Journal of Economics, Finance and Management Studies

ISSN (print): 2644-0490, ISSN (online): 2644-0504

Volume 5 Issue 09 September 2022

Article DOI: 10.47191/jefms/v5-i9-31, Impact Factor: 6.274

Page No. 2766-2771

Productivity Potential and Yield gap estimation of pulse crops in Ethiopian Agriculture

Daniel Hailu[1]*, Rozina Gidey[2]

[1,2]Department of Agricultural Economics, Ethiopian Institute of Agricultural Research (EIAR), Addis Ababa, Ethiopia

ABSTRACT: This study aims to provide a detailed analysis of the pulse crops yield gaps for extra grain in production in Ethiopia. The study covers the period 2006/07-2020/21. Central Statistical Agency of Ethiopia (CSA) Agricultural Sample Survey (AgSS) and crop variety register issue of the Ministry of Agriculture (MoA) data were used for the analysis. The data was analyzed using descriptive statistics and econometric analysis. The descriptive analysis provides quantitative estimates of yield gaps to measure and compare yield potentials and actual yields. Pooled Mean-Group (PMG) model was used to analyze the impact of yield and area on production. After cereals, the second most important crop group (in terms of acreage) is pulses. The area cultivated of pulses is grown by 29.6% between 2006/07-2020/21, which is a faster growth compared to the oil crops area (-3.8%). Pulse production has grown significantly in the country over the past 16 years, rising from around 12.7 million quintals in 2006/07 to 32 million quintals in 2020/21 with growth rate of 151.7%. The production has more than doubled, because of a 64.3% increase in area under the crop and a 35.7% increase in yield during the same period. The average pulses yield level is very low (1.4 tons/ha) as compared to that of the estimated average potential (2.0 tons/ha) in the country for the studied crops. For the analyzed period, results shows 0.2 qt/ha, 8.5 qt/ha, 9.1 qt/ha, 5.7 qt/ha, 2.0 qt/ha, 16.7 qt/ha, and 7.9 qt/ha for chick-peas, faba beans, field peas, gibto, haricot beans, mung bean and, lentils yield gap existed when the national average yield was compared with that of the released cultivars potential under farmer management, respectively for the analyzed period 2020/21. Our findings suggest that if farmers had closed yield gap, Ethiopia could have potential grain surplus of chick-peas, faba beans, field peas, gibto, haricot beans, mung bean, and lentils production by a respective of 4, 427, 200, 8, 61, 67, and 80 thousand Mt, without expanding cropland area. Based on the Pooled Mean-Group (PMG) model result, if cultivated area and yield of crops are increased by 1% then the production growth will be increased by 1% and by 0.99% in the long run respectively. Overall, this study reveals that there are large yield gaps and that substantial benefit for food production are possible through closing these gaps, without the need for new technology and expanding cropland area.

KEY WORDS: pulse crops, cropland area, potential yields, actual yields, yield gaps, crop production, Ethiopia

1. INTRODUCTION

Agriculture in developing countries would transform and increase production by an estimated 70% in order to meet food demands by 2050 (FAO, 2010). A major means to meet the estimated future food demand is to derive more agricultural production from existing agricultural lands (Alexandratos and Bruinsma, 2012). This can be accomplished by reducing the gaps between farmers' actual crop yields and yields that are possible if optimum management is adopted (Van Ittersum et al., 2013) while protecting natural resources.

Much of the worlds' croplands have experienced growth in crop yields (production per unit area) dramatically, with the introduction of green revolution technologies during the mid-twentieth century. For instance, F. Aramburu Merlos et al. (2015) estimated that Argentina could have increased soybean, wheat and maize production by a respective of 7.4, 5.2, and 9.2 Mt, without expanding cropland area.

Ethiopian agriculture is largely characterized by smallholder farming, which generates close to 96% of total area cultivated and the remaining comes from a relatively small number of state owned or private commercial farms (World Bank, 2018; Taffesse et al., 2011). The government of Ethiopia targeted to increase the total annual quantity of crop production in all production systems from 543 million quintals to 925 million quintals in 2030 (Planning and Development Commission (PDC), 2020). Smallholders may not adopt modern inputs or farming techniques that would increase their productivity (Jack, 2011; Shiferaw et al., 2015).

