

Full Length Research Paper

Evaluation of constraints in production of root and tuber crops in Ethiopia: Overview of policy neglected climate resilient food security crops

Semeredin Yimer^{1*} and Tsegaye Babege

¹Hawassa University, School of Governance and Development Studies, Hawassa, Ethiopia

²Mizan-Tepi University, College of Agriculture and Natural Resources, Mizan Teferi, Ethiopia

Received 20 March 2018; Accepted 11 May, 2018

The objective of the current study was to examine the major constraints in production of root and tuber crops in Ethiopia with emphasis on identifying the policy gaps. This appraisal was based on survey report of Central Statistical Agency (CSA) for the period of 2011 to 2015. Data of CSA report was chosen for the current study with the view to gain an overview of policy packages in root crops in contrast with other major crops. Based on the current assessment, a continuous increase in cultivation acreage has been registered. This contributes to the significant increase in volume of annual productions. The production status in the nation however remains far below its potential limit. Several constraints are responsible for this among which poor access to improved seed and pesticide, unforeseen climatic conditions, weed, diseases and pest problems are the major ones. These factors have caused a significant damage of cultivated land (43,503 ha) for the past five years. Of this, weed, diseases and pests coupled with other biotic factors have accounted for about 40% of this damage. This is mainly due to lack of policy attention to these crops. For instance, improved seed coverage from 2011 to 2015 was even less than 1% of the total cultivated area. Similar policy problems are also evident for pesticide coverage and extension package and these represents only 14 and 17% of the total acreage, respectively. The policy so far has focused mainly on cereals. However, the cereal centered policy so far was unable to reduce rural food insecurity and in fact this problem even got worse and worse over time. Thus, it is essential to reorient this policy by the upcoming plan. Root and tuber crops are among the neglected climate resilient food security crops in Ethiopia requiring an immense policy focus. This will substantially contribute to improve the livelihoods of resource poor farmer's in the changing climate.

Key words: Root and tuber crops, constraints, food security, policy packages, Central Statistical Agency (CSA) survey.

INTRODUCTION

Root and tubers contribute a major share of traditional food system in Ethiopia. The principal root and tuber crop in Ethiopia include enset, potato, taro, yams, anchote,

cassava, tannia, and sweet potato (EIAR, 2015).

Currently, many of these crops are used as a major staple diet in South and Southwestern part of Ethiopia.

*Corresponding author. E-mail: semyimer@gmail.com/ semerey@hu.edu.et.

In a country with dominating agrarian economy like Ethiopia, ensuring food security is one of the most important objectives to be attained by the agriculture system. For the past several years, the country has tried to implement “agricultural-lead development strategies” to realize the preceding objective. However, success is very modest and lacks the sort of dynamism needed to bring a pattern of development that could lead to sustainable reduction of rural poverty and food insecurity (Samuel, 2006). In view of the existing deficit of food crops in the nation, increasing the production and productivity of the root and tuber crop is a key alternative.

There are many realistic reasons for encouraging root and tuber production in Ethiopia. First and most importantly, they are one of the most adaptable staples to address food security for millions of people, and produce more food per unit area of land. This may have a meaningful contribution to avoid chronic food insecurity in Ethiopia. Second, they are nutritionally rich staple foods that contribute protein, vitamins (A and C), zinc, and iron towards the dietary demands of the society (Sanginga and Mbabu, 2015; EIAR, 2015). However, the nation still suffers from malnutrition, for example, vitamin A deficiency (EIAR, 2015). The third realistic reason is that some of these crops are suitable for double cropping. For example, potato and sweet potato are one of the short cycling crops with three to four months cropping cycle which are well suited to the double cropping particularly in rain-fed systems (EIAR, 2015; Sanginga and Mbabu, 2015). Fourth, these crops insure sustainable food availability throughout the year. In this case root and tuber crops even with longer cropping cycles are quite essential. The longer cropping cycle crops such as yam, cassava and enset for instance play a vital role for annual cycle of food availability. In addition, most of these crops are the known climate resilient crops withstanding the unforeseen climatic conditions. For instance, enset is one of the drought tolerant food security crops, where it supplements human calorie requirements of around 20 million people in Ethiopia. The crop also has an enormous potential in other regions of sub-Saharan Africa, where it is known only as a wild plant (Olango et al., 2015).

