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LIVESTOCK AND LIVESTOCK PRODUCT TRENDS BY 2050: REVIEW

Melkamu Bezabih Yitbarek

Department of Animal Sciences, College of Agriculture and Natural Resources, Debre Markos University

ABSTRACT

This review was done on livestock and livestock product trends by 2050 from different scientific papers. Globally, livestock and livestock products are changing rapidly in response to human population growth (9.2 billion), urbanization (70%), and growing incomes (1.1-3.1%) by 2050. More than 60 billion land animals are used worldwide for meat, egg, and dairy production. The global livestock population could exceed 100 billion by 2050, pig meat by 290%; sheep and goat meat by 200%; beef and buffalo meat by 180%; milk by 180%; poultry meat by 700%; and egg by 90%. In 2004, livestock consumes nearly 43% of feed and could rise to 48–55% by 2050. Global feed demand will be almost doubled, and 1.3 billion tonnes of grain is consumed by farm animals each year. The average grazing intensities in the world are expected to increase by about 70%, from 0.19 in 2000 to 0.098 Tropical Livestock Unit (TLU) per ha in 2050 and uses one-third of the world's fresh water. Climate change may alter the productivity, reproductive efficiency of animals. Contrarily, livestock production is a significant contributor to environmental problems, leading to increased greenhouse gas emissions, land degradation, water pollution, and increased health problems. To solve the challenges of livestock and livestock products,, biotechnology and nanotechnology are being harnessed in various aspects of the livestock industry to hasten breed development for improved animal health and welfare, enhanced reproduction, and improved nutritional quality and safety of animal-derived foods.

Keywords: Feed, Grazing intensity, Livestock

***Correspondence to Author:**
Melkamu Bezabih Yitbarek
Department of Animal Sciences, College of Agriculture and Natural Resources, Debre Markos University

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INTRODUCTION

Livestock systems occupy about 30% of the planet's ice-free terrestrial surface area and a significant global asset with a value of at least $1.4 trillion (Steinfeld *et al*. 2006). The world's 60 billion of land animals occur in three main types of production systems such as confined intensive, mixed crop–livestock, and open grazing systems (Herrero et al., 2009). Globally, livestock contributes about 40% to the agricultural gross domestic product (GDP) and constitutes about 30% of the agricultural GDP in the developing world (World Bank, 2009). Even so, livestock production and merchandizing in industrialized countries account for 53% of agricultural GDP (World Bank 2009). Livestock products contribute 17% to kilocalorie consumption and 33% to protein consumption globally (Rosegrant et al. 2009). The livestock sector employs at least 1.3 billion people globally and directly support the livelihoods of one billion poor smallholder farmers in the developing world (Thornton *et al*. 2006 ; Frans et al, 2010). 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).

The World Human population in 2050 is estimated to be 9.2 billion people to feed, 1.3 times as many as in 2010 and this population will consume almost twice as much animal protein as today (UNDP, 2008). This situation results the related 'nutrition transition' in diet changes from staples to higher value foods such as livestock products. In 2050, 2.3 time as much poultry meat and between 1.4 and 1.8 times (meat 1.7 times and milk, 1.6 time) as much of other livestock products will be consumed as in 2010 (FAO, 2011). 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 tasks for animal scientists, researchers and scholars should understand the global livestock and livestock product trends by 2050 for improving of livestock productivity to satisfy the world population demand. Therefore, this review attempts to provide a rapid summary of global livestock and livestock products trends by 2050 from different scientific papers.

Trends of Livestock Population and Growth Rate

Livestock Population

More than 60 billion land animals are used worldwide for meat, egg, or dairy production, and if current trends persist, the global livestock population could exceed 100 billion by 2050-a number more than 10 times the projected human population. The IMPACT model (International Model for Policy Analysis of Agricultural Commodities and Trade) projects that, the livestock population will be increased largely and rapid from 2000 to the next 2050 (Thornton and Herrero, 2010). Now, it is hard to envisage meeting projected demand by keeping twice as many poultry, 80 percent more small ruminants, 50 percent more cattle and 40 percent more pigs, using the same level of natural resources that they currently use (FAO, 2011). For example, between 2000 and 2050, the global cattle population will increase from 1.5 billion to 2.6 billion, and the global goat and sheep population will increase from 1.7 billion to 2.9 billion.

Trends of Livestock Products Demand

Increasing Demand

Global production of meat, milk and eggs has expanded rapidly during the last decades, in response to rapid growth in demand for livestock products. This increase in demand, which has been particularly strong in developing regions, has largely been driven by growing populations, urbanization and incomes. Between the 1960s and 2005 for example, annual per capita consumption of meat more than tripled, that of milk almost doubled, while per capita consumption of eggs increased fivefold in the developing world (FAO, 2009a). Driven by demand, global production of meat is projected to more than double from 200 million tonnes in 1999/2001 to 470 million tonnes in 2050, and that of milk to increase from 580 to 1,043 million tonnes (FAO, 2006). Annual demand for meat will increase by between 6 and 23 kilograms per person worldwide by 2050, and the absolute increase will be largest in Latin America and the Caribbean (LAC) and East and South Asia and the Pacific (ESAP), with demand doubling in Sub-Saharan Africa (SSA).

