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Assessment of the factors affecting wheat yield: the case Tiyo Woreda Arsi zone of Oromia region in Ethiopia

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Abstract

Objectives: To assess the factors affecting the production of wheat in Tiyo Woreda of Oromia regions, Ethiopia.
Methods: This study is based on primary and secondary data collected from the farm households, different publications, from Woreda office, etc. Mixed method research approach was used to mix qualitative and quantitative data. The total of 101 sample size was selected using systematic random sampling method.Linear regression econometric models were employed as a medium of data analysis.
Findings: The study revealed that the educational level, farmlands allocated for wheat production,use of modern inputs such as utilization of chemical fertilizers, pesticides, and herbicides,use of improved variety of wheat seeds, traditional way of farming methods, broadcasting way of sowing methods and shortage of access to training for farmers at farmers training centers are the important determinants significantly affecting wheat yield.
Improvements: Identifying these key factors was helpful for Rural Development Association (RDA) and Zonal Administration of the Woreda for policy formulation and on planning so as to assist them to build a holistic strategy that help the farmers in the improvement of wheat productivity and also for future researchers.
Recommendations: Therefore, government and non-government bodies shoulddevelop modern farming system, arrange forum, exhibition for experience sharing, give training for farmers and finally, further research should continue.
Keywords: Wheat, Production, Factors, Tiyo, Ethiopia.

1. Introduction

1.1. Background of the study

Ethiopia is one of the Sub-Saharan African countries situated at the Horn of Africa with a population of 94.4 million people [1]. According to [2], agriculture is the main engine of the economic growth for Sub-Saharan African countries. However, feeding the increasing population of Sub-Saharan Africa is becoming a critical challenge for most of the countries in this area [3]. Hence, subsistence and rain-fed agriculture is the economic base and means of livelihood of the majority of these people. The overriding objective of the government is to attain fast, broad-based economic development. Thus, the government of Ethiopia has tried to improve the performance of agriculture by planning and implementing different strategies like Sustainable Development and Poverty Reduction Program (SDPRP), a Plan for Accelerated and Sustained Development to End Poverty (PASDEP) and the recent Growth and Transformation Plan (GTP) are some of the development strategies of the government. A development strategy known as the Agricultural Development-Led Industrialization (ADLI) has been formulated to focus on agriculture and views agriculture as an engine of growth, on account of its potentially superior growth linkages, surplus generation, market creation, and provision of raw materials and foreign exchange and finally for poverty reduction.In Ethiopia, agriculture employs 80% of the total population and contributes about 41% of GDP and 86% of total exports [4].Similarly, [5] confirms that an agricultural stimulated growth of one per cent annual increase in Ethiopia's per capita GDP leads to a 1.7% reduction in the poverty rate per year.The agricultural sector in Ethiopia is dominated by subsistence, low input, low output and rain-fed farming system.Cereals dominate Ethiopian agriculture; accounting for about 70% of agricultural GDP. Wheat is one of the major cereal crops grown in Ethiopia [6]. In sub-Saharan Africa, Ethiopia is the second largest wheat producing country in Africa after South Africa.The total area covered by the wheat farm in Ethiopia about (50%) is located in Oromia region. Arsi, Bale, and parts of Shoa are considered the wheat growing