Productivity Potential and Yield gap estimation of pulse crops in Ethiopian Agriculture

In Ethiopia, pulses constituted the major food crops, source of income at household level and a contributor for the country's foreign currency earnings, among others (CSA, 2021). Out of the total grain crop area cultivated (12,979,459.91 hectares), 12.9% was under pulses. In the production season of 2020/2021, the total grain production reached to 341.8 million quintals, of which pulses production accounted for 32 million quintals. The production obtained from faba beans, haricot beans, chick peas and field peas accounted for 33.6%, 16.8%, 15.8% and 12.5% of the pulse grain production, in that order. However, not all regions have uniformly achieved gains using the right cultivars, inputs, and other management practices. The Crop yields are inevitably affected by many factors, these are weather, inputs applied, changes in farming practices, amounts of fertilizer used, quality of seed varieties, technology and use of irrigation (CSA, 2021; Getaye G. 2020; Kihara J. et.al.2022; Merga, B., & Haji, J. 2019).

The yield gap has arisen again as a focus for agricultural research to ensure food security and economic growth for farmers around the world. In Ethiopia, no assessment to date has tried to estimate the potential for extra grain production for pulses. Much of the literature and research on the yield gap has been framed by larger concerns and initiatives to raise agricultural productivity at micro level. Increasing agricultural productivity, and closing the yield gap, must be addressed with the broader approach, by yield gap closure on existing cropland area and its impact at a global scale.

Many yield gap studies in Ethiopia consider a single year or period. Therefore, this study aims to quantify the gap between actual and potential yields, the potential to increase food production as a result of closing these yield gaps and propose policy measures or initiatives that will assist yield gains in Ethiopia.

2. OBJECTIVES

The main objective of this paper is to provide a detailed analysis of yield gap and yield advantage of pulse crops in Ethiopia. Specifically,

- To assess the area of land planted and production patterns of pulse crops over the years
- To analyze the yield gap trends in production varies across years and the potential production increase on existing crop area
- To analyze the impact of Yield and area on production

3. METHODOLOGY

Secondary data was used for the study. Changes in cultivated area, average actual yield and production of rainfed farming of major pulse crops are also based on Central Statistical Agency of Ethiopia (CSA, 2006; 2021) Agricultural Sample Survey (AgSS) and cover the period 2006/07-2020/21. Yield potential was based on generated crop cultivars estimated by breeding based on Ministry of Agriculture (MoA) crop variety register issue. The data was analyzed using descriptive statistics and econometric analysis. Production increase on existing crop area was assessed for pulse crops by quantifying the yield gap (Yg), that is, the difference between yield potential (Yw) and actual yield (Ya).

Pooled Mean-Group (PMG) model was used to analyze the impact of yield and area on production, as developed by M. Hashem et.al. 1999.

d.y_it = phi*(y_(it-1) + beta*x_(it)) + d.y_(it-1)a_1+… + y_(it-p) a_p+d.x_(it) b_1+…+d.x_(it-q) b_q + e_(it)

i = {(1,…,N)}; t = {(1,…,T_i)},

Where,

phi is the error correction speed of adjustment parameter to be estimated
beta is a (k X 1) vector of parameters
a_1,...,a_p are p parameters to be estimated
x_(it) is a (1 X k) vector of covariates
b_1,...,b_q are q parameters to be estimated and
e_(it) is the error term

The pooled mean-group model (pmg) estimates where the long-run effects, beta, are constrained to be equal across all panels. The short-run coefficients, including phi, are allowed to differ across panels.

4. RESULT AND DISCUSSION

4.1. Area of land planted and production patterns of pulse crops

After cereals, the second most important crop group (in terms of acreage) is pulses. In the periods 2020/21 pulse acreage was 1.7 million hectares (12.9%) of the grain crop area cultivated. This share of area cultivated with pulses was increased from 12.7% in the period 2006/07. The area cultivated of pulses is grown by 29.6% between 2006/07-2020/21, which is a faster growth compared to the oil crops area (-3.8%). The main legumes Faba beans, haricot beans, chick peas, and field peas were planted on 75% of the pulse acreage.

