Livestock Production Systems Analysis: Review

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ABSTRACT

This review was aimed at to assess the livestock production systems analysis in the tropics through critical review of scientific papers. Tropical continents have ample natural resources: livestock, land, human resources. Livestock plays multiple roles in the livelihoods of people in this region, especially the poor. There are five classes of livestock production systems based on agro ecological zone, animal type, function and their management. Climatic conditions determine the energy and nutrient metabolism of farm animals and have a major influence on livestock heath, behaviour, welfare and performance. Contrary livestock production contributors to environmental problems: leading to increased greenhouse gas emissions, land degradation, water pollution and losses of biodiversity. Through the result of environmental impact assessment, climate risk-management action /mitigation/ should be taken to reduce the impacts of global warming and or climate change. Designing climate resilience green economy policy should be the first agenda of all the government of the nations to create the healthy environment for the life. Integration of livestock production systems increases the stability of the production of the farm and reduces risks for resource-poor households. Intensifications of the system and carrying out organic animal farming, increases animal productivity, due to better nutrition, health and housing management. Therefore measures such as sustainable intensification of the production system, payments for ecosystem services, income diversification, and market oriented production system, regulation of industrial systems and livestock product demand management could play a significant role in ensuring sustainable livestock production, livelihoods and environmental protection.

Keywords:

Livestock, climate change, organic farming, intensification, sustainability

1. INTRODUCTION

Livestock systems occupy about 30 per cent of the planet's ice-free terrestrial surface area (Steinfeld *et al.* 2006). Currently, livestock is one of the fastest growing agricultural subsectors in developing countries. Globally, livestock contributes about 40 percent to the agricultural gross domestic product (GDP) and constitutes about 30 percent of the agricultural GDP in the developing world (World Bank, 2009). This growth is driven by the rapidly increasing demand for livestock products, this demand being driven by population growth, urbanization and increasing incomes in developing countries (Delgado, 2005).

Livestock is a major contributor to food and nutritional security, and serves as an important source of livelihood for nearly one billion poor people in developing countries (Frans et al, 2010). Keeping livestock is an important risk reduction strategy for vulnerable communities, an important provider of nutrients and traction for growing crops in smallholder systems. Livestock products contribute 17 percent to kilocalorie consumption and 33 percent to protein consumption globally (Rosegrant et al. 2009).

By 2020, consumers in developing countries will eat 87% more meat and 75% more milk (FAO, 2005). About 3 billion new middle class consumers may emerge in the next 20 years (McKinsey, 2011) and World Human population in 2050 is estimated to be 9.15 billion, with a range of 7.96–10.46 billion (UNPD, 2008). This situation results the related ‘nutrition transition’ in diet changes from staples to higher value foods such as livestock products. Thus, there is no way to reach the millennium development goal of doubling of food production by 2050 without making livestock production more efficient (*Irene and Roswitha, 2012)*. To make more efficient of livestock production and answering livestock product demand of the population, increasing livestock productivity through scientific and technological developments is paramount important. So, as one of the task for animal scientists, researchers and scholars should be to understand the present livestock production systems and its analysis in the continent particularly in the tropics helps to maximize the improvement of livestock productivity to reach the desired goal. Therefore, to know in detail about the livestock production system and it analysis, this review is done from different scientific papers.

2. LITRATURE REVIEW

2.1 LIVESTOCK PRODUCTION SYSTEMS IN THE TROPICS

Livestock production is undertaken in a multitude of ways across the planet, providing a large variety of goods and services, and using different animal species and different sets of resources, in a wide spectrum of agro-ecological and socio-economic conditions (Steinfeld et al, 2006). Livestock in the tropics play many different roles in supporting families and are particularly important for the poorest families (Christie, 2010). Livestock are vital to subsistence and economic development in sub-Saharan Africa. They provide a flow of essential food products throughout the year, are a major source of government revenue and export earnings, sustain the employment and income of millions of people in rural areas, contribute draught energy and manure for crop production and are the only food and cash security available to many Africans (Jahnke, 1982). Livestock production in the tropics is characterized by great complexity not only in environment but also in livestock types, products, functions and management principles and is compounded by often perplexing interactions with the human sphere (Jahnke, 1982).

There is considerable diversity of livestock production systems across the continent, which is largely shaped by climate (rainfall amount and distribution, as well as temperature), and landscape as well as socio-cultural and economic factors (OCDE, 2008). According to the report of FAO (2010), integration with crops, relation to land, agro-ecological zone, intensity of production, and type of product are used as criteria for preliminary classifications of livestock production systems. Livestock production systems are defined on the basis of land use by livestock, and for this purpose the distinction between grazing systems, mixed farming systems and industrial (or landless) systems (Seré and Steinfeld,1996) has been widely accepted. According to WISP (2010), based on the degree of homogeneity in terms of resilience to climate change three categories (range based livestock systems, mixed farming systems and off land systems) were identified in Africa. However, the livestock production system in the tropics is put in the context of the large classes of farming systems and in the context of the principal ecological zones and the type of livestock and the livestock products, by the function livestock have and by the management principles of production five classes of livestock production systems were identified (Jahnke, 1982). They are pastoral range- livestock production system, crop-livestock production system in the low lands, crop-livestock production system in the highlands, ranching and landless livestock production system

2.1.1 Pastoral Range-livestock Production Systems

Range-livestock production systems are production systems based on the use of the natural or semi-natural vegetation via domestic animals, in particular ruminants (Jahnke, 1982). Grazing ruminants are the dominant form of land use. Nomads make use of the hyper-arid zones, usually with camels and goats in a higher proportion with cattle rather. The system has the lowest livestock densities with 11 TLU/km^2 (tropical livestock units) compared to 20 TLU/km^2 and 55 TLU/km^2 in crop-livestock production system in lowlands and crop-livestock production system in highlands respectively (WISP, 2010). The proportion of cattle in herds increases in arid regions where transhumance becomes more important. Livestock production is a tribal affair based on traditional rights to the rangelands. The main product is milk, the major component of the human diet; meat is not a major concern. FAO (1982) reported that beef/milk production under high pressure on natural resource with cattle being important risk balances in the Kordofan and Darfur Provinces of Sudan. Pastoralists basically seek to attain their subsistence from their livestock and are therefore more interested in continuous flows of food, such as milk, dairy products or blood, than in terminal products such as meat of slaughtered animals. This is also a reason for keeping small ruminants, being smaller units easier to handle and trade (Seré and Steinfeld, 1996).

A limited number of animals are sold for cash in order to purchase cereals or clothing or to pay taxes. The major goals in pastoral systems are to assure subsistence for the increasing community and to avert risk of disease and drought mainly by maximizing livestock numbers. Also social and cultural functions are also important (Jahnke et al, 1989). In the extensive grazing systems of the tropics, seasonal fluctuations in feed supply are mainly buffered by the loss of weight of the animals. This, however, limits their productivity, which is found mostly in marginal locations, its production potential in global terms is relatively low (Seré and Steinfeld, 1996). In this pastoral range-livestock system, labour is extensive, using of capital-intensive technologies is very low to enhance the productivity of the basic resource, a productive rangeland. Pastoral peoples carry forward an array of diverse cultures, ecological adaptations and management systems that have changed with modernity (WISP,2010). Management is characterized by the adaptation of the feed requirements of the animals to the environment through migration; land tenure is communal (Jahnke et al, 1989). The major environmental concern in the system is the degradation of rangelands through inappropriate range management practices (Seré and Steinfeld, 1996).

2.1.2 Crop-livestock Production Systems in the Lowlands

According to the report of Jahnke (1982), crop-livestock production systems denote land use systems in which livestock husbandry and cropping are practised in association. This association may be close and complex or livestock husbandry and cropping may be parallel activities without interaction, possibly not even belonging to the same management unit. In this case the association is reduced to geographical proximity. Essentially crop-livestock production is used for livestock production that takes place in arable areas or in areas with an arable potential. Farmers herd livestock in the rangelands and also produce crops on fertile land. The system is used in a dual sense: Firstly it refers to farming systems entirely based on livestock but practised in proximity to and perhaps functional association with other farming systems based on cropping. Secondly it refers to the livestock sub-system of crop-livestock farming. The term mixed farming will be reserved for such farming systems in which crop production and livestock production display pronounced and mutually beneficial interactions within a farm. Both the crop and the animal system are managed by distinct decision makers, but decisions are closely interrelated. Recent surveys of livestock biomass distribution in selected countries of sub-Saharan Africa document the increasing contribution of crops to feeding the regional ruminant livestock population (Wint and Bourn, 1994).

Crop-livestock production systems in the lowlands, has the higher livestock densities with 20 TLU/km^2 (tropical livestock units) compared to 11 TLU/km^2 in pastoral range-livestock production system (WISP, 2010). In this system the important share is Zebu breeds, African hairsheep and dwarf goats are usually kept for local consumption. Herd structure normally reflects the fact that these systems tend to produce mainly beef. Either they sell store cattle for finishing close to market places or they produce finished steers of three to four years of age. Milk is more important in the subtropical and drier parts of the tropics, particularly where farms are smaller and access to markets is provided. Productivity levels tend to be low (e.g. weight gains of 0.3 kg/head/day in steers, milk yields of 2 kg/cow/day in addition to what the calf suckles) (Seré and Steinfeld, 1996).

There is an ample land resource in this system in relation to its population. Many of the potentially suitable land resources are not used in this system as a result of trypanosomiasis constraining livestock production. This system is characterized by low performance of cattle due to disease pressure Otchere (1984). In Africa, trypanotolerant *Bos taurus* mainly the N'Dama breed,are important in humid ecosystems.

2.1.3 Crop-livestock Production Systems in the Highlands

This system is defined as a combination of rainfed crop and livestock farming in tropical highland areas in which crops contribute at least 10 percent of the value of total farm output. It is found in the tropical highlands of eastern Africa (Ethiopia, Burundi, and Rwanda) and the Andean region of Latin America (Ecuador, Mexico) (Seré and Steinfeld, 1996).

Originally the highlands probably attracted people for reasons of military security, relative freedom of disease and high potential productivity. The natural conditions as characterized by ample sun, good soils and the absence of temperate extremes are indeed favourable to both crop and livestock production (WISP, 2010). The system has the highest livestock densities with 55 TLU/km2 (tropical livestock units) compared to 20 TLU/km2 and 11 TLU/km2 in mixed crop livestock production system in lowlands and pastoral range livestock production system, respectively (WISP,2010). The largest in terms of stock numbers of cattle and small ruminants as well as their meat and milk outputs in this system.

In crop-livestock production system in the highlands, livestock tend to be of secondary importance vis-à-vis the crops output (Seré and Steinfeld, 1996). However Fertile soils, suitable climatic condition, higher population densities are a number of features that make the farming systems in the highlands different from those in the lowlands due to these features the crop , fodder, and animal productivities are high compared with the other system(Jahnke ,1982),

Mixed farming and livestock systems benefit greatly from proximity to urban centres, which allows farmers to market their products and enables them to use livestock, particularly smaller stock, as a financial reserve. These systems contribute 35% of the total production of beef, 20% of goat and sheep meat, 35% of poultry, 40% of pork, 15% of milk and 10% of eggs in West Africa (OCDE, 2008). According to the World Bank (2009), mixed farming systems provide about three quarters of all the meat and milk produced in the developing world, which implies that African mixed farming systems produce below the global average, perhaps reflecting the significantly higher than average proportion of rangelands in Africa**.** In this systems in which more than 90% of dry matter fed to animals comes from rangelands, pastures, annual forages and purchased feeds, and less than 10% of the total value of production comes from non-livestock farming activities. Mixed farming systems are livestock systems in which more than 10% of the dry matter fed to animals comes from crop by-products such as stubble, or where more than 10% of the total value of production comes from non-livestock farming activities (Steinfeld et al,2006).

crop-livestock production system in the highlands serves several purposes: The manure is used as fertilizer; animals are used for draught and transport; Crop residues are used as livestock feed; animals can be sold and the revenues re-invested in agriculture or sold when the crop is failing because of weather or pests; Cereals and most staple foods are produced in quantities that cover the family needs, and excesses are sold (WISP, 2010).

2.1.4 Ranching

The term 'ranching' has been used in African livestock development to refer to a particular brand of rangeland livestock production modelled on US (and to a lesser extent

Australian) beef farming (WISP, 2010). Ranching systems are range-livestock production systems like pastoral systems, but production parameters, livestock functions and livestock management are radically different (Jahnke,1982). Ranching is labour-extensive undertaking specializing in the production from one or two livestock species of a marketable commodity, mainly live animals for slaughter, i. e. for meat, skins and hides, but also wool and milk. The function of livestock is therefore to provide cash income.

