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# IMPROVING GLOBAL FOODS SYSTEM, HUMAN HEALTH, AND ALLEVIATING POVERTY THROUGH SMALL RUMINANT PRODUCTION: THE NIGERIAN GAINS

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## ABSTRACT

Small ruminant has great potential in enhancing the global food system, improving human health, and alleviating poverty. Nevertheless, on average, small ruminant production has not been able to keep pace with the overall food demand globally. Meaning that without drastic action, the world food crisis will continue to persist and many people around the world will continue to live in abject poverty. To avert this ongoing phenomenon, this paper examines how the global food system and human health can be improved and poverty alleviated through small ruminant production; and how Nigeria will benefit from it. To properly articulate the theme of this paper, the discussion will focus on what small ruminant animals are; their benefits and constrain; the global food system, small ruminant production and its relation to human health and poverty eradication, efforts at improving small ruminant production and how this will have an impact on the Nigerian economy. Furthermore, the paper provides recommendations for the improvement of small ruminant production in Nigeria

**KEYWORDS:** Global food system, World food crisis, Small ruminant animals, Small ruminant production, Human health, Poverty alleviation, Nigeria.

## INTRODUCTION

The global food system is already living beyond its means, consuming resources faster than they can be replenished. The world is currently faced with two main food-related challenges: widespread hunger and malnutrition, and the mismanagement of natural resources. The failure of a large share of the world population to meet food needs is a reflection of widespread poverty. An instance of this is reflected in a report which states 'of the 1.2 billion people (about 20 percent of the world population) who earn less than a dollar a day, 800 million are food insecure, that is, they do not know where they will find their next meal. About 165 million pre-school children (one-third of all pre-school children in developing countries) are malnourished and they do not grow to their full potential. Five to ten million of them die every year from nutrition-related illnesses (British Government Report, BGR, 2011). Similarly, it can be rightly said that the existing food system is failing half of the people on earth, with 1 billion going hungry, and 1 billion lacking crucial vitamins and minerals from their diet. The global food system is spectacularly bad at tackling hunger or at holding itself to account. Haddad (2008) stated that expanding world population combined with the need to stop over-exploiting natural resources such as soil and water means there is a compelling case for urgent action.

It is assumed that small ruminant animal production can eradicate the problem of the global food system, improve human health, and alleviate poverty. However; slower increases were achieved with small ruminant species (like goats and sheep) which do not compete directly with a human for food. Nevertheless, there is a lot of places and ground to increase ruminant animal production based on forages and non-human edible feedstuffs, which would contribute to the world food system in three ways: more ruminant animal, high-quality foods for humans, more grain, and other edible agriculture food for human beings and a better environment (Sal. 2009).

Small ruminant animals are one of man's most valuable and renewable resources. As protein is one of the most limiting in human alimentation, the ruminants are indispensable in utilizing marginal lands, crop residues, and products inedible by humans (Sal, 2009). It is stated that the greater the effort to increase small ruminant animal products, the more food for people and the better for the planet. The prospect of using small ruminants as food has not been fully exploited. Small ruminants produce food and fibre for a man at a relatively low cost as they graze on pasture and feed on-farm by-products (Anaeto*et al*., 2010).

Poverty levels in the world are now highest among many households, particularly in developing countries. Small ruminants are the major livestock species reared by

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poor families in most of these countries and this could be a means of alleviating poverty especially among vulnerable groups. Based on all the above, it is clear that small ruminant production is playing an important role in the improvement of the incomes for poor families in the rural areas and is contributing to poverty and hunger alleviation. To support this**,** research has documented the potential of small ruminants for poverty alleviation (Saadullah*et al*., 1997; Kristjanson*et al.,* 2004; Peacok, 2005; Doss*aet al*, 2008).

There are documentation on the benefits that can be derived from small ruminant products regardless, of the breed or region. Small ruminant meat is a source of high-quality protein and low saturated fats which is good for human health. The use of small ruminant meat and milk as therapeutic aids in heart-related diseases and other ailments is unknown to many. Besides, Sargison (2016) stated that efficient production from the small ruminants industry is essential to meet the needs of the world's growing human population which currently exceeds 7 billion. Different breeds and types of small ruminants have been adapted and selected to suit specific climates and environmental resources and their potential as a means of alleviating poverty in diverse, often seasonally resource-poor, environments are well recognised (Pollott and Wilson, 2009). Small ruminants are therefore adaptable to meet global needs for food security and have potentially important roles in improving the health and well-being of the rural poor in their marginal environments. Small ruminants are further suited to enhancing the livelihoods of the poor, due to their manageable size, relatively low maintenance requirements, low capital investment cost, short generation interval, and ease of marketing of animals and products, hence suitability as short-term economic reserves. Small ruminant farming is widely considered to be a solution to the challenge of achieving socioeconomically and environmentally sustainable global food security in the face of the effects of population growth, urbanisation and affluence, vulnerability to climate change, and the hitherto irresponsible agricultural use of drugs and chemicals (McNeilly 2017). Yekola (2015) Small ruminants, such as sheep and goats, represent a significant part of the global livestock industry, particularly in developing countries. They contribute to food security and nutrition, livelihoods, national economic development, and the overall well-being of people. Women, particularly from poor farming communities, are dependent on small ruminant production, making it an important resource for them to invest in improved nutrition and their children's education. Goat meat, mutton, and small ruminant milk are nutritious foods, which directly contribute to household food intake. Small ruminants are a readably available source of cash to meet social and financial obligations and deal with emergencies.

