Adoption of Wheat Production Technologies and Productivity: Evidence from South Eastern Ethiopia

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Abstract: Wheat is the third most important cereal crop in Ethiopia as to production after Maize and Tef. The adoption of improved wheat production technologies is a central for increasing the production and productivity of farmers. The aim of the study is to assess the adoption of production technology and wheat productivity in South Eastern Ethiopia. The analysis was based on a household survey data collected from 180 randomly selected households. The results of the study revealed that all sample households were used chemical fertilizers (NPS and Urea) for wheat production. In the study areas more than 14 wheat varieties were grown by farmers in the study area. The results of the study revealed that the first three popular varieties grown by farmers was Ogolcho 33 (18.3%), Kubsa 33 (18.3%) and Pavan 29 (16.6%) and the majority of farmers 80 (44.4%) used own saved wheat seed. In terms of weed control in the study areas more than 20 herbicides were used by sample households and the widely used herbicide is Palas 61 (33.9%). To manage wheat rust disease most of households used Rexido, Tilt and Natura 23.3%, 13.9% and 6.7% fungicides, respectively. Regarding the harvesting and threshing technologies all sample households used combiner for harvesting and threshing of wheat. In the study areas the total hectare covered for wheat production is 186.5 and a total of 664, 14.0 tone output is produced by sample households. The average wheat productivity in South Eastern Ethiopia is 3.56 t/ha. Thus, future development intervention should give emphasis on providing widely adopted improved seed and effective weed control herbicides and disease management fungicides to improve the production and productivity of wheat by farmers in South Eastern Ethiopia.

Key words: Production Technology · Wheat · Adoption · South Eastern Ethiopia

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops grown worldwide and is a common component of the diet for more than one third of the world population [1]. In Ethiopia, wheat is grown by farmers for household consumption and generating income from selling, wheat provides about 15% of the daily caloric intake of the population [2]. The adoption of improved agricultural production technologies is a central for increasing production and productivity. The adoption of new agricultural inputs such as fertilizer, improved seed, agronomic practices, herbicides and mechanization tools including harvester and thresher is a central to agricultural growth and poverty reduction efforts. Demand for wheat in Africa is growing faster than for any other food crops. The demand in Africa is expected to increase by higher percent in the future years because of the growing population and low production and productivity of wheat and this is a challenge for food security in developing countries where urban population growth is forecasted to increase by higher percent. Several developing countries could achieve wheat yields exceeding 6 t/ha but are faced with many challenges in realizing this potential [3, 4].

Agriculture in Ethiopia is continuing to be a vital sector and largely dominated by smallholder farmers. Ethiopian smallholder farmers grow various crops for own consumption and/ or economic benefits. Within the category of Grain crops, Cereals are the major food crops both in terms of the area they are planted and volume of production obtained. Out of the total grain crop area, 81.19% (10, 538, 341.9 hectares) was under cereals. Wheat took up 14.62% (1, 897, 405.05 hectares) of the grain crop area. As to production, Cereals contributed

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88.36% (about 302, 054, 26.06 tones) of the grain production; wheat contributed 16.91% (57, 801, 30.61 tones) of the grain production [5]. Nutritionally, wheat is a very rich source of proteins, vitamins, minerals, carbohydrates and provides a balanced diet [6]. Wheat is used mainly for consumption and as a source of income in many house-holds. In the past, wheat products were consumed by urban and peri-urban dwellers on special occasions or festive seasons. This has increased the demand for wheat produced and imported into the country [7].

Adoption of agricultural production technologies is a mental process through which an individual passes from hearing about an innovation to its adoption that follows awareness, interest, evaluation, trial and adoption stages [8]. According to CSA data, wheat covering 1, 897, 405.1 hectares of cultivated area of land and grown by 4, 579, 491 farmers in Ethiopia, it covers 996, 364.4 hectares of cultivated area of land and grown by 1, 832, 546 farmers in Oromia region and in South Eastern Ethiopia (Arsi, West Arsi & Bale) it covers 459, 278.7 hectares of cultivated area of land and grown by 657, 135 farmers in the study areas [5].

