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Effects of inorganic fertilizer on agricultural productivity in Ganta Afeshum woreda, Tigray region, Ethiopia

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ABSTRACT

A study was conducted to assess the practice, causes and effects of inorganic fertilizer on agricultural productivity in Ganta Afeshum woreda. The study area was selected, simple random sampling and the development agent respondents were selected in terms of purposive sampling methods of the 134 household respondents. The data collected was used, administering written questionnaires, interviews and direct observation techniques, and calculated mean, SD, tabular, percentages, one sample t-test, chi-square, correlation and regression methods were used for analyzing the data. Based on the finding the research shows a strong positive correlation between land holding in hectares and household monthly income, which was statistically significant, and the variance of inorganic fertilizer applied in farmland area was influenced by household monthly income in Birr. The study shows that there is a difference between the users and non-users of inorganic fertilizer on agricultural productivity in the study area. The final output of the study shows that the effect of inorganic fertilizer on the productivity of irrigated farmland was both positive effects such as increment of productivity, increment of soil fertility, fulfilment food consumption and increment of income earnings and negative effects such as adding acidity, adding salinity and changing the physical and biological properties of soil.

Key words: Agriculture; Inorganic fertilizer; Ganta Afeshum; Ethiopia

1) INTRODUCTION

Living Inorganic fertilizers are used to offer instantaneously vitamins to the plant once they want it not like natural fertilizers that simplest have a sluggish launch capability. Inorganic fertilizer works more rapidly, and it may be utilized in balance of the farms need. They are less expensive than commercial organic fertilizers as well as may be used in large amounts [1].

The global standard is greater than 90 kg/ha; it is greater than 100 kg/ha in all developing nations, including Africa [2]. In 1994/95, farmers on nearly 170 million ha of arable in Africa used only 3.5 million plant nutrients. Inorganic fertilizers are required for promoting plant growth and production. They enhance the chemical soil properties, such as increasing the supply of macro and micro essential nutrients to meet the crop needs [3]. The average rate of use in Africa was 21 kg/ha. In sub-Saharan Africa (SSA), excluding South Africa, however, it was only 10 kg/ha. Only 4 countries (Egypt, South Africa, Swaziland, and Zimbabwe) used more than 50 kg/ha, and 31 countries used less than 10 kg/ha [2].

Ethiopia is located in the horn of Africa, and it has an estimated area of 122 million hectares of which 65% is arable. At present 15% of the area is cultivated for the production of major food crops. About 84% of its 90 million people are dependent on agriculture for their lives. On the other hand, the government of Ethiopia gives highly prior to increasing agriculture production and productivity in order to ensure food security, improving rural live hood and promote industrial development and growth [4].

The Ethiopia development policy of the current regime, agricultural development lid industrialization (ADLI) claims to adhere to the second lion of argument and place faith on agriculture. In general, and its small holder variant in particular as the engine of growth in terms of its potential in surplus formation, market creation, provision of raw materials and generalization of foreign exchange. It intends to develop agricultural productivity and production to mobilize sufficiency resources sustain the structural transformation of the whole economy [5]. Currently, 90 percent of the fertilizer is delivered on credit at below-market interest or even at zero interest. Subsequently, the total fertilizer use has increased from 250,000 tons in 1995 to 400,000 tons in 2008 [6].

This research investigated the effects of inorganic fertilizer on agricultural productivity in Ganta Afeshum woreda. The farmers of the Woreda as the observation of the study largely depend upon inorganic fertilizer like DAP and UREA. This research gives necessarily aware of the impact fertilizers on social and economic conditions for the farmer households. The research assessed the effectiveness of inorganic fertilizer on agricultural productivities of Ganta Afeshum woreda.