At this juncture, it is essential to emphasise that the global food system can be improved significantly through small ruminant production. This means that the production of a small ruminant has great potential in improving the global food system, and human health and alleviating poverty. Nevertheless, on average, small ruminant production has not been able to keep pace with the overall food demand globally. Meaning that, without drastic action, the world food crisis will continue to persist and many people around the world will continue to live in abject poverty. To avert this ongoing phenomenon, this paper examines how the global food system and human health can be improved and poverty alleviated through small ruminant production; and how Nigeria will benefit from it

**Small Ruminant Animals**

Small ruminant animals – sheep and goats - are an important source of income. This is mainly because they require low initial capital and maintenance costs and use marginal lands and crop residues - otherwise of little or no value – to produce milk and meat. Nevertheless, despite their importance, small ruminants usually receive relatively little attention from research workers. Only recently, more attention has been paid to small ruminants because of their ability to produce meat and milk even in hostile environments, their resistance to harsh conditions and disease, and their capacity to generate additional income in poor rural areas are increasingly appreciated.

Small ruminants are indigenous, unselected breeds that are highly variable, both in size and productivity (Sabrani*et al*., 1982; Mack *et al*., 1985). Ownership is widespread and the average flock size is small. Small ruminant production is a subsidiary or minor enterprise; it is not specialized livestock production and it provides a comparatively small proportion of total farm income, although the proportion increases for smaller farmers. In West Africa, contrary to many other farm· resources, small ruminants are frequently owned by individuals for whom they might represent a major income source. They are also a convenient source of bulk income.

Lagemann (1974) associates the increasing importance of livestock income relative to total farm income, in southeast Nigeria with off-farm employment. This is considered part of the advantages of ruminant animal production.

**Advantages and disadvantages of small ruminant production**

Binh and Lin (2009) identified the advantages and disadvantages of small ruminant production as The rapid expansion of small ruminant production is meeting the policies of many governments by creating employment and improving the well-being of poor farmers. The production of small ruminants results in low investment in breeds sheds and feeds resulting in high returns to capital invested through short generation cycles and high production rates and efficient use of available pastures in the hilly and mountainous areas. Simple feeds for small ruminants from agricultural by-products are efficiently converted into animal products. It should also be noted that the efficiency of converting feed into small ruminant meat and milk is higher than that found for larger ruminants such as beef and dairy cattle. Lamb meat, goat meat, and milk are highly appreciated and more expensive than other products, which in turn, can provide higher incomes for producers and better nutrition for humans, particularly malnourished children (comprising 30% of children) and the elderly.

Aside from producing meat, milk, fibre and skins, small ruminants utilise non-marketable crop residues and available grazing to generate value-added products such as meat, milk, fibre, and skins. Their dung and urine promote soil fertility, especially in the semi-arid

and arid areas, and promote effective use of unpaid family labour, with concurrent low labour requirements. They provide ready means to consume meat and milk, without the need for storage. Their skins are a growing source of value-added income and their production systems provide considerable opportunities to accelerate research and development efforts (Davendra, 2008).

In terms of adaptation to the environment, a small ruminant usually adapts generally to most environments. They are suitable for small farm systems and are usually less affected by drought, with no after-effects on reproduction. They browse and feed more effectively and use marginal land effectively. They are well suited for integration into perennial tree crop systems. They serve as a major source of survival and assets for the landless and very poor, food and nutritional security, and promote social values (village cohesiveness and recreation); and they areTrypanotolerance and helminth disease resistance.

Contrarily, Binh and Lin (2009) proceed further to identify the major constraints of small ruminant production systems. These authors argued that while some appropriate technologies for improving small ruminants' production have been developed in the last few years, these technologies are region-specific and need to be modified and expanded to meet the needs of all regions.

Traditional small ruminant production systems are still very poor. The incidence of undernutrition, inbreeding, and poor hygiene is still widespread in these village systems, as is infection with internal parasites. Therefore, small ruminants in these systems have low production, low reproductive and growth rates, and high mortality. Lack of experience and knowledge, availability of credit, technical information, and lack of productive breeds severely affect the rate and extent to which small ruminant productivity can be improved, especially in hilly and mountainous areas of the world.

Small ruminants can cause damage to the environment: damage to the environment is inevitable so long as there is no control over numbers and also grazing, especially in situations where feeds are very scarce. In these circumstances, goats and sheep have to search for feeds over long distances in very extensive systems. In most situations, available feeds, feed production, and use are not identified with goat numbers, with resultant environmental damage, and also to forests. Another noticeable disadvantage of small ruminants is the fact that their breeding programmes are difficult to control in an extensive system and they are susceptible to disease, with poor access to services and poor overall resource allocation for research and development.

**Global Food System**

A "global food system" is defined here as a system that links national and local food systems from around the world in a clearly defined manner, for example, through trade, information sharing, technology, or some other observable way (Anderson, 2002). It has been observed that the global food system is already living beyond its means, consuming resources faster than they can be replenished. According to a report, billion people are going hungry with another billion people suffering from 'hidden hunger, whilst a billion people are over-consuming (Down.COM, 2011)." The report stated that new technologies such as genetic modification, cloned livestock, and nanotechnology "should not be excluded on ethical or moral grounds" and have the potential to be "very valuable for the poorest people in low-income countries". The world needs fundamental changes to the global food system to feed the expanding population, according to a (British Government Report, BGR, 2011) on how to feed the planet until 2050, it was stated that the global food system is already living beyond its means, consuming resources faster than they can be replenished. The question now is how does this relate to or link up with small ruminants' production?

In terms of percentage contribution to global food, available data indicated that small ruminants represent about 6.5 percent of the sector's global emissions, emissions from small ruminants amount to 475 million tonnes CO2-eq of which 299 million tones are allocated to meat production, 130 million tones to milk production and 46 million tones CO2-eq to other goods and services.

