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Constraints to the linkage between maize and livestock sub-systems in Ethiopian agriculture

Ashenafi Mengistu[1], Belay Kassa[2]*, Eyassu Seifu[3] and Ananadajayasekeram Ponniah[4]

[1]Department of Animal Production, College of Veterinary Medicine and Agriculture, Addis Ababa University, Ethiopia.
[2]School of Agricultural Economics and Agribusiness, Haramaya University, Ethiopia.
[3]School of Animal and Range Sciences, Haramaya University, Ethiopia.
[4]International Livestock Research Institute, Ethiopia.

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The study was conducted with the objective of assessing constraints to the linkage between maize and livestock subsystems in the Ethiopian agriculture system or practices. The linkage between the maize and livestock subsystems towards an integrated maize-livestock production system has been constrained by several factors. These factors affect resource flows between the two subsystems. These included socio economic, biophysical and institutional constraints, ever increasing population pressure which influences the availability of land for maize production and grazing; and large family size of households motivating farmers to cultivate more land dictated by the demand for enough grain, affecting the linkage. Feed shortage coupled with disease problems cause continuously declining livestock number and productivity constraining the contribution of livestock to the maize subsystem. Unbalanced research and extension focus between the maize and the livestock subsystems, difficulties in the process of technology popularization and inefficient and ineffective input, credit and veterinary services are the important institutional bottlenecks for integrating the maize and livestock subsystems to the desired level. Continuous extension education on natural resource conservation along with lessons on family planning is desirable to limit the effect of population pressure on the ecology and natural resource base. Moreover, research and extension support focusing on the generation and adoption of agricultural technologies that would help maximize output per unit of land from maize and livestock operations is required.

Key words: Ethiopian agriculture, extension, linkage, livestock production, maize sub-system research, production constraints.

INTRODUCTION

Agriculture is the backbone of Ethiopia's economy. It is dominated by a subsistence type mixed crop-livestock system where both crops and livestock are owned by smallholders. Mixed crop-livestock production system in Ethiopia has a long evolutionary history as sedentary agriculture. Currently, this is the most dominant land use

*Corresponding author. E-mail: belayk@hotmail.com

system where the largest share of both crop and livestock products are derived (CSA, 2008). The potential of the system for achieving food self sufficiency, poverty reduction and establishing reliable material supply for industrial processes is immense provided a sustainable balance among the different components of the system is maintained and/or promoted in line with other efforts to improve the performance of agriculture. Within the agricultural sector, intensive cereal based growth offers the best prospects for sustained poverty reduction and economic growth (Dorward et al., 2004).

Maize production accounts for 16% of the total area under cereals and 27% of cereal grain production in the country (CSA, 2008). Livestock in the mixed crop-livestock system primarily serve as inputs for cereal agriculture. Maize production in the system supplies significant amounts of feed particularly in the major maize growing zones (Berhanu et al., 2007). Draught power supply for cultivation and for transporting maize produced to market is a crucial contribution of livestock to maize production. The magnitude of the interdependence is expected to increase in view of the ever declining size of land for grazing pushed by population growth. Thus, integrating the maize and livestock subsystems through innovations would be a viable option to achieve sustainable socioeconomic development. This could be materialized by establishing and maintaining functional linkages between the maize and livestock subsystems. Proper understanding of the mixed crop-livestock systems is critically important in order to devise appropriate technology transfers and institutional reforms for poverty alleviation, food security and sustainable resource management (Kristjanson and Thornton, 2004).
A study as a component of a larger project on 'improving the utilization of maize as a food-feed crop' came up with a set of constraints that limit the linkages between the maize and the livestock subsystems in the Ethiopian agriculture. This paper discusses the major constraints that limit the linkage between the maize and livestock subsystems, and suggests possible interventions.

METHODOLOGY

The study involved collection and analyses of both primary and secondary data. The secondary data sources were published and unpublished reports from Ministry of Agriculture and Rural Development offices and Research Institutes. The primary data were collected through focus group discussions, key informant interviews and household level surveys. The study areas were identified by combining and overlaying maps and information from International Center for Wheat and Maize Improvement (CIMMYT), International Food Policy Research Institute (IFPRI) and International Livestock Research Institute (ILRI). In the process of selecting the study sites, information related to maize cropping areas and mega environments, human population densities, livestock systems and livestock numbers were synthesized using GIS. The identified areas were Awassa, Bako and Ambo areas from which Awassa, Bako Tibe and Ambo districts were randomly selected for the household level study. The household level data were generated using a structured questionnaire involving a total sample size of 350 involving 90, 120 and 140 randomly selected households from Awassa, Bako Tibe and Ambo districts, respectively, from 11155, 14872 and 17351 farm households in that order.