This highly market oriented production system is largely focused on beef production and is characterized by high capital inputs, sedentary production, and often some form of private land tenure. Ranching systems have been developed on state owned rangelands as well as private and group ranches, and the system is particularly prevalent in eastern and southern Africa. Ranching is rare in West and Central Africa, apart from a few cases where the objective is often that of developing and promoting a specific breed on behalf of the state. Livestock management is characterized by grazing within fixed boundaries by individual tenure and by intensification possibilities (Jahnke,1982)..

One of the major challenges that all rangeland producers face is to produce livestock at the required standard to enter international markets. Even southern African countries armed with preferential trade agreements with Europe have consistently failed to meet their export quotas, in some cases despite massive state subsidies (e.g. Botswana). Some ranchers in southern Africa have adapted to this challenge by diversifying production into game ranching, targeting markets for bush meat, game viewing and even a small but lucrative market for live wildlife sales. Though not very common, this may present an adaptation option for arid rangeland environments faced with climate change (WISP, 2010).

2.1.5 Landless livestock production systems

Landless livestock production is largely carried out urban and peri-urban areas and it is defined by the use of monogastric species (mainly chicken and pigs) and ruminants (cattle and marginally sheep) (Seré and Steinfeld, 1996). Two main types of husbandry practices have been identified under urban/peri-urban production system. First, livestock is either controlled or zero grazed. Second, livestock grazing is not fully controlled, but forage under free roaming condition on vacant plots and along the roadsides or scavenge on garbage sites (WISP, 2010). Landless LPS are a subset of the pure livestock systems in which less than 10% of the dry matter fed to animals is farm produced and in which annual average stocking rates are above ten livestock units per hectare of agricultural land (on average at census unit level (Steinfeld et al,2006). The system is very knowledge- and capital-intensive, Production efficiency is high in terms of output per unit of feed or per man-hour. Concentrate conversion rates range between 2.5 - 4 kg/kg of pork, 2.0 to 2.5 kg feed DM/ kg of poultry meat, and even lower for eggs (Seré and Steinfeld, 1996).

It is not possible to generalize over livestock species kept in urban or peri-urban systems because of the great variation among cities and countries. Nairobi’s urban farmers keep goats rather than chicken and ducks, whilst in Kampala cattle are preferred. In Dar es Salaam cattle, goats and sheep are kept by over half of all households and in Addis Ababa sheep are kept by a similar proportion, whereas goats are kept by only 13% of households (WISP, 2010).

Zero grazing systems are independent of any agricultural use of the land. They use only animal feeds such as cultivated fodder and agro-industrial by-products, whether concentrated or unrefined: cereals, oil seed cakes, bran, hay and straw or sometime only manufactured feed (pig fattening or pig production). These systems are found in or on the outskirts of towns, and have developed with growing urbanization and a demand for animal products that distant small farming or pastoral systems are unable to meet. They focus mainly on poultry (for eggs and meat), pig farming, and milk production to a lesser extent. Free-roaming animals feed on whatever they find: on garbage, household kitchen waste, leftovers from hospitals, hotels, schools, markets and crop residues in addition to grazing on free plots of land (Jahnke, 1982).

The productivity of livestock in peri-urban and urban areas is generally low and faces a number of challenges:

- Animal waste disposal can cause environmental and public health hazards;
- Competition for water resources with humans;
- Animal health is often poor due to inadequate husbandry practice and overcrowding;

- Animals often kept in a small area within a homestead;
- Feed availability is a particular constraint for larger livestock species such as cattle;
- Feed quality is a problem for free-roaming livestock as there is no, or very limited, control over feed sources;
- Urban livestock keepers are poorly organized and their needs are poorly represented;

Despite the challenges, there are numerous benefits from urban and peri-urban livestock production and a number of opportunities for its development. Urban livestock keeping fits different livelihood strategies and contributes to food security, income and employment opportunities and savings, insurance and social status. It also provides easily convertible assets for covering important expenditures (school fees, health treatments and social obligations) and contributes to supporting vulnerable groups of the community. With increasing demand for land for residential purposes, urban livestock keeping provides a way to increase returns per unit of land utilized. Urban livestock keeping also provides opportunities to make use of household wastes, agro-industrial by-products such as molasses and brewery residues, weeds and grass from public land and crop residues from markets and peri-urban farmers. Vulnerable groups such as female-headed households, children, retired people, widows and people with limited formal education are particularly involved in urban livestock keeping as a social security strategy (Ellis and Sumberg, 1998). A commercial rather than a subsistence activity, undertaken to take advantage of growing demand for high value and import-substituting food and livestock products within cities and towns (Sabine 2002).

Livestock Production Systems in Ethiopia

The diversity of Ethiopia's topography, climate and cultural conditions make it difficult to generalize about livestock production systems in the country (Alemayehu, 1985). Numerous authors used different criteria to classify livestock production systems in Ethiopia. However, about five production systems have been identified based on integration of livestock with crop production, level of input and intensity of production, agro-ecology and market orientation.

The following systems have been defined viz. pastoral, agro-pastoral, mixed crop-livestock farming, urban and peri-urban dairy farming and specialized intensive dairy farming systems (Mohammed et al., 2004; Yitay, 2007).

In the lowland agro-ecological setup with pastoral production system, livestock do not provide inputs for crop production but are the very backbone of life for their owners, providing all of the consumable saleable outputs and, in addition, representing a living bank account and form of insurance against adversity (Coppock, 1994). This system is characterized by sparsely populated pastoral rangelands, where subsistence of the pastoralists is mainly based on livestock and livestock products. The livestock husbandry in this system is dominated by goats, cattle, sheep and camels. Since the main source of food is milk, pastoralists tend to keep large herds to ensure mainly sufficient milk supply and generate income (IBC, 2004).

Agro-pastoral form of livestock production system dominates in mid agro-ecological zones where a tendency for crop production has shown besides livestock production. Agro pastoralists are sedentary farmers who grow crops and raise livestock. Livestock are used for draught, savings and milk production. The production system is subsistence type of milk and or meat production (Zinash et al., 2001; Alemayehu, 2004). Cattle and small stock play a critical role in the agro-pastoralist household economy. Agro-pastoralists tend to retain female stock to produce milk and to maintain the reproductive potential of the herd. Oxen are also important for draft so that stock sold tend to be oxen and cows, which have lost their productive capacity. However, because average herd size is generally low, many herders are increasingly forced to sell young males and even females of optimum reproductive age (ILRI, 1995).

In the highland livestock production system, animals are part of a mixed subsistence farming complex (Alemayehu, 1987). Livestock provide inputs (draught power, transport, manure) to other parts of the farm system and generate consumable or saleable outputs (milk, manure, meat, hides and skins, wool, hair and eggs). About 88% of the human population, 70% of cattle and sheep, 30% of goats and 80% of equines are found in this region (Alemayehu, 2004). The principal objective of farmers engaged in mixed farming is to gain complementary benefit from an optimum mixture of crop and livestock farming and spreading income and risks over both crop and livestock production (Lemma and Smit, 2004; Solomon, 2004).

Urban and peri-urban production systems are developed in areas where the population density is high and agricultural land is shrinking due to urbanization around big cities like Addis Ababa and other regional towns. In this system crossbred animals (ranging from F1 to a higher blood level of exotic breeds mainly Holstein Friesian) are kept in small to medium-sized farms. Urban and peri-urban production systems include commercial to smallholder dairy farms. Such farms are reported to be found in and around major cities including Addis Ababa and other regional towns. This sector own most of the country's improved dairy stock (Sintayehu et al., 2008). The main source of feed is both own farm produced and purchased hay and the primary objective is to get additional cash income from milk sale (Yitay, 2008).

Intensive dairy farming used to be predominated by the state sector and urban and peri-urban private milk production has developed in and around major cities and towns with high demand for milk (Felleke and Geda, 2001). The system comprised of small and medium sized dairy farms located in the highlands are based on the use of purebred exotic or high grade and crossbred dairy stock. Producers use all or part of their land for fodder production and purchase of concentrate is also another source of feed (Yoseph, 1999).

2.2 INTEGRATION & INTERACTION OF LIVESTOCK PRODUCTION SYSTEMS

Population growth, urbanization and income growth in developing countries are fuelling a substantial global increase in the demand for food of animal origin, while also aggravating the competition between crops and livestock (Antonio and Silvia, 2010). To meet the rapidly increasing demand for food globally (2.5%), by an ever-expanding human population, production from crop agriculture must expand by 4% annually while the production of food from animal agriculture must expand by more than 3% annually, by the year 2025 (World Bank, 2007). Efforts to raise agricultural productivity in the farming systems of the developing countries have developed recent policy interventions. In the tropics, most of the governments have promoted several programmes to enhance the productivity of small farms that now have to compete with the established commercial farms which have always been better able to withstand the harsh past and current socio economic environment.

Now it is necessary to satisfy consumer demand, improve nutrition and direct income growth opportunities to those who need them most, it is also necessary to alleviate environmental stress. Conventional agriculture is known to cause soil and pasture degradation because it involves intensive tillage, in particular if practised in areas of marginal productivity. Technologies and management schemes that can enhance productivity need to be developed. At the same time, ways need to be found to preserve the natural resource base. Within this framework, an integrated crop-livestock farming system represents a key solution for enhancing livestock production and safeguarding the environment through prudent and efficient resource use.

2.2.1 Integration crop livestock farming

The term Crop-Livestock Integrated Farming System (CLIFS) refers to it as an agricultural system that is characterized by the systematic production of livestock and crops on the same farm. A number of researchers often tend to describe CLIFS as Integrated Bio-System or Mixed farming system (Block and Webb, 2001). In crop-livestock integrated farming systems the most visible feature is the synergy between crops and livestock. At one level, animals gain from crops produced on the farm. For example, crops provide animals with fodder from grass, leguminous forages, and crop residues. At the other level, crop farming takes advantage of the animals on the farm to improve the environment in which crop production takes place. The animals provide draught power in crop production where the practice of animal traction is popular and their dung (or waste matter) can be used as manure to improve soil fertility on crop fields. Animals can also be used in weed control when they graze under trees and on stubble. Livestock used as a source of food and income, and as an asset for insurance (Thomson and Bahhady, 1995).

There are other dimensions of integration as captured by the literature. For instance, crop-livestock integration may occur at other segments of the supply and value chain in both production and marketing. The more familiar one is when the integration of crops and livestock in a farming system occurs in terms of products or by-products of one component serving as a resource or input for the other products in the chain. That is, where the system is capturing synergies and complementarities among the two enterprises which is feasible when the farming activities are treated as interdependent entities rather than being viewed as isolated enterprises even if they are existing on the same farm. For example, dung produced by the animals is used by the crops and the straw produced by the crops is eaten by the animals which in turn defecate the waste matter, thus repeating the cycle (Block and Webb, 2001). In general, where farming is not mechanized and there is a culture of animal traction, especially among small-scale farmers in developing countries, draught power and crop residues are the main links between crops and livestock.

As already noted earlier, there are several reasons for implementing crop-livestock integrated farming system, although the main reason put forward is that it is one important strategy to improve sustainable productivity. As compared to other farming systems, Chan (2003) states that it is possible to reap the same or higher levels of output with integrated farming, whereas integrated farming uses relatively less inputs, making it a highly efficient system in terms of resource use. It is further contended that the yield would be inherently more sustainable because the waste of one enterprise becomes the input of another, leaving almost no waste to pollute the environment or to degrade the resource base. In this way, crop-livestock integration becomes an effective and at the same time productive means for achieving waste recycling (Thornton and Herrero, 2001).

An integrated crop livestock farming system consists of a range of resource-saving practices that aim to achieve acceptable profits and high and sustained production levels, while minimizing the negative effects of intensive farming and preserving the environment. Based on the principle of enhancing natural biological processes above and below the ground, the integrated system represents a winning combination that, reduces erosion, increases crop yields, soil biological activity and nutrient recycling, intensifies land use, improving profits; and can therefore help reduce poverty and malnutrition and strengthen environmental sustainability (Antonio and Silvia, 2010).

2.2.2 Interactions in Crop-Livestock-Fish Integrated Farming Systems

Possible on-farm interactions between the various subsystems in a crop-livestock-fish integrated farming system are presented in Fig. 1. The schema excludes products from the various subsystems and merely indicates on-farm linkages. Rice-fish culture is well-established in certain Asian countries (de la Cruz and Carangal, in press) and involves a variety of systems e.g., trenches and ponds, constructed in rice land. Livestock excreta (manure) may be used as a fishpond input or to fertilize crops. It is also feasible to incorporate manure into livestock rations. Human excreta may also be used to fertilize the pond or as a crop fertilizer.