Table 1 Projections of livestock population from 2020 up to 2050 in four decades (in billions)

Livestock	2020	2030	2040	2050
Cattle	2.170	2.423	2.593	2.636
Sheep & Goat	2.359	2.566	2.677	2.939
Pigs	1.115	1.121	1.076	1.141
Poultry	24.760	28.819	32.423	37.030

Source: Rosegrant et al., 2009

Table 2 Annual livestock growth rate (percent per annum)

Country	2005-2030	2030-2050
Developing	2.0	1.3
Developed	0.6	0.2
World	1.4	0.9

Source: Rosegrant et al., 2009

Livestock Growth Rate

Livestock growth rate per annum in 2005-2030 and 2030-2050 in developing and developed nations and in the world is presented in table 2

Human Population Growth

Growth in population is an important driver of demand for food and livestock products. There are several estimates of human population growth to 2050. The UNPD (2008) revision of 2005 puts total population at 9.2 billion in 2050 which is 34 percent higher than today, and FAOSTAT's current estimate is just over 9 billion in 2050. Globally, the population growth rate peaked towards the end of the 1960s at about 2.04 percent per year, and by the late

1990s this had fallen to about 1.35 percent per year. The growth rate may be around 0.33 percent per year by the late 2040s. Most of these population increases are projected to take place in developing countries. Even within developing countries, there will be marked differentiation. For example, East Asia will have shifted to negative population growth by the late 2040s (FAO, 2006). In contrast, Sub-Saharan Africa's population will still be growing at 1.2 percent per year. By 2050, 18 million of the 26 million people added annually to world population will be living in Sub-Saharan Africa (FAO, 2006). In Ethiopia, 180-205 million people expected to be alive in 2050 (www.brightergreen, org). The continual rapid population growth could lead high livestock products demand and to be an important impediment to achieving improvements in food security in some countries.

Table 3 Projections of annual population growth rate from 2020 to 2050

Period	Africa	L.America	N.America	Asia	Europe	Ocienia	World
2020-2025	2.08	0.96	0.66	0.89	-0.12	1.00	1.00
2030-2035	1.62	0.77	0.23	0.68	-0.22	0.52	0.78
2040-2045	1.19	0.55	0.14	0.49	-0.26	0.39	0.57
2045-2050	1.14	0.47	0.15	0.40	-0.26	0.35	0.51

Source: UN, 1995

Urbanization

Another important factor determining demand for food is urbanization. Urbanization will continue at an accelerated pace, and about 70% of the world's population will be urban (compared to 49% today). Urbanization rates varying from less than 30% in South Asia to near 80% in developed countries and Latin America. Rapid urbanization is expected to continue in developing countries. Urbanization has considerable impact on patterns of food consumption in general, and there is plenty of evidence that increases in livestock product consumption may be associated with increases in urbanization rates (Rae, 1998; Delgado, 2003).

Income Growth

A third key driver that has led to increased demand for livestock products is income growth. Between 1950 and 2000 world GDP grew by 3.85 percent annually, resulting in a per capita income growth rate of 2.1 percent (Maddison, 2003). As income grows, so does expenditure on livestock products (Steinfeld *et al*. 2006). The Economic growth is expected to continue into the future, typically at rates ranging from between 1.0% and 3.1% (Van Vuuren et al. 2009). Growth in industrialized countries is projected to be slower than that in developing economies (Rosegrant et al. 2009). Over the next 40 years global real per capita income growth measured in US dollars is expected to grow by over 10,000 per capita. In

Ethiopia GDP growth of between 5 and 10% a year to 2030 and the GDP per capita exceeding $1,000 by 2050 (John, 2010).

Trends of Meat, Milk and Egg Production and Consumption

Sustainable food production in 2050 would require enormous changes in the current food production technologies and consumption habits. The main function of livestock products in human nutrition is to provide a source of protein and energy. As income increases, people start improving the variety and balance of their diets by eating more meat, milk and eggs. In fact, the United Nations Food and Agriculture Organization (FAO) predict a 60 % increase in demand for meat, milk and eggs by 2050. For instance, the meat demand will double by 2030, and milk demand triple from 2005 levels in Ethiopia (www.brighter green,org). The rapidly growing world population will be consuming two-thirds more animal protein by 2050 than it does today (Bryan, 2011). The total average protein consumption globally is 75.3 g/person/day of which 24.3 g is animal protein (FAO, 2006). In the industrialized countries the average protein consumption is 106.4 g/person/day of which 56.1 g comes from animal products. FAO, (2006c) suggest that in 2050, 2.3 times as much poultry meat and between 1.4 and 1.8 times as much of other livestock products will be consumed as in 2010. Globally, calories delivered per day increase from 2,712 to 3,226 from 2010 to 2050 (John, 2010). From livestock products supply around 17% of calories consumed worldwide and 20.3% in developed countries (FAO, 2009b). Even more important, perhaps, is their contribution to protein consumption, estimated at 33% worldwide and 47.8% in developed countries. In Ethiopia, in the year 2000, the share of calorie intake by meat consisted out of 1.8% of the diet and is expected to increase to 3.0% of the total calorie intake by the year 2030. Differences in the consumption of animal products are much greater than in total food availability, particularly between regions. Food demand for livestock products will nearly double in sub-Saharan Africa and South Asia, from some 200 kcal per person per day in 2000 to around 400 kcal per person per day in 2050 (Thornton, 2010). On the other hand, in most OECD countries that already have high calorie intakes of animal products (1000 kcal per person per day or more) consumption levels will barely change (Van Vuuren et al. 2009).