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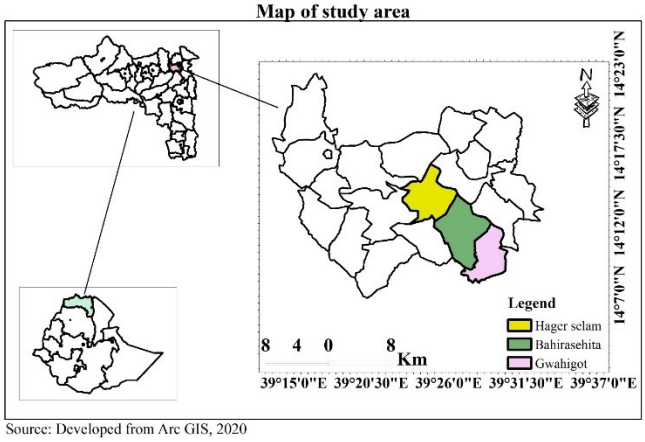
The overall objective of this paper was to investigate the effects of inorganic fertilizer on agricultural productivities in Ganta Afeshum woreda, eastern Tigray region. The sub objectives are to describe the practice and adaptation of inorganic fertilizer in the study area, to identify the major causes for using of inorganic fertilizer on agricultural productivities in the study area and to analyze the major effects of inorganic fertilizer on agricultural productivity in the study area.

2) MATERIALS AND METHODS

Study area: Ganta Afeshum is one of the woredas in the Tigray Region of Ethiopia. Part of the eastern zone. It is located between 14°19'54. 49"N latitude and 39°15'11. 82"E longitude. Ganta Afeshum is bordered on the south by Hawzen, on the west by the Mehakelegnaw (Central) Zone, on the north by Gulomahda, and on the east by Saesie Tsaedaemba. Towns in Ganta Afeshum include Bizet. Since the town of Adigrat split off Ganta Afeshum as a separate woreda, it is surrounded by this woreda [7].

Based on the 2007 national census conduct Accessed the Central Statistical Agency of Ethiopia (CSA), this woreda has a total population of 88,644, an increase of 3.79% over the 1994 census, of whom 42,096 are men and 46,548 women; 3,636 or 4.10% are urban inhabitants. With an area of 1,636.36 square kilometers, Ganta Afeshum has a population density of 54.17, which is less than the Zone average of 56.93 persons per square kilometer. A total of 19,301 households were counted in this woreda, resulting in an average of 4.59 persons in a household, and 18,855 housing units.

A sample enumeration performed by the CSA in 2001 interviewed 20,704 farmers in this woreda, who held an average of 0.37 hectares of land. Of the 7,710 hectares of private land surveyed, 83.38% were under cultivation, 2.67% pasture, 5.15% fallow, 1.95% in woodland, and 6.86% was devoted to other uses. For the land under cultivation in this woreda, 64% was planted in cereals, 8.9% in pulses, 0.61% in oilseeds, and 13 hectares in vegetables. The total area planted in fruit trees was 646 hectares, while 78 were planted in gesho. 72.00% of the farmers, both raised crops and livestock, while 25.63% only grew crops and 2.37% only raised livestock. Land tenure in this woreda is distributed amongst 94.88% owning their land, 3.39% renting, and 1.74% holding their land under other forms of tenure [8].



Source: Developed from Arc GIS, 2020

Target population and Sampling

Population: The population that was studied is known as target population, which was inorganic users of the three tabias in Ganta Afshum woreda. The total population considered in this study was about 3971 inorganic user farmers while 134 were a sample unit.

Sample size and Sampling technique: An important decision that has to be taken while adopting a sample technique is about the size of the sample. Appropriate sample size depends on various factors relating to the subject under investigation like the time aspect, cost aspect, degree of accuracy desired [9]. The larger the sample is the more it is to achieve the desired objectives of analysis.

To make the study more accurate and viable, determination of the appropriate number of sample sizes is important. Therefore, Kothari [10] was proposed, assuming 95% confidence level and e =0.05)) sample size of the study.

$$n = \frac{Nz^2PQ}{E^2(N-1) + z^2PQ}$$

$$n = \frac{3971(1.96)^2(0.9)(0.1)}{(0.05)^2(3971-1) + (1.96)^2(0.9)(0.1)}$$

$$n = 134$$

The study employed non-probability sampling technique has helped to select the study area from 20 Tabias based on frequently used inorganic fertilizer on agricultural productivity and the DAs was selected by purposive sampling.

The study also used a probability sampling technique, stratified random sampling was used to get information from different Tabias of the Ganta Afeshum Woreda. This technique was preferred because it was used to help in minimizing bias when dealing with the population and due to the heterogeneity of irrigated farmlands in each Tabia of the study area. This step allows a fair representation of the various types of household size of inorganic fertilizer users in the study area.

