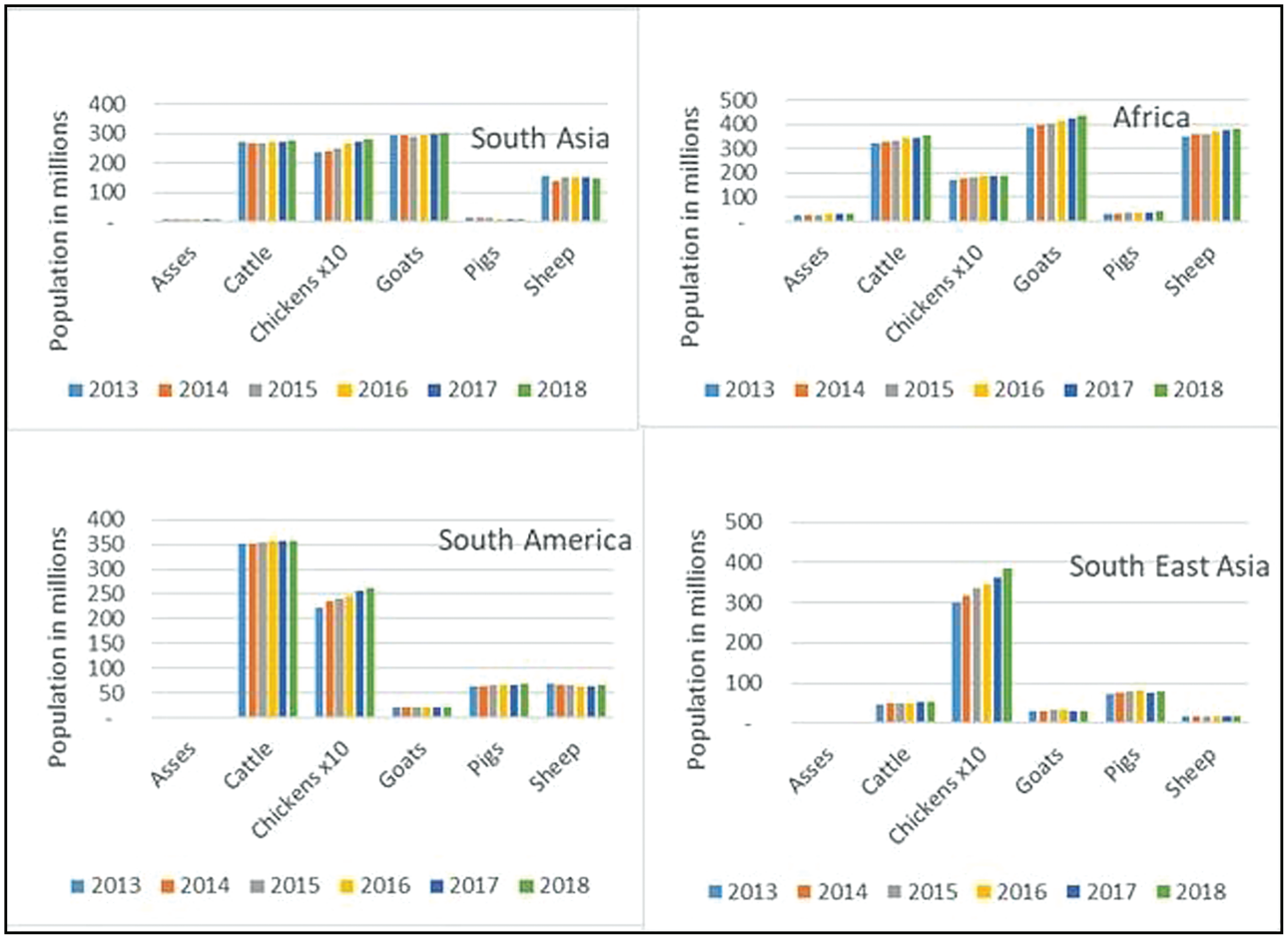

Figure 2. Populations of different livestock species in different regions with developing countries. Data source: FAOSTAT (2020).

In South America, the major species dominating seem to be cattle and chickens, whereas, in South East Asia, it is chickens.