RESULTS AND DISCUSSION

The constraints that limit the linkage between the maize and livestock systems assessed were broadly categorized into two sets namely; socioeconomic and biophysical constraints, and institutional constraints. The socioeconomic and biophysical subset of the constraints includes population pressure and large family size, and prevalence of diseases pests; whereas the institutional constraints encompass balance of research focus, and issues related to the extension services. The discussion follows this order.

Socioeconomic and biophysical constraints

Population pressure and large family size

Ethiopia has the second largest human population on the African continent (UNDP, 2009). Its population grows at a steady rate of 2.7% per annum (CSA, 2007). To feed this increasing human population, more land has been brought under cultivation. This is accompanied by extensive disturbance of the natural ecology through deforestation resulting in changes in the temperature and rainfall regimes of a given ecological system. Low amounts of rainfall and irregularity in its pattern cause crop failure due to moisture stress or confusions in planting calendar. A 10% drop in rainfall (below the long term national averages) resulted in an average drop of 4.2% in cereal yields in the country (Dagnachew, 2008). Land degradation is also one of the consequences of such a disturbance, affecting maize production and productivity due to decreasing soil fertility.

As a result of population pressure, land holding per family becomes smaller and smaller. For example, Byerlee et al. (2007) showed the magnitude of decrease in per capita land holding from 0.5 ha in the 1960s to only 0.2 ha by 2005 in Ethiopia. This impacts feed availability since farmers tend to cultivate more land available to them to produce enough food for their family at the expense of their grazing lands. With their perception of the urgency of securing grain as a result of large family sizes, farmers do not put feed related parameters as selection criteria for maize varieties.

In the current study, households were found to have large family size and the average family sizes per household were 6.5, 7.2 and 7.5 persons for Ambo, Bako and Awassa districts, respectively with the maximum ranging from 15 persons in Ambo to 24 persons in Bako, the figure in Awassa being 17 (Table 1). These figures

Table 1. Average family size and landholding per household and proportion of farmers who reported land shortage in the study districts.

District	n	Land ownership (ha)	Proportion of farmers facing land shortage (%)	Family size
Ambo	140	5.41	54	6.46
Bako Tibe	120	3.84	61	7.17
Awassa	90	1.72	79	7.54

n = number of respondents.

Table 2. Common livestock disease and parasite problems reported by district.

Disease/parasite reported	District		
	Ambo	Bako Tibe	Awassa
Black leg	*	*	**
Anthrax	**	*	*
Pasteurolosis	*	*	NR
Trypanosomiasis	**	***	*
Internal and external parasites	*	*	*
Mastitis	*	*	*

NR = Not reported. *the relative importance of the disease over sites where the number of asterisks increases with increasing importance of the disease.

indicate the magnitude of the burden for a household to produce enough grain to feed the large family. However, the average land holdings cultivated are virtually small ranging from one hectare in Awassa to three hectares in Ambo (Table 1). This was evidenced by the fact that 54, 61 and 79% of the sample farmers in Ambo, Bako and Awassa areas, respectively, reported that the land they owned was not sufficient to produce enough grain to feed their families (Table 1). In order to satisfy their demands for additional land, sharecropping and renting are the strategies employed. However, they do not get enough land to rent or share crop with. The shortage of land usually motivates them to cultivate more land accessible to them and the piece that is left for grazing is the immediate target which in turn aggravates feed shortage. Extended dry seasons and severe overgrazing make the carrying capacity of the piece of land that is left for grazing very low and unproductive by destroying the plant composition and depleting the regrowth potential of important species.

Prevalence of diseases and pests

Ethiopian agriculture is highly affected by the prevalence of diseases and pests of crops and livestock. Livestock diseases are among the constraints that affect the integration of maize and livestock subsystems in the major maize growing areas of the mixed crop-livestock system by causing high mortality rates of animals. For example, EARO (2001) estimates an annual loss of 2.4 to 3 million heads of cattle due to mortality. On the maize side, released varieties once believed to be resistant to certain diseases and pests go out of production due to disease and/or pest problems. This happens either because of the occurrence of new diseases or increased virulence of existing diseases as a result of ecological changes. The incidence of diseases and pests caused total crop failure or significant yield reductions both in maize grain, and stover which could be used to feed livestock

Diseases and parasites which affect livestock were reported by farmers in the study districts during focus group discussions supported by information from district offices of agriculture and rural development are indicated in Table 2. The situation is aggravated by the fact that livestock production is pushed to marshy areas where disease and parasite infestations are very high. Some of the diseases reported are anthrax, black leg and mastitis which are known to be diseases of intensification. Any effort towards an intensified maize-livestock system should take preventive, treatment and control strategies and their effective implementation as a crucial step. However, the situation in the study districts is constrained by several problems.