The 134 household head respondents were selected from the total households using simple random sampling technique. Therefore, 134 household heads are the sample unit or a sample size of the study, because the problem is common throughout the study area.

Data source and analysis

The study used both primary and secondary sources of data collection. To obtain sufficient primary data, a well-designed questionnaire with the help of ODK was used in the study. The questionnaires were completed by the household respondents. Besides, face-to-face interviews were also made to the selected respondents and the DAs experts who head the agricultural office of the study area. Secondary data were gathered from published and unpublished documents, journals, reports, and internet sources related the topic.

3) RESULTS AND DISCUSSION

In order to get the effects of inorganic fertilizer on agricultural productivity, Quantitative and Qualitative data

were gathered by questionnaire, ODK, field observation and interview.

A questionnaire was used to collect data related to agricultural productivity via our ODK. The questionnaire had 35 items; all items of the questionnaire were developed by the author based on scholars' suggestions and recommendations and questionnaire were administered by the data collectors.

An interview was held to collect data from key respondents or DAs in order to get relevant information about the extent and causes of inorganic fertilizer on agricultural productivity in the study area by questions and answers.

Direct observation was made to collect relevant and sufficient information about the research problem as a non-participant in the study area and it was helpful to identify the major causes and its effects of inorganic fertilizer.

The study employed a mixed approach and generated both qualitative and quantitative data. Qualitative research such as descriptive statistics (mean, median, standard deviation and pie charts, bar graphs) was used to describe the general characteristics and to compare the different factors of the role of inorganic fertilizer on agriculture. And also, a qualitative approach to gather information that emphasizes describing a phenomena manner in deep comprehensive which are not rigorously examined or measured in terms of quantity, amount, intensity or frequency in the study areas. Quantitative research, such as statistical techniques, such as: One-sample t-test was employed to compare the standard with study area of inorganic fertilizer per hector, the correlation was employed to evaluate land holding in hectare and household monthly income, chi-square (x2) was applied to evaluate variables of inorganic fertilizer on an irrigated farm. Regression was applied to evaluate the effect inorganic fertilizer on agricultural productivity. Finally, Statistical package for Social Science (SPSS) version 20 Software employed to analyze the data obtained.

According to the above table 1, the mean inorganic fertilizer per hectare in kg at the study area M = 138.3721 was significantly greater than the world standard of inorganic fertilizer M = 90, *t* (133) = (9.171), P =. 000. The use of inorganic fertilizer of world standard means we're less than the mean of inorganic fertilizer per hectare in the study area. However, the world consumption rate and inorganic fertilizer consumption in the study area had been different since obtaining a value of 9. 171is significant at the 5% level. In Line with this, Consumption of fertilizer is one of the vital inputs in crop production. Without utilization of fertilizer, world food production could be reduced from 40-60% annually [11]. In line with this, the sum of fertilizer utilized all over the nation has expanded more than triple amid the same period which demonstrates that the application rate has too been expanded, in spite of the fact that gradually. The application rate on normal expanded from 66 kilograms per hectare in 2003/04 to 104 kilograms per hectare in 2015/16, considering fertilized cropland as it were [12].

In table 2, see that this is statistically significant among land holding in hectare and household monthly income after Appling inorganic fertilizer rate properly. There was a strong, positive correlation between household monthly income and land holding in a hectare, which was statistically significant (r = 0.849 and p < 0.000). In addition, this inorganic fertilizer rate resulted in a grain yield comparable to that obtained from applying 100% of the recommended inorganic fertilizer rate [13].

As show the above table 3, 45.52% of the household respondents were getting benefit increase production capability from inorganic fertilizer, 33.58% of the household respondents were getting a benefit increase comes from inorganic fertilizer and 20.90% of household respondents were getting motivation for farther utilize by applied of inorganic fertilizer. In addition to this the key respondents replied that the household farmers had gotten on average 24 quintals per hectare in one term, then based on this productivity the farmers accumulated high capital per annual. Thus, the study concluded inorganic fertilizer users gained advantage such as increase production capability; motivation for farther utilize and increase income from irrigated farmlands. And also, Chemical fertilizers perform valuable contribution to get high crop productivity [14].