Food Roles of Livestock

Animal protein is a high-quality, easily digested protein that possesses a high biological value (Alonso et al., 2019). According to Dror and Allen (2011), livestock-derived foods have a specific nutrient composition that satisfies well the needs of the human body and reduces stunting and some key micronutrient deficiencies in humans (Alonso et al., 2019). Compared with plants and their derived products, meat and meat products provide essential nutrients that are important to the human diet (Byers et al., 2002). It is well established that meat is an integral part of a balanced diet that contributes valuable nutrients that are beneficial to the human health. Milk and milk products are useful foods throughout all human life periods because they adequately supply nutrients for the promotion of skeletal, muscular, and neurologic development. Poultry provides meat, eggs, and other products. For instance, chickens provide a cheap source of animal protein and readily available meat (Yared et al., 2019) that contains essential amino acids required for human beings, and eggs are richly endowed with nutrients (Lahkotia, 2002). Observations show that there tend to be more edible animal parts in developing countries than in developed countries. Parts such as chicken heads, intestines, and legs, which are often dressed off in developed countries, are readily consumed and considered delicacies in developing countries. Various animal products and how they are processed in Africa have been described by Mattiello et al. (2018).

After an animal is slaughtered, it provides a wide range of byproducts that can further be processed and used in other industries (Alao et al., 2017). These byproducts can further be utilized by humans as food or reprocessed as secondary byproducts for both agricultural and industrial uses (Liu, 2002). The nonedible animal byproducts are the ones that provide some of the nonfood roles directly, and these include products used as a raw material in the fabric, cosmetic, pharmaceutical, and animal feed industry. On the other hand, the condemned parts (gastrointestinal tract contents, trimmings, and fetus) may be used in biogas and fertilizer production industries (Figure 3).

Nonfood Roles of Livestock

Apart from food, livestock provide byproducts and nonfood roles that are often ignored, difficult to quantify, and are easily left out in evaluating the importance of livestock (Figure 2).

Animal byproducts

Apart from meat, pigs provide byproducts (water filters, rubber, antifreeze, certain plastics, floor waxes, crayons, chalk, adhesives, etc.). Cattle and other bovine animals provide tallow (fat), which is used in wax paper, crayons, margarines, paints, rubber, lubricants, candles, soaps, lipsticks, shaving creams, and other cosmetics. Poultry provide feathers that can be used as stuffing (down) in jackets and pillows. Furthermore, bees provide honey and wax that are used to make candles, lipstick, lotions, shoe polish, crayons, chewing gum, and floor polish.

Role of livestock in household income

Livestock play multiple roles in supporting household income (Herrero et al., 2012). Research has shown that 68% of households across the developing world earn income from livestock (Davis et al., 2007). For instance, the poultry industry contributes significantly in providing employment and supplementary income to the people and is an important instrument for socioeconomic improvement among the rural farmers. Mutami (2015) reported that, in Zimbabwe, backyard poultry production stimulates local economic development of urban centers and villages through the development of related micro-enterprises wholly or partly (Figure 4). Dairy production is another source of income in many developing countries. It is one of the enterprises that ensures a steady flow of income once animals start calving. The income is directly from product sales (milk, manure, and meat [after culling]) or indirectly as a source of employment for herdsmen or fodder suppliers. Other sources of income include hiring out animals for draft power and breeding services.

Sociocultural importance of livestock

Various livestock species play important sociocultural functions for rural households in developing countries (Bettencourt et al., 2014). The social roles of livestock include a set of rituals and social obligations, such as funerals, ritual slaughter, and bridewealth, which are provided formally or informally (Bettencourt et al., 2015). However, the sociocultural functions of livestock are underestimated in most of the communities. Poultry, compared with other livestock species, are socioculturally important with few religious taboos attached (Upton, 2004). For instance, some phenotypes of indigenous chickens (such as frizzled, black, or white plumage) in African countries are associated with customs such as being demanded to be used as fines or ritual slaughters. Similar beliefs extend to species such as goats and sheep in some cultures.