Ethiopia has possibly the highest potential for root and tuber crop production than any country in Africa. This can be explained by the fact that wide ranges of opportunities are available in Ethiopia since the nation has abundant natural resources and favorable agro-ecological conditions that are suitable to grow a number of crop species including root and tuber crops. Meanwhile, the root and tuber sector has never reached its full potential of production that it has in avoiding the problem of malnutrition and in supporting food insecurity. Several factors are responsible for this, among which lack of adaptable high yielding variety, shortage of good quality planting material and inability to control biotic factors (disease and pest) are listed as a primary limiting factor

in most earlier reports (EIAR, 2015; Ephrem, 2015; Helen, 2016). Most of these crops have also faced with research and policy neglect for the past several years (Tamiru et al., 2007). Moreover, the contribution of root and tuber crops to the national gross domestic product (GDP) is not well known. Very few reports deal with aspects of root and tuber crops production in Ethiopia. Inadequate storage, transportation and marketing facilities are the other constraints of root and tuber crops production in Ethiopia.

Keeping in view all these points, assessment and analysis of the production trend and the constraints in production of root and tuber crops in Ethiopia are urgently needed. This is because such assessment helps to understand the nature of policy packages for root crops in contrast to major crops. Thus, the primary objective of the current study was to examine the major constraints in production of root and tuber crops for the period of 2011 to 2015. The second objective was to assess the policy gaps that these crops have faced over the same period. Finally, this study was designed to suggest possible actions to overcome for the problems identified in this assessment.

RESEARCH METHODOLOGY

The current evaluation is a quantitative and non-experimental study where survey reports of Central Statistical Agency (CSA) was used as a major source of secondary data. CSA report was chosen for the present inquiry because; it allows us to gain an overview of policy packages in root crops in relation with other major crops. Hence, data on production trend and constraints in production of root crops from 2011 to 2015 were considered for this study. From the major constraints in production of root crops, the biotic factors were purposefully selected and the averages of these data were used to compare the extent of damage caused by this factor. Other production constraints such as access to important inputs were also considered in this assessment. Accordingly, important policy package such as access to improved seed, extension packages and access to pesticide in root crops were compared with the packages realized for other major crops. For avoiding outliers problem in comparison process, only one tenth of these packages for cereal and the total packages for the remaining major crops were taken.

Data analysis

All the data obtained from the report of CSA survey were subjected to analysis of variance using Statistical Analysis Software (SAS, version 9.1.3). Mean comparisons were made using a least significant difference (LSD) test at 5% probability level.

RESULTS AND DISCUSSION

Root and tuber crops production trend in Ethiopia, 2011-2015

Regardless of their importance in Ethiopia, root and tuber crops have been seen as the secondary to non-cereal

Table 1. Actual Area Harvested, Annual Production and Yield for Root Crops Total and Major Root Crops from 2011-2015, Meher Season (CSA, 2016).