From the collected household level data, it was learnt that 58, 93 and 80% of the respondents with livestock in Ambo, Bako Tibe and Awassa districts, respectively, had access to veterinary services. Though the proportions of farmers who got veterinary services were not as low as

Table 3. Rank of major constraints associated with livestock production at each site as identified by farmers.

Constraint	Rank of constraints by district		
	Ambo	Bako Tibe	Awassa
Disease	3 (73)*	1 (92)	4 (42)
Feed shortage	2 (76)	3 (63)	1 (74)
Shortage of land for grazing	1 (89)	2 (81)	2 (60)
Lack of capital for initial investment	4 (35)	4 (23)	3 (55)

* Numbers in parenthesis refer to the number of farmers who reported the problem.

Table 4. Mean distance to market (km), and percentage of farmers who sell maize grain and their means of transport.

District	Distance to market	Sell maize (% of total respondents)	Means of transport (as % of respondents who sell maize)						
			Pack animal	Human power	Pack animal + human power	Animal drawn cart	Vehicle	Pack animal + animal drawn carts	Animal drawn carts + vehicle
Ambo	8.2	22	79	6	15	0	0	0	0
Bako Tibe	4.8	70	44	1	6	38	2	8	1
Awassa	2.9	70	33	0	0	42	4	21	0

what would be expected, the quality of the services is highly affected by the technical inefficiency of veterinary personnel and lack of appropriate physical facilities for diagnosis and treatment of livestock diseases. For example, only one junior veterinary technician is assigned to supervise/attend to veterinary issues in three to five peasant associations in the study areas[1]. Besides their number, their technical capacity (education) limits them as they possessed diploma level of training. Vaccinations are practiced when national and/or regional campaigns were initiated. That is why repeated appeals by livestock owning farmers for the treatment of disease outbreaks did not get fast responses and appropriate measures. This was especially reported by farmers in the Bako area during the focus group discussions

Table 3 presents rank of key constraints to livestock production identified by farmers in the study districts. Feed shortage alone, as reported by farmers, ranked first in Awassa, second in Ambo and third in Bako Tibe. However, shortage of land for grazing is again to mean feed shortage. Therefore, overall feed shortage is the most critical livestock production problem in all of the study districts followed by diseases. Disease problem was reported with a much higher frequency in Bako Tibe than in Ambo and Awassa. This is because the Bako Tibe district is located in and around the Gibe Valley which is known for its high infestation rate with tsetse fly which transmits trypanosomiasis.

Disease prevalence coupled with feed shortage reportedly influenced the number and productivity of livestock owned by households. A considerable proportion of the farmers in the study districts were without an ox for cultivation. Though there are established social norms and arrangements of sharing animals for power, those without oxen are liable to maize failure due to delayed planting as the priority in the arrangements goes for those who own the oxen. Almost all sample farmers in the study districts use animal power for transporting maize grain to market (Table 4). This is a strong evidence which shows the extent of farmers' dependence on animal power/livestock for household activities in addition to using them for cultivating their lands. Animals that are used for transporting maize grain to market are equines mainly donkeys. As shown in Table 8, farmers located far from market places tend to keep equines. It seems that the reason why 92 (66%) of the sample farmers in Ambo keep at least a donkey as compared to 26 (22%) in Bako Tibe and 21 (23%) in Awassa districts is distance to market centers. Obviously, manure is among the important resources from livestock that could be used for fertilizing maize plots. However, it was found that its use is very little in all of the study areas due to small livestock holdings. Even the amount obtained from households with larger livestock holdings is

[1] Peasant associations are the lowest administration units in rural Ethiopia. According to the Ethiopian Federal Democratic Republic administrative hierarchy, the regional states are divided into zones, districts and Peasant Associations (*kebeles* in urban areas), in that order.

Table 5. Annual capital budget share (in thousand Birr) allotted to crops and livestock research processes/Directorates for five years (2005-2009) in the Ethiopian Institute of Agricultural Research.