Importance of livestock in emergencies and disasters

Livestock are used as coping strategies to shocks in food security and emergency response, such as worsening economic conditions,

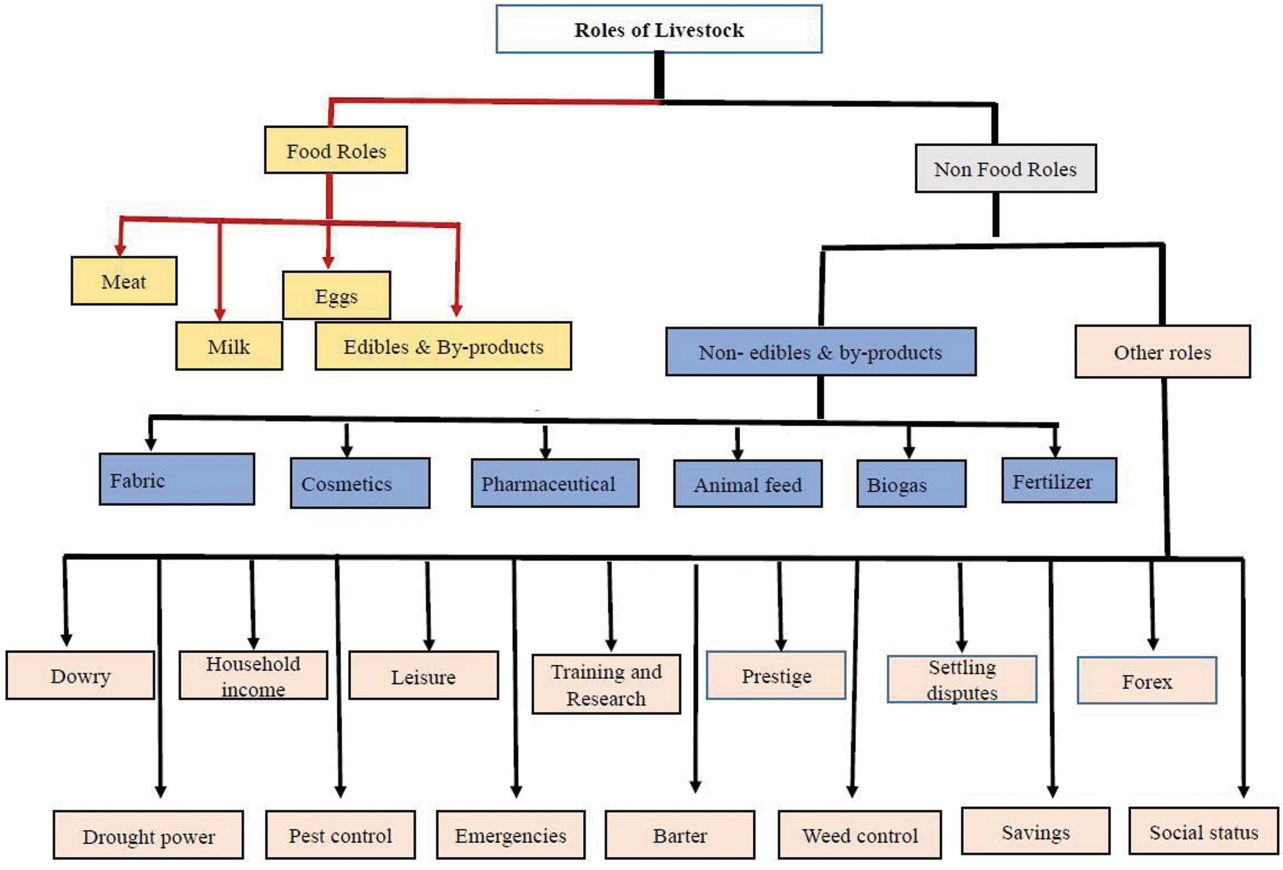

Figure 3. Classification of food and nonfood roles of livestock. Source: Adapted from Alao et al. (2017).