Parameter	Area harvested in thousand hectare					Average	Mean annual increase in area harvested (%)				Average
	2011	2012	2013	2014	2015		2011-2012	2012-2013	2013-2014	2014-2015	
Root crops, total	199.89	203.96	209.89	216.67	213.77	208.84	2.03	2.9	3.24	-1.34	1.71
Major root crops											
Potato	59.51	74.93	66.74	67.36	70.13	67.73	25.92	-10.93	0.92	4.12	5.01
Taro	39.69	41.34	42.66	48.66	48.52	44.17	4.14	3.19	14.07	-0.28	5.28
Sweet potato	51.31	41.63	53.37	59.27	41.41	49.40	-18.86	28.19	11.05	-30.76	-2.61
Parameter	Annual production in million metric ton					Average	Mean annual increase in volume of production (%)				Average
	2011	2012	2013	2014	2015		2011-2012	2012-2013	2013-2014	2014-2015	
Root crops, total	16.71	36.31	41.61	54.61	39.98	37.84	117.22	14.63	31.26	-26.79	34.11
Major root crops											
Potato	4.75	8.63	7.85	9.22	9.43	7.98	81.59	-9.08	17.43	2.32	23.11
Taro	3.15	11.18	11.93	14.49	12.11	10.57	254.58	6.78	21.39	-16.40	66.59
Sweet potato	3.90	11.85	17.83	27.01	13.72	14.86	203.75	50.43	51.54	-49.20	64.13
Parameter	Yield (ton/ha)					Average	Mean annual increase in yield (%)				Average
	2011	2012	2013	2014	2015		2011-2012	2012-2013	2013-2014	2014-2015	
Root crops, total	8.36	17.79	19.82	25.21	18.7	17.98	112.9	11.39	27.14	-25.79	31.41
Major root crops											
Potato	7.98	11.52	11.76	13.68	13.45	11.68	44.21	2.11	16.37	-1.73	15.23
Taro	7.94	27.04	27.98	29.78	24.98	23.54	240.49	3.48	6.42	-16.17	58.55
Sweet potato	7.6	28.46	33.4	45.58	33.44	29.70	274.37	17.36	36.46	-26.64	75.39

crops. Mean annual production of root and tuber crops in Ethiopia for the period of 2011 to 2015 was over 37.84 million metric tons (Table 1). A continuous increase in volume of production has been registered for root crops for the period from 2011 to 2014. The increase in volume of production was mainly brought about by the increase in the total area harvested. This was supported by a strong and significant correlation of annual production with area cultivated ($r =$

0.91*), in which it accounts for about 82% of the increase (Table 2). In Ethiopia, yield per hectare of root and tuber crops for the period of 2011 to 2015 was increased on average by 31.4%. This was mainly brought about by the mean increase in yield per hectare of major root and tuber crops among which sweet potato and taro accounts for about 134% of the increase (Table 1). On the other hand, the average yield of potato in Ethiopia for the period of 2010 to 2015 was 11.68 ton ha⁻¹.

This is far below the level realized at global (19.15 t ha⁻¹) level (FAOSTAT, 2014).

Area expansion in root crops compared with other major crops, 2011 to 2015

The highest expansion in mean area harvested was observed for cereal crops while the lowest expansion in mean area harvested was observed

Table 2. Pearson correlation coefficient for annual production, area harvest, pesticide coverage and improved seed coverage (CSA, 2016).

Parameter	Improved seed coverage	Pesticide coverage	Area cultivated	Annual production
Improved seed coverage	1	0.53488 ^{ns}	0.32737 ^{ns}	0.24279 ^{ns}
Pesticide coverage	-	1	0.89793*	0.67895 ^{ns}
Area cultivated	-	-	1	0.90627*
Annual production	-	-	-	1

Ns: Non-significant at 5% probability level, *Significant at 5% probability level.

Table 3. Average of Actual Area Harvested for Root Crops in Relation with Other Crops and Area Harvested in Major Root Crops from 2011-2015, Meher Season (CSA, 2016).