Program/Directorate	2005		2006		2007		2008		2009	
	Amount	% of total	Amount	% of total	Amount	% of total	Amount	% of total	Amount	% of total
Crops Research Process/Directorate	9495	5.32	10097	6.11	9970	8.94	9884	16.06	12483	13.83
Livestock Research Process/Directorate	4493	2.52	4459	2.70	4226	3.79	4804	7.80	8600	9.53

Source: Planning Office, Ethiopian Institute of Agricultural Research (personal communication).

confined to the use for backyard maize production.

Institutional constraints

Balance of the research focus and professional thinking

Agricultural research in Ethiopia is mainly focused on crops and related issues. This is reflected by the imbalance in staffing and financial resource allocation. The budget share allotted to crops and livestock research processes/Directorates for five years is shown in Table 5. In all of the years until 2009, the budget share for livestock research did not surpass half of the amount allotted for crops research. That difference in terms of percentage of the total budget is simple evidence that could show the imbalance. But the actual causes and picture go beyond that extent. Except in few, in most of the agricultural research centers, the primary mandate for their establishment goes for crop issues. This is linked to the motto of "food security" which has been echoed for several decades. Policy implementation has been considering livestock as a secondary enterprise (Habtemariam, 2003). Regardless of the importance of livestock in rural livelihoods, where farmers in the study areas state that "if there are no livestock, there is no life", the focus of research seems to be more on crop production, maize as one of the commodity crops for food security, has got far better attention than livestock subsystem..

The maize research has been predominantly focusing on the development and release of maize genotypes that are adaptable to various climates and high yielding. The parameters considered through the process are all related to grain yield. Feed related traits were considered bad and negatively correlated with grain yield until very recently that maize breeders were convinced by evidence that informed the possibility of combining food and feed traits (Adugna, 2002; Devendra and Pezo, 2004; Singh et al., 2004). Nevertheless, the state of consensus among professionals on the way forward has not been determined yet. The absence of any involvement of livestock scientists in the maize breeding and selection programs in the Ethiopian Institute of Agricultural Research system could be an evidence to support the stated status.

Despite the global trend and professional thinking towards agricultural intensification through crop and livestock integration, the situation in Ethiopia in terms of research effort is below what could be expected. People view agricultural problems through their narrow professional perspective, being highly confined to discipline/enterprise specific activities. Regardless of the importance of livestock in the agricultural sector, even to the production of cereals like maize through the resources farmers get from, the research efforts to integrate maize and livestock are not up to the level the scenario demands. Feed shortage has been rated as the most important livestock production problem in Ethiopia. However, the conventional thinking to solve the problem has focused mainly on the improvement of grazing land productivity (which is almost non-existent on lands that are in the hands of smallholder farmers in the mixed crop - livestock system) and increase fodder availability through the dissemination of forage technologies to farming communities which is again constrained by shortage of land and seeds. Realizing the potential of crop residues for livestock feeding, research efforts on how to improve their utilizations were one of the areas of intervention that have been tried for many years (EARO, 2001). Attempts to improve maize stover utilization were employing different supplement strategies and treatment options. These strategies and options are labor and, more importantly, capital intensive which make them unaffordable to smallholders. Moreover, unavailability of feed resources for supplementation complicates the problem. Therefore, development of maize genotypes that could provide better quality and quantity feed should have presumably been the best option and focus of research towards an integrated and sustainable smallholder maize and livestock production in Ethiopia.

Table 6. Percentage distribution of household heads by education level (years of schooling).

District	Education level (years of schooling)				
	0	1-6	7-12	Mean	SD
Ambo(n=140)	44	30	26	3.64	3.904
Bako Tibe(n=120)	38	41	22	3.45	3.295
Awassa (n=90)	42	45	14	2.94	3.043

SD = Standard deviation; n = number of respondents.

Table 7. Number and proportion (%) of farmers who got their maize farm visited by extension agents at least once during the growing season.

District	Extension agent visit	
	n	%
Ambo (n=135)	23	17
Bako Tibe (n=118)	32	27
Awassa (n=88)	49	56

n = number of respondents.

The extension system and associated functions

In spite of the commendable magnitude of focus and efforts put forward to bringing success in agricultural development by the government through strengthening the agricultural extension system, there are still difficulties facing the system particularly when viewed from the angle of integrating the maize and the livestock sub-systems.