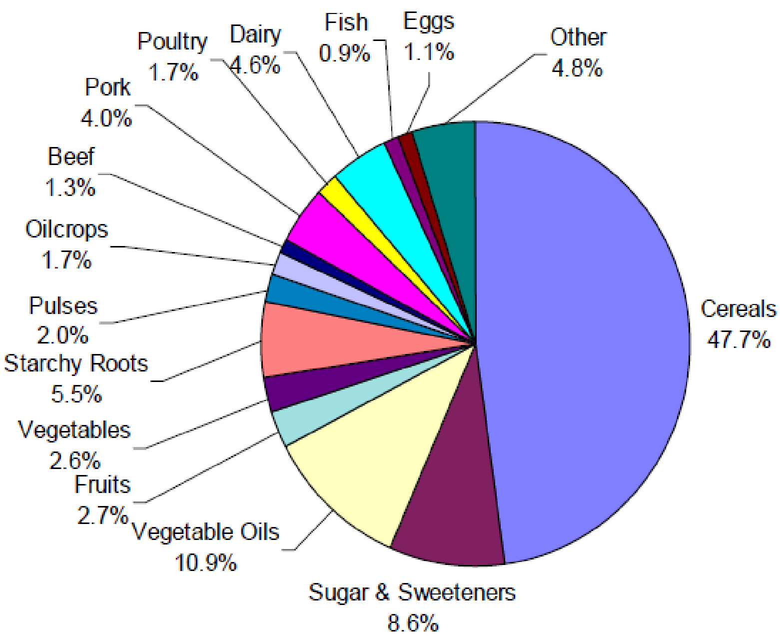

Figure 1 ***Total Calories Delivered Per Capita per Day in 2000 World Average 2,712***

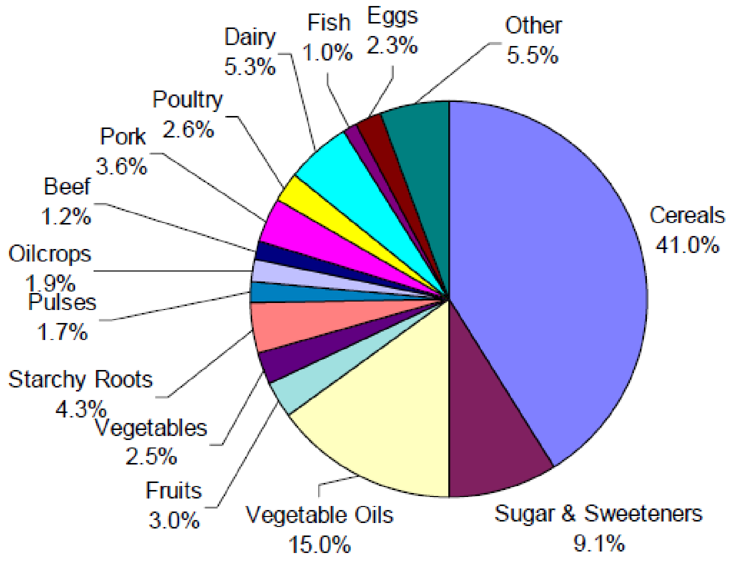

Figure 2 ***Total Calories Delivered Per Capita Per Day in 2050 World Average 3,226***

Trends of Meat Production and Consumption

Since the 1970s, global meat production has tripled, increasing 20% since 2000 alone.. Annual meat production will need to rise by over 200 million tonnes to reach 470 million tonnes. Global production pig meat is increased by approximately by 290%; sheep and goat meat by 200%; beef and buffalo meat by 180% and poultry meat by 700% (Bryan, 2011).

Trends of Carcass Weight

Trends of carcass weight in each species of animals in 2007 and 2050 is presented in table 5

Trends of Milk Production and Consumption

Related to rapid population growth, it's estimated that the need for milk, for example, will more than quadruple from 2003 demand levels by 2050. Milk output per animal remains higher in developed countries than in developing ones. Annual average milk yields were 1.3 and 5.0 tonnes per milking cow respectively. The global milk production is increased by 180 percent in 2050 (Bryan, 2011). The trends of milk production and consumption is presented in table 6

Table 4 Meat production, consumption and growth rate in the world

Meat	Production 2007 In 000 t	Production Growth rate (%) per annum 2030	Production Growth rate (%) per annum 2050	Consumption 2007 In 000 t	Consumption Growth rate (%) per annum 2030	Consumption Growth rate (%) per annum 2050
Bovine	63 585	1.3	1.2	62 321	1.3	1.2
Ovine	12 876	1.6	1.5	12 670	1.7	1.5
Pig	99 917	1.2	0.8	99 644	1.2	0.8
poultry	81 994	2.1	1.8	81 545	2.1	1.8
Total Meat	258 370	1.5	1.3	256 179	1.6	1.3

Source: Nikos and Jelle, 2012

Table 5 Number of animals, annual growth rate and carcass weight in the World

Animals	Number of animals in Million		Annual growth rate of animals (% per annum) 2007-2050	Carcass weight in Kg/animal	
	2007	2050		2007	2050
Cattle and buffaloes	1532	2636	0.6	202	227
Sheep and goat	1915	2939	1.0	14	17
Pig	917	1141	0.5	79	84
Poultry	19160	37030	1.5	1.6	1.7

