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Climate Change and the Preference of Rearing Poultry for the Demands of Protein Foods

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ABSTRACT

Related research results and facts of climate change scenarios and the preferences of animal species that reared for animal protein productions were reviewed with the aim of delivering synthesized information for the beneficiaries. Both of the climate change and animal productions have always negative impacts one over the other. Livestock is responsible for 18% of GHG emissions measured in CO_2-eq. Upcoming animal protein supply and demands will pose a challenge to the environment. However, due to its low global warming potential, poultry has advantages over other livestock industries. Chicken is the cheapest, without taboos and nutritious of all livestock meats but the red meat industry is a pro-active for environmental concerns. Birds, however, tolerates a narrow temperature ranges and are vulnerable to climate changes. There is a positive relationship between the level of income and the consumption of animal proteins. As a result, animal protein production is projected to double by 2050. Consequently, poultry consumption is expected to grow at 2-3% per year and its share is also around 33% of the total meat produced in the world. The average per capita consumption of poultry is around 11 kg. Technology favors the intensification of poultry production in developing countries but environment and health issues will be the concern. A grain yield is adversely affected by warming that leads to food-feed competitions. This competition gives rise to looking for alternative feeds and other utilizing techniques to improving the nutritive values of poor ingredients. It needs 2 and 4 kg of cereals, to produce 1 kg of chicken meat and pork, respectively. This shows that chicken is relatively efficient in feed conversion ratio than other livestock. It is therefore, concluded that to coping up with climate changes, poultry is the preferred species of farm animals that allowed for protein food productions. Moreover, it is also the preferred species of farm animal that will satisfy the demands of protein foods of the people.

Key words: Chicken, climate changes, food-feed competition, preferences, protein-foods

INTRODUCTION

Both of the climate change and animal productions have always negative impacts one over the other. Climate change could affect animal productions due to the impacts of increasing air temperature, feed-grain availability and favoring the diseases (Adams *et al*., 1990; Bowes and Crosson, 1993). In Sub-Saharan Africa, the expectation of climate change will have negative impacts on the food security (Thompson *et al*., 2010) of the people. On the other hand, FAO (2006) reported also that livestock production is one of the major causes of the world's most pressing environmental problems. Although, much evidence has been provided on the negative impacts of animal agricultural on climate changes, this sector has remained underestimated and underappreciated (Koneswaran and Nierenberg, 2008). FAO (2006) reported also that around 18%

of negative impacts of climate change mainly come from the ruminant animal production of which that consumes roughage and produce methane gas. Reducing negative impacts of climate change from the responsible animal production in general and ruminants in particular, is both urgent and critical (IPCC and Al-Gore, 2007).

The poultry sector is characterized by its industrlization, faster growth in consumption and trade than any other major agricultural sectors in the world. However, poultry production in most tropical countries is based on scavenging production systems. Chicken population in Ethiopia is around 34.2 (CSA, 2007) million that constitutes 60% of the total population of East Africa (Mekonnen *et al*., 1991). Out of which 97.82% of them are local birds that kept in extensive production systems (FAO, 2008). However, FAO (2010a) reported that extensive poultry production system has higher Feed Conversion Ratio (FCR) and longer growing periods. Moreover, this system needs higher energy and has negative impacts for climate changes.

Due to various reasons, the grazing and hay harvesting lands in Ethiopia have been gradually reduced. As the consequences of these facts, ruminant animal productions become difficult in the country. Hence, poultry production is becoming the first priority to supply animal protein source foods and is an income generating activity. Similarly, FAO (2010a) reported that nowadays, poultry meat represents about 33% of the total global meat production. Moreover, Van der Sluis (2007) reported that poultry meat and egg production is the most environmentally efficient animal protein production system. Likewise to this, Van der Sluis (2007) reported that intensive poultry production has much less impact on global warming than organic or free-range production. Likewise to this, Bos and Wit (1996) stated the facts that poultry provides an acceptable form of animal protein to most people throughout the world and intensively kept poultry is seen as a way of rapidly increasing animal protein supplies for rapidly growing urban populations. Therefore, reviewing the impacts of climate changes on animal, particularly poultry productions or its reciprocal effects is seems to be the priority research area.