Figure 4. Farmers generate income from livestock sales in various forms (from left to right: live chickens, live goats, and fried goat meat and tripe).

droughts, floods, and crop or livestock disease epidemics. These disasters affect rural livelihoods through loss of assets including livestock. Comparatively, complete loss of livestock as assets generally is not as acute as that of crops. Livestock tend to be more resilient than crops when disasters such as drought and floods strike. In Malawi, there is evidence that farmers owning animals such as goats are better able to cope with drought than those that rely on producing crops only as they can sell goats and buy food long after crops have wilted. However, most of the relief services do not consider livestock replacement in recovery programs as it is generally expensive. Relief items are usually in the form of processed food items or easy to grow food crops, thereby not replenishing livestock populations in communities affected by the disaster such as floods and droughts.

Importance of livestock dung as mosquito repellant

Studies have shown that animal dung can be used as an insect repellant (Mandavgane et al., 2005). In the ancient world, people used to burn animal dung as an insect repellant and even mixed with mud when building mud houses to control insects. But the modern world has ignored this indigenous knowledge and uses modern insect repellants, some of which are harmful to the environment as well as to human health. Researchers proved that pyrethroids used in repellents lead to hyperexcitation of the nervous system and prolong uses result in corneal damage, liver damage, and asthma. About 12% of users are seriously affected by the use of repellents (Mandavgane et al., 2005). In another study, the use of elephant dung as one of the main ingredients in the production of mosquito repellant proved to be eco-friendly organic herbal repellent with long-lasting protection and safe for human life, animal skin, and humans with no side effect and could be an alternative to commercially available synthetic chemical repellents (Ramya et al., 2019).

Importance of livestock in weed control

Weed control is another nonfood role of livestock, which remains untapped. It is established that livestock can be used in weed control such that the cost of weeding using human labor or herbicides is offset. They may be used to directly graze weeds or consume weeds that have been cut. Goats being browsers are useful in controlling shrubs and thistles. Sheep are considered as best for weed control as they graze close to the ground and easily control leafy plants, which in turn are nutritious to the animals. Sheep and geese are known to control grassy weeds in fields for legumes and other crops. There are recommended stocking densities of animals such as pigs, cattle, sheep, and goats in controlling perennial weeds between cropping seasons. Livestock can also be used in early grazing to prevent weed growth. They can also be used in clearing crop residues after harvest. In large plantations of trees such as rubber, livestock are used to control the overgrowth of cover crops. When they graze on mature weeds, they help destroy many weed seeds although not completely all. Ducks have also been used in integrated farming systems whereby their role is to control weeds and pests while supplying manure in the form of droppings (Figure 5). However, in many communities, grazing animals are used primarily for food or fiber, and their use for weed control is of secondary concern. Apparently, Integrated Weed Management has not been adopted as widely or as readily as Integrated Pest Management.

Use of livestock manure in mixed farming systems

Livestock play a vital role in nutrient recycling in the soil through the provision of manure. In most developing countries whose economies are agro-based, poverty has often been associated with poor soil fertility (Sanchez, 2002), and sensible use of organic resources (Chivenge et al., 2011) can improve the situation since few smallholders can afford enough mineral fertilizers for crop production. In this regard, livestock play a major role in land use system and facilitate soil fertility management and reduce costs associated with inorganic fertilizers. For instance, in Malawi, the use of manure from cattle feedlots have been attributed to increased sugarcane yield in sugar plantations while largely offsetting the use of inorganic fertilizers. Non-livestock owners are known to purchase manure to apply in their gardens. Manure has recently become an additional source of income to many livestock farmers, while, in the past, it used to be given out for free or sold at greatly reduced prices. Some farmers in Malawi further incorporate manure with inorganic fertilizers creating a mixture capable of achieving similar maize yields to fields with only inorganic fertilizer applied.

Role of livestock in draught power

Livestock provide nonhuman energy (animal power) to poor farmers for ploughing, drawing water, and transporting sick people and goods. Draught animal power provides an intermediate level of mechanization between human power and engine power (Figure 6). As such, it is attractive to smallholder farmers, who wish to improve their productivity within the availability of their limited livelihood assets, particularly in sub-Saharan Africa. Draught power is also used as a service in the community or hired out as an additional source of income. The species that are key in draught power are cattle, donkeys, mules, camels, and buffaloes.