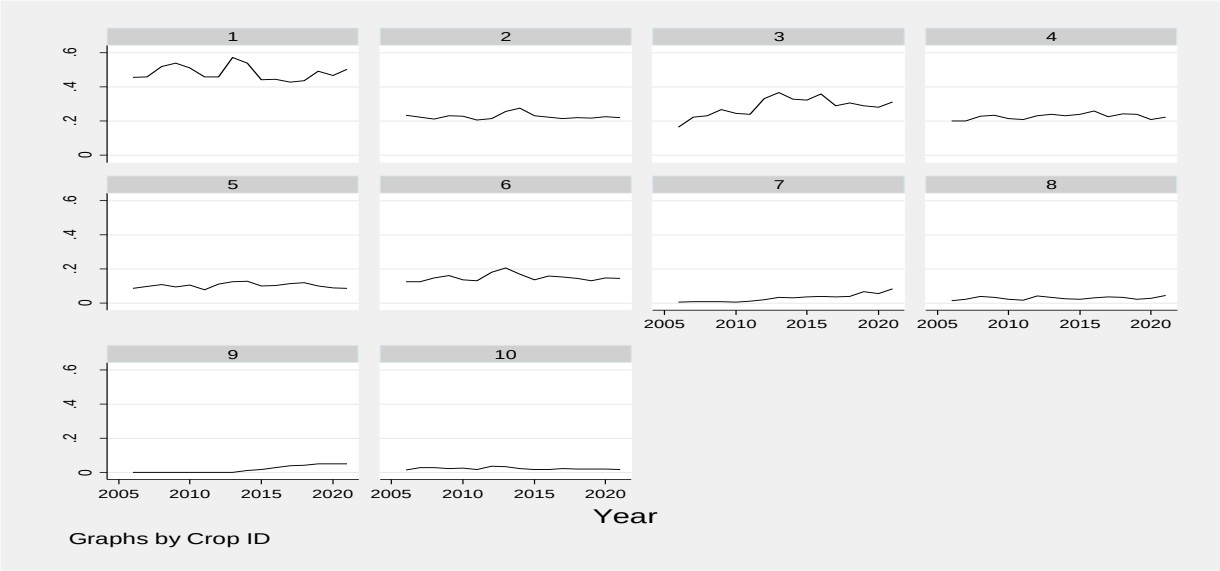

Figure 1: Cropland area trends of cereal crops

Crop ID: 1=Faba beans, 2=Filed Peas, 3=Haricot beans, 4=Chick peas, 5=Lentils, 6=Grass peas, 7=Soybeans, 8=Funegreek, 9=Ming bean, 10=Gibto

Production Patterns

Pulses grain production in 2020/21 covered 9.4% (about 31,999,988.64 quintals) of the grain crops. The production obtained from faba beans, haricot beans, chick peas, field peas, grass pea, soybean, lentils, mung bean, funegreek, and gibto was 33.5%, 17.3%, 14.3%, 11.8%, 9.1%, 6.5%, 3.5%, 1.6%, 1.6% and 0.9% of the grain production, in that order.

Pulse production has grown significantly in the country over the past 16 years, rising from around 12.7 million quintals in 2006/07 to 32 million quintals in 2020/21 with growth rate of 151.7%. The production has more than doubled, which was because of a 64.3% increase in area under the crop and a 35.7% increase in yield during the same period.