Based on this outlined background, the objectives of this study were:

- To review impacts of climate change on animal (poultry) production or its reciprocal effects
- To identify those species of farm animals that have advantages for protein food production on the scenarios of climate changes
- To review additional advantages of chicken rearing for the demands of protein food productions

Most of the research findings which focus on climate change impacts on poultry productions and the negative impacts of livestock production to the climate change, were reviewed. Various reports of research findings that were focusing on negative impacts of climate change on disease occurrences of birds were reviewed. Effects of food-feed competitions on chicken production types of chicken were also reviewed, depicted and sourced. Trends of production, trade and consumption of poultry were reviewed. Comparative studies of land requirements and feed efficiency of livestock and poultry were reviewed. Moreover, the impacts of climate change on cereal grain productions were also reviewed and synthesized.

Outlined decryption of climate change and protein food demands: A climate change is a physical consistent set of changes in meteorological variables (Rosenzweig *et al*., 1993). APF (2007) reported that climate change is a major threat to sustainable growth and development in Africa by reducing agricultural production and worsening food security. Moreover, Thompson *et al*. (2010) reported that due to climate change there is land degradation in Sub-Saharan Africa. According

to Mitloehner (2010) reports, upcoming animal protein supply and demands will pose a challenge to the environment. Animal protein production projected to more than double the current rate by 2050 and the majority of this livestock production growth occurring in the developing world (Mitloehner, 2010). Assessing of the holistic impacts of food animals in the context of global and regional environmental policy and food security becomes imperative

On the other hand, livestock and poultry sector is growing at an unprecedented rate and the driving force behind this enormous surge is a combination of population growth, rising incomes and urbanization. Similarly, FAO (2010a) reported that there is a strong positive relationship between the level of income and the consumption of animal proteins. According to Grimes (2009) reports, the current growth of poultry production and consumption makes a good case for the need and desire for future growth of the poultry industry. Moreover, Harlan (2007) also reported that poultry consumption is expected to grow at 2-3% per year. Likewise to this, Abedullah *et al.* (2007) reported that the major contribution of poultry consumption in improving per capita nutrients level is well documented. Consequently, Ivo (2009) reported that the possibilities of village poultry as a viable sector to boost protein deficiencies in Cameroon.

However, FAO/WHO (2003) reported that there has been an increasing pressure on the livestock and poultry sector to meet the growing demand for high-value animal proteins. The constraints on future development are: feed sources, climate and competition from poultry imports are all discussed. Moreover, http://www.fao.org/ag/portal/index_en/en/) reported also that advances in technology favors the intensification of poultry production in developing countries but fundamental knowledge of the environmental and health issues associated with poultry waste management will serve now and in the future. Thornton (2010) reported also that in the future, poultry production will increasingly be affected by competition for natural resources. Moreover, FAO (http://www.fao.org/ag/portal/index_en/en/) reported that the growing demand for livestock products is likely to have an undesirable impact on the environment. Similarly, Harlan (2007) reported that the poultry industry has to look at issues like global warming and use of feed stocks. Therefore, to satisfy the future demands of protein foods, experience is needed for the trends of poultry productions and consumptions in the world.

Trends of poultry production and consumption: Poultry production and consumption has been increased in the world. Poultry meat accounts for about 33% (87% chicken and 6.7% Turkey) of the global meat consumption (FAO, 2010a). The worldwide average per capita consumption of poultry is around 11 kg (in the year 2003) and poultry meat and eggs are highly nutritious.

Poultry meat and egg production is the most environmentally efficient animal protein production system. Intensive poultry production has much less impact on global warming than organic or free-range production (Van der Sluis, 2007). However, Gueye (2009) reported that despite efforts to develop intensive poultry production, family poultry remains important in the developing countries of Africa. Similar to this argument, Seo and Mendelsohn (2006) reported that small farms of livestock (poultry) are better able to adapt to warming. However, organic egg production needs more energy than non-organic and increases most environmental burdens (Table 1).

The most disadvantageous, from environmental point of view, is litter-free breeding of birds which causes great amounts of liquid manure. Thornton (2010) reported that the livestock and poultry sector globally is highly dynamic, particularly in developing countries that evolving in response to rapidly increasing demand for animal products. Thus, with this fatly growing poultry production, trade and consumptions, human heath should be also considered.