The report from CSA, 2021 shown that the national productivity of wheat is 3.05 t/ha and the Oromia region wheat productivity is 3.3 t/ha where as in the study areas it is 3.48 t/ha which is higher than the national and regional average an indicator of the potential. In Ethiopia, there are two agricultural production seasons; *meher* (long rainy season) and *belg* (short rainy season). The *meher* rains start in June and extends up to mid-September, while the *belg* rainy season start from March and lasts to May [9]. Despite the suitability of the climatic conditions for wheat production smallholder farmers are still food insecure. Agricultural advisory services are defined as the entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills and technologies to improve their livelihoods and well-being [10].

The extension system is mandated to promote improved agricultural technologies and knowledge generated by the research system to the producer which contributes for food security. So far Ethiopian institute of agricultural research and government agricultural extension systems performs technology and knowledge dissemination, capacity building and enhanced the linkage and partnership with technology adopter/beneficiaries but still there is low yield. An acceptable and meaningful transformation of agricultural technologies through research extension system will be expected to improve productivity, build resilience to farming systems, improve livelihoods and reduce harm to the environment [11]. So far, many improved wheat varieties are introduced to farming communities in the study areas but still most of the farmers are exploiting their own saved seed. Therefore, considering the high potential of South Eastern Ethiopia for wheat production this study aims to assess the adoption of wheat production technology and productivity by farmers in the study areas.

MATERIALS AND METHODS

Description of the Study Areas: The study was conducted in three zonal administration areas Arsi, West Arsi and Bale zone of Oromia region, South Eastern Ethiopia. The six districts considered for the study were Tiyo and Hetosa districts were located at Arsi zone and Arsi Negelle and Shashemene districts were located West Arsi zone of Oromia region, Sinana and Goba districts were found in Bale zone, South Eastern Ethiopia. The two zones lie between 6° 45'N to 8° 58'N and 38° 32 E to 40° 50' E and 6°12'29" to 7°42'55" latitude and 38°04'04" to 39°46'08" longitude. Arsi zone is dominantly characterized by moderately cool (about 40%) followed by cool (about 34%) annual temperature. West Arsi zone also possesses three major agro-climatic zones highland, midland and lowland. On average, the annual mean rainfalls are 1020 mm and 1300 mm for Arsi and West Arsi zone respectively. The two zones have suitable climatic and edaphic factors for agricultural production. Thus, the major annual crops grown in the two zones include wheat, barley (food and malt), bean, pea, maize, teff, sorghum, oats, chickpea, nueg, linseed millet, potato and others vegetables [12].

Bale zone is located in the South Eastern part, Sinana and Goba districts were found in Bale zone of Oromia region, Ethiopia. Astronomically, it is located between 5°22' - 8°08' north latitude and between 38° 41'- 4°44' east longitudes. Sinana/ Robe extends from 7°3'30" N to 7°10'45" N with an approximate extension of 7'15" or 13.4 kms if the value of a degree along the equator is 111kms. The mean annual temperature of the district is 11.5°C. The lowest temperature is 5°C nd highest is 18°C respectively. The mean annual rainfall is 1000 mm whereas the lowest and highest rainfall is 800mm and 1200mm respectively [13].

Types and Sources of Data: Both primary and secondary data was employed in the study. Primary data were collected from randomly selected wheat producers in the three zones Oromia region, South Eastern Ethiopia. Secondary data on socio-economic information was obtained by reviewing secondary sources focusing on the objectives of the study.

Methods of Data Collection: Primary data on household demographic characteristics, agricultural input on wheat production and geographical information were collected by structured and semi-structured questionnaires. whereas secondary data were obtained from published and unpublished documents, journals and websites.