Major crops	Average of actual area harvested (ha)	Major root crops	Average of actual area harvested (ha)
Cereals	9,831,455 ^a	Potato	67,735 ^a
Pulses	1,686,829 ^b	Taro	44,174 ^b
Oilseeds	846,061 ^c	Sweet potato	49,325 ^b
Root crops total	208,835 ^d	-	-
LSD0.05	200,294	LSD0.05	9416
CV (%)	4.6	CV (%)	12

Means within a column followed by the same letters are not significantly different at 5% probability level.

for root crops total. Among the major root crops the highest actual area harvested was observed in potato. However, area expansion in taro and sweet potato varied non-significantly over the past five years (Table 3). The current scenario clearly indicates that the expansion in major root crops did not reach their full potential of production. Meanwhile, there is a possibility to increase the production level beyond the existing potential. This is due to the fact that most of these crops are suitable for double cropping. For example, potato and sweet potato are one of the short cycling crops with three to four months cropping cycle which are well suited to the double cropping particularly in rain-fed systems. Others such as yam, cassava, and enset are the known climate

resilient food security crops, but they are also faced with policy problems. When faced with such problems, one may rightfully ask: why are crop improvements strategies in root crops stagnating? Additionally, the scenario observed especially for the period of 2011 to 2015, initiates us to evaluate this inquiry? The detailed explanation for the current question is explained subsequently.

Constraints in production of root crops in Ethiopia

Poor access for important inputs

The production status in root crops is low by

national standards, mainly due to lack of important inputs. Lack of wide adaptive improved varieties, shortage of good quality planting material and lack of pesticides are the major production problems in Ethiopia. For example, for the period from 2011 to 2015, only few farmers have got an access to improved seed. This represents only 0.8% of the total cultivated area in the country. In addition, pesticide coverage accounts for only 14% of the total cultivated acreage over the same period (Table 4). This problem is further worsening due to weak extension systems and delays in distributing the important inputs. Moreover, seed multiplication efforts matching cultivars to production environments and customer desire is still not having the desired scale (EIAR, 2015).

Table 4. Access to important inputs for root crops, from 2011 to 2015, Meher Season (CSA, 2016).

Crop	Policy packages	Policy packages realized over the past five years (ha)					Average
		2011	2012	2013	2014	2015	
Total root crops	Actual area harvested	199,900	203,958	209,880	216,672	213,767	208,835
	Improved seed coverage	*	2,418	1,713	2,871	2,602	2,401
	Pesticide coverage	21,613	23,774	26,476	36,915	40,645	29,885
	Extension package	17,392	30,308	40,991	45,446	42,460	35,319

*Data not accessed.

Table 5. Actual damage recorded in root crops for the period from 2011 to 2015, Meher Season (CSA, 2016).

Damage caused by biotic factors	Average damage (ha)	Damage caused by abiotic factors	Average damage (ha)
Pests (Locust, Bird and other)	6,015 ^a	Frost	4,409
Crop disease	2,135 ^c	Short of rain	8,376
Weeds	3,783 ^{bc}	Too much rain	5,487
Other	5,277 ^{ab}	Hailstone	7,725
LSD _{0.05}	2,199	LSD _{0.05}	Ns
CV (%)	37	CV (%)	150

Means within a column followed by the same letters are not significantly different at 5% probability level. Ns: non -significant, the CV for abiotic factor is reduced to 15% on log transformed data.

This compels farmers to continue to grow local, low yielding varieties that are susceptible to disease and pests. In support of this argument, Helen (2016) reported that the use of local varieties is one and the most important factors which contribute to the low yield of potato in Ethiopia. This is because the local varieties are susceptible to late blight and of course low yield potential. Low yield of cassava due to shortage of improved cultivars are also reported by Tesfaye et al. (2013). Recent reports by Birhanu et al. (2014) confirmed that lack of improved sweet potato varieties suitable for different agro-ecologies and resistant to insect pests are some of the factors that hinder the crop expansion. Many developing countries lack efficient systems for the regular multiplication and distribution of certified seed tubers (Lutaladio et al., 2009).