Table 1: Main burden of animal products (1 Tone dead weight, 20,000 eggs and 10,000/milk)

	Meat					
Impacts and resources used	Beef	Pig	Poultry	Lamb	Eggs	Milk
Organic share in parenthesis (%)	0.8	0.6	1	1	1	2.5
Primary energy used, GJ	27	23	15	26	14	26
GWP100, t CO_2	15	4.9	3.6	17	3.8	11
Eutrophication potential, kg PO_4	101	32	26	153	26	45
Acidification potential, kg SO_2	162	83	61	130	70	94
Pesticides used, dose ha	1.3	1.8	1.5	0.9	1.3	0.8
Abiotic resource use, kg antimony	34	41	28	29	36	31

*Adopted from Van der Sluis (2007) www.worldpoultry.Net

Poultry product consumption and human health: According to FAO (2010a) reports, the human population benefits greatly from poultry meat and eggs which provide food containing high-quality protein and a low level of fat with a desirable fatty acid profile. Similarly, Costa (2009) reported that the consumer demands for chicken meat has been growing steadily over the last decade. However, there are a number of risks (e.g bacteria) to humans associated with poultry production and the consumption of poultry meat and eggs. Andreoletti *et al.* (2010) reported that handling, preparation and consumption of broiler meat may account for 20 to 30% of human cases of campylobacteriosis while 50 to 80% may be attributed to the chicken reservoir as a whole. Moreover, Bingham *et al.* (2002) also reported that there is an epidemiological association between red meat consumption and colorectal cancers.

However, FAO (2010a) reported that a comparison of chicken meat with other meats shows that it is a healthy meat that it contains low in total fat and high in the desirable monounsaturated fats. Similarly, Costa (2009) reported also that other attributes that delineate the chicken meat industry from red meat industries are the fact that the industry is intensively-based and vertically integrated. Moreover, Pisulewski (2005) also reported that consumption of poultry and fish has not been found to be associated with increased risk of cancers. Private body concern appears as the main reasons for red meat exclusion but, Kubberod *et al.* (2002) reported that recently, red meat avoidance has shown an increment in the industrialized countries, especially among young female consumers. FAO/WHO (2003) also reported that the by-products of poultry production are of value if managed and recycled; however, if not managed or recycled properly are of concern. In addition to preferring poultry rearing as a solution to satisfy the protein demands, poultry disease occurrences should be the seasonal concern on the face climate changes.

Climate change and poultry disease situation: According to Guis *et al.* (2011) reports, climate change will alter global disease distribution and the author suggested that more research is needed to identify what we think might really happen in the future. Elijah and Adedapo (2006) reported also that climate change has an effect with poultry feed intake, encourage outbreak of poultry diseases which invariably reduce egg production. However, Gilbert *et al.* (2008) reported that little is known about the direct effect of climate change factors on highly pathogenic avian influenza transmission of domestic birds and persistence to allow inference about the possible effects. Due to climate change and population growth, food-feed competition is an event and that leads to another concern of poultry productions.

Climate change and the feed source scenarios of poultry production: According to the Rosenzweig *et al.* (1993) reports, the effect of climate change on crop yields is more adverse. Due to climate change there is a consistent prediction of decreased crop productivity, high market prices and malnutrition in Sub-Saharan Africa (Thompson *et al.*, 2010). Chadd (2008) reported also that additional legislation will affect most aspects of the feed sector, including those pertaining to environmental protection, feed hygiene and those linked to food-safety issues throughout the poultry supply chain. Moreover, Hendy *et al.* (1995) reported that the key factors affecting demand for feed commodities are human populations and incomes.

According to Yotopoulos (1987) reports, the proper lesson from the food-feed competition is substitution and correct pricing, rather than abstention. This author added that animals raised on grain substitutes do not compete for the staple commodity of the poor.

Substitution of grains in animal feeding systems goes a long way in resolving the food-feed competition. Similarly, Hinrichs and Steinfeld (2008) reported that the global poultry industries have faced competition for feed ingredients including the prospect of future ethanol production. Moreover, the same authors stated that feed competition gives rise to a need to search for alternative feed ingredients like byproducts. Utilization of these byproducts can be improved by fermentation complex enzyme systems that will fill feed-availability gaps.

Furthermore, Hendy *et al.* (1995) suggested that the composition of livestock populations and the intensity of feeding systems determine the mix of concentrate feeds required. Thus increased monogastric livestock populations and more intensive feeding systems with improved genotypes of livestock result in relatively greater demand for higher quality concentrate feeds. Chadd (2008) reported that it is predicted that elevated levels of poultry feed will be required, in the fast-developing poultry sectors to meet the burgeoning consumer demand for poultry products.