Sampling Procedure and Sample Size Determination: In this study a purposive and multi-stage sampling procedure was employed. Three zones of South Eastern Ethiopia were selected purposively based on potential area of wheat production. In the first stage, six wheat producing districts were randomly selected. In the second stage, 18 kebeles were randomly selected from the total kebele administrations three kebele per district. Finally, a total 180 sample household heads were selected randomly, using probability proportionate to size. The total sample size (n=180) was determined following a simplified formula provided by Yamane [14].

$$n = \frac{N}{1 + N(e)^2} \qquad (1)$$

where: n = sample size, N = population size (sampling frame) and e = level of precision and a 95% confidence level with degree of variability of 5%.

Methods of Data Analysis: Descriptive statistical analysis method such as mean, proportions, percentages, standard deviations, were used in describing the demographic and socio-economic characteristics of respondents.

RESULTS AND DISCUSSIONS

Demographic and Socio-Economic Characteristics of Farmers: The results of the study revealed that from the total of 180 sample households, 155 (86%) households are male-headed and 25 (14%) were female-headed households (Table 1).

Educational level of sample household was measured by the formal schooling the household head attended. With regards to the educational level of sample household heads, the average number of formal schoolings completed was 6.75 years with a standard deviation of 3.59. The Age of respondents is taken to be the number of years of an individual. The average age of sample respondents was 44.82 years with standard deviation of 13.41 (Table 2).

The mean areas of land allocated for wheat production by sample respondents is 1 hectare with standard deviation of 1.18 (Table 2). As to the total wheat output produced the average Quintals produced is 36.89 with standard deviation of 44.75. The mean altitude of the study areas is 2258.1 meters a.s.l and the minimum and maximum altitude is 1860 and 2605, respectively.

Adoption of Wheat Production Technologies: The farm inputs used in wheat production by sample households includes in-organic fertilizers (NPS and Urea), wheat seed and herbicide. In addition to the inputs used improved farm machinery were also be used by all sample households.

Chemical Fertilizer Use: In the study areas all sample households were used recommended rate of chemical fertilizers for wheat production. The most commonly used chemical fertilizer for wheat production were NPS and Urea. The farmers in most parts of the country have limited information on the impact of different types and rates of fertilizers except blanket recommendation of nitrogen (41 kg N ha^{-1}) and phosphorus (46 kg P2O5 ha^{-1}), i.e. 50 kg Urea and 100 kg DAP ha^{-1} [15]. Until recently, the agricultural extension program has promoted a blanket recommendation of 100 kg DAP and 100 kg urea/ha for all cereal crops and soil types but the actual application rate is 65 kg DAP and 45 kg urea/ha [16]. From this information it's clear that there is a need to refine fertilizer recommendation of each crop for a specific soil type and geographical locations.

Wheat Varieties Used by Producers: Adoption of high-yielding wheat varieties have a positive effect on production and productivity. Sampled household heads in the study area used different types of wheat seed. As indicated on Table 3, more than 14 wheat varieties were presently grown by farmers in the study area. The data collected from sample households revealed that the most popular varieties was Ogolcho 33 (18.3%), Kubsa 33 (18.3%), Pavan 29 (16.66%), Hidase 26 (14.44) and Huluka 19 (10.56). The rest varieties constitute 22.23% of wheat varieties released in the study areas (Table 3).

Table 1. Sex of household heads

Variables	No	%
Sex of household head		
Male	155	86
Female	25	14

Source: Own computation from survey result, 2018

Table 2: Descriptive statistics values of continues variable

Variables	Mean	Std. Dev.	Min	Max
Educational level of household heads	6.75	3.59	1	15
Age of household heads	44.82	13.41	21	85
Altitude (m)	2258.1	241.64	1860	2605
Area (ha)	1.04	1.18	.2	12
Wheat Output (tone)	3.69	4.85	.4	36

