International Journal of Agricultural Economics
2022; 7(5): 227-231
http://www.sciencepublishinggroup.com/j/ijae
doi: 10.11648/j.ijae.20220705.14
ISSN: 2575-3851 (Print); ISSN: 2575-3843 (Online)

Potential for Oil Seed Crops Production Increase in Ethiopia Through Closure of Existing Yield Gaps

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To cite this article:
Daniel Hailu, Rozina Gidey. Potential for Oil Seed Crops Production Increase in Ethiopia Through Closure of Existing Yield Gaps. *International Journal of Agricultural Economics*. Vol. 7, No. 5, 2022, pp. 227-231. doi: 10.11648/j.ijae.20220705.14

Received: August 16, 2022; **Accepted**: September 15, 2022; **Published**: September 29, 2022

Abstract: The objective of the study was to analyze the status of oil seed production and yield gaps in Ethiopia. The data were analyzed using descriptive and econometrics analysis. In Ethiopia, oil seed production and productivity has shown an increasing rate while cropland area growth rate was negative and 3.8 percent. Between 2006/07 and 2020/21, average actual yield growth is 87.3, 74.2, 133.8, 63, -3 and 53.7 percent for groundnuts, linseed, neug, rapeseed, sesame, and sunflower respectively. Oilseeds production increased 59.9 times, in the period which was because of 53.4 percent in area and a 46.6.7 percent in crop yield. Even though it shows increasing, oil seed production and productivity is relatively small as compared to potential. Findings suggest that the country produced between 7.4 and 49.4 percent of their locally attainable oil seed crops yields given their weather, inputs applied, change in farming practices, amounts of fertilizer used, quality of seed varieties, technology and use of irrigation in the production system. The average oilseeds yield level is very low (1.1 tons/ha) as compared to that of the estimated average potential (1.4 tons/ha) in the country for the studied crops. For the analyzed period 2021, the national level yield gaps existed (5, 4.5, 1.3, 0.6 and 10.1 qt/ha) between the released cultivars potential yield and national average yield for groundnuts, linseed, rapeseed, sesame, and sunflower respectively. If farmers had produced the potential yield levels, Ethiopia could have increased production in the same order a respective of 57, 36, 1, 21, and 4 thousand Mt, with improved management from the current level of cropland area. In conclusion, the combination of new crop breeding technologies and crop management practices could enable farmers to significantly increase their yields without bringing new land into production.

Keywords: Ethiopia, Oil Seed, Crop Production, Yield Potential, Actual Yield, Yield Gaps

1. Introduction

Feeding a growing global population and to cope an increasing food demand by 2050, crop production needs to increase by 60 percent [1]. Production increase can be achieved either by expansion of current crop area or producing higher yield per unit area, or both [2]. Moreover, yield increases per unit area can be achieved through increases of yield potential and/or through closure of yield gaps [3].

Ethiopia's agriculture creates 46 percent of gross national production, employs 85 percent of its population, and creates 75 percent of export commodity value [4]. Despite its large scale, the agricultural sector is largely dependent on smallholder subsistence farms burdened by reliance on erratic rain-fed systems. In all, smallholder farmers accounted for 96 percent of the total area cultivated [5].

In Ethiopia, oil crops constituted the major food crops, source of income at household level and a contributor for the country's foreign currency earnings, among others [6]. In production season 2020/21, oil seeds added 5.9 percent (about 0.7 million hectares) of the grain crop area and 2.27 percent (about 7.8 million quintals) of the production to the national grain total. The agricultural sample survey report of Central Statistical Agency (CSA) of Ethiopia revealed that 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 [6, 15].

Yields are often much lower than their potential among smallholder farmers in sub-Saharan Africa [7]. Smallholders may not adopt modern inputs or farming techniques that would increase their productivity because they face one of several constraints [8, 9]. Meanwhile, governments in sub-Saharan Africa have renewed efforts to increase local food production by promoting the use of modern inputs and practices [10, 11]. In Ethiopia large-scale programs (cluster farming) which support smallholder have begun since 2019. Such programs function on the ground that with better modern input availability, smallholder farmers can close the gap between their productivity levels and levels found in local experiment stations.