According to Schnepf (2011) reports, feed cost increments have outpaced livestock price increases, squeezing the profitability of livestock and poultry producers in US and feed grain demand has been exceeding production. Likewise to this, Chadd (2008) also reported that globally few protein and energy ingredients are used in the manufacture of poultry feed and the feed versus fuel debate over cereal usage is a set to continue that affects livestock productions.

Thus, the higher the price of grains fed to animals, the less meat will be consumed and the more grains will be substituted by non-grain feeds. Hendy *et al.* (1995) changes in feeding systems will, however, be constrained or influenced by the need to make the best use of resources available that can also lead to significant changes in demand for some feeds. Due to negative impacts of climate change on animal productions and its reciprocal effects, it is a milestone to compare animal species that best fits to this scenario.

Climate change and the species of farm-animals for protein-food production: Thornton (2010) reported that livestock production is likely to be increasingly affected by carbon constraints, environmental and animal welfare legislations. Generally, Seo and Mendelsohn (2006) reported that global warming will be harmful to commercial livestock owners and warming causes the net revenue from all animals to fall, especially cattle owners. Pant (2011) reported also that farmers have to bear direct cost of climate change that involves reductions of yield in livestock (poultry) and indirect costs of adaptation.

However, Costa (2009) reported that the poultry industry has a natural advantage over other livestock industries because of its low global warming potential. Moreover, according to FAO (2010b) reports, compared with cattle, chickens emit no methane and emit less phosphate and

carbon dioxide than other meat-producing animals. Grimes (2009) reported also that the desire for poultry meat and eggs and the relative ease in establishing poultry as an industry (compared with other animal agriculture) is driving this movement. Thus, FAO (2010b) reported that chicken is usually the cheapest of all domestic livestock meats, particularly for sub-Saharan African and South Asian countries.

According to Costa (2009) reports, the red meat industries have been pro-active in addressing environmental concerns. ILRI (2006) reported that the genetic diversity in fowl is much higher corporeal than other livestock species that most of the indigenous breeds have a good adaptability for climate and disease. Thus, Ivo (2009) reported that climate changes such as prolonged droughts, unpredictable rainfalls etc plus shrinking Fisheries as indicators for the need to diversify incomes and improve rural well being via sustainable village poultry. Moreover, FAO (http://www.fao.org/ag/portal/index_en/en/) reported that poultry foods are usually without taboos and can be consumed by a family in a single sitting. Poultry meat and eggs are highly nutritious that it takes less than 2 kg of cereals to produce 1 kg of chicken meat as compared with 4 kg of cereals to produce 1 kg of pork (FAO, 2010b).

On the other hand, Costa (2009) reported that poultry flocks are particularly vulnerable to climate change because birds can only tolerate narrow temperature ranges. Poultry farmers need to consider making adaptations now to help reduce cost, risk and concern in the future. Furthermore, exceeding to preferring animal species production that best fits to the scenarios of climate change and protein food demands, types of implementing production systems will be also another issue that needs emphasis.

Climate change and the employed systems for animal production: Intensive production systems are devoid of environmental stimuli and tend to produce more manure that can be used as fertilizer on nearby cropland. According to FAO (http://www.fao.org/ag/portal/index_en/en/) reports, advances in technology favor the intensification of poultry production in developing countries and if their by-product isn't managed or recycled properly, it will be the concern of environment. According to FAO (2010b) reports, recent research suggests, contrary to widespread belief, that intensive poultry production may have a lesser impact on the environment and global warming than organic or free-range production. This organic poultry has higher feed conversion efficiency (FCR) and a longer growing period for the heavier chickens that are produced. However, water contamination has become a major issue confronting industrial poultry operators. Based on the climate change and breeds, Rajkumar *et al.* (2011) reported that the growth performance and dressing percentage higher for naked neck than the normal birds in both winter and summer season because of reduced plumages.

CONCLUSION AND RECOMMENDATIONS

Animal productions, particularly the ruminants contributed around 18% of negative impact of climate change. However, poultry has low global warming potentials and its product is cheap and nutritious and is also without taboos of all livestock meats. This all makes poultry production; particularly the intensive system will be the preferred and recommend production types for protein demand of the people.