Source: Own computation from survey result, 2018

Table 3: Wheat varieties used by sample households

Variety	Freq.	Percent
Ogolcho	33	18.3
Kubsa	33	18.3
Pavan	29	16.1
Hidase	26	14.4
Huluka	19	10.6
Kingbird	12	6.7
Kakaba	9	5
Danda'a	6	3.3
Sofoumer	4	2.2
Tusi	3	1.7
Shorima	2	1.1
Simba	2	1.1
Digelu	1	0.6
Madawalabu	1	0.6

Source: Own computation from survey result, 2018

Table 4: Source of improved wheat seed

Seed source	Freq.	Percent
Own saved	80	44.44
Neighbor	35	19.44
Union	18	10
Market	18	10
Seed multipliers	9	5
Agriculture office	8	4.44
Research Center	6	3.33
GIZ project	4	2.22
University	1	0.56
world vision	1	0.56

Source: Own computation from survey result, 2018

In Ethiopia, the sources of improved seeds are Federal and regional research centers, seed enterprises and different NGOs. The result from the study showed that majority of the farmers 80 (44.4%) used own saved wheat seed and this is an indication that provision of well adopted and high yielding wheat varieties is mandatory to boost wheat production (Table 4).

Table 5: Herbicides used to control weeds

Herbicides	Freq.	Percent
Palas	61	34
2, 4-D	45	25
Palas & 2, 4-D	21	11.7
Palas, Greenstar	7	3.9
Palas, 2, 4-D & Topic	6	3.3
U-46	5	2.8
Atlas	4	2.2
Greenstar	4	2.2
U-46, 2, 4-D	4	2.2
Topic, Greenstar	3	1.7
Palas & Topic	3	1.7
Palas, Atlantice	3	1.7
2, 4-D & Topic	2	1.1
2, 4-D, Greenstar	2	1.1
Atlas, Greenstar	2	1.1
Palas, Greenstar, 2, 4-D	2	1.1

Source: Own computation from survey result, 2018

Table 6: Fungicides used to control wheat rust

Fungicide	Freq.	Percent
Rexido	42	23.3
Tilt	25	13.9
Natura, Rexido	14	7.8
Natura	12	6.7
Natura, Tilt	12	6.7
Natura, Tilt, Rexido	7	3.9
Rexido & Tilt	6	3.3
Rexido	5	2.8
Natura & Rexido	3	1.7
Natura, Tilt	3	1.7
Bles, Progress, Tilt & progress (each)	2	1.1
Mancozeb, Nativo, Natura & Tilt, Redomil, Rexido & Progress, Rexido, Bles, Rexido, Tilt, Tilt & Rexido, Natura & Progress (each)	1	0.6

Source: Own computation from survey result, 2018

Weed Control Mechanism: Regarding weed control methods almost all sample respondents used herbicides was applied for control of unwanted plants. As indicated on Table 5 the most widely used herbicide was Palas 61 (34%) and 2, 4-D 45 (25%) (Table 5). The survey results clearly indicated that more than 21 herbicide groups were used and this indicates that farmers are applying herbicides that afford their income and available in local markets. Awareness creation is essential for the farmers to use the right types of herbicides to control the major yield dipping factors which weed.

Wheat Rust Disease Management: Table 6 below shown that the majority of households 144 (80%) used different types of fungicides for wheat rust disease management and 36 (20%) of sample households not used in the cropping season. The study shown that most of households used Rexido, Tilt and Natura 23.3%, 13.9% and 6.7%, respectively (Table 6).