**Table 1:** Global production of milk and meat from different small ruminants\

| GLOBAL REGION (MEAT PRODUCTION ) | GOATS | SHEEP |
|---|---|---|
| AFRICA | 1,301,339.13 | 1,687,934.45 |
| ASIA | 3,805,642.70 | 4,254,075.25 |
| CENTRAL AMERICA | 40,540.20 | 61,120.50 |
| EUROPE | 112,260.40 | 1,130,147.60 |
| NORTH AMERICAL | 1.88 | 90,280.00 |
| OCEANIA | 27,329.18 | 1,110,589.00 |
| SOUTH AMERICA | 73,491.48 | 242,076.34 |
| GLOBAL REGION (MILK PRODUCTION ) | GOATS | SHEEP |
| AFRICA | 4,184,887.00 | 2,250,650.00 |
| ASIA | 10,653,508.50 | 4,823,340.00 |
| CENTRAL AMERICA | 155,354.00 | -- |
| EUROPE | 2,526,426.00 | 3,021,664.00 |
| NORTH AMERICAL | -- | -- |
| OCEANIA | 50.00 | -- |
| SOUTH AMERICA | 220,162.00 | 42,095.00 |

Source:

FAOSTAT (2013) Food and Agriculture Organization of the United Nations -Statistics Division.Livest Prim Prod Commodity.
deTarso SGS, Oliveira D, Afonso JAB (2016)