Technology favors the intensification of poultry production in developing countries but if not managed, environment and health issues will be the concern of the future. A grain yield is adversely affected by warming that leads to food-feed competitions. This competition gives rise to

looking for alternative feeds and other ingredient utilization techniques for birds. It is therefore, concluded that intensifying poultry production will reduce negative impacts of climate changes and it will also satisfies the demands of protein foods.

REFERENCES

Abedullah, A. Maqbool and K. Bakhsh, 2007. Issues and economics of poultry production: A case study of Faisalabad, Pakistan. Pak. Vet. J., 27: 25-28.

Adams, R.M., C. Rosenzweig, R.M. Peart, J.T. Ritchie and B.A. McCarl *et al.*, 1990. Global climate change and US agriculture. Nature, 345: 219-224.

Andreoletti, O., H. Budka, S. Buncic, J.D. Collins and J. Griffin *et al.*, 2010. Scientific opinion on quantification of the risk posed by broiler meat to human campylobacteriosis in the EU. EFSA J., Vol. 8, 10.2903/j.efsa.2010.1437

APF, 2007. Climate change and Africa. Proceedings of the 8th Meeting of the Africa Partnership Forum, May 22-23, 2007, Berlin, Germany, pp: 1-28.

Bingham, S.A., R. Hughes and A.J. Cross, 2002. Effect of white versus red meat on endogenous N-nitrosation in the human colon and further evidence of a dose response. J. Nutr., 132: 3522S-3525S.

Bos, J.F.F.P. and J. De Wit, 1996. Environmental impact assessment of landless monogastric livestock production systems. Livestock, Environment and Development (LEAD) Initiative, International Agriculture Centre Wageningen, The Netherlands, http://www.fao.org/WAIRDOCS/LEAD/X6110E/X6110E00.HTM

Bowes, M.D. and P.R. Crosson, 1993. Consequences of climate change for the mink economy: Impacts and responses. Climatic Change, 24: 131-158.

CSA, 2007. Agricultural sample survey 2006/07. Volume II. Report on livestock and livestock characteristics. Statistical Bulletin, Addis Ababa, Ethiopia.

Chadd, S., 2008. Future trends and developments in poultry nutrition. Proceedings of the International Conference of Poultry in the 21st Century Avian Influenza and Beyond, November 5-7, 2007, FAO, Bangkok.

Costa, N.D., 2009. Climate change: Implications for water utilization in animal agriculture and poultry, in particular. Proceedings of the 20th Annual Australian Poultry Science Symposium, February 9-11, 2009, University of Sydney, Australia.

Elijah, O.A. and A. Adedapo, 2006. The effect of climate on poultry productivity in Ilorin Kwara state, Nigeria. Int. J. Poult. Sci., 5: 1061-1068.

FAO/WHO, 2003. Diet, nutrition and the prevention of chronic diseases. Report of the joint WHO/FAO expert consultation: WHO Technical Report Series, No. 916 (TRS 916). World Health Organizations and Food and Agriculture Organization of the United Nations, pp: 160, http://www.who.int/dietphysicalactivity/publications/trs916/e

FAO, 2006. Livestock a major threat to the environment: Remedies urgently needed. FAO, Rome, Italy, http://www.fao.org/newsroom/en/news/2006/1000448/index.html

FAO, 2008. Poultry sector country review: Ethiopia. An Analysis of the Poultry Sector in Ethiopia, FAO, Rom, Italy, pp: 48. ftp://ftp.fao.org/docrep/fao/011/ai320e/ai320e00.pdf

FAO, 2010a. Poultry Meat and Eggs: Agribusiness Handbook. Director of Investment Centre Division, FAO., Rome, Italy, pp: 77.

FAO, 2010b. The State of Food and Agriculture 2009: Live Stock in the Balance. Bernan Assoc., USA., ISBN: 9789251062159, Pages: 166.

Gilbert, M., J. Slingenbergh and X. Xiao, 2008. Climate change and avian influenza. Rev. Sci. Tech., 27: 459-466.

Grimes, J., 2009. Daghir, N. J., ed. poultry production in hot climates. J. Applied Poult. Res., 18: 131-134.

Gueye, E.F., 2009. The role of networks in information dissemination to family poultry farmers. World's Poult. Sci. J., 65: 115-124.