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belt. The average wheat yield in per hectare was 26.75 quintal in Ethiopia, 29.65 quintal in Oromia Region and 32.09quintal in Arsi zone. Altitude plays an important role in the production of wheat and has an influence on rainfall, temperature, and diseases. Rainfall distribution (end of June up to end of September) was good in most parts of the wheat growing areas. Arsi Zone is widely perceived to be among the most productive regions in the country, with enlightened farmers well disposed to using purchased inputs. According to [7], Arsi Zone produces about 75% of Ethiopian bread wheat. Within the region, Tiyo Woreda is also a wheat belt areas in which wheat is the main source of income and food for households and about 76% of the farmers planted wheat. The Woreda is characterized by high input and output. But, in some kebeles farmers has been facing different problems like poverty, malnutrition, low productivity of crop especially wheat yield, and low standard of living, even if the area was wheat belt area. This is the main motivation behind this study which aims to find the source of the problem. Agriculture is the main source of food and income earner, livelihood, and way of living for about 85% of Ethiopians living in rural areas. Ethiopia's agricultural production is by and large rain-fed and dominated by small-scale farmers and enterprises. Wheat is widely produced in Tiyo Woreda. But, due to several technical and socio-economic constraints the wheat yield gained by the farmers from year to year is low and unstable in the study area. In this perspective, statement of the problem aswell as objective was to identify the factors affecting the production of Wheat in Woreda and to give policy recommendations and training for farmers in cooperation with concerned bodies from kebeles, Woreda, and zone. The study will be benefial to identify key factors affecting the production of wheat especially for; Rural development association (RDA), Zonal Administration of the Woredafor policy formulation andon planning so as to assist them to build a holistic strategy that help the farmers in the improvement of wheat productivity and finally for future researchers, research institutions, students and other researchers as an empirical literature review in the study area. The scope of this study will be limited to cover and analyze only those factors influencing wheat yield of farmers to the selected kebeles of Tiyo Woreda.

2. Materials and methods

2.1. Description of the study area

Tiyo Woreda is found in the Oromia Region. The Woreda is bordered on the south by Munesa, on the west by Ziway Dugda, on the northeast by Hitosa, and on the southeast by Digelu and Tijo Woreda. Asella town is the administrative center of the Tiyo Woreda and Zone. A survey of the land in this Woreda shows that 40% is arable or cultivable (32% is planted with cereals), 23.1% is pasture, 8.7% is forest, and the remaining 28.2% is swampy, mountainous or unusable land. According to the National Census Report of 2015, the total population of the Woreda were 107, 8.95% of its total population were urban dwellers. Tiyo has an estimated population density of 285.4 people per square kilometer. The Woreda has 18 kebeles. Further, according to the socio-economic activity and geo-ecological location criteria by [8, 9] the zone is categorized as a hotspot for climate change impacts. The zone is mid and lowland and many of the districts are located in the Great Rift Valley and have been plagued by frequent climatic impacts, and also the Woreda was one of the wheat belt in Arsi zone.

2.2. Data source and type

Mixed method research approach ordesign which involves the mixing of qualitative and quantitative research methods was usedin a single study. In the present study both the primary data that has been collected through the structured questionnaires, interviews, and field observations from the smallholder farmers producing wheatand secondary sources of data thathas been obtained from the agricultural bureau of the Woreda, development association, farmers training center, different publications (reports, documents and other related studies) and other relevant sources have been used.

2.3. Method of data analysis

The linear regression econometric models that were used in this research are based on the scientific requirements of the variables (dependent and explanatory), and the SPSS Version 20 software was used as a medium of analysis for the model. Accordingly, the following regression model is specified:

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$$Y= \beta_0+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \text{-----} + \beta_KX_K+ \varepsilon$$

This means,

$$y = X' \beta + \varepsilon$$

Where: Y= is the dependent variable; y= estimated dependent variables
X= explanatory variables; β= the parameter to be estimated; ε= the error term.

2.4. Sampling design and sampling methods

The respondents were selected from their list at each village using a two-stage sampling approach. First, four kebeles namely Dhankaka Qonicha, Abosara Alko, Oda Dhawata and Hamsa Gasha were selected purposively based on agro-ecological zones and secondly the total sample size were selected from each kebeles using systematic random sampling method proportionally. Hence, the systematic random sampling method used to determine the sample size was;

N=nK,
Where; N-is total population,
n-sample size,
K-sample interval
Where, N_1, N_2, N_3, and N_4 show the population size in four kebeles.

The sample size selected from every four kebeles is represented by, n_1, n_2, n_3, and n_4, in which each of them has been selected from the respective number of total population of the kebeles. To select farmers from the list of the kebeles, we use the series, i, i+k, i+2k, i+3k … i+ (n-1) k Where i=is any positive integer unit which is less than or equal to k, i.e, i≤k. Based on the result of the above formula to collect the survey data, questionnaires were distributed for 101 rural households.