Disease and pest problems

Diseases and insect pests and problem are another major constraint in production of root and tuber sector. From the total area covered by root crops in the past five years, about 43,503 ha of the cultivated land was damaged by different factors (CSA, 2016). Off this, about 17,210 ha of the cultivated land was damaged by biotic factors. Among these biotic factors, pest has caused a significant damage, in which it represents over 40% of this damage. However, it was statistically at par with the damage caused by other biotic factors. Disease and

weed problems were equally threatening the production of root crops over the same period (Table 5). Various earlier works have also reported the major disease and pests that threaten the production of root crops in Ethiopia. Major insect pests of root crop in Ethiopia include aphids, tuber moths, leaf miners, green mite, beetle, butterfly, hornworm and weevil (Ferdu et al., 2009). Pests such as weevil and butterfly on sweet potato, tuber moth on potato and green mite and red spider mite on cassava greatly hampered the productivity of these crops (Tefaye et al., 2013; Ermiyas et al., 2013; EIAR, 2015). Major diseases of root and tuber crops in Ethiopia include late blight, virus and bacterial wilt (Ephrem, 2015; Helen, 2016; EIAR, 2015). Late blight constitutes the most serious threat to increased potato production. Second to late blight in importance, particularly in warmer, more humid regions, is bacterial wilt. It hampered the productivity of enset and potato in south and southwestern, Ethiopia. Currently, a country wide establishment of bacterial wilt on potato was reported by more recent reports.

Policy related problem

Over the past two decades, Ethiopia has pursued a range of policies and investments to boost agricultural production and productivity, particularly with respect to the major staple foods that are critical to reducing poverty in the country. A central aim of this process has been to

Table 6. Policy packages implemented for cereal, pulse, oilseed and root crops from 2011-2015, Meher Season (CSA, 2016).

Crop type	The average policy package realized (ha)		
	Improved seed coverage	Pesticide coverage	Extension package
Cereals	97,101 ^a	268,633 ^a	325,980 ^a
Pulses	9,541 ^b	115,687 ^b	189,038 ^b
Oilseeds	6,451 ^b	22,949 ^c	90,480 ^c
Total major Root crops	2,401 ^b	29,885 ^c	35,319 ^d
LSD _{0.05}	12,059	25,582	39,195
CV (%)	30.3	17	18

Means within a column followed by the same letters are not significantly different at 5% probability level.

increase the availability of improved seed, chemical fertilizers, and extension services for small-scale, resource-poor farmers, particularly those cultivating staple food crops (Spielman et al., 2012). However, policies and investments on agricultural production and productivity primarily focused on cereals (FDRE, 2016). Comparable policy problem was also apparent in this evaluation. For example, from 2011 to 2015, the highest improved seed coverage was observed for cereals. While, the lowest improved seed coverage was observed from root crops over the same period. As a result, farmer-based seed systems are still common. In addition, crop protection strategies in root crops are also regarded as secondary non-cereal. For instance, the pesticide coverage was even far lower than pulses shown in Table 6. Root crops are also face with poor extension packages for the past five years. The average extension packages used for root crops were significantly lower than realized for other major crops (Table 6).

This is the result of research and policy neglect that root crops have been faced for the past several years. In the past several years, policy priority has been given to cereal crops. In support of this, Birhanu et al. (2006) reported that the primary emphasis of extension system has been focused on cereal crops and little attention was given to other subsectors. In addition, Spielman et al. (2012) reported that the national extension programs so far were a top-down type which lacks sort of dynamism to exploit the production potential and have not yet allowed the emergence of a dynamic demand driven system. With a few notable exceptions such as Ethiopia most developing countries have policies toward the root and tuber sector, and especially small-scale producers (Lutaladio et al., 2009). Moreover, these crops are faced with research neglect and very few reports deal with aspects of root and tuber crops production in Ethiopia. Most of the references on these subjects are often scant and fragmentary.

Socio-economic problems

Compared to other food crops, production of root and

tuber crops is capital-intensive, requiring the purchase of large quantities of bulky seed and the application of high-cost inputs such as pesticides. In many areas of the country, such problems limit the expansion of root and tuber crops production. Small-scale producers have weak and limited access to markets. Agricultural markets world-wide are characterized by market structures, both quantitative-aggregation, storage, and processing facilities, and qualitative-quality standards, information services, logistics for distribution of agricultural products. Many of these structures do not exist in Ethiopia for root and tuber crops distribution. Most of such products have good value in form of fresh product but there are challenges in marketing associated with transportation and storage facilities to maintain quality. The high costs of transportation, makes small producers to sell most of their product at local markets.