Source: Nikos and Jelle, 2012

Table 6 Trends of Milk Production, consumption and growth rate

Country	production			Consumption		
	2007 In million	2030 Growth rate (%)	2050 Growth rate (%)	2007 In 000 t	2030 Growth rate (%)	2050 Growth rate (%)
Developing	306	2.1	1.8	324	2.1	1.7
Developed	358	0.5	0.3	333	0.5	0.3
World	664	1.3	1.1	657	1.3	1.1

Source: Nikos and Jelle, 2012

Trends of Annual Per Capita Consumption of Meat and Milk

The additional demand beyond that expected from population growth will result from increases in income encouraging a higher consumption per person. The largest growth is expected in developing countries, which are anticipated to overtake developed countries in their total consumption of livestock products. The resultant trends in meat and milk consumption figures in developing and developed countries are shown in table 7. In Ethiopia, the 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 and the national per capita consumption of milk and milk products is about 17 kg (Staal et al. 2008). In 2030, the per capita consumption meat will be between 14 and 20 kg a person a year (up from current) and milk, 40 to 60 kg per person per year (www.brightergreen,org)

Table 7 Trends of meat and milk per capita consumption in developing and developed countries.

Country	Year	Annual per capita consumption	
		Meat(kg)	Milk(kg)
Developing			
	2015	32	55
	2030	38	67
	2050	44	78
Developed			
	2015	83	203
	2030	89	209
	2050	94	216

Source: Data for 2015 adapted from Steinfeld et al. (2006) and for 2030–2050 from FAO (2006).

Table 8 Projections of total consumption of meat and dairy products

	2010	2020	2030	2050	2050/2010
	(million tonnes)				
WORLD					
All meat	268.7	319.3	380.8	463.8	173%
Bovine meat	67.3	77.3	88.9	106.3	158%
Ovine meat	13.2	15.7	18.5	23.5	178%
Pig meat	102.3	115.3	129.9	140.7	137%
Poultry meat	85.9	111.0	143.5	193.3	225%
Dairy not butter	657.3	755.4	868.1	1 038.4	158%
DEVELOPING COUNTRIES					
All meat	158.3	200.8	256.1	330.4	209%
Bovine meat	35.1	43.6	54.2	70.2	200%
Ovine meat	10.1	12.5	15.6	20.6	204%
Pig meat	62.8	74.3	88.0	99.2	158%
Poultry meat	50.4	70.4	98.3	140.4	279%
Dairy not butter	296.2	379.2	485.3	640.9	216%

Source: FAO, 2006c. Some calculations by authors.
Note these figures are based on World Population Prospects: The 2002 Revision.

Projections of Meat and Dairy Products Consumption

Meat and dairy products consumption in the world is projected in table 8

Projections of Meat and Dairy Products Consumption

Meat and dairy products consumption in the world is projected in table 8

Trends of Poultry Meat and Egg Production and Consumption

The world poultry meat production elevated from 91.9 to 104.0 million tonnes during the year 2009 and 2012. In poultry meat production, chicken meat contributes a major stake of about 87.4%, turkey 6.6%, duck 4.2% and geese 2.7% (Watt Executive Guide, 2012). During the year 2003, world poultry meat consumption was 11.6 kg/person/year, which increased to 12.62 kg/person/year in the year 2009. Demand for poultry meat will rise by 121% in 2050 because of a growing population, increasing wealth and urbanisation

During 2009, worldwide hen eggs production was 62.8 million tonnes from a total of 6.4 billion laying flocks of hens (FAO, 2009). Similarly, global average of egg consumption is currently around 8.57 kg/person/year. For eggs, consumption will grow from 6.5 to 8.9 kg in developing countries and from 13.5 to 13.8 kg in industrial countries in 2030. Demand for eggs will rise by 64 % in 2050. The demand for eggs by 2050 would increase by 40 million tonnes. Forty two kilograms (42 kgs) feed consumed and 20 kgs eggs produced per hen per annum, 40 million tonnes of eggs will require an additional 84 million tonnes of feed required. Egg production in 2007 was 62 million tonnes and it will be 102 million tonnes in 2050 with annual growth rate of 1.1% from 2007-2050. About 1.1 trillion eggs were produced in 2009 from 6.4 billion hens. Each hen produced about 173 eggs that year. Projections for 2050 call for 1.9 trillion eggs needed to satisfy world demand. At present levels of productivity, we would need 10.8 billion hens. If, however productivity per hen were to increase to 276 eggs per bird per year, we could meet demand with 6.8 billion hens (James, 2011).

Trends of Livestock Products' Prices

Combining all of these factors, there is a strong possibility that prices of livestock products will increase. Projections by OECD and FAO suggest that average prices of poultry meat and beef will be higher in real terms during 2010–19 than they were in 1997–2006, with limits in supply, higher feed costs and rising demand all contributing to the effect (OECD-FAO, 2010). Average dairy prices in real terms are expected to be 16-45 percent higher in 2010–19 compared to 1997-2006.This prise growth continues up 2050.