Crop yield gaps have received increased attention in recent years due to concerns over land scarcity, stagnating crop yield trends in some important agricultural areas, and large projected increases in food demand. Despite the critical nature of this research, little is known about time scale variation in yield gap, which is an aspect that has not been analyzed in previous yield gap analyses. In order to propose policies that help to reduce the yield gap and enhancing food security, will require a diversity of solutions while protecting natural resources. Therefore, it is important to quantify the yield gaps and yield advantage of oil crops. This finding can bring some light on yield gap, especially across time scales.

2. Objectives

The general objective of this study was to measure the gap between current and potential yields for major oil crops in Ethiopia.

Specifically,

1) To assess the area of land planted and production patterns of oilseeds crops over the years;
2) To analyze the yield gap trends in production varies across years and the potential production increase on existing crop area;
3) To analyze the impact of Yield and area on production.

3. Methodology

We use two yield definitions, i.e. average farm yield and potential yield. The average (farm) yield is the average yield achieved by farmers in a defined region and period. We used Central Statistical Agency of Ethiopia [12] Agricultural Sample Survey (AgSS) to estimate average farm yields of rainfed farming for the period 2006/07-2020/21. The potential yield is defined as the maximum yield of a crop cultivar grown under farmer management in Ethiopia. Crop variety register issue simulated by Ministry of Agriculture (MoA) was used to estimate the potential crop yields [14].

The data was analyzed using descriptive and econometric analysis. Production increase on existing crop area was evaluated 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 [13].

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.

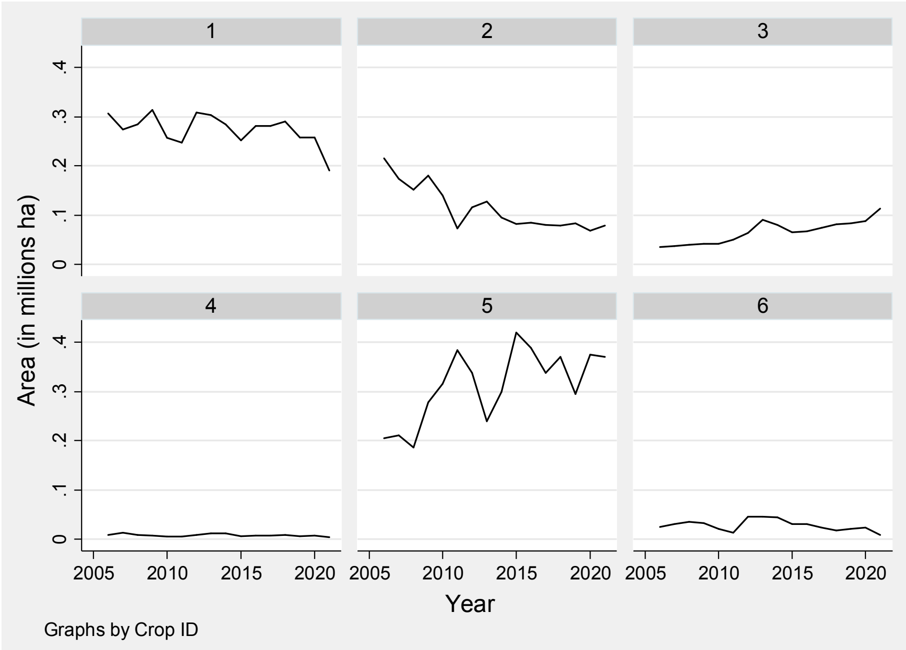
4. Result and Discussion

4.1. Area of Land Planted and Production Patterns of Oil Crops

Oilseed crops together are grown on an area of 0.77 million ha next to cereal and pulse crops based on acreage. Area cultivated by oilseeds occupied 7.8 percent and 5.9 percent of the total grain crop acreage in the periods 2006/07 and 2020/21, respectively. Sesame and neug covered 73.3 percent of the oil crop area. The area growth rate was negative and 3.8 percent in the period. This slower growth is mainly because of a negative yearly growth rate in neug and linseed area by 63.3 and 37.5 percent respectively. However, this is balanced by a fast growth in groundnuts and sesame area. Groundnuts and sesame has grown with an impressive growth of 220.1 percent and 80.3 percent respectively in 2006/07 to 2020/21.