Table 7: Area, production and yield of wheat for 2020/21

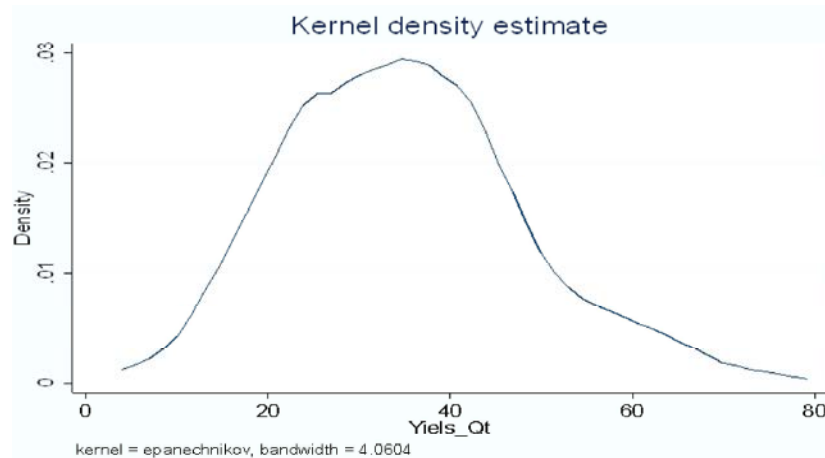|	Number of holders	Area in hectares	Production in quintals	Yield (t/ha)
Ethiopia	4, 579, 491.0	1, 897, 405.1	57, 801, 305.9	3.05
Oromia	1, 832, 546.0	996, 364.4	32, 877, 497.1	3.30
Arsi	360, 697.0	209, 433.1	7, 200, 170.9	3.44
West Arsi	166, 569.0	120, 724.1	4, 183, 076.6	3.46
Bale	129, 869.0	129, 121.4	4, 561, 911.1	3.53

Source: Central Statistical Agency (CSA), 2021

Fig. 1: Kernel density estimate of wheat productivity per hectare in qt
Source: Own computation from survey result, 2018

Table 8: Area, production and yield of wheat in the study areas

Zone	Area in hectares	Production in quintals	Yield (t/ha)
Arsi	58.42	218000	3.73
West Arsi	49.205	149920	3.05
Bale	78.89	296220	3.75
Total	186.5	664, 140	3.56

Source: Own computation from survey result, 2018

Harvesting and Threshing of Wheat: In the study areas all sample respondents replied that combiner was used for harvesting and threshing of wheat. All sample households used combine harvester and thresher machine by renting from combiner owners. The traditional method of manual harvesting by sickle and oxen threshing is not used for wheat harvesting and threshing.

Wheat Production and Productivity in the Study Areas: As shown on Table 5 below the CSA data indicated that the study areas contributed 15, 945, 15.9 (48.5%) of regional and 27.6 % national wheat production in tones (Table 7).

Figure 1 below shows that the kernel density estimates of wheat productivity per hectare in qt at South Eastern Ethiopia.

The national productivity of wheat is (3.05 t/ha) and wheat productivity in Oromia region is (3.3 t/ha) where as in the average wheat yield in the study areas is (3.56 t/ha)

which is higher than the national and regional average [5]. As depicted in table below, in the study areas out of the three zones of South Eastern Ethiopia the productivity of wheat in Arsi and Bale is higher than West Arsi (Table 7 and 8).

CONCLUSIONS AND RECOMMENDATIONS

The national productivity of wheat is 3.05 t/ha and wheat productivity in Oromia region 3.3 t/ha whereas the productivity in the study areas is 3.56 t/ha which is higher than the national and regional average. The study was conducted in three zonal administration areas Arsi, West Arsi and Bale zone of Oromia region, South Eastern Ethiopia. The six districts considered for the study were Tiyo and Hetosa, Arsi Negelle, Shashemene, Sinana and Goba districts, South Eastern Ethiopia.

Descriptive statistical analysis method was employed to describe the collected data from sample households. The results showed that 155 (86%) households are male-headed and 25 (14%) were female-headed households. The farm inputs used in wheat production by sample households includes are in-organic fertilizers (NPS and Urea), wheat seed and herbicide. In addition to the inputs used improved farm machinery were also be used by all sample households. From the survey result it's

revealed that there more than 14 wheat varieties were grown by farmers and the five most popular varieties was Ogolcho 33 (18.3%), Kubsa 33 (18.3%), Pavan 29 (16.66%), Hidase 26 (14.44) and Huluka 19 (10.56). The majority of the farmers 80 (44.4%) used own saved wheat seed and the most widely used herbicide was Palas 61 (34%) and 2, 4-D 45 (25%). Regarding fungicide use for wheat rust disease management most of households used Rexido, Tilt and Natura 23.3%, 13.9% and 6.7%, respectively. Thus, based on the findings of the study future development intervention of both Governmental and Non-governmental organizations should have to focus on delivering full and recommended wheat production technology packages to enhance wheat productivity and the livelihoods of farming households.