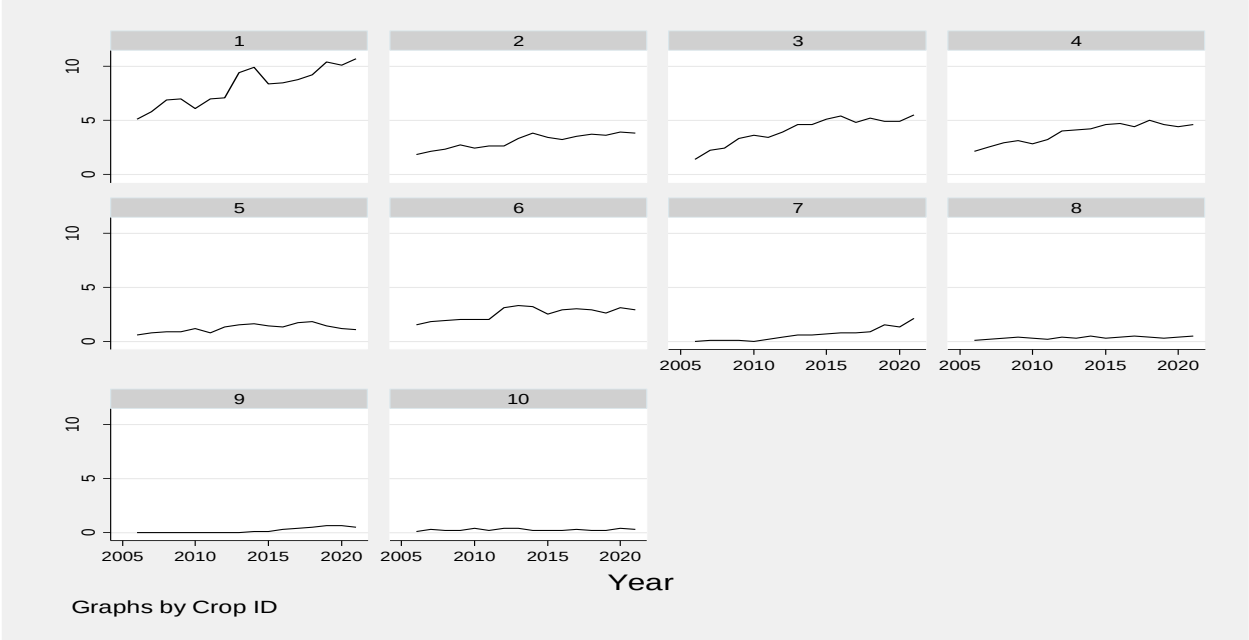

Figure 2: Production patterns of cereal crops

Crop ID: 1=Faba beans, 2=Filed Peas, 3=Haricot beans, 4=Chick peas, 5=Lentils, 6=Grass peas, 7=Soybeans, 8=Funegreek, 9=Ming bean,

10=Gibto

4.2. Potential yields and yield gap trends

The average actual yield growth is 97.7%, 89.1%, 118.8%, 89.6%, 112.5%, 70.5%, 109.6%, 96.9%, 42.4% and 117.3% for chick-peas, faba beans, field peas, funegreek, gibto, grass peas, haricot beans, mung bean, lentils and soybeans respectively between 2005/06 and 2020/21.

The average pulses yield level is very low (1.4 tons/ha) as compared to that of the estimated average potential (2.0 tons/ha) in the country for the studied crops. Results shows 0.2 qt/ha, 8.5 qt/ha, 9.1 qt/ha, 5.7 qt/ha, 2.0 qt/ha, 16.7 qt/ha, and 7.9 qt/ha for chick-peas, faba beans, field peas, gibto, haricot beans, mung bean and, lentils yield gap existed when the national average yield was compared with that of the released cultivars potential under farmer management, respectively for the analyzed period 2020/21.

The yield gap analysis in 2021 shows that 0.9%, 28.6%, 34.7%, 23.2%, 10%, 37.2% and 60.8% of chick-peas, faba beans, field peas, gibto, haricot beans, mung bean and, lentils yield gap existed when the national average yield was compared with that of the released cultivars potential under farmer management, respectively.