Issues related to technology popularization

For a successful adoption of a technology, popularization is a crucial step as it promotes better social inclusion in the use of the technology. This could be achieved through demonstrations and training. Organizing farmers' field days is one of the mechanisms to demonstrate a technology to end users. These are particularly important in the Ethiopian condition where the education level of farmers is considerably low. For example, 44, 38 and 42% of the sample farmers in Ambo, Bako Tibe and Awassa, respectively had no formal education (Table 6).

Teaching farmers on improved agricultural practices through frequent visits to farmers' fields, particularly in the growing season is an important extension activity to enhance the uptake of a technology at a larger and wider scale. However, as shown in Table 7, the percentage of farmers who got extension visits at least once during the growing season is markedly low in Ambo (17) and Bako Tibe (27) though the figure in Awassa (56) looks encouraging.

Moreover, the proportion of farmers who got training on improved agricultural practices is less than one third (Table 8) whereas participations in farmers' field days (Table 9) were limited to less than a quarter of the sample farmers in all of the study districts. Looking at those levels of participation in training and field days, it is evident that the focus is more on maize crop than livestock. A similarly low level of participation in livestock packages and training as compared to that of crops was reported by EEA/EEPRI (2006). Even the much higher figures of participation in both enterprises reported in the current study do not necessarily reflect the magnitude of efforts made to integrate maize and livestock sub-systems. Had it been like that, the practice of farmers in Ambo and Bako areas where maize stover is left to be consumed by animals and finished/spoiled in the field would have been processed to animal feed. Absence of extension education on how to integrate maize and livestock was reflected by the unchanged practice of not using collected and conserved maize stover in Ambo and Bako Tibe in spite of the reported severity of feed shortage particularly in the dry season.

The maize input system

A significant proportion of farmers used second generation seeds since they could not get seeds of their preference. As learned from farmers' experience, the use of second generation hybrid maize seeds causes yield reductions of up to 50%. The maize seed system suffers from a serious shortfall from the demand. Dawit et al. (2007) reported only a 53% success rate in 2004/05 cropping season in terms of satisfying the demand for improved maize seeds.

In addition to the overwhelmingly reported shortage of inputs in terms of quantity documented during focus group discussions, farmers ranked high price of inputs and their late supply as the most critical maize production problem in all of the study sites (Table 10). These are indications that the input system is inefficient and ineffective.

The credit system

The proportion of farmers who had access to credit

Table 8. Proportion of farmers who participated in training and the distribution by type of training.

District	Participation		Participation by type of training (as % of farmers participated)		
	n	%	Crops	Livestock	Both
Ambo (n=140)	24	17	12	4	84
Bako Tibe (n=120)	26	22	36	8	56
Awassa (n=90)	28	31	25	11	64

n = number of respondents.

Table 9. Distribution of sample respondents by their participation in farmers' field days by enterprise type and district.

District	Participation		% participation by enterprise		
	n	%	Maize	Livestock	Both
Ambo (n=140)	31	22	26	0	74
Bako Tibe (n=120)	26	22	19	0	81
Awassa (n=90)	22	24	50	0	50

n = number of respondents.

Table 10. Rank of key constraints in maize production as identified by sample respondents.

Constraint	District		
	Ambo (n=135)	Bako Tibe (n=118)	Awassa (n=88)
High price of inputs	1 (135)*	1 (118)	1 (88)
Late supply of inputs(seed and fertilizer)	2 (122)	2 (112)	2 (73)
Land shortage	4 (26)	3 (34)	3 (61)
Late onset of rain	3 (49)	4 (21)	4 (23)

* Numbers in parenthesis refer to the number of farmers who reported the problem. n = number of respondents.

Table 11. Proportion (%) of farmers who got credit facilities.

District	Credit service			
	Yes		No	
	n	%	N	%
Ambo (n=140)	117	84	22	16
Bako Tibe (n=120)	89	74	31	26
Awassa (n=90)	2	2.	89	98

n = number of respondents.

facilities in Ambo and Bako Tibe districts looks reasonably good and very much higher than that of Awassa where 98% of the sample farmers had no access to credit facilities (Table 11). However, those who had access to credit facilities reported problems about thecredit service they got. The widely stated problems included high interest rate, request to pay debt early in the dry season and down payment in order of importance

Request for debt repayment before the selling price of maize grain rises coupled with the stated high price of inputs creates a serious and devastating problem to farmers which forces them to sell livestock (including oxen) and other assets. Contracting out land was also reported as one of the practices. These all negatively affected the farmers' success rates in their engagements using both maize and livestock subsystems.