3. Major findings and discussions

3.1. Regression model

The result of the regression model and determinants of wheat yield are explained in the Table 1. This table provides the *R*, R^2, adjusted R^2, and the standard error of the estimate, which can be used to determine how well a regression model fits the data. Value of *R* is the multiple correlation coefficientsand can be used as a measure of the quality of the prediction of the dependent variable; in this case, a value of 0.613, indicates a good level of prediction. The coefficient of determination is 0.376; therefore, about 37.6% of the total variation in wheat yield is explained by the change in explanatory variables. This means, about 62.4% variations in dependent variables are not explained by the change in explanatory variables. This indicates that there is a weak relationship between wheat yield and its explanatory variables in the study area. The regression equation appears to be very useful for making predictions even if the value of r^2 is weak. Predictors: (Constant), sowing method, method of agronomy, climate change.

Table 1. Summary of regression model

Model	R	R Square[b]	Adjusted R Square	Standard Error of the Estimate
1	.613[a]	.376	.266	.751

Source: Field survey, 2017

Dependent Variable: Wheat yield per season/year in quintal. Further, we can also examine the analysis of variance using F-test. The linear regression's F-test has the null hypothesis that the model explains zero variance in the dependent variable (in other words $R^2 = 0$). The F-test is highly significant, thus we can assume that the model explains a significant amount of the variance in wheat yield. These *F*-ratios in the Anova Table 2 tests whether the overall regression model is a good fit for the data. Therefore, the table shows that the explanatory variables significantly predict the dependent variable, $F(15, 85) = 3.412$, $p < 0.0005$ (i.e., the regression model is a good fit of the data). Dependent Variable: Wheat yield per season/year in quintal. Predictors: (Constant), sowing method, method of agronomy farmers used usage of compost in kilogram. In order to identify the impact of explanatory variables on wheat yield, a regression model was used. Unstandardized coefficients

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indicate theextent to which a dependent variable varies with an independent variable when all other independent variables are held constant.

Table 2. Analyasisi of variance for regression

Model	Sum of Squares	Degree of freedom	Mean Square	F-test	Significant
Regression ResidualTotal	28.86847.94476.812	1585100	1.925.564	3.412	.000[b]

Source: Field Survey 2017

According to the regression results shown in table, we can observe that the educational level, land allocated for wheat production, fertilizer utilization, herbicide and pesticide utilization, plantation of improved variety of wheat seed, access to farmers training center, farming methods and sowing methods of the households are statistically significant variables, which means, these variables are the main determinant factors for wheat yield in the study area. In this table (Table 3), the unstandardized coefficient β_1 for an educational level is equal to 0.266 which means that an increase in educational level of the household by one level leads to an increase in wheat yield by 0.266 times. We can also observe that as the household increases theallocation of land for wheat production by one hectare, the wheat yield increases by 0.354 times, holding other variables constant. This implies that more a household allocates the land for cultivation of wheat, the more wheat yield they get from the land. The use of modern (scientific) inputs like fertilizer, herbicide, and pesticide is the critical factors in the rural areas. In relation to fertilizer, herbicide and pesticide utilization the results indicates that the use of additional kilogram of fertilizer, additional one liter of pesticide and herbicide lead to an increase in wheat yield by 0.25, 0.676 and 0.58 times. Application of an improved variety of wheat seed is also another significant variable of the regression model. The result indicates that farmers who apply improved wheat seeds on their farm land have a chance to increase their wheat yield by 0.133 times**.**

Table 3. Regression results of factors affecting wheat yield

Model	Unstandardized coefficient		Standardized coefficient	T-values	Significance
	β	Std. err	Beta		
(Constant)	1.04	.299		3.49	.001
Educational level	.266	.107	.231	2.49	.015*
Farm land allocated for wheat	.354	.115	.287	3.09	.003*
Fertilizer utilization	.25	.090	.252	2.8	.006*
Compost utilization	.067	.114	.052	.587	.559
Pesticide utilization	.676	.241	.251	2.80	.006*
Herbicide utilization	.580	.288	.189	2.02	.047*
Wheat production damage	.218	.308	.209	.34	.72
Plantation of IVS	.410	.163	.208	2.07	.038*
Distance to get IVS	-.003	.116	-.003	-.03	.976
Access to extension service	.121	.242	.048	.500	.618
number of times meet DA	.004	.071	.005	.052	.959
Access to FTC	.65	.294	.202	2.2	.029*
Farming method	.73	.306	.3063	2.68	.004*
Climate change	.105	.224	.046	.469	.641
Sowing method	.197	.0.96	.196	2.06	.043
Note (*)-significant at 0.05					