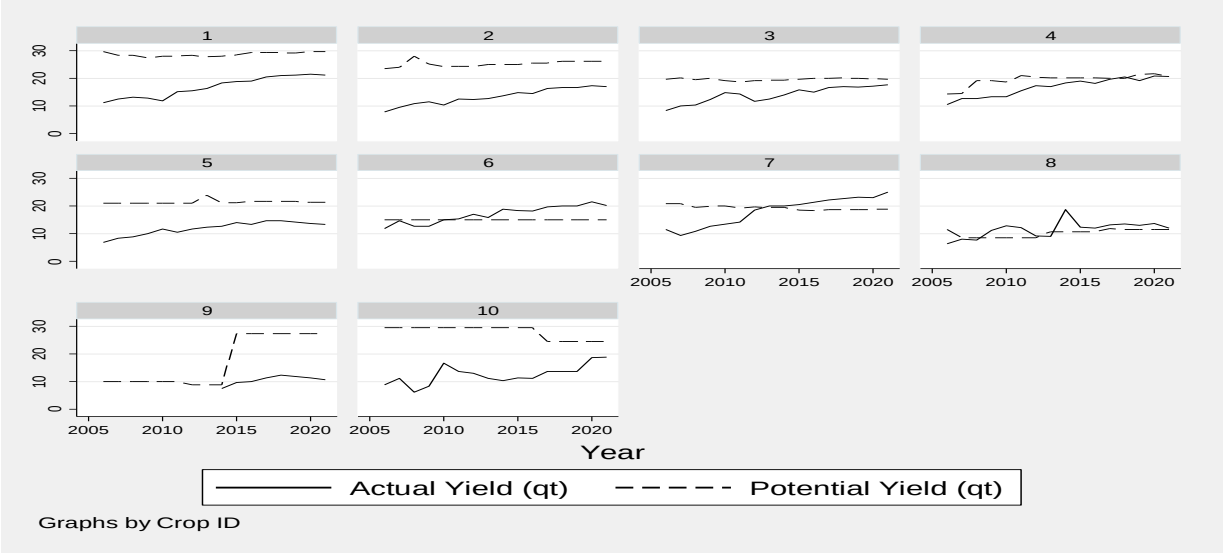

Figure 3: Potential yields and yield gap trends of cereal crops

Crop ID: 1=Faba beans, 2=Filed Peas, 3=Haricot beans, 4=Chick peas, 5=Lentils, 6=Grass peas, 7=Soybeans, 8=Funegreek, 9=Ming bean, 10=Gibto

Our findings suggest that if farmers had closed Yg, Ethiopia could have potential grain surplus of chick-peas, faba beans, field peas, gibto, haricot beans, mung bean, and lentils production by a respective of 4, 427, 200, 8, 61, 67, and 80 thousand Mt, without expanding cropland area. Yields of funegreek, grass peas and soybeans crops were already near to, or in some cases, even higher than their estimate of yield potential.

4.3. The impact of Yield and area on production

The relative contributions of acreage to output growth were statistically significant, except for faba bean and fiel pea. Moreover, statistically significant correlation can be detected between yield changes as a source of growth in that crop's output.

Table 1: Pairwise correlations

VARIABLES	(1)	(2)	(3)
(1) PRODUCTION	1.000		
(2) AREA	0.952	1.000	
	(0.000)		
(3) YIELD	0.471	0.281	1.000
	(0.000)	(0.000)	

Based on the Pooled Mean-Group (PMG) model result, in the short run area and yield variables are insignificant while in long run these variables are significant. If cultivated area and yield of crops are increased by 1% then the production growth will be increased by 1% and by 0.99% in the long run respectively.

Table 2: Impacts of yield and area on production

D. production	Coef.	Std. Err.	z	p>|z|	[95% Conf. Interval]	
_ec						
area	1.000229	.000052	1.9e+04	0.000	1.000127	1.000331
yield	.9999502	.0000135	7.4e+04	0.000	.9999237	.9999767
SR						
_ec	18.70212	19.81153	0.94	0.345	-20.12778	57.53201
area D1.	19.70139	19.81414	0.99	0.320	-19.13362	58.5364
yield D1.	19.70003	19.80908	0.99	0.320	-19.12505	58.52511
_cons	.050729	.0532472	0.95	0.341	-.0536336	.1550915