Table 1: Inorganic fertilizer per hectare in the study area

One-Sample Test						
	Test Value = 90					
	T	Mean	Std. Deviation	Df	P - Value	Mean Difference
Inorganic fertilizer	9.171	138.3721	48.91434	133	.000	48.37209

Table 2: land holding in hectare and household monthly income.

Correlation		
Pearson Correlation	R	P- value
	.849	.000

Table 3: inorganic fertilizer and the benefit you get from inorganic fertilizer.

		Benefit from inorganic fertilizer			Total
		Increase production capability	Motivation for further utilize	Increase income	
Inorganic fertilizer	Yes	61	28	45	134
Percent		45.52	20.90	33.58	100

Table 4: causes for using of inorganic fertilizer

Items	Frequency	Percent
Increment of productivity	39	29.11
Increment of income earned	24	17.91
Increment of soil fertility	34	25.37
Fulfillment food consumption	23	17.16
Regulation market price	14	10.45
Total	134	100.0

Table 4 showed that causes for using of inorganic fertilizer of samples households or respondents. Accordingly, 29.11% of the respondents were used inorganic fertilizer for increment of productivity, 25.37% of the household respondents said that used inorganic fertilizer for increment of soil fertility, 17.91% of the household respondents were inorganic fertilizer used for increment of income earnings, 17.16% of the household respondents were used for fulfillment food consumption and 10.45% of the household respondents were used for regulation market price. In addition to this, the interview conducted with 100% of key respondents and with some selected model farmers inspired to apply inorganic fertilizer on their irrigated farmlands because of increment of productivity, increment of income earned, increment of soil fertility, fulfillment food consumption and regulation market price. Based on this it is possible to conclude that the majority of farmers have produced after using inorganic fertilizer, especially using the NPS on their irrigated farmlands. In line with this, many types of fertilizers are consumed in the world, among them only Urea (CO (NH) and diammonium phosphate (DAP) are dominantly consumed in Ethiopian mainly for grain crops [15]. Urea has the highest nitrogen content compared to all solid nitrogen containing fertilizers commonly used in agriculture [16].

In contrast with this, the increased application of Nitrogen to fields destroys the balance between the three nutrients such as N, P and K with the passage of time which would cause lack in micronutrients. It also damages topsoil. Sandy soil is more prone to soil acidification than the other soil layers like clay soil which have the capability to buffer the effects of excess fertilization. Continuous use of chemical fertilizer may result in toxic storage of heavy metal such as arsenic, cadmium and uranium in the soil. The effects of chemical fertilizers on soil are very adverse and irretrievable [17].

Table 5: effects of inorganic fertilizer on productivity and effect of inorganic fertilizer on soil quality

Chi-Square Tests			
Pearson Chi-Square	X^2 Value	Df	P- value
	10.165	2	.006

As demonstrations the above table 5 there was a significant association between inorganic fertilizer and benefit your get from inorganic fertilizer $X^2((2, N=86) = 10.165, P< 0.05))$ since, x^2 value 10.165 is greater than the critical value 5.99 between effects of inorganic fertilizer on productivity and effect of inorganic fertilizer on soil quality were associated significant each other at df=2, P<0.05. In addition to this 100% of the key respondents said that using of inorganic fertilizer on farmlands was affected the soil physical and biological properties and it was bringing soil acidity and salinity in the study area. And this is also similar to the finding of [13] inorganic fertilizers (worth the price of 20 kg N ha−1 and 10 kg P ha−1) are possible, with the additional benefit of improving the physical and chemical conditions of the soil. And highly significant (P < 0.01) influence on all grain yield and yield components measured. Significant influence (P < 0.01) of year on the agricultural productivities due to fertilizer application [18]. Table 6 indicated that the multiple correlation coefficient of the three models (*R*; i.e. the correlation between the predictor and the outcome variables) is 0.746, 0.714 and 0.816 respectively. The first model of regression 0.557 which can be thought of as the amount of variance in the outcome variable that is accounted for by the predictor variable or 55.70% of the variance of inorganic fertilizer applied on the farmland area was contributed for agricultural product per quintal in kg and the second model of regression is 0.510 which can be thought of as the amount of variance in the outcome variable that is accounted for by the predictor variable or 51.00% of the variance of inorganic fertilizer applied on your farmland area was sketched for improvement of soil physical conditions. The third model of regression is 0.666 which can be thought of as the amount of variance in the outcome variable that is accounted for by the predictor variable or 66.60 % of the variance of inorganic fertilizer applied on the farmland area was enhancing livelihood of the people. In addition to this, the use of 50% and 100% inorganic fertilizer increased grain yield by 360 and 617 kg ha−1, respectively, over the fertilizer control. Greater grain yields, however, were obtained by the mixture of FYM and inorganic fertilizer than with either manure or inorganic fertilizer alone. The combined application of all the FYM levels with 50% and 100% of the recommended inorganic fertilizer rate significantly increased grain yield over the control [13]. And also, inorganic fertilizers, additionally to the additive effect on nutrient supply and improvement of soil physical conditions, checks N losses and conserves soil