Crops may be fed to livestock or used as supplementary fish feed. Water from the fishpond may be used to water crops or as drinking water for livestock. Mud removed from the pond may be used to fertilize crops. Fish that are too small to be marketed may be used as a high protein ingredient in livestock or fish feed.

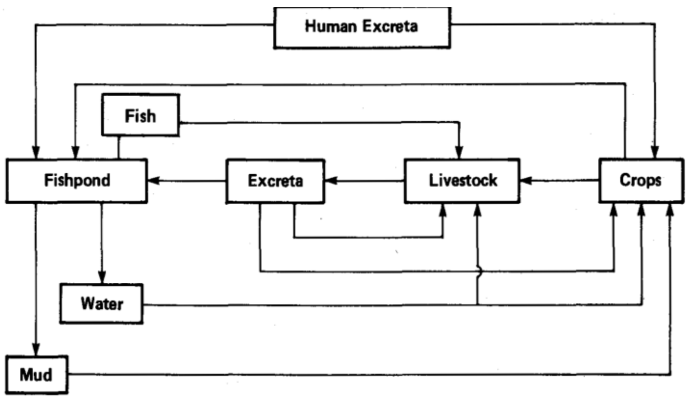

Figure 1 ***Schema of possible on-farm interactions between the various subsystems in a crop-livestock-fish integrated farming system.***

2.2.3 Duck-Fish Integration

Duck-fish integration is the most popular form of integrated farm system, in full meaning it is duck-fish-rice integration. Emphasizing the duck production, fish is the products of subsystem. Addition of manure and waste duck feed into water ponds give benefits to fishes, then productivity may be improved even better. Duck-fish operation is suitable for family household and enterprise as well. From some empirical experiences in province Fujian, utilizing river side the stocking rate of ducks is 1300 per hectare of water surface. Each duck supplies 30 kg of manure, in turn may yield 2 to 3.5 kg of fish, 2.8 kg in average. Jingdin duck is able to lay 180 eggs a year. Such a model allows farmers to get 702 thousand yuan from eggs and 29 thousand yuan from fish per ha. If net income from eggs is half of the gross income, then the fishes give full net income, which means 10% more increases of net income from fish crop (Hirofumi et al, 1997).

2.2.4 Pig-Fish or Pig-Duck-Fish Integration

Pork in China takes more than 70% of meat consumption, in agriculture area it takes more than 80%. Instead of duck, pig may fully or partially takes part in integration. From the experiences each hectare of water surface needs 110 pigs and 320 ducks in order to have enough excrement to feed the fishes. Each hectare of water surface gains 800 thousands of yuan of income with very good ecological effect (Hirofumi et al, 1997).

2.2.5 Pig-Vegetable Integration

Pig and vegetable are integrated through methane and green house operation. A 10 m width and 40 m length greenhouse need dung from a 4-5 person's family and 3 pig's feedlot that can meet the cot supply and energy for heating in winter. Mechanic ways of coz supply need big input that offsets the benefit and is impossible at power shortage regions, a methane generating pit constructed by having 8 to 10m ^{2} is enough to operate a 400 square meters green house. And 4 to 6 ovens in a greenhouse are necessary to warm the house in winter, the same time this amount of cot gas is enough for photosynthesis of plants. It was reported that 3 to 4 rotational crops of vegetable in this size of greenhouse were capable to earn 12 000 yuan a year (Hirofumi et al, 1997).

2.2.6 Chicken-pig Integration

A traditional grain producer may have a pig stay with chicken coop at top, drooping and wasted feed is to be fallen into pig manger. This is a self-sufficient or more than sufficient farming, which is reasonable at undeveloped area, but lack in meaning of commodity production. In other side large chicken enterprises try to process droppings into feed for cattle, pigs and chicks. Today there is no research and observation to claim its parameters for references. Even though it is necessary to say, that China, having 2692 millions of chickens, is capable to process 80 million tons of droppings a year. In comparison with 103.5 million tons of feed produced in whole China the dropping processing is quite meaningful (Hirofumi et al, 1997).

2.2.7 Livestock-Environment Interaction

One of today's crucial agricultural dilemmas is how to find a balance between a fast growing global demand for food and the need to sustain the natural resource base of land, water, air and bio-diversity (Cheeke, 1993; Steinfeld, et al., 1998). As important component of agriculture, livestock are one of the main users of natural resource and can favorably and unfavorably react with the environment. Sere and Steifeld (1996) reported that about 34 million km2 or about 21 percent of the world's land area is used for grazing livestock, and 3 million km2 or about 21 percent of the world's arable land is used for cereal production for livestock feed. Haan, et al (1989) and Steinfeld et al (1998) have made a comprehensive review and have critically analyzed livestock-environment interaction impacts across the livestock production systems. In the Ethiopian Highlands negative livestock-environment interaction impacts are associated with overgrazing and land degradation (Steinfeld et al., 1998). But how do they happen? While grazing animals can improve soil cover by dispersing seeds with their hoofs; through manure; while controlling shrub growth; breaking up soil crust and removing bio-mass (which otherwise might provide fuel for bush fires), on the other hand heavy grazing or overgrazing causes chemical and physical soil degradation (Cheeke, 1993; Steinfeld, 1998). Overgrazing reduces plant cover, causes soil compaction and hence reduces infiltration and increases run-off, decreases soil fertility, organic matter content, all contributing to physical and chemical land degradation. Grazing per se, does not destroy or degrade grasslands and ranges. The major threat to grassland ecosystems today is their potential for conversion to farmlands, which has often been favored by development programs and policies (Cheeke, 1993).

Across the world the most productive pasture lands are being turned into crop lands as demands for arable lands continues to increase with the rapid increase of human population, with livestock being marginalized into limited and increasingly poorer and fragile grazing area. The situation is the same in the Highland Production System of Ethiopia.

Therefore, livestock associated environmental damages have a lot to do but with the ever increasing and conflicting interests that people carry for both livestock and the environment. More often ignorance about ecosystems and their links with livestock leads to wrong policy and development decisions. The challenge is to critically identify and enhance positive contributions of livestock in agricultural development that will satisfy current and future human needs, while preserving the natural resource base. With government support and willingness and commitment by all stakeholders, there are sufficient mechanisms to keep adverse effects of livestock production within acceptable limits. Thereby enhance the net contribution of livestock to sustainable agriculture; such a move contributes significantly towards the efforts to ensure food security and food self-sufficiency.

2.2.8 Wildlife- Livestock Interaction

The study was conducted by David et al (2012) on the impacts of wildlife-livestock interactions within and around Arusha National Park (Tanzania). The result indicated that five factors influencing wildlife-livestock contacts were identified, the most significant being wildlife habitat loss and drought. Generally, no diseases were identified inside the park but to livestock keepers; the tick-borne disease, East Coast Fever (ECF) was a great threat as it caused large economic losses. About 623 cattle deaths that happened in the study villages in year 2009 and 2010 were attributed to ECF. Also in the Northern Tanzania, there was a severe drought in the same years (2009/10) that might have predisposed the livestock to disease conditions and ultimate deaths. Spotted hyena (Crocuta crocuta) was pointed out to be the most problematic wild carnivore that attacks goats and sheep, mostly during night times. Livestock diseases are still potential threat to wildlife conservation initiatives, therefore efforts should be made to control them if sustainable wildlife conservation is to be attained.

2.3 INTENSIFICATION OF ANIMAL PRODUCTION

Intensification of livestock systems is the process of modifying production practices to increase output per animal, per unit of land and per unit of labour (Nicholson et al., 1995). For instance, in ruminant livestock production, production output is measured in terms of the amount of milk or beef per unit of land. In its broadest sense, intensification can range from minor modifications to the complete restructuring of existing systems.

In extensive systems, increasing the number of animals reared without improving system performance places pressure on the available resources, often resulting in land and pasture degradation. For example, in southern Africa, poor range management involving overgrazing practices are to blame for increased soil erosion and increased amount of poor pasture and invasive plant species on the natural pasture. Often, degraded cropland is converted into pastures. Pasture productivity has lagged far behind that of cultivated areas, although detailed estimates are difficult to make. These trends demand new policy and well-defined roles for public and private institutions to manage system dynamics and ensure equitable use of available resources without compromising the needs for future generations. Obviously, different forms of production will have different impacts on the environment, and social structure of rural areas. When population density increases and less land becomes available, the general trend is for crop and livestock activities to integrate and later to specialise in separate intensive and large-scale crop and livestock farms.

Intensification of livestock production is taking place mostly with regard to inputs. There is a shift towards more grain-based production and away from traditional livestock production systems based on locally available feed resources, such as natural pasture, local fodder, crop residues and unconsumed household food (FAO, 2005). Pressure to intensify livestock production systems has resulted in direct competition between crops for human and animal feed and biofuels. For instance in 2004, 690 million tonnes of cereals (34 percent of the global cereal harvest) and another 18 million tonnes of oilseeds (mainly soya) were fed to livestock. In addition, 295 million tonnes of protein-rich processing by-products were used as feed (mainly bran, oilcakes and fish meal). In this context, intensification draws on technological improvements in areas such as genetics, health, feed and farm management that contribute to increased natural resource use efficiency and output per animal.

A dramatic shift towards the production of monogastric animals, such as chickens and pigs, which use concentrated feeds more efficiently than cattle or sheep, has occurred in the last decade. Chickens and pigs also have short life cycles that accelerate genetic improvements. For instance, between 1980 and 2004, pig meat, chicken meat and milk offtake per unit of stock increased by 61 percent, 32 percent and 21 percent respectively (FAO, 2005). According to Naylor et al. (2005), the average time needed to produce a broiler in the USA was cut from 72 days in 1960 to 48 days in 1995, and the slaughter weight rose from 1.8 to 2.2 kg. Meanwhile, feed conversion ratios (FCRs) of kilogram of feed per kilogram of meat produced were reduced by 15 percent for broilers and by over 30 percent for layers.

Overall, annual growth in pig and poultry production in developing countries was twice the world average in the 1990s. By 2001, three countries – China, Thailand, and Vietnam – accounted for more than half of the pigs and a third of the chickens produced worldwide (Delgado et al., 2008). Brazil is also a major producer of chickens and pigs and is expected to become the world's leading meat exporter (FAO, 2005).

Determining the most appropriate ways to increase production is critical in intensive systems. Feed accounts for about 50–60 percent of total production costs in ruminant feeding systems, and 65–80 percent in industrial or intensive systems. Smallholder farmers are more wary of large production costs, especially feed costs, and industrial production systems depend heavily on external inputs (Devendra and Sevilla, 2002).

The increased cereal requirements needed to meet increased feed demand of the pig and poultry population over the next two decades will require an additional 65 million hectares to be placed under cultivation, an area more than the size of France (World Bank, 2005).

Rudimentary indicators that define livestock systems' levels of intensification and specialisation or diversification will need to estimate the share and trend of agricultural land engaged in livestock breeding or cereal (wheat and maize). The Role of Livestock in Developing Communities: Enhancing Multifunctionality production. This means assessing the number of livestock units (stocking density) per hectare of utilised agricultural land and milk or cereal production trends per hectare.

The intensification and concentration of the livestock industry over the last decades is threatening to crowd out the poor. Successfully protecting the smallholders therefore, depends to a large extent on the level and success of pro-poor policies, institutions and technologies focused on poverty alleviation (de Haan et al., 2001). Mitigating the negative effects and enhancing the positive effects of livestock intensification, and to enhance sustainability, the following factors have become crucial: environmental impact, markets, food safety and institutional arrangements.

2. 4. ENVIRONMENTAL IMPACT AND POLICY ASSESSMENT

Livestock agriculture is the world's largest use of land resources and engages very closely with landscape management, biodiversity, soil conservation and the holistic function of agro ecosystems. Within these the major environmental impacts are on land degradation, water depletion and pollution and biodiversity. These impacts are however dependant on the system of production and its intensity. Extensive systems can make positive contribution of land scape and biodiversity and efficient manure management can improve nutrient supply to soils. Conversely when mismanaged or through pressure on land, livestock can have marked adverse environmental impact.

The livestock sector is by far the single largest anthropogenic user of land. According to Steinfeld (2007), "Extensive livestock production plays a critical role in global warming, land degradation, air and water pollution, and loss of biodiversity. Grazing occupies 26 percent of the Earth's terrestrial surface, while feed crop production requires about a third of all arable land. Expansion of grazing land for livestock is a key factor in deforestation, especially in Latin America: some 70 percent of previously forested land in the Amazon is used as pasture, and feed crops cover a large part of the reminder. About 70 percent of all grazing land in dry areas is considered degraded, mostly because of overgrazing, compaction and erosion attributable to livestock activity.