Trends of Animal Feed Demand

Livestock production is the world's largest user of land, either directly through grazing or indirectly through consumption of fodder and feed grains. For instance in 2004, 690 million tonnes of cereals (34% 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) (Melkamu and gebreyohhanes, 2014). To feed people and livestock, the world will need to produce an additional 1 billion tonnes of cereals annually in the next decades, a 50% increase. A significant part of this increase will be used for animal feed (FAO, 2006). Livestock feed consumes nearly 43% of the food energy (kilocalories) produced by the world's total harvest of edible crops after post-harvest losses (Smil, 2000; Lundqvist et al, 2008). This proportion is set to rise to 48–55% by 2050. They also calculated that, on average, about 4 kcal of crop products are used to generate 1 kcal of animal products (Prajal et al, 2013). To produce 1 kg of edible meat by typical industrial methods requires 20 kg of feed for beef, 7.3 kg of feed for pig meat and 4.5 kg of feed for chicken meat (Smil, 2000). On average, to produce 1 kg of high quality animal protein, livestock are fed nearly 6 kg of plant protein (IAASTD, 2008). The researchers project that, when considering dietary changes, global feed demand will be almost doubled (increasing 1.8–2.3 times) by 2050 compared to 2000. In Each year 1.3 billion tonnes of grain are consumed by farm animals and nearly all of it is fed to livestock, mostly pork and poultry, in the developed world and in China and Latin America. All of the livestock in sub-Saharan Africa eat just 50 million tonnes of grain a year, otherwise subsisting on grasses and on crop residue. It is estimated that 77 million tonnes of plant protein are consumed annually to produce 58 million tonnes of livestock protein (Steinfeld et al., 2006).

Trends of Grazing Intensity

Grazing intensity is calculated as the total number of Tropical Livestock Units (TLU) (bovines, sheep and goats, where one bovine is equivalent to one TLU and a sheep or goat to 0.1 TLU) in the rangeland system, divided by the total hectares of rangeland in each region. Ruminant grazing intensity in the rangelands increases in all regions in the in the world, but there are considerable regional variations. In Latin America and Caribbean countries , for instance, average grazing intensities are expected to increase by about 70%, from 0.19 in 2000 to 0.32 TLU per ha in 2050 (Rosegrant et al., 2009).

Table 9 Grazing intensities in rangeland systems to 2030 and 2050 by region (TLU per ha).

Country	2000	2030	2050
CWANA	0.052	0.077	0.083
ESAP	0.044	0.067	0.067
LAC	0.188	0.293	0.318
NAE	0.052	0.063	0.060
SSA	0.062	0.090	0.090
World	0.064	0.094	0.098

CWANA Central and West Asia and North Africa; ESAP East and South Asia and the Pacific; LAC Latin America and the Caribbean;

NAE North America and Europe; SSA Sub-Saharan Africa

Source: Rosegrant et al., 2009

Trends of Livestock Water Demand

The world economy is expected to grow at an average rate of just over three percent per annum from 2011 to 2050. Livestock production which includes meat, milk and eggs contributes 40% of global agricultural gross domestic product, provides income for more than 1.3 billion people and uses one-third of the world's fresh water **(**Susan, 2013). The agricultural sector is the largest user of fresh water resources, accounting for some 70% of water use. Globally, freshwater resources are relatively scarce, amounting to only 2.5 % of all water resources (MA, 2005). Groundwater also plays an important role in water supply: between 1.5 and 3 billion people depend on groundwater for drinking, and in some regions water tables are declining unremittingly (Rodell *et al*. 2009). By 2025, 64 % of the world's population will live in water-stressed basins, compared with 38 % today (Rosegrant *et al*. 2002). Increasing livestock numbers in the future will clearly add to the demand for water, particularly in the production of livestock feed: one cubic metre of water can produce anything from about 0.5 kg of dry animal feed in North American grasslands to about 5 kg of feed in some tropical systems (Peden *et al*., 2007). The production of just 1 kg of beef, as a global average, consumes nearly 15,500 litres of water (Hoekstra and Chapagain, 2007). Peden et al. (2007) estimated that about 450 m^3 of water per TLU per year to provide the feed needed for maintenance, compared with about 9-18 m^3 per TLU per year for drinking water. Several entry points for improving global livestock water productivity exist, such as increased use of crop residues and by-products, managing the spatial and temporal distribution of feed resources so as to better match availability with demand and managing systems so as to conserve water resources (Peden *et al*. 2007)

Table 10 Consumptive water use for livestock for 2000 and 2050 in km^3 per year

Country	2000 (in km^3)	2050 (in km^3)
CWANA	12	19
ESAP	16	24
LAC	6	9
NAE	6	5
SSA	4	7
Developing	38	58
Developed	7	6
World	45	63

CWANA Central and West Asia and North Africa; ESAP East and South Asia and the Pacific; LAC Latin America and the Caribbean;

NAE North America and Europe; SSA Sub-Saharan Africa

Source: IMPACT model simulations (Rosegrant et al., 2009).