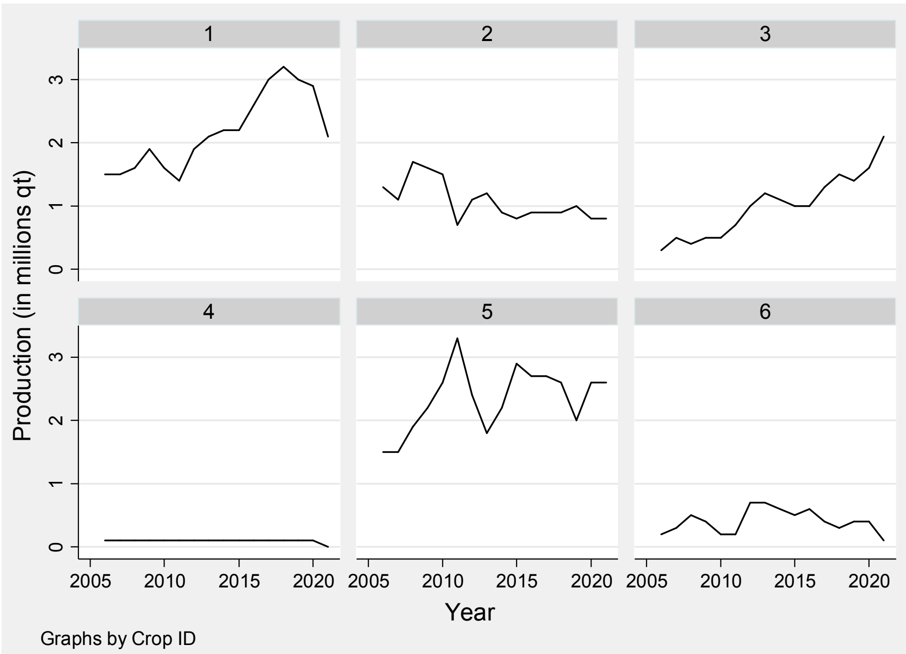
Production Patterns

Oilseeds form the third most important crop group. In 2020/21, a total of 777,444.4 thousand ton of oilseeds was produced; this is 2.3 percent of total annual grain production. Sesame, Neug, sesame, groundnuts, linseed, rapeseed and sunflower covered 33.5, 27.6, 26.4, 10.3, 1.6 and 0.6 percent of the oils seeds grain production respectively. Between 2006/07 and 2020/21, the oilseeds production increased 59.9 times, which was because of 53.4 percent in area and a 46.6.7 percent in crop yield.