Guis, H., C. Caminade, C. Calvete, A.P. Morse, A. Tran and M. Baylis, 2011. Modelling the effects of past and future climate on the risk of bluetongue emergence in Europe. J. R. Soc. Interface, (In press), 10.1098/rsif.2011.0255

Harlan, D., 2007. Perspectives on the globalmarkets for poultry products. Proceedings of the International Conference on Poultry in the 21st Century, November 5-7, 2007, Bangkok, pp: 37-38.

Hendy, C.R.C., U. Kleih, R. Crawshaw and M. Phillips, 1995. Livestock and the environment finding a balance: Interactions between livestock production systems and the environment impact domain: Concentrate feed demand. Natural Resources Institute, UK, pp: 141, http://www.fao.org/wairdocs/lead/x6123e/x6123e00.htm

Hinrichs, J. and H. Steinfeld, 2008. Global feed issues affecting the Asian poultry industry. Proceedings of the International Conference of Poultry in the 21st Century Avian Influenza and Beyond, November 5-7, 2007, FAO, Bangkok, pp: 33-35.

ILRI, 2006. Functional gene discovery for disease resistance in chicken. International Livestock Research Institute, http://www.ilri.org/FunctionalGeneDiscovery.

IPCC and Al-Gore, Jr., 2007. An HSUS report: The impact of animal agriculture on global warming and climate change. Intergovernmental Panel on Climate Change, USA, pp: 70, http://www.humanesociety.org/assets/pdfs/farm/animal-agriculture-and-climate.pdf

Ivo, A.M., 2009. Why village poultry is a necessary route for cameroon? African Centre for Community and Development, Bradford, UK., http://www.africancentreforcommunity.com/Why%20Village%20Poultry%20is%20a%20necessary%20route%20for%20Cameroon%20by%20Arrey%20Mbongaya%20Ivo.pdf

Koneswaran, G. and D. Nierenberg, 2008. Global farm animal production and global warming: Impacting and mitigating climate change. Environ. Health Perspect., 116: 578-582.

Kubberod, E., O. Ueland, M. Rodbotten, F. Westad and E. Risvik, 2002. Gender specific preferences and attitudes towards meat. Food Qual. Preference, 13: 285-294.

Mekonnen, G., F. Teketel , G. Alemu, Z. Dagnatchew and A. Anteneh, 1991. The Ethiopian livestock industry: Retrospect and prospects. Proceedings of the 3rd National Livestock Improvement Conference, November 13-15, 1991, Institute of Agricultural Research, Addis-Ababa, Ethiopia.

Mitloehner, F.M., 2010. Is the rising demand for animal protein fuelling climate change? J. Anim. Breed. Genet., 127: 421-422.

Pant, K.P., 2011. Economics of climate change for small holder farmers in Nepal: A review. J. Agric. Environ., 12: 113-126.

Pisulewski, P.M., 2005. Nutritional potential for improving meat quality in poultry. Anim. Sci. Papers Rep., 23: 303-315.

Rajkumar, U., M.R. Reddy, S.V.R. Rao, K. Radhika and M. Shanmugam, 2011. Evaluation of growth, carcass, immune response and stress parameters in naked neck chicken and their normal siblings under tropical winter and summer temperatures. Asian-Aust. J. Anim. Sci., 24: 509-516.

Rosenzweig, C., M.L. Parry, G. Fischer and K. Frohberg, 1993. Climate Change and World Food Supply. Oxford University, Oxford Environmental Change Unit, UK.

Schnepf, R., 2011. U.S. livestock and poultry feed use and availability: Background and emerging issues. Congressional Research Service, CRS Report for Congress, http://www.nationalaglawcenter.org/assets/crs/R41956.pdf.

Seo, S.N. and R.O. Mendelsohn, 2006. The Impact of Climate Change on Livestock Management in Africa: A Structural Ricardian Analysis. World Bank Publications, USA., Pages: 48.

Thompson, H.E., L. Berrang-Ford and J.D. Ford, 2010. Climate change and food security in Sub-Saharan Africa: A systematic literature review. Sustainability, 2: 2719-2733.

Thornton, P.K., 2010. Livestock production: Recent trends, future prospects. Phil. Trans. R. Soc. B, 365: 2853-2867.

Van der Sluis, W., 2007. Intensive poultry production. World Poult., 23: 28-30.

Yotopoulos, P.A., 1987. The new food-feed competition. Proceedings of the FAO Expert Consultation on the Substitution of Imported Concentrate Feeds in Animal Production Systems in Developing Countries, September 9-13, 1985, FAO, Bangkok.