Livestock Competition for Land

Agriculture now occupies about 40% of the global land surface. At the same time, land-use intensity has increased substantially in many places. Recent scenarios of agricultural land use (cropland and grazing land) have generally projected increasing global agricultural area, typically by 10% to 2050, and smaller forest land area, usually at the expense of cropland increases (Rosegrant et al., 2009). 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 which is either directly through grazing or indirectly through consumption of fodder and feed grains (DeHaan et al. 1997). The livestock sector is by far the single largest anthropogenic user of land. For instance, the production of 1 kg of beef requires 15 times as much land as the production of 1 kg of cereals and 70 times as much land as the production of 1 kg of vegetables. One kilogramme of pig meat uses over six times as much land as 1 kg of cereals and 30 times as much land as 1 kg of vegetables (Gerbens-Leenes, and Nonhebel , 2005). Bruinsma, (2003) estimated that at least 75% of total production growth to 2030 will be in confined systems; however there will be much less growth of these systems in Africa. The crop areas are relatively increases from

1.5 billion ha now to 1.60 or 1.77 billion ha in 2030 (Van Vuren et al., 2009). The open grazing lands (range land) cover 45% of the earth's surface, excluding Antarctica (Asner et al., 2004). In general, the world's 60 billion livestock occur in three main types of production systems: confined intensive, mixed crop–livestock, and open grazing systems (Herrero et al., 2009a). The grazing systems supply 9% of the world's meat and 12% of milk; mixed crop–livestock systems contribute 46% of meat, 88% of milk, and 50% of cereals; while intensive systems provide 45% of meat (Steinfeld et al., 2006; Thornton and Herrero 2010).

Livestock and climate change

Estimates of temperature increases in the Fourth Assessment Report (AR4) are in the range 1.8 to 4°C in 2090-2099 relative to 1980-1999, depending on the scenario of future greenhouse gas emissions that is used to drive the climate models (IPCC, 2007). At the lower end of this range, global food production might actually increase but above this range would probably decrease (IPCC, 2007). Increasing frequencies of heat stress, drought and flooding events are estimated to be likely. These will have adverse effects on crop and livestock productivity over and above the impacts due to changes in mean variables alone (IPCC, 2007). Example, in 2050 climate change will decrease food and agricultural production by up to 30 % in parts of developing countries (FAO, 2014). Climate change would reduce water availability; livestock feed (both in quality and quantity) and lead to increase animal parasites and diseases,

Livestock's Impact on Climate

Greenhouse gas emission

A total emission of greenhouse gas (GHGs) from agriculture, including livestock, is estimated to be in between 25 and 32% depending on the source and on the proportion of land conversion to livestock activities (US EPA, 2006; IPCC, 2007). Agricultural crops are estimated to account for 14% of this total. Steinfeld et al. (2006) estimated that overall, livestock activities contribute some 18% to total anthropogenic greenhouse gas emissions. the major contributors: land use and land-use change, 36%; feed production, 7%; direct emission by animals, 25%; manure management, 31%; and processing and transport, 1%. The three major greenhouse gases involved are carbon dioxide from land-use conversion mostly, methane from enteric fermentation, and nitrous oxide from manure management practices, mostly in the developed world.

Carbon Dioxide (CO2)

Increasing carbon dioxide concentrations have had more impact on historical radiative forcing than any other greenhouse gas (MA, 2005). Annual net additions of carbon to the atmosphere are in the range 4.5 to 6.5 billion tonnes. Livestock may account for 9% of global anthropogenic emissions of CO2. As farming systems become more intensive and industrialized in places, CO2 emissions will increase (Steinfeld et al., 2006).

Methane

Like CO2, methane has a positive radiative forcing on climate: the global warming potential of methane is 21 times that of CO2 over 100 years (UNFCCC, 2007), although it is much shorter-lived in the atmosphere. It also has impacts on high-atmosphere ozone formation. Livestock account for 35-40% of global anthropogenic emissions of methane, via enteric fermentation and manure, which together account for about 80% of agricultural emissions (Steinfeld et al., 2006). By 2050, the projected enteric methane emission in the world is 120 kg $\times 10^9$kg and average groth rate is 0.90% (Amlan , 2014)

Recent estimates by Herrero et al. (2008) indicate that methane emissions from African cattle, goats and sheep are likely to increase from their current level of about 7.8 million tonnes of methane per year in 2000 to 11.1 million tonnes per year by 2030, largely driven by increase in livestock numbers. Again, there are considerable differences in methane emission per tropical livestock unit (TLU, 250 kg bodyweight), depending on production system and diet, from 21 (less productive systems) to 40 (more productive systems) kg per TLU per year.

Nitrous oxide (N_2O)

The third important greenhouse gas is nitrous oxide, a powerful, long-lived gas (its global warming potential is 310-times greater than CO2 over a 100-year time horizon) (UNFCCC, 2007). Nitrous oxide also has impacts on stratospheric ozone depletion. Ecosystem sources (mostly soil micro-organisms in a wide variety of environments) account for about 90% of all emissions (MA, 2005). Increased emissions are driven largely by fertilizer use, agricultural nitrogen fixation, and atmospheric nitrogen deposition. Livestock activities contribute substantially in two ways: in the use of manure and slurry as fertilizers, and through the use of fertilizers to produce feed crops. These account for some 65% of global anthropogenic emissions (75-80% of agricultural emissions). Emissions of N2O originating from animal manure are much higher than any other N2O emission caused by the livestock sector, and these emissions are dominated by mixed crop-livestock systems (Steinfeld et al., 2006). For the future, agricultural N2O emissions are projected to increase by 35-60% by 2030, because of increased nitrogen fertilizer use and increased animal manure production (Bruinsma, 2003).

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 (DeHaan 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.

Water Pollution 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). The livestock industry affects water quality ‘‘through the release of nutrients, pathogens and other substances into waterways, mainly from intensive livestock operations’’ (FAO. 2006b).