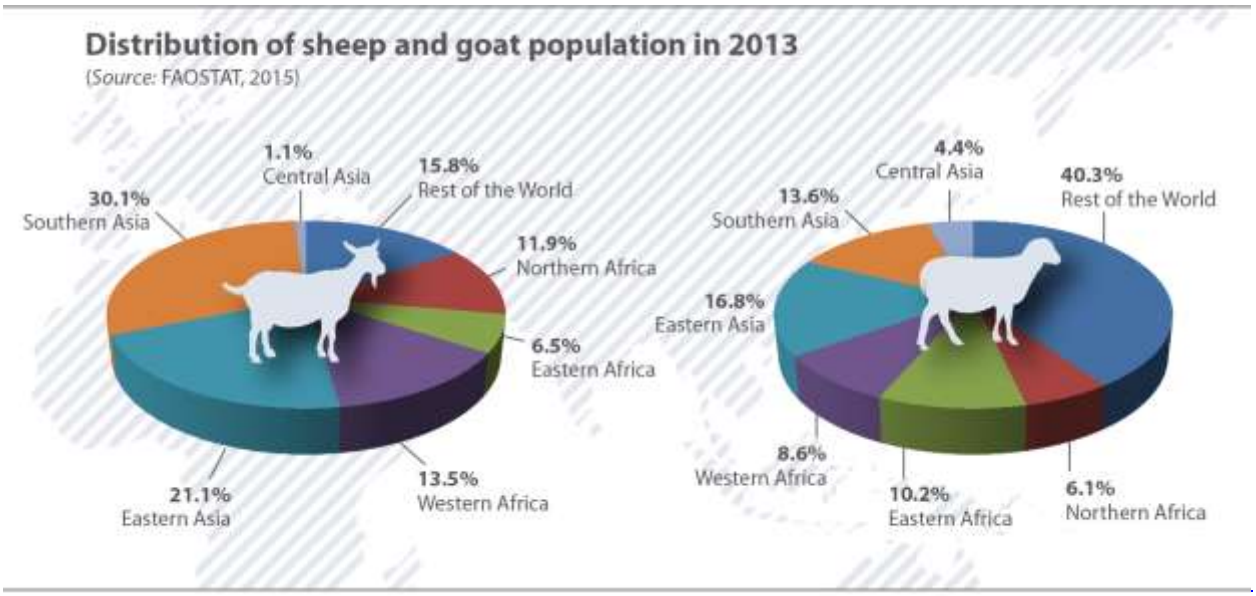


**Figure 2: Source: Tekola (2017).**

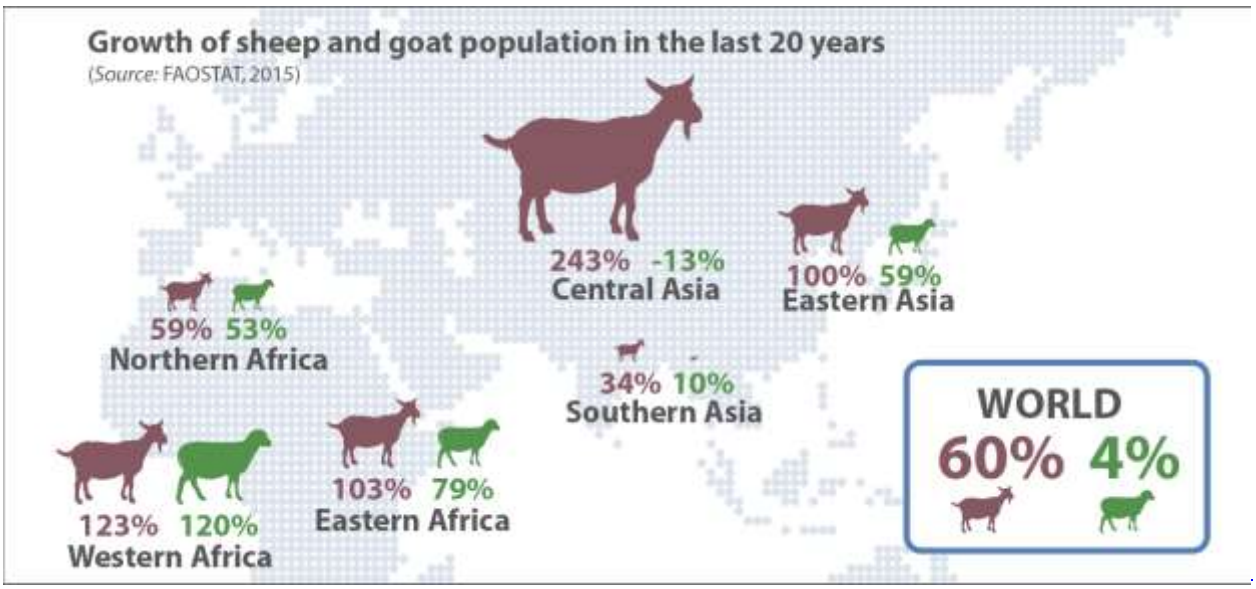


**Figure 2:**

**Source: Tekola (2017).**

From the table, goats continue to play a significant role in human nutrition. Their number is increasing more rapidly in comparison with the sheep, especially in the less developed parts of the world, indicating an increased role of this livestock in global food production. In developing countries of the world, goat milk production has increased significantly. On a global basis meat, milk, eggs, and fibre together contribute about 40 percent of the total value of crop (excluding trees) and livestock (excluding fish) production (Gerber et al. 2013; FAOSTAT, 2013; de Tarso et al., 2016). No doubt, the small ruminant production is growing globally and this assists in combating hunger worldwide (see figs 1 and 2).

**Small Ruminants Production and Global Food**

Ruminant animals in developing countries far outnumber all other domestic animals not only as a source of the high-quality human world food system but also regarding other issues like being a source of fibre, energy power, employment, capital accumulation, export earnings for the countries, by-products and their use as manure and energy; as well as social and cultural significance. The global importance of livestock and its products is increasing as consumer demand in developing countries expands with population growth and rising incomes. The trends in livestock production in developing countries as well as in the world show more rapid growth in the production of pig and poultry meat in comparison with that of ruminant, bovine, goat and sheep meat.

Over the last two decades, ruminant production increased by about 40%, meanwhile, monogastric meat production more than doubled (Upton, 2004). The numbers show two developing countries with a dominant role in increasing livestock production: China for non-ruminant (mainly poultry and swine) livestock and Brazil for ruminant, especially beef meat production. Brazil became the first beef exporter in the world in 2004 and it made it based on a great increase in permanent pasture area (see Table 2.1 and 2.2).

**Table 1:World agricultural population, percentage of poor within livestock production systems, land use per head, and permanent pasture per head**

| Country Grouping Item | Developed Countries | Developing Countries | Latin America & the Caribbean including Brazil | Sub-Saharan Africa | North Africa & Near East | South Asia including China | East & South East Asia |
|---|---|---|---|---|---|---|---|
| % Agriculture Population (of Total Population 2001) | 7.3 | 51.5 | 20.4 | 63.5 | 32.1 | 53.7 | 59.8 |
| Annual Growth Rate (%) of Agric. Population (2001 | -2.9 | 0.6 | -0.8 | 1.8 | 0.5 | 1.0 | ,02 |
| Estimated % Agriculture Population in 2010 | 5.5 | 46.5 | 16.3 | 58.3 | 2.73 | 49.0 | 53.9 |
| % Poor Within Livestock Product. Systems (2001) | ND | 86 | 70 | 81 | 79 | 69 | 65 |
| Land Area in Hectare / Head (Cow Equivalent) | 56.48 | 3.16 | 19.02 | 6.69 | 10.31 | 0.62 | 1.41 |
| Permanent Pastures Has / Head (Cow Equivalent) | 12.47 | 0.92 | 5.56 | 1.87 | 3.54 | 0.03 | 0.49 |

Source: Upton 2004

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**Table 2: Net Trade-in Livestock Products by Continent**

| Net Trade-in LLPs Overall | Sub-Saharan Africa | Near East and North Africa | South Africa Net Exporter | East and South Asia including China | Latin America |
|---|---|---|---|---|---|
| | Net Importer | Net Importer | | Net Importer | Net Importer |
| Main Net Import by Value | Cattle Beef Poultry-Meat, Milk Egg | Cattle Sheep Sheep and Goats, Poultry-meat, Hides, and Skin | Wool | Cattle, Beef, Lamb, Wool, Hides, and Skin | Pig Meat, Beef |
| Main Net Import by Value Meat | Sheep and Goats (Sudan) | None | Buffaloes | Pig (China) Poultry-meat (Thailand) | Cattle (Mexico) Poultry (Brazil) |
| Principal Source Country in Parenthesis | Camel Somalia | | | Buffalo Meat (India), Rabbit meat (China), Hone (Vietnam) Egg (Malaysia) | Honey (Brazil) |

Source: FAOSTAT 2003

Nevertheless, on average, livestock production has not been able to keep pace with the overall meat/milk demand in developing countries (Pica-Ciamarra, 2005). According to FAO/IAEA (2003) food balance sheets, in the developing world between 1982 and 2002 per-capita meat consumption increased from 14.9 to 28.5 kg/year and milk consumption from 24.8 to 45.6 kg/year. It is also predicted that aggregate meat demand will grow from 209 million tonnes in 1997 to 327 million tonnes by 2020 and milk consumption from 422 to 648 million tons (FAO/IAEA, 2003). Delgado *et al*. (1999) labelled this trend 'the livestock revolution. The market value of that increase in consumption totalled approximately $155 billion, more than twice the market value of increased cereals consumption under the better known 'green revolution in wheat, rice, and maize. (Delgado *et al*. 2001).

The livestock revolution is propelled by demand. However, despite the livestock revolution, in developing countries, people consumed one-third of the meat and one-fifth of the milk consumed by people in developed countries. Poultry consumption in developing countries is projected to grow at 3.7% per annum through 2020, followed by beef at 2.9% and pork at 2.4%. The poor could gain from the livestock revolution. Preliminary estimates indicate that of the 1.3 billion poor worldwide, around 42% depend on livestock as part of their livelihood (Pica- Ciamarra, 2005).