In the large-scale livestock operations, there are a wide variety of problems caused by intensive livestock production, including increased greenhouse gas emissions, increased health risks to workers and those living near intensive livestock farms, land and water shortage and degradation, environmental problems related to the storage and disposal of manure, and health problems caused by the use of hormones and antibiotics.

According to Vries (2010), twenty five studies were conducted to assess the impact of production of pork, chicken, beef, milk, and eggs using life cycle analysis (LCA). Only 16 of these studies were reviewed, based on five criteria: study from an OECD (Organization for Economic Cooperation and Development) country, non-organic production, type of LCA methodology, allocation method used, and definition of system boundary. LCA results of these 16 studies were expressed in three ways: per kg product, per kg protein, and per kg of average daily intake of each product for an OECD country. The review yielded a consistent ranging of results for use of land and energy, and for climate change. No clear pattern was found, however, for eutrophication and acidification. Production of 1kg of beef used most land and energy, and had highest global warming potential (GWP), followed by production of 1kg of pork, chicken, eggs, and milk. Differences in environmental impact among pork, chicken, and beef can be explained mainly by 3 factors: differences in feed efficiency, differences in enteric CH_4 emission between monogastric animals and ruminants, and differences in reproduction rates. The impact of production of 1kg of meat (pork, chicken, beef) was high compared with production of 1kg of milk and eggs because of the relatively high water content of milk and eggs. Production of 1kg of beef protein also had the highest impact, followed by pork protein, whereas chicken protein had the lowest impact.

Elferink (2008) reported that the environmental impact of meat is high mainly due to the feed required by livestock in combination with the impacts of cultivating, transporting and processing of feed crops. Like regular feed crops, livestock also feed on residue from the food industry, such as pulp, scrap and peels. Both types of raw material have different environmental impacts. Feeding food residue to livestock is an efficient way to upgrade a low quality material into high quality foods. The environmental impact of animals feed food residue-based feed is also significantly lower than grain-based feed. Changes of vegetable and animal product consumption for pigs influence the environmental impact of pork. Increasing of meat consumption would require more feed grains with a correspondingly larger environmental impact because food residues are used up.

2.4.1 Livestock Impacts on the Environment

2.4.1.1 **Increased Green House Gas Emissions**

The increase in greenhouse gas emissions caused by raising animals, especially the increase in concentration of animals in intensive livestock farms, has been well-documented by the UN. Livestock is in fact responsible for a higher share of greenhouse gases: 18% of greenhouse gas emissions, which is more than the whole transportation industry (FAO, 2006a). While all farm animal operations release large amounts of carbon dioxide (9%), intensive livestock farms require more energy than traditional farming methods (FAO, 2006b). Because intensive livestock farms usually raise animals indoors, they use large amount of energy for heating, cooling, and ventilating as well as for feed production and transportation (FAO, 2006b). In fact, operating intensive live-stock farms produces even more carbon dioxide emissions than does the manufacturing of chemical fertilizer for animal feed (FAO, 2006b). But looking only at carbon dioxide emissions is insufficient. The livestock sector also emits 68% of anthropogenic nitrous oxide (most of which comes from manure), which stays in the atmosphere for up to 150 years and has 296 times the global warming potential of carbon dioxide (FAO, 2006b). It adds to global warming, and it adds to the depletion of the ozone layer (FAO, 2006b). Livestock are also responsible for almost 64% of anthropogenic ammonia emissions, which contribute significantly to acid rain and acidification of ecosystems (LEAD, 2006).

As the UN report on livestock shows, worldwide, farm animals are also the most sig-nificant source of anthropogenic methane, responsible for 35–40% of global methane emissions (FAO, 2006b). Methane has 23 times the global warming potential of carbon dioxide (LEAD, 2006). Farm animal operations lead to increased methane emissions because of the animals’ diet, which causes the ruminants to develop a number of illnesses (Smith 1998; Russell and Rychlik 2001) and to generate 50% more methane emissions than cattle raised on grasses in the

United States (US EPA, 1998).

2.4.1.2 Land Degradation

Farm animals raised for their meat, egg, and milk already cover one-third of the planet's total surface area and use more than two-thirds of its agricultural land (de Haan et al. 1997). Farm animals are a major cause of deforestation because forests are cut down to make room for grazing animals, and to plant animal feed. Therefore grazing is cause of land degradation. Using large areas of land for animal feed can result in major biodiversity losses, such as those occurring in the Cerrado region in Brazil, the world's most biologically diverse savanna. Converting land to pasture or fields of soy and corn used to feed animals grown for meat and milk results in deforestation, biodiversity losses, worsened soil erosion, and increased carbon emissions (Kaimowitz and Smith, 2001). The impact this is having will only worsen with the increased demand for animal products per capita, the spread of intensive livestock farms, and population growth.

2.4.2.3 Water Poullusion and Water Shortage

The other problem with both intensive livestock farms and traditional livestock farming methods is water pollution and water shortage. ''nutrients from livestock and poultry manure are key sources of water pollution caused by ever-growing numbers of livestock and poultry per farm and per acre'' in intensive livestock farms (Ribaudo, 2003). ''The livestock sector is a key player in increasing water use and water depletion'' (FAO, 2006b). Irrigating feed crops alone uses seven percent of the global water use (FAO, 2006b). While animals used in extensive livestock systems use more water per animal (FAO, 2006b,), intensive systems allow for a much larger number of animals to be raised, thus using more water. Furthermore, the livestock industry affects water quality ''through the release of nutrients, pathogens and other substances into waterways, mainly from intensive livestock operations'' (FAO. 2006b).

2.4.2.4 Losses of Biodiversity

The sheer quantity of animals being raised for human consumption also poses a threat of the Earth's biodiversity. Livestock account for about 20 percent of the total terrestrial animal biomass, and the land area they now occupy was once habitat for wildlife. In 306 of the 825 terrestrial eco-regions identified by the Worldwide Fund for Nature, livestock are identified as "a current threat", while 23 of Conservation International's 35 "global hotspots for biodiversity" - characterized by serious levels of habitat loss - are affected by livestock production.

2.4.2 Measures To Mitigate Livestock's Threats To The Environment:

The FAO report recommends a range of measures to mitigate livestock's threats to the environment:

Land degradation: Restore damaged land through soil conservation, silvopastoralism, better management of grazing systems and protection of sensitive areas.

Greenhouse gas emissions: Sustainable intensification of livestock and feed crop production to reduce carbon dioxide emissions from deforestation and pasture degradation, improved animal nutrition and manure management to cut methane and nitrogen emissions.

Water pollution: Better management of animal waste in industrial production units, better diets to improve nutrient absorption, improved manure management and better use of processed manure on croplands.

Biodiversity loss: As well as implementing the measures above, improve protection of wild areas, maintain connectivity among protected areas, and integrate livestock production and producers into landscape management.

2.4.3 The policy frame Work

To run successful animal production without affecting the environment needs strong policy support. The policy addresses the use of natural resources and management practices and that provide for environmentally sustainable development. Some factors to be considered include watershed management, nutrient recycling, and biodiversity, changing socio-economic conditions and attitudes, and consumer preferences.

2.4.4 Design Environmental Impact Assessment as a Policy tool

Environmental impact assessment is a systematic framework for identifying, predicting and evaluating the environmental effects of proposed actions and projects. This framework is implemented to provide information for decision-making on the environmental consequences of proposed actions; and to promote environmentally sound and sustainable development through the identification of appropriate enhancement and mitigation measures**.** Therefor all the nations must design the policy and prepare the guideline to take corrective measures.

2.4.5 Design Green Economy Policy (Ethiopia)

According to NankiKuar (2013) report, the Ethiopian government wants the country to achieve middle-income status by 2025 in a carbon neutral way by transforming development planning, investments and outcomes. The country's Climate Resilient Green Economy Strategy (CRGE) was developed in 2011 by the late Prime Minister, Meles Zenawi. The CRGE has widespread political support. It's viewed as an opportunity to transform the country's development model by leapfrogging to modern energy-efficient development trajectories.

Ethiopia is one of the few countries to have formally merged its aims of developing a green economy and greater resilience to climate change under a single policy framework in support of its national development objectives. While the government is still preparing its climate resilience objective, the Green Economy component of the CRGE has already been developed.

It aims to develop Ethiopia's green economy by:

- Improving crop and livestock production practices to improve food security and increase farmer's incomes while reducing emissions;
- Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks;
- Expanding electricity generation from renewable energy sources for domestic and regional markets; and
- Leapfrogging to modern and energy-efficient technologies in transport, industrial sectors, and buildings.

Therefore all countries thought out the world must design climate resilience green economy policy to create the safest environment for the healthy life of the citizen.

2.4.6 Stricter Regulations

Strict regulations must be increased to save the environment. It helps to prevent the health and environmental problems caused by intensive livestock farms. If the regulations were stricter, it is assumed that air, land, and water pollution and use fewer natural resources are regulated for healthier life.

2.4.7 Community Mobilizing

This involves focusing on areas where intensive livestock farms may be built in a sophisticated manner, and mobilizing the community in order to prevent intensive livestock farms from being built in that particular community. The idea here is that if every community did this, we may be able to prevent intensive livestock farms from being built altogether.

2.4.8 Decreasing Demand

Animal agriculture in the developed nations, like many other industries, works on the principles of supply and demand. By decreasing the demand for these products, Individuals can do this by becoming vegetarian or vegan, but also by simply cutting down one's consumption of meat, eggs, and milk produced in intensive livestock farms.

2.5 CONCEPTS OF ORGANIC ANIMAL FARMING

Organic animal husbandry is defined as: a system of livestock production that promotes the use of organic and biodegradable inputs from the ecosystem interms of animal nutrition, animal health, animal housing and breeding. It deliberately avoids the use of synthetic inputs such as drugs, feed additives and genetically engineered breeding inputs (Chander et al, 2011).

Animal production is an important part of organic farming that aims at achieving a balanced relationship between the soil, the plants and the animals in a farming system (Vaarst et al, 2006). Each component is as important as the other in contributing to the overall effect and in fulfilling the key values of naturalness, harmony, local circulation of resources and the principle of precaution. Consumers expect the food from organic production to be of a certain quality that makes it different from conventionally produced food. Acknowledged consumer interests cover a wide range of issues, from the nature of farming as a whole (environmentally friendly, socially just, animal welfare friendly) to the concern over own health (buying organic food based on a perception of organic food being more healthy).

The organic farming values and the consumer expectations form a complex concept of quality. Organic farming standards are designed to reduce the environmental impact of food production, to encourage socially and ethically just food production and to guarantee safe and healthy food.

In organic livestock production systems, consumers expect organic milk, meat, poultry, eggs, leather products, etc. to come from farms that have been inspected to verify that they meet rigorous standards, which mandate the use of organic feed, prohibit the use of prophylactic antibiotics (though in fact all antibiotics are discouraged except in medical emergencies) and give animals access to the outdoors, fresh air and sunlight. Production methods are based on criteria that meet all health regulations, work in harmony with the environment, build biological diversity and foster healthy soil and growing conditions. Animals are marketed as having been raised without the use of persistent toxic pesticides, antibiotics or parasiticides (Von Borell & Sørensen, 2004).

To be precise, organic meat, milk and eggs are produced, harvested, preserved and processed according to verified organic standards. Practically speaking, organic methods call for a change in existing production systems. Organic livestock production is more demanding than crop production since, to raise livestock organically, their fodder crops must also comply with strict organic standards.

The primary characteristics of organic livestock production systems are:

- Well-defined standards and practices which can be verified
- greater attention to animal welfare
- no routine use of growth promoters, animal offal, prophylactic antibiotics or any other additives
- at least 80% of the animal feed grown according to organic standards, without the use of artificial fertilisers or pesticides on crops or grass.

2.5.1 Key Considerations in Organic Livestock Production

Some key considerations in organic animal husbandry that producers and other stakeholders need to take into account are listed below:

2.5.1.1 Origin of livestock

All livestock (and all products from these livestock) that are sold, labelled or advertised as organic must be raised under continuous organic management from the last third of gestation or at hatching.

2.5.1.2 Livestock feed

The total rations of livestock that are produced under organic management must consist of agricultural products that have been organically produced and handled organically. This includes pasture, forage and crops. Certain non-synthetic and synthetic substances may be used as feed additives and supplements. Twenty percent of the feed for dairy cattle under nine months of age is allowed to come from non-organic sources. Plastic pellets, urea, manure and by-products from mammalian or poultry slaughter are not allowed.

2.5.1.3 Living conditions

An organic livestock producer must create and maintain living conditions that promote the health and accommodate the natural behaviour of the animal. These living conditions must include access to the outdoors, shade, shelter, fresh air, direct sunlight suitable for the particular species and access to pastures for ruminants.