Losses of Biodiversity

Livestock are having widespread direct and indirect impacts on biodiversity, via the increasing demand for and consumption of livestock products. In varieties of domestic animals, for example, of the nearly 4000 breeds of ass, water buffalo, cattle, goat, horse, pig and sheep recorded in the twentieth century, some 16% had become extinct by 2000, some 20% of reported breeds are now classified as at risk, and almost one breed per month is becoming extinct (CGRFA, 2007). Much of this genetic erosion is attributed to global livestock production practices and the increasing marginalization of traditional production systems and associated local breeds. Ultimately, as Steinfeld et al. (2006) noted that, land-use intensification need not be a threat to biodiversity: given the growth of the global livestock sector, intensification is also an important technological pathway to reducing the pressure on natural land and habitat.

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.

Climate change's impacts on livestock

The climate change has its own impacts on livestock feeds and water, genetics and breeding and livestock health (Thornton et al., 2008).

Feeds and water

Population growth, economic development and climate change impacts will undoubtedly have a substantial effect on global water availability in the future. The response of increased temperatures on water demand by livestock is well-known. For Bos indicus, for example, water intake increases from about 3 kg per kg DM intake at 10 °C ambient temperature, to 5 kg at 30°C, and to about 10 kg at 35°C (NRC, 1981). One of the most evident and important effects of climate change on livestock production is mediated through changes in feed resources. Although indirect, effects on feed resources can have a significant impact on livestock productivity, the carrying capacity of rangelands, the buffering ability of ecosystems and their sustainability, prices of stovers and grains, trade in feeds, changes in feeding options, greenhouse gas emissions, and grazing management.

Livestock genetics and breeding

Livestock genetic adaptation responses will vary from intensifying and managed systems to adaptive systems in more marginal environments. Greater climatic variability and stresses anticipated, this is a most logical response to the adaptive challenges that will be faced in selection and cross breeding programs. The adaptive challenge will improve productivity traits while maintaining adaptive traits.

Livestock (and Human) Health

Diseases in food producing animals globally amount to a loss of 20% in production. According to the world organization for animal health (OIE) of the nearly 1,500 infectious diseases affecting people, almost two thirds can pass between animals and people (zoonoses). Additionally, 75% of emerging infections amongst humans are believed to have originated in animals. The major impacts of climate change on livestock and human diseases have been on diseases that are vector-borne (Woolhouse 2006). Increasing temperatures have supported the expansion of vector populations into cooler areas, either into higher altitude systems (for example, malaria and livestock tick-borne diseases) or into more temperate zones (for example, the current outbreak of bluetongue disease in northern Europe). Changes in rainfall pattern can also influence an expansion of vectors during wetter years. Beyond vector-borne diseases, helminth infections, particularly of small ruminants will be greatly influenced by changes in temperature and humidity. The future infectious disease situation is going to be different from todays, and will reflect many changes, including changes in mean climate and climate variability, demographic change and different technologies for combating infectious diseases (Woolhouse 2006).

Improving livestock and livestock products through improved technology by 2050

Globally demand for meat and milk production is also expected to double in 2050, where population is expected to 9.2 billion. Thus, increasing production and the safe processing and marketing of livestock products are big challenges for livestock producers. To solve the challenge, biotechnology is being harnessed in various aspects of the livestock industry to hasten breed development for improved animal health and welfare, enhanced reproduction, and improved nutritional quality and safety of animal-derived foods. Therefor reproductive biotechnology, Genomics and Marker-Assisted Selection (MAS) applications, DNA-based technology and nanotechnology in livestock improvement will be employed widely by 2050.

Reproductive Animal Biotechnology

Various biotechnology methods are used in improving the breeding stock of animals. These include artificial insemination (AI), embryo transfer (ET), in-vitro fertilization (IVF), somatic cell nuclear transfer, and the emerging technology on somatic cell nuclear transfer.

Artificial Insemination

It is one of the earliest perfected technologies where new breeds of animals are produced through the introduction of the male sperm from one superior male to the female reproductive tract without mating. AI reduces transmission of venereal disease, lessens the need of farms to maintain breeding males, facilitates more accurate recording of pedigrees, and minimizes the cost of introducing improved genetics (Wilmut et al, 1979). Various technologies have evolved that led to the efficient use of AI in developing desired livestock, including the methods of freezing semen or cryopreservation and sperm sexing.

In-vitro Fertilization

In case other artificial reproductive techniques fail due to difficulties such as blocked reproductive systems, non-responsive ovaries in the females, marginal semen quality and quantity in the male, and presence of disease, in vitro fertilization (IVF) is used. The fertilization of the sperm and the egg is conducted in vitro (outside the animal's body) at specific environmental and biochemical conditions. To date, successful IVFs have been conducted in various animal species due to advances in embryo production and cryopreservation of reproductive cells. In 1959, through IVF the first rabbit was conceived (Chang, 1959). IVF offsprings have been born in mice, rats, hamsters, cats, guinea pig, squirrels, pigs, cows, monkeys, and humans (Bearden and Fuquay 2000).

Embryo Transfer

Embryo transfer (ET) from one mother to a surrogate mother makes it possible to produce several livestock progenies from a superior female. Selected females are induced to superovulate hormonally and inseminated at an appropriate time relative to ovulation depending on the species and breed. Week-old embryos are flushed out of the donor's uterus, isolated, examined microscopically for number and quality, and inserted into the lining of the uterus of surrogate mothers.