Crop ID: 1=Neug, 2=Linseed, 3=Groundnuts, 4=Sunflower, 5=Sesame, 6=Rapeseed

Figure 1. *Cropland area trends of cereal crops.*



Crop ID: 1=Neug, 2=Linseed, 3=Groundnuts, 4=Sunflower, 5=Sesame, 6=Rapeseed

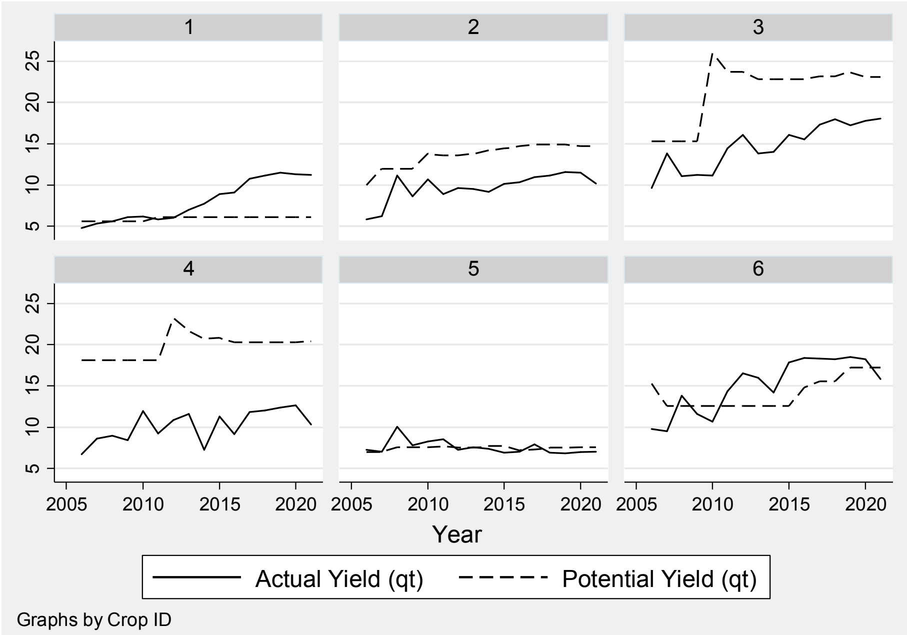
Figure 2. *Production patterns of cereal crops.*

4.2. Potential Yields and Yield Gap Trends

The average oilseeds yield level is very low (1.1 tons/ha) as compared to that of the estimated average potential (1.4 tons/ha) in the country for the studied crops. The average actual yield growth is 87.3, 74.2, 133.8, 63, -3 and 53.7 percent for groundnuts, linseed, neug, rapeseed, sesame, and sunflower respectively between 2005/06 and 2020/21.

The yield gap analysis in 2021 shows that yield gap between the released cultivars potential yield (18.1, 10.2, 15.9, 7.0 and 10.3 qt/ha) and national average yield (23.1, 14.7, 17.2, 7.6 and 20.4 qt/ha), represented a 21.8, 30.7, 7.7, 7.4 and 49.4 percent of groundnuts, linseed, rapeseed, sesame, and sunflower yield gap existed, respectively.

The gap between average and best yields could still be reduced, except neug which meets the yield potential. Thus, the Ethiopian farmers' could have increased by groundnuts, linseed, rapeseed, sesame, and sunflower production a respective of 57, 36, 1, 21, and 4 thousand Mt, with improved management from the current level of cropland area.



Crop ID: 1=Neug, 2=Linseed, 3=Groundnuts, 4=Sunflower, 5=Sesame, 6=Rapeseed.

Figure 3. *Potential yields and yield gap trends of cereal crops.*

4.3. The Impact of Yield and Area on Production

Table 1. *Pairwise correlations.*

Variables	(1)	(2)	(3)
(1) production	1.000		
(2) area	0.932	1.000	
	(0.000)		
(3) yield	0.087	-0.113	1.000
	(0.081)	(0.024)	

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

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 is increased by one percent then the production growth will be increased by 1 and by 0.99 percent 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	1.003404	.0018216	550.84	0.000	.9998339	1.006974
yield	.9960078	.0030847	322.88	0.000	.9899618	1.002054
SR						
_ec	-1.011356	.1353496	-7.47	0.000	-1.276637	-.746076
area D1.	-.0140542	.1350235	-0.10	0.917	-.2786954	.250587
yield D1.	-.0112061	.1375859	-0.08	0.935	-.2808696	.2584573
_cons	.0288188	.0024512	-11.76	0.000	.033623	-.0240146

5. Conclusion and Recommendation

Yield gap evaluation performed in this study shows that Ethiopia had the potential to noticeably increase grain production of groundnuts, linseed, rapeseed, sesame, and sunflower, by a respective of 57, 36, 1, 21, and 4 thousand Mt, without expanding cropland area. This large variation in yield gaps was found across regions and years as compare to their potential. This potential grain surplus would have a great impact on grain exports and oil production in the country.

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