Small ruminant production, in the context of sustainable livelihood of the poorest, is facing the following problems ( SAPPLOP, 2011): poor awareness regarding the importance of small ruminants in the livelihood system, absence/lack of active rearer and farmer organisations, inadequate veterinary health services, lack of adequate focus on genetic or breed improvement, reduced or lack of access to credit and insurance, lack of efficient marketing mechanisms and poor interdepartmental coordination. However, if all these identified small ruminant animal production problems can be solved, it is hoped that there will be an improvement in the global food system.

In terms of contribution and value-added to human health, small ruminant, for instance, goat meat is a good source of proteins and also has health benefits when it is consumed in appropriate portions (Pollott& Wilson, 2009). In comparison, beef has similar protein, lower fat, higher calcium, magnesium, potassium, similar iron, and lower $B_{12}$ and folate contents (Johnson et al 1995). Similarly, goat meat contains a low amount of saturated fatty acids and cholesterol and it is a healthier alternative compared to other types of red meat (Ivanovic et al 2016). Small ruminants as source foods are nutrient-dense components of diversified diets, providing highly bio-available macro-(i.e., protein and fats) and micronutrients (e.g., iron, Vitamins A and B12) that are critical for health, particularly for adolescents and women of reproductive age, as well as for infant and child growth (including critical contributions to cognitive development) (Randolf et al., 2007). According to (Feed the Future, 2017), small ruminant contributes to nutritional outcomes through three key pathways: direct consumption of self-produced; indirectly through income from the sale of produce; and through women's economic empowerment and sharing of household decision making (Feed the Future, 2014). However, while the contribution of livestock is broadly positive, livestock also brings environmental health and food safety risks (Feed the Future, 2017).

According to de Tarso, Oliveira, and Afonso (2016), goats are generally efficient in their metabolism and tolerance of poor quality and potentially toxic nutrients, while sheep are particularly well-adapted to convert short herbage to milk or meat. Different small ruminant breeds and production systems have been developed to

suit local resources in seasonally biodiverse environments throughout the world. Small ruminants are therefore adaptable to meet global needs for food security and have potentially important roles in improving the health and well-being of the rural poor in their marginal environments. Thus, while FAO/WHO recommends a minimum animal protein intake of 35g per person per day only 10 grams have been achieved in Nigeria (FAO, 2018).

**Small Ruminants Production and Human Health**

According to Kues and Niemann (2004), farm animals have made significant contributions to human health and well-being in mankind's history. The nutritive value of goat meat as well as other food items is becoming increasingly important in the health management of people. Addrizo (2000) stated that in an attempt to reduce heart diseases through diets, 80% of the patients who eat goat meat (chevon) had a lower hyperlipidemic state. Also, Nagura (2002) reported that people in the Okinawa area in Japan have been eating goat meat as medicinal dishes for such purposes as recovering from fatigue and regaining physical strength during pregnancy and childbirth. Goat milk contains much taurine, a substance added to health drinks and revitalizers and there are reports that goat milk contributed to the treatment of diabetics. According to Haenlien (1996), the medical and pediatric literature has documentation on the treatment benefits of medium-chain fatty acids in cases of malabsorption syndromes, premature infant feeding, cholesterolemia, gallstones, and cystic fibrosis. Besides, goat milk fed to infants or children with digestive malnutrition is equal to or even a superior substitute to cow's milk (Hachelaf*et al*. 1993; Razafindrakoto*et al*. 1993).

The use of goats for pharmaceutical production**:** According to Kues and Niemann (2004) with the advent of transgenic technologies the potential of farm animals for improving human health is growing and many areas remain to be explored. Also, Rudolph (1999) stated that farm animals such as goats; pigs, and even rabbits have several significant advantages for the production of recombinant proteins over other systems including their potential for large-scale production of pharmaceutical products. The drug called Aimspro made from goat blood offers hope to multiple sclerosis patients by improving their vision. It is the first time that any treatment has been shown to reduce an aspect of disability in the chronic phase of the disease. Matthews (2005) who led the trial said the results were encouraging. According to Anon (2009), it would be the first time an anti-clotting drug has been made from the milk of genetically engineered goats. The drug ATryn has already been approved for use in Europe. Up to now, antithrombin has been produced from blood collected from human donors. A Tryn is for use only when patients are undergoing surgery or having a baby. At a time when the danger of clots is particularly high, the patients would receive the drug by intravenous infusion for a limited time before and after their procedures. All these summarily suggest that small ruminant animals play a significant role in humans health.

**Small Ruminants Production and Poverty Alleviation**

Research has documented the potential of small ruminants for poverty alleviation (Dossa, *et al*, 2008). Small ruminants are the major livestock species reared which could be a means of alleviating poverty among poor and vulnerable groups of people in the world. To increase the production of small ruminants profitably, adequate feeding is recognized as the most important factor, next to health (Bosman*et al,* 1996).In traditional systems with minimal cash inputs, small ruminant rearing mostly relies on family labour, most of which goes into grazing, herding, or fodder collection (Saadullah*et al*, 1997). A clearer assessment of the current feed situation is required if feeding is to be used as a basis for enhanced small ruminant production (Oppong-Anane, 2001). Similarly, small ruminants depend mainly on natural pasture and crop residue, though a decrease in grazing land and biodiversity attributed to the expansion of cropping areas (Gyasi*et al*., 1995) and feed shortages exacerbated by indiscriminate bush fires have also been reported (Opong-Anane, 2001).

To identify the potential of small ruminant rearing for poverty alleviation in the world through adequate feeding, existing feeding practices in crop-livestock systems, and farmers' knowledge and perceptions about feeds and feeding practices should first be sought; especially in the midst of rapidly changing ecological, social and cultural conditions (Ayatunde*et al*., 2008). In light of this, what efforts are needed to improve small ruminant production to alleviate poverty in the world?