5. CONCLUSION AND RECOMMENDATION

Analysis of potential yields and yield gaps of pulse crops in Ethiopia showed that the actual yields obtained by the farmers are much below the potential yields that can be obtained with improved management. It is clear that the full potential of rainfed farming has not been exploited as yet. Our findings suggest that if farmers had closed Yg, Ethiopia could have potential grain surplus of chick-peas, faba beans, field peas, gibto, haricot beans, mung bean, and lentils production by a respective of 4, 427, 200, 8, 61, 67, and 80 thousand Mt, without expanding cropland area. It is possible to increase food production substantially through crop yield improvements in Ethiopia if the government provides suitable policy environments and institutional support to promote greater adoption of new and improved technologies as well as crop management practices.

REFERENCES

1) Alexandratos, N., Bruinsma, J., 2012. World Agriculture towards 2030/2050: The 2012 Revision. FAO, Food and Agriculture Organization of the United Nations.
2) CSA (Central Statistical Agency) 2006; 2021. Agricultural sample survey. Report on area and production of major crops (Private peasant holdings, Meher season). Addis Ababa, Ethiopia.
3) CSA (Central Statistical Agency) 2021. Agricultural Sample Survey. Report on Area and Production of major crops, Meher season. Addis Ababa, Ethiopia.
4) FAO (Food and Agriculture Organization of the United Nations), 2010. 'Climate-smart' Agriculture. Policies, Practices and Financing for Food Security, Adaptation and Mitigation. Conference on Agriculture, Food Security and Climate Change, 31 October-5 November 2010, The Hague, 2010.
5) Fernando Aramburu Merlosa,∗, Juan Pablo Monzonb, Jorge L. Mercauc, Miguel Taboadad,Fernando H. Andradea,b, Antonio J. Halle, Esteban Jobbagyc, Kenneth G. Cassmanf,Patricio Grassinif 2015. Potential for crop production increase in Argentina through closure of existing yield gaps. Field Crops Research 184 (2015) 145–154.
6) Getaye Gizaw. Muniu 2020. Factors Affecting Agricultural Productivity in Doba Woreda, Oromia National Regional State, Ethiopia. Int J Econ Manag Sci, 9 doi: 10.37421/ijems.2020.9.577
7) Jack, B.K., 2011. Constraints on the adoption of agricultural technologies in developing countries. J-PAL and CEGA Agricultural Technology Adoption Initiative White Paper, CEGA, Berkeley, CA.
8) Kihara J, Gurmessa B, Tamene L, Amede T, and Sommer R. 2022. Understanding factors influencing wheat productivity in Ethiopian highlands. Experimental Agriculture. https://doi.org/10.1017/S0014479721000296
9) M. Hashem Pesaran, Yongcheol Shin & Ron P. Smith 1999. Pooled Mean Group Estimation of Dynamic Heterogeneous Panels, Journal of the American Statistical Association, 94:446, 621-634, DOI: 10.1080/01621459.1999.10474156
10) Merga, B., & Haji, J. 2019. Factors impeding effective crop production in Ethiopia. Journal of Agricultural Science 11(10), 1–14. doi:10.5539/jas.v11n10p1
11) Planning and Development Commission of the Federal Democratic Republic of Ethiopia (PDC) 2020. Ten Years Development Plan. A pathway to prosperity 2021-2030.
12) Shiferaw, B., Kebede, T., Kassie, M., Fisher, M., 2015. Market imperfections, access to information and technology adoption in Uganda: Challenges of overcoming multiple constraints. Agric. Econ. 46(4), 475–488.

13) Taffesse, A., Dorosh, P., Asrat, S., 2011. Crop Production in Ethiopia: Regional Patterns and Trends ESSP II Working Paper No. 0016 (Addis Ababa, Ethiopia).
14) Van Ittersum, M.K., Cassman, K.G., Grassini, P., Wolf, J., Tittonell, P., Hochman, Z., 2013. Yield gap analysis with local to global relevance—a review. Field Crop Res. 143, 4–17.
15) World Bank. 2018. Ethiopia growth and competitiveness (P168566). The World Bank 1818 H Street, NW Washington, D.C. 20433.