Table 6: Multiple linear regression model

Regression								
Variables	R	R^2	Adjusted R Square	Std. Error of the Estimate	Change Statistics			
					F Change	df1	df2	Sig. F Change
Agricultural product per quintal	.746	.557	.553	.47938	148.314	1	132	.000
Soil physical conditions	.714	.510	.507	.344	137.582	1	132	.000
Livelihoods per income	.816	.666	.663	.272	263.223	1	132	. 000

N by forming organic-mineral complexes, thus ensuring continuous N availability and greater yields [19].

The research finding, the majority of the farmers in the Kebele use chemical fertilizer while remain community cannot use because of several factor like attitude toward using fertilizer, rising in price of fertilizer and lack of awareness to community how they can use this fertilizer and also they have strong positive correlation among the trend of irrigated practice and household month income. Because of several effects like rise in production capability and rise both quality and quantity of production, it is better for farmers to ensure food security and being independent at the household level of the basic need of food and get another profit. The research finding that, not all the farmers use chemical fertilizer, because of not having a detail, understanding about the effect of inorganic fertilizer and also, they have carelessness on their farm land and they do not have sufficient knowledge.

The findings of the study indicate that there was a significant difference between using the mean of inorganic fertilizer in the world standard per hectare and the mean of inorganic fertilizer per hectare in the study area. And the findings of the study show a strong, positive correlation between household monthly income and land holding per hectare, which was statistically significant ($r = 0.849$ and $p<0.000$). At the same time, direct observation of the effects of inorganic fertilizer had positive importance for improving agricultural productivity per hectare.

The findings of the study indicate that the main reasons for using inorganic fertilizer were to increase productivity, increase income earned, increase soil fertility, fulfill food consumption, and regulate market prices. And there is also a significant association between inorganic fertilizer and the benefit you get from inorganic fertilizer X^2 ($(2, N = 86) = 10.165, P< 0.05$)).

The findings of the study indicate that the effects of inorganic fertilizer provide significant support for agricultural product per quintal (55.70%), soil physical conditions (51.00%), and livelihoods per income (66.60%). In line with this, the linear regression analysis indicated that grain yield had a highly significant ($R^2 = 0.928$) and positive relationship with biomass yield. This implies that a unit increase in grain yield is brought about by a unit increment in biomass yield [20].

The findings of the study are consistent with previous research that has shown a positive association between using of inorganic fertilizer and its effects on agricultural productivity. The results also highlight the potential benefits of tillers for individuals and their families, as well as for the communities and countries involved.

4) CONCLUSION

On the basis of data collected, this study was attempted to assess the effects of inorganic fertilizer on irrigated farmland. The finding of the study indicates that a minority of the farmers don't understand the effect of chemical fertilizer. The problem of inorganic fertilizer is currently a hot issue, not only in the study area, but also at national level risk on soil productivity, soil degradation, and generally changes of physical and biological prosperity of soil. So that in order to sustain and increase both capacity and awareness among wide community, the role of the community itself, and the role of agriculture office to reduce or escaping this problem and habitations of soil productivity in the area but still not created. The results of study show chemical fertilizer have high impacts on soil and crop field. Those impacts were infertile soil, acidic, and salinity.

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