The importance of small ruminants in income generation and households' social and financial security is well established in the literature (Zelalem& Fletcher, 1993; Barrs, 1998; WorknehAyalew, 1999). Small ruminants have several advantages for being an integral component of the pastoral production system in Nigeria (Oluwatayo & Oluwatayo, 2012). The small size of sheep and goats has distinct economic, managerial, and biological advantages. Economically, low individual values mean a small initial investment and a correspondingly small risk of loss by individual deaths. Managerially, they are conveniently cared for by women and children, occupy little housing space, lower feed requirements, and supply both meat and milk in quantities suitable for immediate family consumption. Moreover, sheep and goats are kept for a variety of economic reasons including savings and investment, security and insurance, stability, and social functions. The role of sheep and goats as a continuous source of protein during and immediately following a period of drought is one major reason for making them the most important component of livestock in the pastoral and agro-pastoral production systems (Wilson, 1991).

Small ruminants are a source of food and financial security for the rural poor in Nigeria. According to FAO (1983), more than 50 percent of milk produced for human consumption is from sheep and goats in Niger and Somalia. Thirty-five percent of the total Nigerian meat supply comes from small ruminants (Bayer, 1982, Oluwatoyo&Oluwatayo, 2012) and almost 30 percent of the total meat consumed in the semi-arid zone is from

small ruminants (Wilson, 1982; Feed the Future, 2017). Little (1982) found that in pastoral production systems, goats are usually the only source of milk available for households in the dry season when both sheep and cattle have migrated. Because of their small size, sheep and goats provide more convenient sources of meat than cattle as shown by Sarniguet et al., and Bayer (1982) found that small ruminant meat contributes three times more than beef to the total meat consumed in rural areas of northern Nigeria. It is generally more suitable to slaughter a sheep or a goat than a large animal such as a cow to feed community members engaged in communally private fieldwork. Also, small ruminants provide cultural and economic benefits for households. In the same vein, while a 10 to 15 kg small ruminant carcass is easily handled by a rural household for either home consumption or sale without means of preservation, slaughtering even a steer (when it is available) for the same purposes is generally impracticable and uneconomical and is, therefore, a rare event (Oluwatayo&Oluwatayo, 2012). Where access to cash is limited and livestock marketing is not organized, small ruminants are directly exchanged for grain. Small ruminants are often slaughtered in honour of a special guest, a visiting friend or a relative, for festivities and religious rituals. Small ruminants are also kept by poor rural households for ready cash income to meet immediate needs such as acquiring agricultural inputs, paying school fees, and purchasing larger animals such as cattle (Oluwatayo&Oluwatayo, 2012). This is because rural households find it easier to find a buyer for a goat or a sheep than a cow. More importantly, small ruminants play a key role in stock association building between members living in the same community in rural areas (Okello, 1985, Oluwatayo&Oluwatayo, 2012).

When explaining different ways by which small ruminants are being employed as a source of financial security in rural Southwest Nigeria, Oluwatayo and Oluwatayo (2012) indicated that respondents in their study were given the freedom to express their minds. They reported that most of the respondents (67.7 percent) expressed that the income generated from their involvement in small ruminants rearing helped them significantly to attend to other important issues in the welfare of household members since the income generated from other sources is not enough to cope with increasing demands on the home front. For example, small ruminant rearing has provided leeway for important unforeseen financial demands like paying hospital bills (10.4 percent) and assisting relations in emergencies (7.8 percent). From the interviews conducted, most of the households surveyed rely on income from small ruminants' sales especially when food is scarce either due to lean harvest or when the stock of available food is exhausted. Again, a sizeable number of the respondents rely solely on small ruminants rearing in paying the school fees of their wards. This is done in such a way that the repayment plan of any money borrowed/loan taken to meet this important obligation coincides with the time these animals are ready for the market (i.e. attain market weight).

Small ruminant production provides an opportunity for sustainable economic development, inclusive employment, wage labour, and women's empowerment (CCAFS, 2010). Ownership of productive small ruminant assets and linkages also contributes to household, community, and system-level resilience capacities (Mercy Crops, 2017; Randolf et al., 2007) and now supports the development of social capital, for example, through inter-household livestock gifts and loans. Well-managed small ruminant builds a household's asset base; reduces risk (by facilitating livelihood diversification), and effectively serves as a form of financial services (e.g., insurance against crop failure, investment capital, and savings). According to Misra (2005) small ruminants contribute enormously towards the promotion of livelihood security and as an insurance cover to cope with crop failures, especially in Sub-humid and humid areas where mixed farming is more common and goats contributed between 17.1 to 58.0% of total farm income. A study done by Devendra (2001) on the Contribution to food security, poverty alleviation, and opportunities for productivity enhancement in Asia concluded that the levels of income reported are a proportion of the actual value of the small ruminants due to lack of market access resulting to farmers losing 40-45% total value of the animal to middlemen who exploited the situation. de Tarso, Oliveira, and Afonso (2016), also added that small ruminants are further suited to enhancing the livelihoods of the poor, due to their manageable size, relatively low maintenance requirements, low capital investment cost, short generation interval, and ease of marketing of animals and products, hence suitability as short-term economic reserves. Small ruminant farming is widely considered to be a solution to the challenge of achieving socioeconomically and environmentally sustainable global food security in the face of the effects of population growth, urbanisation and affluence, vulnerability to climate change, and the hitherto irresponsible agricultural use of drugs and chemicals.

Metawi's (2015) study showed that the contribution of livestock to household income ranged from 40.8 to 71.6% across AEZ. Under DA conditions, livestock production contributed 71.6% to household income. Livestock contributes 40 % of the global value of agricultural output and supports the livelihoods and food security of almost 1.3 billion people. The livestock sector is one of the fastest-growing parts of the agricultural economy (FAO, 2018). Under watershed development programmes, the rearing of *sheep* and goats is promoted as an *income-generating* activity for landless and poor people, because increasing the *income* of the poor has an immediate and direct impact on poverty.