2.5.1.4 Waste management

Organic livestock producers are mandated to manage manure so that it does not contribute to the contamination of crops, soil or water and optimises the recycling of nutrients**.**

2.5.1.5 Health care

Organic livestock production requires producers to establish preventive health care practices. These practices include:

- selecting the appropriate type and species of livestock
- providing adequate feed
- creating an appropriate environment that minimises stress, disease and parasites
- administering vaccines and veterinary biologics
- Following animal husbandry practices to promote animal well-being in a manner that minimises pain and stress.

Producers cannot provide preventive antibiotics. Producers are encouraged to treat animals with appropriate protocols, including antibiotics and other conventional medicines when needed, but these treated animals cannot be sold or labelled as organic. Producers cannot administer hormones or other drugs for growth promotion.

2.5.1.6 Record keeping/audit trail

Organic livestock operations need to maintain records for a number of reasons. Certainly, records are important for the financial management of any organic livestock enterprise. However, records are also important to verify the organic status of the animals and the production, harvesting and handling practices associated with them and their products.

2.5.2 Benefits of Organic Livestock

Although livestock are usually the last part of the farm to be certified organic, they are often central to the farm and can contribute to its success. Livestock play an even more critical role on organic farms than they do on conventional farms. Livestock on an organic farm play a key role in:

- *Nutrient cycling*: a process in which nutrients are returned to the soil through manure and compost. Amending soils with animal manures can increase microbial biomass, enzymatic activity and alter the structure of the microbial community incorporation of feed crops, such as alfalfa or grasses into crop rotations helps to build soil organic matter Increasing cropping options, adding diversity to the agro-ecosystem
- *Weed control*: feed crops can be used to suppress and control weeds and animals can be used to graze out weeds on crops or pastures
- *Preparing the ground for cropping*: Livestock such as pigs can 'plough' rough or new land before planting vegetables or grains, reducing tillage and weed control costs
- *Interrupting insect and disease cycles*: by taking land out of cropping
- *Adding value*: to grass-lands and promoting the use of green manures
- *Reducing the financial risks*: of farming by converting lower quality grain crops and screenings into profit and spreading income more evenly over the year

2.5.3 Problems in Developing Organic Animal Husbandry

While many tropical countries are making great efforts to boost organic production with considerable success, some serious problems are still restricting growth in organic farming. Some of these potential obstacles, especially when exporting livestock products, are as follows: lack of knowledge, small farm size and problems in livestock feeding, sanitary regulations, traceability, disease and lack of training and certification facilities.

2.6 ROLES OF ANIMALS IN SUSTAINABLE AGRICULTURE & ECONOMIC DEVELOPMENT

The majority of the world's estimated 1.3 billion poor people live in developing countries where they depend directly or indirectly on livestock for their livelihoods (World Bank, 2008 and FAO, 2009). Globally, livestock contributes about 40 percent to the agricultural gross domestic product (GDP) and constitutes about 30 percent of the agricultural GDP in the developing world (World Bank, 2009). Livestock in Ethiopia is an integral part of the agriculture and the contribution of live animals and their products to the agricultural economy accounts for 40%, excluding the values of draught power, manure and transport of people and products (Winrock International, 1992) and accounts 19% to the export earnings (Befekadu and Birhanu, 2000). These estimates highlight the important contribution of livestock to sustainable agricultural development.

The contribution of livestock to the world's food supply, family nutrition, incomes, employment, soil fertility, livelihoods, transport and sustainable agricultural production continues and helps for the contribution of Food security and poverty reduction (Randolph et al., 2007). Furthermore, estimates show that globally, livestock provide animal traction to almost a quarter of the total area under crop production and also provides traction for about 50% of the world's farmers (Devendra, 2010). Livestock also provide a safety net in times of need in the form of liquid assets and a strategy of diversification for food production (Freeman et al., 2007).

Generally to fully understand the positive contribution of livestock to the production system, with regard to food security and food self-sufficiency, the major contributions of livestock are as followes:

2.6.1 Source of Food and Nutrition

In order to increase livestock's contribution to the livelihoods of developing communities requires improved understanding of livestock's multiple and complex roles. The contribution of food from animal origin to the nutritional status of the world population is well documented (Ndlovu, 2010). Livestock products account for almost 30 percent of human protein consumption (Steinfield et al., 2006).

Livestock are important as producers of meat, milk and eggs, which are parts of the food chain and, which provide high value protein food. They have long played a key role in supplying calories and protein for human food in virtually all parts of the world, both directly (in the form of animal products), and indirectly (from the contribution of manure and draught power to crop production and generation of income to enable purchase of food (Animal Agriculture and Global Food Supply, 1999).

The important contribution of livestock into the human dietary protein has been reported by (Cheeke, 1993; Haan et al., 1998; Animal Agriculture and Global Food Supply, 1999). In the first half of the 1990s, residents of developed countries consumed as food 78 kg of meat and 22 kg of fish per capita, with higher amount of meat in the United States and higher amount of fish in Japan. Corresponding figures for Sub Saharan Africa were 12 kg of meat and 8 kg of fish. The significance of livestock in the food chain can be expected to increase over the next decades. While demand for animal products in the developed world will probably plateau or even decline, there will be a strong increase in the developing countries (Haan et al., 1998; Animal Agriculture and Global Food Supply, 1999). Current levels of meat and milk consumption in the developing world are only about one-fifth of those in the industrialized world (Haan et al., 1998). The driving force for the increased demand for livestock products is a combination of population growth, currently relatively low intake, and rising incomes and urbanization (Cheeke, 1993; Haan et al., 1998). The current demand driven livestock revolution underway is in response to the ever-increasing demand for animal origin food in developing countries. .

Considering the significance of livestock in the food chain (which is also expected to increase over the next decades) and the increasing demand (preference) for animal origin food, the role of livestock in food security and food self-sufficiency is and will be important. Both supply of food and meeting preference are elements of food security and livestock contribution to the availability of food is important in the efforts to ensure food self-sufficiency.

2.6.2 Source of Power

Importance of livestock as major source of power in tropics has been well documented (Steinfeld et al., 1998). Millions of people depend upon animal power for cultivation, planting, weeding, threshing and transportation. Telein and Murry (1991) cited evidence that draft animals provide the power for the cultivation of nearly 50 % of the world cultivated land and the hauling of 25 % carts. More than 240 million cattle and 60 million buffalo are kept as work animals. In Ethiopia, the vast majority of rural people comprising 85 percent of the total population depend on animal power for cultivation, weeding, threshing and transportation. As elsewhere in developing countries (Cheeke, 1993), use of tractors is very insignificant, for reasons of economy, topography and highly fragmented land holdings. Draft animals provide power for about 96 percent of the cultivated land in the Highland areas. Work animals can be also used to cultivate arable land inaccessible to tractors. They are relatively affordable and do not require inputs, which tractors would require such as fuel, repairs, and spare parts. This is particularly important in view of the shortage of foreign currency earnings, which Ethiopia has.

In Ethiopia Gryseels et al (1984) observed a positive relationship between the number of oxen owned by farm household and both the area cultivated and percentage of sown to marketable cereals. There are cases where arable lands are not cropped and/or not timely and efficiently cultivated, due to lack of or emaciated (weak) work animals, which in turn reduces overall crop production, regardless of availability of improved agricultural inputs (seed fertilizer etc.). It can be argued that issues of crop production cannot be efficiently addressed in isolation, without considering livestock, which are the major source of traction power. Therefore as source of power livestock are means of crop production and play role in ensuring availability of food, which is an element of food security. Furthermore, as means of transport for agricultural produce to household and market places, they link supply and demand and hence assist in food distribution.

Nevertheless, until recently recognition of livestock as important source of power has not been well established, and for many years aid programs and foreign specialists virtually ignored the roles of draft animals in food production (Cheeke, 1993). There was often a tendency to regard animal power as an archaic concept, to be replaced with fossil fuel-power device as soon as possible, which reflects disregard and lack of understanding of the role of livestock in the rural setting of developing countries. Accordingly, efforts to improve availability, accessibility and efficiency of animal power have been negligible in programs to boost crop production. However recently, it is being increasingly recognized that animal power will remain important in many developing countries for years to come, and attitude is changing.

2.6.3 Source of Organic fertilizer

Livestock play a significant role in maintaining soil fertility. When spread on cropland, animal manure increases soil organic matter, and improves soil texture (Cheeke, 1993; Haan et al., 1998). For the vast majority of small-holders in the highland area, nutrient recycling through manure, compensate for lack of access to chemical fertilizer, and helps to maintain the variability and environmental sustainability of production (Steinfeld et al., 1998). While global fertilizer use increased from 81 to 96 kg/ha of cropland, fertilizer use in Sub-Saharan Africa in 1988 to 1990 was estimated to be only 11 kg/ha of harvested land. A rate projected to increase to only 21 kg/ha harvested land by 2020 (Animal Agriculture and Global Food Supply, 1999). Chemical fertilizer use in Ethiopia was only 17 kg/ha in 1999/2000 (personal communication), which is very low, indicating the potential role of animal manure as accessible, cheap and valuable fertilizer.

Crop response to manure varies with plant and soil types, agro-ecological zones, and with manure quality (Animal agriculture and Global Food Supply, 1999). Powell (1986) reported a response of 180 kg maize grain per ton of manure applied in the sub-humid zone of Nigeria. An added benefit is the residual positive effect of manure, which may persist for up to three cropping seasons after application (Ikombo, 1989; Powell et.al., 1989). McIntire et.al. (1992), estimated increases in grain ranging from 15 to 86 kg grain per a ton of manure applied to cropland. Therefore efficient use of this valuable resource remains vital, in efforts to attain household food security in a sustainable manner. Generally as source of organic fertilizer livestock play great role in boosting crop production. This is in line with ensuring food availability and preference (the current preference for organic produce), which are elements of food security.

2.6.4 Source of Income and Living Bank

Livestock are important sources of income for at least 200 million small-holder farmers in the Asia, Africa and Latin America (Haan et al. 1998). In the highlands of Ethiopia livestock are indicators of wealth of a family and are used for wealth ranking. Further, they are the main form of investment because of the absence of financial institutions. Livestock are cash at hand and provide owners with purchasing power. In many countries, access to food is limited not by availability but by purchasing power (Animal Agriculture and Global Food Supply, 1999). For example in Ethiopia, crop production has increased and the country has become a net exporter. Yet, some of the export has been purchased by the European Community, for distributing to poor Ethiopians who cannot purchase food regardless of its availability. Livestock are often sold to generate cash, amongst others to purchase food (in times of crop failure) and purchase agricultural inputs, which in turn increase crop production. Therefore livestock as a source of cash ensure economic accessibility to food, hence key role in attaining food security

2.6.5 Source of Foreign Currency

The role of livestock in foreign currency earnings is substantial in Ethiopia, a country, which have very limited export items (Cheeke, 1993; Haan et al. 1998). In Ethiopia, there is huge and yet untapped livestock potential in foreign currency earning. Foreign currency earnings generated from livestock, are used for, amongst others, to import different goods and services for the development of the country.

2.6.6 Social functions

Beyond the important role that livestock play in the provision of food and nutrition in people's diets, they also have important social functions. They raise the social status of owners and contribute to gender balance by affording women and children the opportunity to own livestock, especially small stock (Waters-Bayer and Letty, 2010).

2.6.7 Risk buffer

In marginal areas with harsh environments, livestock provide a means of reducingthe risks associated with crop failure and a diversification strategy for resource poor small scale farmers and their communities (Freeman et al., 2007, Thornton et al., 2007 and Vandamme et al., 2010).

2. 7. CONSTRAINTS OF TROPICAL CLIMATE TO LIVESTOCK PRODUCTION

Numerous physical, biological and socio-economic factors interact to influence the nature and extent of animal agriculture practiced in any region. Climate, which includes both temperature and precipitation, can affect any animals' ability to survive and to be productive in many ways. Some regions, because of temperature extremes, topography or excessive lack of moisture, are totally unsuited for habitation either continuously or during particular seasons. Others may support livestock during some seasons but not others. Climate can affect livestock both directly and indirectly (McCarthy et al, 2001). Direct effects from air temperature, humidity, wind speed and other climate factors, influence animal performance such as growth, milk production, wool production and reproduction. Climate can also affect the quantity and quality of feedstuffs such as pasture, forage and grain, and the severity and distribution of livestock diseases and parasites. In the tropics livestock productivity has been severely affected by vector-borne livestock diseases which are known to be climate sensitive (Ford and Katondo, 1977). The direct effects of climate change could translate into the increased spread of existing vector-borne diseases and parasites, accompanied by the emergence and circulation of new diseases.