Contribution towards addressing the problem

FAO has been supporting the root and tuber subsector in Ethiopia for five year since 2009. The institute aimed to increase and sustain the production and utilization of these crops. The institute working with national partners (EIAR, RARIs and Universities (Haromaya and Jimma)) has been actively involved in providing conducive conditions for resource poor farmers to grow root and tuber crops sustainably and profitably. Some of the projects supported by FAO include scaling up of root and tuber crops diversification and food security support to drought affected communities. The effort made by FAO results in establishment of root and tuber crop nurseries and cooperatives to produce improved planting materials. Other project such as the international potato center (CIP) has also started working on root and tuber crops subsector in Ethiopia since 1985. The CIP project made significant contributions towards root and tuber crops production and expansion in Ethiopia. This project specific emphasis was given to produce high quality planting materials especially for potato and sweet potato. Similar efforts were made by Graduation with Resilience to Achieve Sustainable Development (GRAD) to support

the root and tuber subsector. GRAD identified the potato as an important commodity for household consumption and for generating income. To enable access to improved seeds, GRAD initiated and promoted community based potato seed multiplication using model farmers. In collaboration with researchers, three potato varieties (Belete, Jalenie and Gudenie) were promoted. GRAD facilitated market linkages by engaging the private sector; for example, the Balemlay Special Enjera and Food Flour Manufacturing Industry (BSEFMI) in Bahir Dar.

Conclusion

This assessment examined production constraints and major policy gaps in the production of root and tuber crops in Ethiopia from 2011 to 2015. Even though total production of root and tuber crops have registered a continuous increase within these period, it is mainly attributed to expansion of the area cultivated than increase in productivity. Several factors are responsible for productivity stagnation of root and tuber crops in Ethiopia but the major constraints related to lack of policy attention and package given for these crops in comparison to other major crops. For instance, only few Ethiopian farmers have access to improved seed (0.8% of total acreage) and pesticide coverage (14% of total acreage) for root and tuber crops. No institutionally recognized organization produces and provides improved varieties of such crops; all varieties used at farmer level are susceptible to disease and pests. For this reason, disease and pests coupled with other biotic factors resulted in a significant damage of cultivated land (17,210 ha). Off this, the damage caused by pest, accounts for over 40% of the total damage. Such policy neglect is also evident for extension packages and this package represents only 17% of cultivated area. Thus, calls great attention to raise the country's food self-sufficiency through production of root and tuber crops. To increase the productivity of root and tuber crops, policy attention should be given for the major constraints in production of root and tuber crops.

SUGGESTED ACTIONS

The way forward for root and tuber crops intensification in Ethiopia will include a number of priority areas. First and most importantly, deep reforms should be needed in the extension system. In this regard, policy reorientation emerges as a key alternative and hence, to focus on more responsive, demand driven and climate resilient food security crops. These approaches will require greater flexibility within the current system, which can be accomplished only by investing time, effort, and resources in changing the cultures and practices of the extension system. Second, the lack of adequate quantities of clean

seed is needed to be improved. Third, the sector faces a growing challenge from more aggressive strains of disease and pests and Ethiopia has a limited capacity to control the disease through pesticide application. Continued research on resistance breeding and integrated disease and pest management strategies is essential. Finally, improving the incomes of small scale growers depends on increasing demand driven opportunities and developing value chains which include all market chain actors, from input suppliers to consumers. Linking farmers to markets, especially high-value supermarkets and restaurant chains, can substantially increase the profitability of the root and tuber sector.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