**Data on Ways by which small ruminants assist in meeting households' obligations/Reduce Poverty in Nigeria**

| Variable | Frequency | Percentage |
|---|---|---|
| Buying food | 15 | 3.3 |
| Paying school fees | 189 | 42.0 |
| Paying house rent | 45 | 10.0 |
| Paying medical bills | 47 | 10.4 |
| Building house | 33 | 7.3 |
| Buying other household needs | 09 | 2.0 |
| Assisting relations in settling contingencies | 35 | 7.8 |
| Performing burial rights | 23 | 5.1 |
| Collateral/pledge for land used for farming activities | 13 | 2.9 |
| Performing marriage rights | 17 | 3.8 |
| Meeting naming ceremony obligations | 24 | 5.3 |
| Total | 450 | 100.0 |

Source: Oluwatayo and Oluwatayo (2012).

**Efforts at Improving Small Ruminant Production**

Small ruminants are raised under a low-cost system and farmers are less likely to buy feedstuffs or provide veterinary care for sheep and goats than for cattle. Interventions that call for expenditure are unlikely to be adopted widely, while those that are simple adaptations of existing systems could be more acceptable. There have been efforts to improve small ruminant production**.** Sheep and goats are valuable in developing countries because of their ability to utilize scarce feed resources and can tolerate unfavourable climates. Realizing the importance of goat to man, there have been various efforts at improving the stock. For example, the FAO Small ruminant program was put up to help small farmers to improve production. To aid research, FAO (2003) built a computerized information network database for their ongoing projects. Winrock International, USAID, ILRI, and other institutions are all geared toward promoting goat production. Productivity can be improved by two major routes, with a degree of interdependence.

The first involves improved health care, which reduces the mortality rate. ILCA (1985) has shown that prophylactic health measures in southwest Nigeria allowed goat numbers to rise over two years by 118% compared with a 24% increase in control villages. The possibility of overstocking must always be borne in mind. However attractive increasing flock size appears in the short term, it is a long-term recipe for disaster unless forage availability is also increased. If a reduction in numbers is to accompany health and nutrition interventions, this necessitates increased offtake.

The second major route is improved feeding. The form taken by any nutritional intervention will depend upon the overall farming system employed and environmental conditions. Now the big questions are: What can be found on the uncultivated land? What is available from crop residues? Is the farmer aware of the nutritional value of the potential feed resources? Will the use of the material as animal feed fit into the existing farming system? If not, what changes will be necessary?

It can be argued that extensive systems, implying little competition for the land from arable farmers because of low soil fertility and lack of water, are the most difficult to assist given the necessity of minimal cost interventions. The major feed resource in extensive systems is uncultivated browse and grasses. Goats, in particular, are capable of selecting the most nutritious plants, and parts of plants, obtaining a reasonably balanced diet throughout the year. It is rare to see extensively raised goats in poor condition unless carrying capacity is exceeded. Farmers may assist by lopping branches that would otherwise be outside the reach of livestock, and by providing water to animals overnight.

Another important method of increasing small ruminant production is through genetic engineering -Leng (1991) a study that analyzed improving ruminant animal production in developing countries through the application of biotechnology in nutrition concerning the feed resources available and the climatic and environmental constraints. He found that there were at a minimum five target objectives which could allow a substantial increase in production. These included a) manipulation of the feed base, b) elimination or amelioration of disease/parasitism, c) manipulation of the metabolism and digestive physiology of the animal, d) manipulation of the use of feed for production (partitioning of nutrients), and e) manipulation of the digestibility of feed before consumption.

According to a report by FAO/IAEA (2003), research aimed at improving small ruminant animals' production and health has been revolutionized by recent developments in biotechnology, particularly those involving gene-based technologies. These have generated not only new opportunities for knowledge creation but also new options for solving established and emerging problems, particularly in animal disease diagnostic and therapeutic. The genetic manipulation in tropical forages to increase the efficiency of nutrient availability to animals and to decrease emissions into the environment offers considerable potential in increasing livestock productivity while protecting the environment. Improved ruminant animal production by genetic engineering for ruminal bacteria is one of the most useful development and less controversial. The practical applications of genomic studies on rumen microbes could involve the industrial production of key lignocellulolytic enzymes for the pre-treatment of fibrous residues, which could, in turn, be employed in practical feeding strategies.

Knowing that there is potential consumer resistance to animal food produced using biotechnology, Aldrich and Bkisard (1998) made an ample review of several studies on the market effect of introducing milk from sheep treated with rbST, which is a laboratory-produced hormone that when injected into sheep, increases their milk production. Milk sales in the USA remained steady after rbST became available to dairy farmers, even

though a multitude of public opinion surveys documented widespread concern about safety and biotechnology, and some analysts predicted a drop in milk consumption of up to 20%. The undiminished demand for milk may indicate that consumers will also accept other animal food products from biotechnology. The rbST experience suggests that, while scientific evidence of food safety will not prevent controversy over biotech foods, the controversy will not necessarily inhibit consumer demand for the food.

There have been so many activities implemented by the government of Nigeria to reduce poverty alleviation through small ruminants' production. For instance, mention can be made of:

Agric sector programme: This includes the state agricultural development programmes, the national agricultural land development authority, and the strategic gains reserves programmes.

The programme for small ruminant production, pasture, and grazing reserves: These programmes promote the utilization of land resources through subsidized land development, the supply of farm inputs and services, credit extension to farmers, and institutional support for produce-making cooperatives

Nutrition-Related Programmes consist of programmes aimed at improving food security, prevention of micronutrient deficiencies in children and women, and promotion of food quality and safety, food security provision, micro, and microcredit delivery.