ET increases reproductive rate of selected females, reduces disease transfer, and facilitates the development of rare and economically important genetic stocks as well as the production of several closely related and genetically similar individuals that are important in livestock breeding research. The International Embryo Transfer Society (IETS) estimated that a total of approximately 550,000 in vivo derived bovine embryos, 68,000 sheep embryos, 1,000 goat embryos were transferred worldwide in 2004(Thibier, 2005)

Somatic Cell Nuclear Transfer

Somatic cell nuclear transfer (NF) is a technique in which the nucleus (DNA) of a somatic cell is transferred into a female egg cell or oocyte in which the nucleus has been removed to generate a new individual, genetically identical to the somatic cell donor

(Tian et al, 2003). This technique was used to generate Dolly from a differentiated adult mammary epithelial cell which demonstrated that genes that are already inactivated in differentiated tissues can be completely reactivated. Problems on high rate of pregnancy loss, survival of newborn and increased incidence of abnormal development due to incorrect reprogramming of nuclear DNA (epigenetic inference) and unusual conditions during in-vitro processes make this a pre commercial technology.

Genomics and Marker-Assisted Selection (MAS) Applications

The discovery and identification of DNA sequences or molecular markers associated with important animal traits has various applications that include trait improvement, heritability determination, and product traceability.

Molecular Marker-assisted Introgression (MAI)

Markers are used to guide livestock breeders in selecting individuals expressing the introgressed gene. A series of backcrossing to the recipient parent is usually done in conventional breeding. With the use of molecular markers, the time and number of backcrossing cycles incurred in selection and identification of the desired individual are reduced. Today, molecular markers are being used in various livestock trait improvement activities such as growth, meat quality, wool quality, milk production and quality, and disease resistance.

Parentage, product traceability and genotype verification

Molecular markers are reliable tools used by regulatory bodies to ensure product quality and food safety. Livestock parentage and its products can be identified and traced using molecular markers from farm to the abattoir and from the cut up carcass to consumer’s plate. A similar DNA-based technology has also been developed to detect the presence of around 211 bp fragments to facilitate testing of very small meat samples from the supermarket (Cunningham and Meghen, 2001)

Screening for undesirable genes

Genetic diseases and physical defects can be traced and documented in livestock animals using molecular markers (Cunningham and Meghen, 2001). The cause and origin of these problems can be easily traced to the genetic changes and DNA mutations as they manifest in the protein structure and function (Womack, 2005). With DNA testing, animals carrying these defective genes are easily identified and are culled from the livestock breeding program.

DNA-based Technology in Livestock Improvement

Currently, complete genomic sequencies of important farm animals such as that of chicken, bovine, pig, goat, and sheep have been released. With advances in sequencing farm animal genome, the continuing progress in molecular marker technology, and the use of reproductive biotechnology, windows of research opportunities will be opened to improve and revolutionize the livestock industry. Now days an information on the genetic constitution of the animals that will allow a prediction of the production potential of an animal at birth, or perhaps even as a fetus, as well as the selection of animals best suited to a specific production environment.

Uses of Nanotechnology

Nanotechnology (from the Latin nanus, meaning dwarf) is defined as the technology of materials and structures where size is measured in nanometers, with application in diverse areas (REA, 2001; Buzea et al., 2007). In agriculture it is used in the form of nanofertilizers, water catchers, and trappers of toxic substances (Lal, 2007).Nanotechnology in animal production and health has the potential to solve many more puzzles related to animal health, production, reproduction and prevention and treatment of diseases. It is used to detect nutrient deficiency, drug delivery, disease diagnosis and treatment or other health problem and protection of the environment. For example, in animal breeding - management of breeding is an expensive and time consuming problem for dairy and swine farmers. One solution that is currently being studied is a nanotube implanted under the skin to provide real time measurement of changes in the level of estradiol in the blood. The nanotubes (O'Connell, 2002) are used as a means of tracking oestrus in animals because these tubes have the capacity to bind and detect the estradiol antibody at the time of oestrus by near infrared fluorescence. The signal from this sensor will be incorporated as a part of a central monitoring and control system to activate breeding

CONCLUSION

Projected increases in human population, continuing urbanization, increasing incomes, and changing lifestyles will inevitably lead to considerable increases in demand for livestock and livestock products for the next three decades at least. The increasing demand for livestock products continues to be a key opportunity for poverty reduction and economic growth. Livestock are important to the food security of millions of people today and will be important to the food security of millions more in the coming decades. Globally, increases in livestock productivity in the recent past have been driven mostly by animal science and technology, and scientific and technological developments in breeding, nutrition and animal health will continue to contribute to increasing potential production and further efficiency and genetic gains. Demand for livestock products in the future, particularly in developed countries, could be heavily moderated by socio-economic factors such as human health concerns and changing socio-cultural values. Climate variability is projected to increase in the coming decades, which may alter the productivity, reproductive efficiency of animals 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.

Work is needed on the wide variety of responses to these impacts, including mitigation alternatives that can reduce greenhouse gas emissions and reduce the environmental and social impacts of intensive production, and adaptation strategies that can ensure the food provisioning and environmental goods and services that livestock provide. Using most recent scientific animal breeding techniques, improving the nutrition and the health status of animals, using appropriate animal management practices, carrying out modern animal production systems, bringing attitudinal change of the people towards the use of new technologies will improve the livestock production and productivity.

Ultimately, livestock production practices should be attractive and acceptable to farmers, land managers, consumers and policymakers, at the same time contributing to sustainable development, food security, energy security, and improvement of environmental quality.

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