Source: Field Survey 2017

In addition, the Table 3 indicates that there is a statistically significant relationship between wheat yield and explanatory variables such as access to farmers training, use of modern farming methods and modern sowing method. According to the table results, farmers who attended training at FTC have more chance in an improvement of wheat production. This means those who are attending the training increases their wheat yield by 0.65times than those who do not. Regarding farming methods, use of modern farming methods helps farmers by increasing their wheat yield by 73 times. Applications of drilling way of sowing methods also increases the wheat yield by 0.197 times. We can also see that farmland allocated for wheat production, fertilizer utilization, pesticide utilization and farming method has a higher impact on wheat yield than other explanatory variables by comparing the standardized coefficients (beta which approaches to zero).

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Therefore, the model becomes;

$Y= 1.04+0.266X_1+0.354X_2+0.25X_3+0.676X_4+0.58X_5+0.41X_6+0.65X_7+0.73X_8+0.197X_{9+\epsilon,}$ Generally, a multiple regression model is run to predict the wheat yield from explanatory variables like educational Level, amount of land allocated for wheat production, utilization of fertilizer, herbicide, pesticide, an existence of wheat damage, access to farmers training center at the local level and the like. These explanatory variables significantly predicted the wheat yield in the study area, $F (15, 85) =3.412, R^2=0.376$. All these variables are added significantly to the prediction, $P<0.05$.

4. Conclusion

The agricultural sector is the basis of livelihood for a large segment of population in Ethiopia. The Agricultural Development Led Industrialization (ADLI) is the national policy of the country. Regardless of the government's policy attention and investment, there is a long way to go for smallholders to ensure food self-sufficiency. As we have already discussed that the major factors expected to affect wheat yield of the farming households in the area are, age, educational level, size of cultivated land allocated for wheat production, input utilization (fertilizer, compost, herbicide, pesticide), climate change, access to FTC, sowing method, farming method, access to extension service, utilization to IVS etc. Most of the farmers are not educated well and they do not know how to improve their wheat yield. The regression outcome shows that, plantation of improved variety of wheat seed on their farm improves wheat yields of the farmers by 0.41 times. Farmers who get training at FTC have a chance of increasing their wheat yield by 0.65 times as compared to those who do not take it. From the result we can also conclude that, farming methods and sowing methods contribute more and more for improvement of wheat yield. As shown above, use of modern farming system increases wheat yield by 0.73 times as compared to those who are ploughing their farm land using ox. Scientific way of sowing methods is also essential for the improvement of wheat yield of the farmers. Application of drilling way of sowing methods helps the farmers to increasetheir wheat yield by 0.197 times. Generally, the farm land allocated for wheat production, fertilizer utilization, pesticide utilization and farming method has a higher impact on wheat yield than other explanatory variables by comparing the standardized coefficients (beta which means it approaches to zero). Therefore, based on the above findings, the following recommendations can be made:Governmental, non-governmental, farmers and other concerned bodies,

1. Should make enormous efforts to improve wheat production.
2. Should motivate, help, give training and advise on how to improve the wheat yield.
3. Develop and disseminate available modern farm machinery to improve wheat yield.
4. Giving farmers awareness on the importance of IVS and how to use this seed.
5. Focus on dissemination of not only improved variety of seed but also its management practices. giving access to both formal and informal quality education is need of the time.
6. Modern way of sowing method (drilling),
7. Follow up of extension agents, support from the government, repeated sessions of training at FTC and village level and in combination with increase in land size, for better production of wheat yield in the study area.
8. The adequate supplies of inputs with clear instructions to the farmers about the quantity as well as timings of putting these inputs in the farm frequent follow up by extension
9. Frequently meet extension agent and farm expertise especially during the production season.
10. Improve farmers knowledge in quality seed production;
11. Giving training on agricultural issues, arrange forum and exhibition for experience sharing and solve the wheat yield problem in collaboration.
12. Farmers should try again and again to improve their wheat production using their skills and making linkages with different farmers.
13. Finally, further research should continue to examine factors associated with the wheat yield from time to time.

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