Use of livestock in biomedical research

Biomedical research is another nonfood role of livestock. Often, when there are new techniques, products, or drugs to

Figure 5. Role of livestock in weed control: ducks integrated with rice production.

Figure 6. Livestock are used in various ways for animal traction (from left to right: ploughing, transporting goods, and transportation of water).

be developed for humans, researchers use animals including livestock to test for safety and efficacy prior to making them available to human subjects (Beena, 2019). Though laboratory rodents have been used extensively, they have limitations in organ size, life span, breeding, physiology, metabolic, and behavior patterns (Polejaeva et al., 2016); hence, using livestock (cattle, sheep, goat, and pig) is better since they have common anatomy and physiology with humans. For instance, cattle are the best model for studies on reproductive immunology and placental biology since their reproductive cycles are similar to humans (Beena, 2019), whereas goats and sheep are the best models for studying cardiac and respiratory systems, respectively (Dosdall et al., 2013). Goats have also been developed as a model in orthopedic studies because their anatomy is similar to humans (Pearce et al., 2007). Using farm animals has advantages over smaller animals because livestock are larger in size, thereby easing the collection of larger volumes and more frequent samples for research (Hamernik, 2019).

Use of livestock in leisure

Many animals are bred and bought because people like to spend part of their free time with them (companion animals). Bettencourt et al. (2015) reported that animals play an important role in leisure, and, in some cultures, they are used for betting, racing, fighting, and hunting. For instance, in Timor-Leste, cockfighting is one of the older leisure activities preferred by many people whereby men take cocks as their precious animals ready for fighting. However, there might be concerns with animal welfare with such sport. Other sporting activities such as horse racing are important among the affluent in developing countries.

Challenges and opportunities

Despite the so many food and nonfood roles of livestock to humans, the sector is faced with several challenges, among which is the lack of data on nonfood roles of livestock. Where livestock are kept largely for social status, it becomes a challenge to justify the slaughter for home consumption, and, as a result, family members are denied access to the much-needed animal protein. However, literature shows that livestock play a significant role in rural livelihoods and the economies of developing countries. They are providers of complex functions including food and nonfood functions. Their relevance increases as human populations, disposable incomes, and urbanization rates increase as well as a change in eating habits. Therefore, there is a need for specific research aimed at a better understanding of the role of livestock, especially nonfood roles, which are mostly ignored, in the livelihoods of rural communities in the developing world.

About the authors

Liveness Jessica Banda is an associate professor in Animal Physiology at Lilongwe University of Agriculture and Natural Resources (LUANAR) where she has been working since 2002. She has a PhD in Animal Disease Resistance and Genomics obtained from University of Edinburgh, United Kingdom, in 2014; she also obtained MSc in Animal Science and BSc in Agriculture from University of Malawi in 1997 and 2001, respectively. She is involved in teaching, research, outreach, and consultancy in animal science and related rural development programs. Her research interests are in livestock reproduction, production, and farming systems for sustainable production systems and socioeconomic development. **Corresponding author:** lbanda@luanar.ac.mw

Jonathan Tanganyika is an upcoming scientist and researcher, who is currently a Lecturer in Meat Science since 2015 at Bunda Campus of the Lilongwe University of Agriculture and Natural Resources (LUANAR), Malawi. He holds a Master of Science in Animal Science and currently pursuing a PhD at the University of Pretoria. He has a Veterinary Science background and worked as a field Assistant Veterinary Officer (AVO) for 4 years before joining Bunda. He has collaborated and conducted research at both local and international levels. His research interest areas are meat hygiene, animal behavior, and welfare.

Conclusions

This article has highlighted the diversity of livestock contributions to smallholder farmer livelihoods in developing countries. The value of livestock as a food source, through milk, meat, and eggs, is well established. Further research and documentation of the nonfood contributions of livestock are critical to better quantify and evaluate the true value livestock contribute in these sectors. There is a need for more in-depth research on the nonfood roles of livestock in different communities in developing countries. This is necessary for a more accurate determination of how livestock contribute to the overall economic development, stability, and status in various contexts.

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