REFERENCES

1. Desta, G., A. Mihratu, D. Tolessa, M. Hailu and B. Tadiyos, 2017. Enhancing Sustainable Wheat Productivity and Production through Development of Wheat Varieties Best Adapted to Irrigated Lowland Areas of Ethiopia. International Journal of Agriculture Innovations and Research, 6: 305-310.

2. FAO (Food and Agriculture Organization), 2015. Food Balance Sheets. FAOSTAT. Food and Agriculture Organization, Rome.

3. Rosegrant, M.W. and M. Agcaoili, 2010. Global food demand, supply and price prospects. 2010. International Food Policy Research Institute, Washington, D.C. USA.

4. CIMMYT (International Maize and Wheat Improvement Center), 2012. Wheat for food security in Africa. Africa's food security and the changing demand for wheat over the coming decades.

5. CSA (Central Statistical Agency), 2021. Agricultural Sample Survey 2020/2021 (2013 E.C): Report on area and production of major crops, volume-I. Addis Ababa, Ethiopia.

6. Curtis, B.C., S. Rajaram and H. G. Macpherson, 2002. Bread wheat: Improvement and production. FAO, Rome.

7. FAO (Food and Agriculture Organization), 2007. FAO/WFP crop and food supply assessment mission to Lesotho. FAO, Rome.

8. Bahadur, K.L. and B. Siegfried, 2004. Technology Adoption and Household Food Security. Analyzing Factors Determining Technology Adoption and Impact of Project Intervention: A Case of Smallholder Peasants in Nepal, Paper prepared for presentation at the Deutscher Tropentag, 5-7 October 2004, Humboldt University, Berlin.

9. Almaz Balta, 2015. Assessment of Household Food Security and Coping Strategies in Wolaita Zone: The Case of Sodo Zuria Woreda. Journal of poverty, Investment and Development. International Knowledge Sharing Platform.

10. Birner, R., K.E. Davis, J. Pender, E. Nkonya, P. Anandajayasekeram, J. Ekboir, A. Mbabu, D.J. Spielman, D. Horna, S. Benin and M. Cohen, 2009. "From Best Practice to Best Fit: A Framework for Designing and Analyzing Pluralistic Agricultural Advisory Services Worldwide. Journal of Agricultural Education and Extension, 15 (4): 341-355.

11. Nyasimi, M., D. Amwata, L. Hove, J. Kinyangi and G. Wamukoya, 2014. Evidence of impact: climate-smart agriculture in Africa. In: CCAFS working paper no. 86.

12. OFEDB (Oromia Finance and Economic Development Bureau), 2011. Physical and Socio-Economic Profile of Arsi Zone and Districts. Finfinne.

13. OFEDB (Oromia Finance and Economic Development Bureau), 2002. Physical and Socio-Economic Profile of Arsi Zone and Districts. Finfinne.

14. Yamane, T., 1967. Statistics: An Introductory Analysis, 2nd Edition. Harper & Row, Publisher, New York, pp: 919.

15. Diriba Shiferaw, G., D. Rut-Duga and W. Wogayehu, 2019. Effects of Blended Fertilizer Rates on Bread Wheat (*Triticum aestivum* L.) Varieties on Growth and Yield Attributes. J. Ecol & Nat Resour, 3(3): 000170.

16. Elias, E., 2017. Characteristics of Nitisol profiles as affected by land use type and slope class in some Ethiopian highlands. Environmental Systems Research, 6: 20.