The impacts of climate change also depend on the rainfall which generally affects crop and grassland productivity, ultimately affecting livestock net income (Niggol and Mendelsohn, 2008). There are three plausible explanations. First, farmers shift to crops as rainfall increases; second, grassland shifts to forests as rain increases, reducing the quality and quantity of natural grazing for most animals; and third, increases in precipitation increase the incidence of certain animal diseases (Niggol and Mendelsohn, 2008).

2.7.1 Heat Stress and Livestock

Climatic factors, such as high ambient temperature, high relative humidity (RH), high solar radiation, and low wind speed can induce a heat stress response in heat-susceptible animals. The heat load may, for at least part of the year (seasonal), induce physiological and behavioral changes that contribute to a decrease in production and reproduction, and could impair immune function (Finocchiaro et al, 2005). Biologically, animals are able to minimize adverse effects of a high heat load by invoking physiological mechanisms, such as an increased respiration rate, an increased sweating rate, changes in endocrine function, and a reduced metabolic rate (Sevi et al, 2001). When the physiological mechanisms fail to alleviate the effect of heat load, the body temperature may increase to a point at which animal well-being is compromised. The loss in body weight during hot conditions is essentially a result of reduced dry matter intake and an increase in maintenance requirements caused by the increased physiological functions (Marai et al, 2006).

Under heat stress, a number of physiological and behavioural responses vary in intensity and duration in relation to the animal genetic makeup and environmental factors. Climatic, environmental, nutritional, physical, social or physiological stressors are likely to reduce welfare and performance of animals (Freeman, 1987). Adaptation to heat stress requires the physiological integration of many organs and systems viz. endocrine, cardiorespiratory and immune system (Altan et al, 2005).

Heat stress reduces libido, fertility and embryonic survival in animals. Primary effect of environmental stress in neonates is increased disease incidence associated with reduced immunoglobulin content in plasma. Heat stress in late gestation reduces fetal growth and alters endocrine status of the dam.

Carryover effects of heat stress during late gestation on postpartum lactation and reproduction are also detectable (Collier et al, 1982). Thermal stress lowers feed intake of animal which in turn reduces their productivity in terms of milk yield, body weight and reproductive performance (Kimothi and Ghosh, 2005). High ambient temperature can adversely affect the structure and physiology of cells causing impaired transcription, RNA processing, translation, oxidative metabolism, membrane structure and function (Iwagami, 1996)

The global warming and rise in temperature during summers negatively impact on reproductive functions and milk production of animals in tropics (Upadhyay et al, 2007). The incidence of silent heat or poor expression will be more common at high temperatures during summer of 2015 and beyond particularly in buffaloes that have limited access to water for either drinking and/ or wallowing.

These buffaloes at high temperatures may also fail to conceive due to silent heat or poor expression of heat, loss of conception, causing long dry periods and inter calving intervals ultimately affecting milk production (Upadhyay et al, 2007).

Heat stress in lactating animals result in dramatic reduction in roughage intake, gut motility and rumination which in turn contribute to decreased volatile fatty acid production and may contribute to alteration in acetate: propionate ratio. Rumen pH also declines during thermal stress (Collier et al, 1982). Electrolyte concentrations, in particular Na+ and K+ are reduced in rumen fluid of heat stressed cattle. The decrease in Na+ and K+ are related to increase in loss of urinary Na+ and loss of skin K+ as well as decline in plasma aldosterone and increase in plasma prolactin (Collier et al,1982). Thermal stress also alters dietary protein utilization and body protein metabolism (Ames et al, 1980).

2.7.2 Green House Gas Emission by Livestock Production

Livestock production is not only affected by climate change but also contributes to the cause. Greenhouse gas emissions occur throughout the livestock production cycle. Feed-crop production and management of pastures give rise to emissions associated with the production and application of chemical fertilizer and pesticides and with the loss of soil organic matter. Further emissions occur because of the use of fossil fuels in the transport of animal feed. Further emissions occur directly from the animals as they grow and produce: most notably, ruminant animals emit methane as a by-product of the microbial fermentation through which they digest fibrous feeds.

Emissions of methane and nitrous oxide occur during the storage and use of animal manure. Processing and transport of animal products give rise to further emissions, mostly related to use of fossil fuel and infrastructure development.

On commodity-basis, beef and cattle milk are responsible for the most emissions, respectively, contributing 41 percent and 20 percent of the sector's overall GHG outputs (This figure excludes emissions from cow manure and cattle used as drought). They are followed by pig meat (9 percent of emissions), buffalo milk and meat (8 percent), chicken meat and eggs (8 percent), and small ruminant milk and meat (6 percent). The remaining emissions are sourced to other poultry species and non-edible products. Emission intensities (i.e. emissions per unit of product) vary from commodity to commodity. They are highest for beef (almost 300 kg CO2-eq per kilogram of protein produced), followed by meat and milk from small ruminants (165 and 112kg CO2-eq.kg respectively). Cow milk, chicken products and pork have lover global average emission intensities (below 100 CO2-eq/kg.) (At the sub-global level, within each commodity type there is very high variability in emission intensities, as a result of the different practices and inputs to production used around the world. Enteric emissions and feed production (including manure deposition on pasture) dominate emissions from ruminant production. In pig supply chains, the bulk of emissions are related to the feed supply and manure storage in processing, while feed supply represents the bulk of emissions in poultry production, followed by energy consumption. Greenhouse gas emissions by the livestock sector could be cut by as much as 30 percent through the wider use of existing best practices and technologies (FAO, 2013)

2.7.3 Challenges of Climate Change on Livestock Production System

Livestock production system is expected to be exposed to many challenges due to climate change in the tropics. They are listed as follows:

2.7.3.1 Direct Effects of a Changing Climate and its Alleviation

Direct effect of climate change through raised temperature, humidity and solar radiation may alter the physiology of livestock, reducing production and reproductive efficiency of both male and female and altered morbidity and mortality rates. Heat stress suppresses appetite and feed intake, however, animals' water requirements is increased. In general, the high-output breeds especially crossbreds, which provide the sizable amount of production, are more vulnerable to heat stress as compared to indigenous one. Also, as people are lured by immediate money making methods, indiscriminate cross breeding is adding to the concern, however, this approach is not sustainable.

Options for alleviating heat stress include adjusting animals' diets to minimize diet-induced thermogenesis (low fibre and low protein) or by increasing nutrient concentration in the feed to compensate for lower intake; taking measures to protect the animals from excessive heat load (shading/improving ventilation by using fans) or enhance heat loss from their bodies (Sprinklers/misters); or genetic selection for heat tolerance or bringing in types of animals that already have good heat tolerance (Renaudeau et al,2010). All these options require some degree of initial investment, some require access to relatively advanced technologies, and all except simple shading require ongoing input of water and/or power. The practicality of implementing cooling measures depends on the type of production system.

They can most easily be applied in systems where the animals are confined and where the necessary inputs can be afforded and easily accessed. In extensive grazing systems, it is difficult to do more than provide some shade for the animals and possibly places for them to wallow. Livestock producers in areas where relative humidity is high, face additional problems as there is less potential for the use of methods based on evaporative cooling. Small-scale producers who have adopted high-output breeds, but struggle to obtain the inputs needed to prevent the animals from becoming overheated, may find that their problems are exacerbated by climate change.

2.7.3.2 Challenges of Climate on Livestock Feeding and Nutrition and its Alleviation

Livestock production and its economic efficiency depend on quantity and quality of feed and water that animals need to survive, produce and reproduce. About 10% of cropland is used for producing animal feed and other agriculture land provides crop residues used for feeding livestock. The future of livestock production systems depends on the continued productivity of these various feed-producing areas – all of which are potentially affected by climate change.

The influence of the climate on the distribution of plant variety and type is complex. The effects of climatic interaction with soil characteristics and its direct effect on plants influences the distribution of the various other biological components of the agro-ecosystem – pests, diseases, herbivorous animals, pollinators, soil microorganisms, etc. – all of which in turn influence plant communities. All these processes have the potential to influence directly or indirectly the growth of the plants on which livestock feed.

Pressure on feed resources and other constraints to traditional livestock-keeping livelihoods have promoted the spread of agro-pastoralism (i.e. livelihoods that involve some crop production in addition to livestock keeping) at the expense of pastoralism. In production systems where animals are fed on concentrates, rising grain prices (may be driven by climate change) increase the pressure to use animals that efficiently convert grains into meat, eggs or milk. Thus, within such systems climate change may lead to greater use of poultry and pigs at the expense of ruminants, and greater focus on the breeds that are the best converters of concentrate feed under high external input conditions. Increases in the price of grain may also contribute to the further concentration of production in the hands of large-scale producers.

2.7.3.3 Challenges of Climate Change with the Effects of Diseases and Parasites

The geographical and seasonal distributions of many infectious diseases, particularly vector borne, as well as those of many parasites and pests of various kinds are affected by climate. Pathogens, vectors, and intermediate and final hosts can all be affected both directly by the climate (e.g. temperature and humidity) and by the effects of climate on other aspects of their habitats (e.g. vegetation). If the climate changes, hosts and pathogens may be brought together in new locations and bringing new threats to animal (and in some cases human) health and new challenges for livestock management and policy. However, it is difficult to segregate out epidemiological changes that can be attributed unambiguously to climate change. Climate is characterized not merely by averages, but also by short-term fluctuations, seasonal oscillations, sudden discontinuities and long term variations, all of which can influence disease distribution and impacts.

Rapid spread of pathogens, or even small spatial or seasonal changes in disease distribution whether driven by climate change or not, may expose livestock populations to new disease challenges. Disease-related threats can be both acute and chronic and can be caused by the direct effects of disease or indirectly by the measures used to control disease. The most severe recent epidemics in the tropics in terms of the numbers of livestock lost have involved quite a narrow range of diseases: most notably foot-and-mouth disease, avian influenza, Blue tongue, African swine fever, classical swine fever and contagious bovine pleuropneumonia.

2.7.4 Adaptation and Mitigation Strategies to Climate Change/Variability

Since climate change could result in an increase of heat stress, all methods to help animals cope with or, at least, alleviate the impacts of heat stress could be useful to mitigate the impacts of climate change on animal responses and performance. Different managemental options for reducing the effect of thermal stress are:

2.7.4.1 Genetic Approach

Many local breeds are having valuable adaptive traits that have developed over a long period of time which includes

- Tolerance to extreme temperature, humidity etc.
- Tolerance /resistance to diseases
- Adaptation to survive, regularly produce/ reproduce in low/ poor management conditions and feeding regimes.

Hence, Genetic approach to mitigate the climate change should include measures such as

1. Identifying and strengthening the local genetic groups which are resilient to climatic stress/ extremes
2. Genetic selection for heat tolerance or bringing in types of animals that already have good heat tolerance and crossbreeding the local genetic population with heat and disease tolerant breeds.
3. Identifying the genes responsible for unique characteristics like disease tolerance, heat tolerance, ability to survive in low input conditions and using it as basis for selection of future breeding stock will help in mitigating the adverse effect of climate stress.
4. Breeding management strategies: Changing the breeding animal for every 2-3 years (exchange from other district herd) or artificial insemination with proven breed semen will help in enhancing the productivity. This may be supplemented with supply of superior males through formation of nucleus herd at block level. Synchronization of breeding period depending on the availability of feed and fodder resources results in healthy offsprings and better weight gain. Local climate resilient breeds of moderate productivity should be promoted over susceptible crossbreds.

In the tropics, with small flock sizes, large fluctuations in rearing conditions and management between flocks, and over time within a flock, lack of systematic livestock identification, inadequate recording of livestock performances and pedigrees, and constraints related to the subsistence nature of livestock rearing (where monetary profit is not the most important consideration), the accuracy of selection will be much lower, resulting in even lower rates of genetic gain. However, locally adapted breeds are likely to be highly variable and the highest performing animals of such breeds can have great productive potential. Therefore, the screening of livestock populations previously not subjected to systematic selection is likely to give quicker results to provide high genetic merit foundation stock for nucleus flocks.

2.7.4.2 Nutritional Adjustments

The feed intake by the livestock during thermal stress is significantly lower than those in comfort zone. Hence, the care should be directed towards providing more nutrient dense diet while will help to minimize production losses due to the high temperatures as well as those feed which generates less heat during digestion. This can be achieved by following measures:

1. Feeding dietary fat remains an effective strategy of providing extra energy during the time of negative energy balance. Incorporation of dietary fat at level of 2 – 6 % will increase dietary energy density in summer to compensate for lower feed intake.
2. Adjusting animals' diets to minimize diet-induced thermo genesis (low fibre and low protein diets). High-fiber diets generate more heat during digestion than lower fiber diets.
3. Using more synthetic amino acids to reduce dietary crude protein levels. Excessive dietary protein or amino acids generate more heat during digestion and metabolism.
4. Feeding of antioxidant (Vitamin A, C & E, selenium, Zinc) reduces the heat stress and optimize feed intake.
5. Addition of feed additives/vitamins and mineral supplementations that helps in increasing feed intake, modify gut microbial population and gut integrity and maintain proper action and anion balance.