There is a high level of interdependence between the maize and livestock subsystems in the Ethiopian agricultural system. However, the resource and service flows between the subsystems in a manner that ensures sustainability has been constrained by heavy population pressure and accompanied land shortage; unbalanced research and extension focus; and, high prevalence of livestock diseases/ pests and limitations in veterinary and credit services. Therefore, in order to promote a sustainable integration of the maize and livestock subsystems, there is a need to make a parallel focus on both in terms of research and extension, and equitable share of required resources. Continuous extension education on natural resource conservation along with lessons on family planning is desirable to limit the effect of population pressure on the ecology and natural resource base. Moreover, research and extension support focusing on the generation and adoption of agricultural technologies that would help maximize output per unit of land from maize and livestock operations together is required.

Conflict of Interest

The authors have not declared any conflict of interest.

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REFERENCES

Adugna T (2002). Integrated food and feed production on small-holder mixed farms: Effect of early harvesting or variety on maize grain and stover yield and nutritive value of stover. pp. 187-194. Proceedings of the second National Maize Workshop of Ethiopia. Addis Ababa, Ethiopia, 12-16 November 2001. International Maize and Wheat Improvement Center (CIMMYT) and Ethiopian Agricultural Research Organization (EARO).

Berhanu G, Fernandez-Rivera S, Mohammed H, Mwangi W, Seid A (2007). Maize and livestock: Their inter-linked roles in meeting human needs in Ethiopia. Research Report 6. ILRI (International Livestock Research Institute), Nairobi, Kenya. P. 103.

Byerlee D, Spielman DJ, Dawit A, Gautam M (2007). Policies to promote cereal intensification in Ethiopia: A review of evidence and experience. IFPRI Discussion Paper 00707

CSA (Central Statistical Agency of Ethiopia) (2007). Report on human population. Addis Ababa, Ethiopia.

CSA (Central Statistical Agency of Ethiopia) (2008). Agricultural sample survey report for 2007/2008. Addis Ababa, Ethiopia.

Dagnachew G (2008). Environmental and socio-economic impacts and implications of climate change: regional and national. Paper presented to workshop on climate change. 10 September, 2008. Bahir Dar, Ethiopia.

Dawit A, Mwangi W, Mandefro N, Spielman DJ (2007). An Analysis of Maize Seed Production and Distribution Systems in Ethiopia's Rift Valley. Ethiopian Institute of Agricultural Research (EIAR) research report. Addis Ababa, Ethiopia.

Devendra C, Pezo D (2004). Crop-animal systems in Asia and Latin America: Characteristics, opportunities for productivity enhancement and emerging challenges, including comparisons with West Africa. pp 123-159. Proceedings of an international conference on 'Sustainable crop-livestock production for improved livelihoods and natural resource management in West Africa'. 19-22 November 2001. Ibadan, Nigeria. International Livestock Research Institute.

Dorward A, Kydd J, Morrison J, Urey I (2004). A policy agenda for pro-poor agricultural growth. World Develop. 32:73–89. http://dx.doi.org/10.1016/j.worlddev.2003.06.012

EARO (Ethiopian Agricultural Research Organization) (2001). Livestock research strategy. EARO, Addis Ababa, Ethiopia.

EEA/EEPRI (Ethiopian Economic Association/Ethiopian Economic Policy Research Institute) (2006). Evaluation of the Ethiopian Agricultural Extension with particular Emphasis on Participatory Demonstration and Training Extension System (PADETES). March 2006. Addis Ababa. P. 270.

Habtemariam K. (2003). Livestock and livelihood security in the Hara highlands of Ethiopia: Implications for research and development. Doctoral thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden. P. 163.

Kristjanson PM, Thornton PK (2004). Methodological challenges in evaluating impact of crop-livestock interventions. pp. 160-172. Proceedings of an international conference on 'Sustainable crop-livestock production for improved livelihoods and natural resource management in West Africa'. 19-22 November 2001. Ibadan, Nigeria. International Livestock Research Institute.

Singh BB, Larbi A, Tabo R, Dixon AGO (2004). Trends in development of crop varieties for improved crop-livestock systems in West Africa. pp 371-388. Proceedings of an international conference on 'Sustainable crop-livestock production for improved livelihoods and natural resource management in West Africa'. 19-22 November 2001. Ibadan, Nigeria. International Livestock Research Institute.

UNDP (United Nations Development Program) (2009). Human development report 2009 – HDI rankings. http://hdr.undp.org/en/statistics.