REFERENCES

- Birhanu A, Fetien A, Yemane T (2014). Evaluation of Sweet Potato (*Ipomea batata* L.) Varieties for Total Storage Root Yield in South and South East Zones of Tigray, Ethiopia. *American Journal of Trade and Policy* 1(3):27-32.
- Birhanu G, Hoekstra D, Azage T (2006). Commercialization of Ethiopian Agriculture: Extension Service from Input Supplier to Knowledge Broker and Facilitator. Improving Productivity and Market Success (IPMS) of Ethiopian Farmers Project Working Paper 1. Nairobi, Kenya: International Livestock Research Institute.
- Central Statistics Agency (CSA) (2016). Report on Area and Production of Major Crops during Meher Season. *Statistical Bulletin* 579, Addis Ababa pp. 1-113.
- Ephrem G (2015). Disease Management Practice on Potato (*Solanum tuberosum* L.) in Ethiopia. *World Journal of Agricultural Research* 3(10):34-42.
- Ermias S, Mesele G, Tesfaye T, Elias U (2013). Review of Entomological Research on Sweet Potato in Ethiopia. *Discourse Journal of Agriculture and Food Sciences* 1(5):83-92.
- Ethiopian Institute of Agricultural Research (EIAR) (2015). The Root and Tuber Crops working group proceedings of the first meeting. Addis Ababa, Ethiopia.
- Federal Democratic Republic of Ethiopia (FDRE) (2016). Priorities for Ending Extreme Poverty and Promoting Shared Prosperity. Systematic Country Diagnostic. Document of the World Bank, Report No: 100592-ET
- Ferdu A, Baye M, Emanu G, Temesgen A, Eyobe T, Mesele G, Biruk W (2009). Review of Entomological Research on Root and Tuber Crops in Ethiopia. pp. 1-46. In: Abraham Tadesse(ed.). 2009. Increasing Crop Production through Improved Plant Protection-Vilume II. Plant Protection Society of Ethiopia (PPSE). PPSE and EIAR, Addis Ababa, Ethiopia.
- Food and Agriculture Organization statistics (FAOSTAT) (2014). Agricultural database. <http://faostat.fao.org/> (accessed on June 29, 2016)
- Helen T (2016). A Review on Potato (*Solanum tuberosum* L.) Production Situations in Ethiopia. *Food Science and Quality Management* 57:32-35.
- Lutaladio N, Ortiz O, Haverkort A, Caldiz D (2009). Sustainable potato production guidelines for developing countries. Wageningen. Food and Agriculture Organization of the United Nations (FAO).
- Olango TM, Tesfaye B, Catellani M, Pè ME (2015). Development of SSR markers and genetic diversity analysis in enset (*Ensete ventricosum* (Welw.) Cheesman), an orphan food security crop from Southern Ethiopia. *BMC Genetics* 16:1-16.

- Samuel G (2006). Land, Land Policy and Smallholder Agriculture in Ethiopia. In: Policy Paper Prepared for the Future Agriculture Consortium and Presented at Institute Development Studies, University of Sussex, March 22-22.
- Sanginga N, Mbabu A (2015). Root and Tuber Crops (Cassava, Yam, Potato and Sweet Potato). Feeding Africa. abdou diouf international conference center. Dakar, Senegal.
- Spielman DJ, Dawit K, Dawit A (2012). Seed, Fertilizer, and Agricultural Extension in Ethiopia. University of Pennsylvania Press, Philadelphia.
- Tamiru M, Becker HC, Maass BL (2007). Genetic Diversity in Yam Germplasm from Ethiopia and Their Relatedness to the Main Cultivated *Dioscorea* Species Assessed by AFLP Markers. Crop Science Society of America 47:1744-1753
- Tesfaye T, Getahun D, Ermias S, Shiferaw M, Temesgene A, Birhanu Y (2013). Current status, Potentials and challenges of Cassava production, processing, marketing and utilization: Evidence from Southern Ethiopia. Greener Journal Agricultural Sciences 3(4):262-270.