6. During lean/drought periods, shepherds migrate along with their animals in search of fodder. This migration sometimes creates social conflicts with local people for available scarce fodder resources. Further, this could invite new diseases and parasites which pose health problems in small ruminants. Protein is the first limiting nutrient in many grazing forages and protein availability declines in forages as the plant matures towards the end of winter season. When daytime temperatures and humidity are elevated, special precautions must be taken to keep livestock comfortable and avoid heat stress. Allow for grazing early in the morning or later in the evening to minimize stress.
7. Concentrate mixture (18% DCP and 70% TDN) prepared with locally available feed ingredients should be supplemented to all categories of animals. When no green fodder is available, addition of vitamin supplement in concentrate mixture helps in mitigating heat stress.
8. Further, in extreme conditions, energy intake becomes less compared to expenditure as the animal has to walk more distance in search of grazing resources which are poor in available nutrients. Hence, all the animals should be maintained under intensive system with cut and carry of available fodder. The concept of complete feed using crop residues (60%) and concentrate ingredients should be promoted for efficient utilization of crop residues like red gram stalk, etc. Further, productivity and profitability from ruminants can be increased by strengthening feed and fodder base both at village and household level with the following possible fodder production options.

2.7.4.3 Management Interventions

Water supply: Animals must have access to large quantities of water during periods of high environmental temperatures. Much of the water is needed for evaporative heat loss via respiration to help them cool off. Hence, provision has to be made for supply of continuous clean, fresh and cool water to the animals. Cleaning the feeding trough frequently and providing fresh feed will encourage the animals to take more feed. Splashing the cool water over the animals at regular intervals during the hot period will reduce the heat stress.

*Feeding time***:** Providing feed to the animals during cool period i.e. evening or night will improve the feed intake by the animals.

Stocking density: reducing the stocking density during the hot weather will help the animal to dissipate the body heat more efficiently through manifestation of behavioural adaptation.

Shade: The use of shades is an effective method in helping to cool animals. Shades can cut the radiant heat load from the sun by as much as 40%. Shades with straw roofs are best because they have a high insulation value and a reflective surface. Uninsulated aluminum or bright galvanized steel roofs are also good. The best shades have white or reflective upper surfaces. Planting of trees at certain distance from the shed provides shade to the animals. Shifting the animals to cool shaded area during the hot climatic conditions is also helpful

Provision of vegetative cover over the surrounding area will reduce the radiative heat from the ground. The surface covered with green grass cover will reflect back 5 – 11% of solar radiation as compared to 10 – 25% by dry bare ground and 18 – 30% by surface covered by dry sand adding to thermal stress. Provision of elongated eaves or overhang will provide shade as well as prevent rain water from entering the sheds during rainy season.

Ventilation: increasing the ventilation or air circulation in the animal sheds will aid the animals in effective dissipation the heat. The air circulation inside the shed can be increased by keeping half side wall i.e., open housing system, use of fan, increasing the height of the building etc.

Roof material: the roof material to be used should be bad conductor of heat. i.e., it should prevent radiative heat from entering into the shed. Thatch along with bamboo mat is excellent roofing material for tropical conditions. However, it is prone for fire hazards as well as its longevity is less. The outer surface of the roof should be painted white so that the white surface will reflect the solar radiation back. Some materials such as aluminium reflect heat well as long as they are not too oxidized.

2.8 LIVESTOCK PRODUCTS MARKETING

Markets are essential for the exchange of goods, and services and have existed, in some form, in all societies. Yet even today, in the tropics particularly in many rural areas, markets are poorly developed, reflecting the limited infrastructure of roads, railways, general communications and lack of appropriate market institutions. Markets are incomplete and traditional farm families have to consume trade or sell most of their products locally. Marketing of livestock products is an important activity all over the ctropics .Marketing of livestock products such as milk, butter, egg, hide and skin is also important to households. Fresh milk and eggs are directly sold after meeting family needs at farm level.

Meat, milk and eggs are preferred goods with a relatively high income elasticity of demand, measured as the percentage increase in quantity demanded in response to a one percent rise in income. Whereas the income elasticity of demand for cereals in developing countries have been estimated at below 0.25 or even negative in some cases, that for most livestock products is closer to unity (Sarma 1986). This is reflected in the rapid growth of consumption, of milk, eggs and meat per capita in the developing countries, by 2 percent, 4 percent and 6 percent respectively per year. In the industrialised countries where consumption levels are already close to saturation, income elasticities for livestock products have fallen and may even be negative. The fast growing demand for livestock products, in developing countries, requires a corresponding increase in marketed production in order to avoid shortages and rising consumer prices.

2.8.1 Marketing of Fresh Meat and Milk

2.8.1.1 Fresh meat

The early beginnings of meat marketing might have coincided with the first settlements of mankind and the development of different trades and professions. Since then, meat has developed into a valuable commodity in many countries. Fresh meat is a highly perishable good and therefore prone to spoilage and must be treated with utmost care for consumer protection. Meat must be produced, transported, stored and marketed under hygienic conditions (FAO, 2014). Often fresh or frozen meat is shipped from one region around the globe to markets with higher demands. Industrial meat processors, when faced with a shortage of raw meat materials, are able to import large quantities of frozen meat trimmings from around the world for further processing. It might well be that a canned meat product found on a supermarket shelf in Africa contains buffalo meat from Asia, pork from Europe and beef from South America (FAO, 2014).

In industrialized countries fresh meat is mostly generated in modern slaughter facilities and an uninterrupted cold chain is applied during cutting, transportation and marketing. Meat inspection and quality control procedures are put in place and implementation is monitored by Government authorities. Depending on the location, basically two different marketing systems can be observed: In rural settings of industrialized countries, the whole meat marketing chain is often covered by traditional butcheries selling fresh meat produced in the immediate surroundings, thus avoiding long supply chains. Butchers have direct contacts to the smallholder livestock producers and provide fresh meat and specialized meat cuts to their customers. Having their own slaughter, cutting, processing and sales facilities ensures the freshness and traceability of the meat offered. The responsible local authorities monitor the introduced meat hygiene and safety regulations (FAO, 2014).

In urban centres and industrial areas, the number of small butcheries selling their own produce directly to consumers decreased substantially over the last decades. With growing populations and increasing demands for meat, better suited marketing systems were needed. Modern supermarket outlets took on this role. Such high volume meat production and trade require stringent quality control systems to avoid health hazards for the consumers. Due to the distance from livestock producing areas and resulting longer supply chains for the meat, freshness and traceability present a challenge for all parties involved in the marketing chain. The development and subsequent introduction of stringent quality control systems and efficient traceability mechanisms was a logical consequence.

In some countries where a fast industrialization process took place joined by a concentration of urban population and the development of mega cities, serious problems in food supply emerged. Due to prevailing consumer preferences, fresh meat is often still sold in traditional wet markets, but must be transported from far outside the cities without adequate infrastructure. As a result, serious health hazards for consumers can emerge. In recent years, supermarkets are emerging in such areas, but prices may be higher and meat is often not affordable to lower income groups (FAO, 2014).

In developing countries with predominantly agricultural based economies, fresh meat is still mainly distributed through traditional wet markets or simple meat stalls. These wet markets and meat stalls are often attached to slaughter places or in the proximity of rural slaughter facilities. In the absence of functional cold chains, fresh meat is purchased in the early morning and cooked and consumed the same day. Meat inspection regulations are put in place by local authorities to facilitate the supply of safe and wholesome meat to consumers, but implementation and monitoring still varies widely. In all above mentioned cases, strict regulations on meat hygiene and safety must be applied. In order to facilitate the efforts of Governments and regional and international authorities, FAO and WHO have established the Codex Alimentarius. The various codes are frequently updated and availed to authorities as guidelines for the establishment of appropriate food safety regulations (FAO, 2014).

In Ethiopia, meat sold in domestic markets is not specially packaged or labelled. Most meat and meat products retailed in the domestic meat market in Ethiopia are fresh cuts and no packaging is used apart from newspapers and plastic bags. This prevents meat producers from effectively branding their products and increases the likelihood of disease transmission in handling. There are supermarkets in the capital, however, that make use of foils and other packaging materials to pack meat, especially meat that is chilled or frozen. There is no strict legal compliance related to the meat packaging procedures in butcheries and supermarkets. Labelling activities are almost non-existent in the domestic meat market, although some abattoirs are now branding their production (USAID, 2013).

2.8.1.2 Milk

The marketing of milk, surplus to family and farm needs, improves farm income, creates employment in processing, marketing and distribution, adds value and contributes to food security in rural communities. Marketing of milk is particularly difficult for small-scale producers scattered in rural areas throughout the developing world. The logistics of moving small quantities of a perishable commodity are covered in collection but the marketing aspects require organisational and technical skills and an understanding of quality and safety issues. The choice of product and technologies must be suited to the scale and location of the operation, while the price, promotion and packaging must meet local requirements. In urban markets in developing countries, the sale of raw milk by informal traders is the most important outlet for milk but the associated health risks must be addressed and steps taken to minimise that risk.

In Ethiopia, milk and milk products are marketed through both informal and formal marketing systems. In the dominant informal marketing system, producers sell to consumers directly or to unlicensed traders or retailers. Price is usually set through negotiation between the producer (seller) and the buyer; this system is predominant in the rural dairy production system. In the formal marketing system there are cooperatives and private milk collecting and processing plants that receive milk from producers and channel to consumers, caterers, supermarkets and retailers; this system does exist in urban and peri-urban dairy system of Shashemene–Dilla milkshed, although the number of cooperatives is few and its performance is low (Woldemichael ,2008). In the rural lowland agropastoral system of Mieso, dairy producers use two different milk marketing methods: traditional milk associations/groups and individual sellers. The traditional milk producer associations/groups are locally called *Faraqa Annanni*, and are a traditional voluntary group that involves women who have milking cows or camels.Members are organized based on common interest of selling cow/camel whole milk, whereby milk is transported and sold by one of the member's thus reducing transport and marketing cost per unit of milk through economies of scale.

According to Woldemichael (2008), major milk marketing channels in urban dairy system of Shashemene–Dilla milkshed

- Producer → Consumer
- Producer → Wholesaler → Retailer → Consumer
- Producer → Cooperative → Retailer → Consumer
- Producer → Retailer → Consumer

- Producer → Cooperative → Consumer

In pastoral areas, as few agro-pastoralists surplus milk is shared with neighbours or bartered, but is rarely sold except by households living close (<5 km) to main roads and urban centres where there is demand for fresh and fermented milk and butter. In the Borana pastoral system, the frequency and amount of dairy products traded depended on herd size and distance to the market; butter replaces liquid milk with increasing distance and women from households with large herds trading more often. Butter is often sold to truck drivers and bus passengers en route to Addis Ababa, some 500 km away (Coppock 1994).

In urban areas, where there is a good demand for fresh milk, the surplus can readily be sold. Around Addis Ababa, there is an organized milk collecting system 120 km along the roads leading to the capital. In the rural areas far away from the main roads, the possibility of selling fresh milk is more limited. In addition, followers of the Ethiopian Orthodox Church abstains from consuming milk and animal products during the fasting periods. The surplus milk has thus to be converted into butter and cottage cheese (ayib) and is usually sold in local markets (Debrah and Birhanu 1991). Fresh milk is mainly distributed through the formal and informal marketing systems. The informal market involves direct delivery of fresh milk by producers to consumers in the immediate neighbourhood and sales to itinerate traders or individuals in nearby towns. Milk is transported to towns on foot, on back of donkeys and horses or by public transport (Debrah and Birhanu 1991).

Dairy producers in the Addis Ababa milk shed have a variety of milk outlets for their production. A substantial amount of the milk marketed by producers, some 75% goes through informal channels; defined here as those channels which avoid taxation and quality controls. These include direct sale to individuals, sales to institutions, sales to private milk traders, to retail outlets, and to informal dairy processors. Currently, a number of dairy processing plants have formal outlets for liquid milk and operate a system of milk collection and cooling centres along the major roads radiating from the capital.