Creation of Agriculture and Rural Development Ministry as one of the poverty alleviation ministries: This programme has led to goat multiplication. Goats have multiplied and millions of naira have been invested to buy thousands of goats so that through a revolving scheme, every individual in the participating states that requires economic independence will be assisted to fulfil their dreams.

As indicated by Matheka (2014), the Nigeria Livestock Industry through small ruminants' production has contributed a merger 9 – 10 percent of the GDP and only 35.5 percent of the protein intake of Nigerians (NSAP, 2009), this is despite the great potential the sector has in nutritional and food supply. Thus, the implementation of all of these programmes has been able to reduce the poverty level in Nigeria by at least 10% (World Economic Forum, 2017).

**The Nigeria Gains from Improving Small Ruminant Production**

There is no doubt about the fact that small ruminants are of considerable importance, and there is a whole range of gains Nigeria can derive by improving its production. These gains are discussed in turn in this section.

Improving the production of small ruminants can provide the main, if not the only means of livelihood, combining economic and food security, nutrition, and means of survival to Nigerians. In these circumstances, the importance of small ruminant animals especially to the very poor and landless peasants can increase with decreasing quality of grazing and feed availability in harsh environments.

Sheep and goat are one of the major livestock species kept and caved for many of the world's poor. Goats, the "cattle of the poor", and sheep are reared and can serve as sources not only of milk and meat for family consumption but also a source of income that could be easily mobilized for paying some of the household expenditures, particularly in hard times. In addition to this important economic role, sheep and goats are significant in socio-cultural activities such as funerals, dowries, festivities and holidays, etc.

In many ways the production of small ruminant animals - especially sheep and goats, - is a neglected sector, attracting little interest or investment from the government. Usually, it is only marginal to agricultural programs. Sheep raising nevertheless could become a strategic, important sector, contributing to Nigeria's exports, thereby adding value and creating jobs in rural areas. It also could become an engine for developing related industries such as feed blocks - solidified mixtures of agro-industrial by-products such as tomato pulp, date pulp, rice bran, and poultry parts.

Similarly, small ruminant animals especially goats are now being used to clear bushes in many parts of Nigeria inclusive of trypano-tolerance, and are potentially important likewise in the use of trees and shrubs. A more significant example of beneficial crop-goats and sheep interaction concerns the practice of folding. The migrating flocks of goats and sheep are often used overnight to fertilise cropland, and crop farmers pay relatively high prices or give cereals in return for their service. In northern Nigeria for example, 2000-3000 goats and sheep are folded on 0.2 ha of land which is highly rewarding in terms of cost.

The integration of small ruminant with perennial tree crops like coconuts and oil palm have been associated with the reduced cost of weeding, improved soil fertility, increased crop yields, increased productivity per hectare, and socio-economic benefits to small farmers in Nigeria. In a Country like the Philippines for example, the integration of goats and sheep with coconuts over three years increased the income of farmers by between US$127 and $229 (Davendra, 2008; Binh and Lin, 2009). Likewise, the integration of leguminous hedgerows to reduce soil erosion in upland areas improve soil fertility and nutrients for crops e.g. maize and black pepper, as well as produce forage for goats in a zero-grazing system indicated a mean annual income of US$1354 per 0.5 ha, equivalent to a mean internal rate of return of 38.7% (Laquihon*et al*., 1997). In Malaysia, the integration of goats and cattle with oil palm increased the yield of fresh fruit bunches and palm oil (Devendra, 2004). Nigeria may also reap these types of gains if the small ruminant production is improved.

**RECOMMENDATIONS**

The improvement in the production of small ruminant animals, in general, can significantly contribute to increased global food production and improved livelihoods. In light of this, affirmative action is required that can promote the following:

*i)* ***Increased production will need more efficient use of available breeds and commercially oriented production systems***

Production systems of small ruminant animals need to shift more aggressively from a subsistence base to a more market-oriented outlook to match the market demand with changing consumer preferences.

*ii)* ***Understand markets and marketing systems***

This is a major weakness presently, and a better understanding of these and agribusiness will enable

producer response and the need for policy interventions and more efficient marketing systems.

iii) ***Delivery systems and technology transfer***

There is also the need to make available efficient delivery systems to enhance the high adoption rates of appropriate technologies. This involves interdisciplinary efforts, participatory team efforts involving farmers, researchers and extension personnel, and whole-farm systems.

iv) ***Policy support and institutional commitment***

These are very important prerequisites, and without such institutional commitment, small ruminants will continue to receive only lip service. Policy instruments that can seize this initiative can make a significant impact on increased production and improved livelihoods.

v) ***Owners and producers of small ruminants must think nationally and regionally.***

They need to relate these to the considerable opportunities to benefit from the demand for more *meat* and market potential.

*vi)* ***Need for awareness of the concept of production-to-consumption systems***

This is important to link production, processing, distribution, and consumption in the food chain. This link will help promote the development of the location of slaughter facilities and post-production systems, rural and peri-urban areas, and rural growth.

*vii)* ***Increased resource use***

Increased resource use is urgent. This needs to be targeted at increasing productivity, reducing poverty, improving the livelihoods of the poor, and promoting rural growth. Nigeria and other countries of the world should consider expanding markets for small ruminant products. They should strive to be net exporters of small ruminant animals to be self-sufficient.

## CONCLUSION

Issues related to improving the global food system, human health, and poverty alleviation through small ruminant animals have been discussed. As has been seen, small ruminant animals are vital to the economies of many developing countries. It provides a livelihood for many people, contributes to growth in national income, and the livelihood of rural people, and meets the nutritional requirements of increasing populations. Asides from being a source of food; it has both nutritional and medicinal values for treating human diseases thereby considering it good for improving human health. However, this has not been fully exploited.

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