The farm-to-house arrangement for milk marketing usually involves a contractual type of arrangement in which individual producers may offer to deliver raw milk directly to the consumers at their homes or at some convenient location. This arrangement is especially common in the case of milk producers who are located in and around large cities, such as Addis Ababa. Rural areas which are distant to big cities have limited or little, if any, markets for liquid milk and milk surplus in such areas is converted into butter and/or ghee, and sometimes local cheese (ayib), and sold in local markets. Such sales in local markets are usually made through established local traders, who may buy directly from producers at farm-gate. Processing of butter, ghee and local cheese vary within and between places, usually depending on season. Hence prices tend to be highest during the dry season (Debrah and Birhanu 1991)

2.8.2 Constraints

The following are some of the main constraints:

- *Quality constraints:* Little understanding of processors' requirements, lack of laboratories and instruments for quality control, price and quality of the veterinary services;
- *Financial constraints*: Lack of capital to invest in assets, equipment and inputs that would improve quality;
- *Gender constraints:* In comparison to men, women face higher disadvantages, in particular in terms of mobility, access to assets and to productive resources, and access to market information, with the result that they find it more difficult to access and maintain profitable market niches and capture a larger slice of incomes;
- *Infrastructure constraints:* Lack or inadequacy of, among others, roads, electricity, weighing stations, cattle dips, slaughtering and processing facilities (which raises transaction costs, exacerbates information asymmetries between producers and traders, and discourages investment in processing);
- *Information constraints:* Limited access to market-related information (e.g. on prices, value chains, competitors, consumer preferences);
- *Skills and knowledge constraints*: Lack of business management skills (e.g. production planning) and, in particular, inadequate access to the knowledge and

technologies needed to meet rising sanitary standards, making it extremely difficult for smallholders to gain credible certification of compliance with marketing requirements; and

- *Market constraints*: Low demand, a multiplicity of intermediaries (which increases the charges and shades the transparency of the operation).

2.8.3 Solutions

- Secure and adequate access to basic production inputs together with risk coping mechanisms
- Dissemination of livestock market information to livestock producers;
- Strong relationships among various chain actors (including commitments from these actors to cooperate on mutually beneficial
- actions/investments) and strengthened farmers' organizations;
- Policies and strategies to enhance the ability of smallholders and small-scale market agents to compete in livestock product markets;
- Standards and brand mechanisms to identify high-quality livestock products;
- Kick-starting of domestic markets to allow the poor to exploit market opportunities;
- Reduced fees on the sale or slaughter of livestock;
- New or adapted marketing strategies (for example, promotion of alliances with fair trade chains);
- Adequate responses to volume demand and ability to expand to match increased demand;
- Product differentiation to create niche markets; and
- Linking of poor livestock keepers to expanding urban markets.

2.9 APPLICATION OF PRINCIPLES THROUGH CASE STUDIES AND INDEPENDENT STUDY

2.9.1 Smallholder dairy development case study demonstrates power of value chain linkages in Ethiopia

In the past decades, public sector support for dairy development in Ada'a mainly focused on dairy production and supply of inputs/services, with limited involvement of the private sector and partners. There was also no clear distinction between the dairy system development potentials in urban, peri-urban and rural areas (Abinet, 2013).

With the help of a participatory commodity value chain development approach, introduced by the Improving Productivity & Market Success (IPMS) project, the Ada'a Office of Agriculture managed to address some of these issues in the peri-urban dairy production system. Training, including sharing of knowledge with experienced farmers and follow-up events, especially field days, was used to build capacity of extension staff and farmers. This has helped to promote linkages between producers and input suppliers/service providers (Abinet, 2013).

With the help of Ada'a Dairy Cooperative and the Cooperatives Promotion Office, it was possible to organize collective action for marketing of fluid milk by diary producers in three peri-urban locations. Production of backyard fodder was successfully linked to 143 peri-urban farmers involved in commercial livestock production. The artificial insemination (AI) service delivery system during the project's life changed from public sector dominated system in 2005 (100%) to a private sector dominated system in 2010 (98%). Still considerable efforts need to be made to further improve the effectiveness and efficiency of the system, while the recently IPMS-introduced hormone assisted mass insemination approach should be further explored, especially since pregnancy rates improved by 100% (Abinet, 2013).

As a result of increased demand for dairy products in Addis Ababa and other major urban centres, many more private agribusinesses for supply of inputs and processing of milk established themselves in Ada'a, which can be instrumental in leading development. Government can and should increase its capacity to develop, promote and regulate these new actors to ensure quality of services/inputs and processed products. The impact study conducted by the project in the peri-urban system showed that in 2010 annual gross production value from fluid milk reached over three million Ethiopian birr (ETB), a fiftyfold increase. Annual income/household also increased from less than ETB 1000 in 2005/06 to ETB 19,000 in 2010 (Abinet, 2013).

2.9.2 Challenges, Opportunities and Interventions of Ethiopian Livestock Sector for Development

Ethiopia is believed to have the largest livestock population in Africa and has an immense potential for increasing livestock production, both for local use and for export purpose. The recent livestock population census shows that Ethiopia has about 53.99 million heads of cattle, 25.5 million sheep , 24.06 million goats, 1.91 million horses, 6.75 million donkeys, 0.35 million mules, 0.92 million camels and 50.38 million poultry (CSA, 2013).

Estimates of the contribution of the livestock sector to the total GDP and agricultural GDP in Ethiopia is varying. Halderman (2004) reported that livestock contributes 12–16% of the total GDP and 30–35% of the agricultural GDP. FAO (2004) estimated the contributions of livestock to total GDP at 18.84% and the agricultural GDP at 44.54%. On the other hand, MoARD (2007) reported that the livestock sector accounts for 16% of the national and 27–30% ofthe agricultural GDPs, and 13% of the country's export earnings.

Ethiopia's domestic meat consumption for 2006/07 is estimated at 2.4 kg/capita/year for beef, and 0.7 and 0.4 kg/capita/year for sheep and goat meat, respectively. Total meat consumption was close to 276 MT in 2006/07, of which beef and mutton account for 68 and 21 percent, respectively. Pronounced differences have been identified between rural and urban patterns of meat consumption, particularly for beef (1.7 kg/capita/year versus 7.0 kg/capita/year respectively) and mutton (BFPAPI, 2013)

The total milk production from about 10 million milking cows is estimated at about 3.2 billion liters, an average of 1.54 liters per cow per day over a lactation period of about 6 months (CSA, 2008). The performance of Ethiopian dairy subsector has been lagging far behind that of the neighboring countries with comparable agro-ecological conditions. The national milk production had increased by 1.6% and per capita production declined by about 0.8% annually during 1966–2001 (Staal et al. 2008). In Ethiopia, the national per capita consumption of milk and milk products is about 17 kg, which is one of the lowest in sub-Saharan Africa, due to economic and cultural factors. The average expenditure on milk and milk products by Ethiopian households accounts for only 4% of the total household food budget (Staal et al. 2008). Although milk production is increasing by 1.2% per annum

Ethiopia is one of the lowest countries in egg and chicken meat consumption/capita which stands at 57 eggs and 2.85 kg of meat per annum. in Ethiopia, the current per capita egg and poultry meat consumption has been declining by a rate of 0.12 for poultry meat and 0.14 for eggs (USAID, 2006) in the face of population growth. The annual output of the country is 72,300 metric tons of meat and 78,000 metric tons of eggs (Hailemariam et al., 2006).

However Ethiopia owns a significantly large livestock population, the sector has remained underdeveloped and its potential has not been efficiently and effectively used (Azage et al, 2010), resulted that the livestock resource of the country is characterized by low productivity and production levels. Because livestock production and expansion is constrained by inadequate nutrition, disease, a lack of support services such as extension services, insufficient data with which to plan improved services, and inadequate information on how to improve animal breeding, marketing, and processing (Berhanu et al,2007).

The major constraints for livestock development in Ethiopia can be broadly categorized into technical, organizational, institutional, infrastructural, and environmental and policy aspects. The major technical constraints are undernutrition and malnutrition, high prevalence of diseases, relatively low efficiency uses of genetic potential for productive traits, poor management practices and weak market infrastructure (Azage et al, 2010).

Ethiopia has the unique genetic diversity of the livestock population and the diverse agro-ecologies that allow different production systems and should take advantage of the current and future opportunities for more market-oriented development. Location and commodity specific interventions with appropriate targeting of production systems and households have to be designed to address major constraints to the livestock sector. Improved technological applications, efficient and effective input supply system, better management options, access to knowledge and credit are required on the supply side. The development of market infrastructure and market institutions is also very important for inducing efficiency and incentives for market participants along the value chain (Berhanu et al, 2007)

The Government of Ethiopia has attached a significant importance to the development of the livestock sector in a sustainable manner. However, it has to be noted that livestock development programs are expensive, have long gestation period, and require strong and continuous commitment and collaboration from stakeholders at all levels. One of the limiting factors for developing the livestock sector is that substantial numbers of oxen are locked into fulfilling the power requirements of millions of smallholder farmers for crop production. Development and use of alternative sources of traction power need to be looked into wherever feasible. Controlled grazing and intensification are key elements that need to be addressed in optimizing productivity with minimal environmental impacts. This has to be based on the value chain development framework and innovation systems approach. Ensuring quality, sanitary and phytosanitary standards and food safety are key elements for market participation. This will require capacity building in the regulatory directorate and in market extension (Azage et al, 2010).

Changes in organizational and institutional arrangements need to be addressed and refocused to respond to more market-oriented challenges. Higher learning institutions have to revisit the relevance of their curricula. The research system has to also refocus its efforts to addressing key constraints to commodity development along the value chain. Capacity building of farmers and the private sector in knowledge-based commercial livestock production and processing is essential (Azage et al, 2010).

The existing livestock input supply and service provision is weak and has to be reoriented and re-focused to face the current challenges and open up opportunities for the development of market-oriented livestock production system. This will require public– private partnerships, such as following of the established dairy and meat board for the dairy and meat sector, and a more targeted intervention with stratified and segmented approach. The role of the private sector has to be promoted and supported in different forms to ensure proper input supply system. The government's role in capacity building and regulating has to be strengthened (Berhanu et al, 2007).

The Middle East countries are Ethiopia's traditional destinations for meat and livestock exports and the exports to these countries have been increasing over the years. Given their high income and the consumer preferences for Ethiopian products and the proximity to these countries, there is high possibility to boost export. New markets in Africa and Asia should also be explored and pursued aggressively. A major shift from live animal export to value added animal products with compliance to sanitary and phytosanitary standards and food safety should be considered in order to increase income and minimize the risk of export bans due to diseases (Azage et al, 2010).

3. CONCLUSIONS

Livestock have multi functions in the tropical environment, but the production system varies. There are five classes of livestock production systems in the tropics based on the ecological zones and the type of livestock and the livestock products., by the function livestock have and by the management principles of production such as pastoral rang-livestock production system, crop-livestock production system in the low lands, crop-livestock production system in the highlands, ranching and landless livestock production system. Livestock production depends on natural resources. Climate change affects these natural resources; therefore affects livestock production in myriad ways, both directly through impacts on livestock performance, and indirectly through impacts on the environment, society and economy. Heat is the major constraint in tropical and subtropical climatic conditions which negatively affects production and reproduction of livestock species. Alterations of temperature and humidity profile may alter the productivity, reproductive efficiency and may aggravate the spread of disease and parasites into new regions. Contrarily livestock production is now one of three most significant contributors to environmental problems, leading to increased greenhouse gas emissions, land degradation, water pollution, and increased health problems.

A combination of fans, wetting, shade and well-designed housing can help to alleviate the negative effect of thermal stress on animals. Careful management and feeding strategies are important in achieving the optimum animal performance. While there are many methods of reducing thermal stress, selection of the most appropriate technique and its proper application is essential. If one method proves successful in one place, this does not guarantee success elsewhere.

Providing sustainable diets can only be achieved with a combination of sustainable improvement of livestock production and a combination of policy approaches integrating the full concept of sustainable diets, accompanied by awareness raising for the value of biodiversity and investing in research as basis for sound decisions. With regard to livestock diversity and in view of uncertainty of future developments and climate change this implies the need to develop simple methods to characterize, evaluate and document adaptive and production traits in specific production environments.

Integration of livestock production systems benefits in terms of productivity and resource use efficiency. Without a doubt, the diversity of farming activities may increase the stability of the production of the farm and reduce risks for resource-poor households, whereas integration of activities using the outputs of one activity as input in another activity may reduce dependency on external resources. These systems have the potential to increase grain, meat and milk productivity and to reduce the risks of degradation of natural resources. Today, most production systems are intensive, with very high per-animal productivity, due to better nutrition, health and housing management. However, the recent focus on and concerns over food quality, animal welfare, traceability, human health and environmental quality have led to the emergence of and growing interest in organic livestock farming, which is gradually spreading across the world.

Changes in resource/demand patterns cause changes in the behaviour of (livestock) production systems. This implies that livestock can be essential for the sustainability of one system in one context and detrimental for the same or another system in a context elsewhere with other resource flows. It is possible to identify contexts and systems where livestock can be useful for increased sustainability.

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