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Productivity and Welfare Impact of Adoption of Improved Seed in Ethiopia; Critical Review

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Abstract

Background: This paper is primarily concerned with reviewing the productivity and welfare impacts of improved seeds in Ethiopia. **Methodology:** This study reviews both theoretical as well as empirical research conducted in Ethiopia. The method of analysis used in this paper is content analysis of literature, with careful organization and presentation of the results. **Finding:** The result of this critical review has confirmed that using improved seeds enhances productivity and welfare in a significant and promising way. Adoption of improved seeds boosts farm household income, food security, household spending, and poverty reduction. It is also implying that improved seed's impact can be increased if it is paired with other technologies such as fertilizer. Finally, it is suggested that increasing awareness of the availability and benefits of improved seed, increasing access to improved seed, and combining improved seed with other agricultural technologies such as fertilizer help to promote farm household production and well-being.

Key words: Improved seed, Adoption, Productivity, Welfare, Impact, Ethiopia.

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1. Introduction

Agriculture is extremely important to the global economy, accounting for 4% of world gross domestic product (GDP) and more than 25% of GDP in developing countries (WB, 2021). Agricultural development is one of the most effective techniques for reducing extreme poverty, establishing economic stability, and feeding the world's rapidly expanding population. According to a WB report (2021), agricultural expansion is two to four times more effective than other sectors in improving incomes among the poorest people.

Agriculture is the dominant sector in Sub-Saharan African (SSA) nations in general and Ethiopia in particular, supporting the livelihoods of the majority of the poor. Ethiopia's economy is heavily reliant on agriculture, which generates 34.1% of GDP, 79% of exports, and employs over 79% of the country's workers (Getachew, 2020). This sector determines the growth of all other sectors and the whole national economy. Even if agriculture is a major means of obtaining both food and income for farm households,

agriculture in Ethiopia is sometimes fragile and at the mercy of nature, making it an uphill battle for landowners to make ends meet.

Ethiopia's agricultural sector is dominated by smallholder farming, which is characterized as farms with less than 2 hectares of land that are mostly managed by family labor (Aweke, 2017). Even though land is a key economic variable, Ethiopia's average national farmland holding is 0.96 hectares per household, with regional variances. Tigray and the Southern People's Regions each have 0.49 hectares. Amhara Region has 1.09 hectares per household, while Oromia Region has the highest, with 1.15 hectares per household (Headey et al., 2014). Moreover, even if Ethiopia has the largest livestock population in Africa by 2020 (CSA, 2020a), with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels, and 49 million poultry, the agriculture sector is still at a subsistence level.

In developing nations like Ethiopia, improved agricultural technologies are critical to the transformation of farming systems and a road out of poverty. Increases in technology adoption, such as new agricultural practices, high-yielding varieties and the associated products such as crop insurance, have the potential to contribute to economic growth and poverty reduction among the poor (Tilahun, 2018; Wake and Degye, 2019; Endeshaw, 2021 and Jaleta et al., 2018).

Over the last few decades, the Ethiopian government has worked through extension programs to disseminate agricultural technology in order to boost smallholder crop yields and farmers' income through excess crop output. Surprisingly, recent research found that farmers employ fewer than 5% of major agricultural inputs such as high-yielding varieties (ATA, 2014; Taffes et al., 2013). Socioeconomic variables such as livestock ownership, farm size, active family members, and so on, as well as organizational elements such as access to financing, input and output markets, and agricultural extension services, all have a significant impact on agricultural technology adoption (Berhanu, 2018; Milkias and Abdulahi, 2018 and Mengistu et al., 2016). In addition, crop insurance is not widely implemented in Ethiopia, which makes farmers ready to employ technology if crop insurance is structured to incentivize them by providing price insurance, yield insurance, and honor incentives (Wei et al., 2021).

Due to low production, Ethiopia has been unable to feed its rapidly growing population. As a result, improved agricultural technology must be successfully implemented in order to increase output. The most important way for developing countries to increase agricultural output and improve farmer well-being is to conduct research and development of new improved seeds that are suited to local agro-climatic settings, as well as their dissemination. Indeed, several studies have been conducted on the impact of agricultural technology on increasing farm production and household well-being. As a result, this review summarizes both theoretical literature and empirical evidence on the productivity and welfare impacts of improved seeds in Ethiopia from 2016 to 2021. Examining the impact of agricultural technology adoption has a significant advantage

for a country like Ethiopia, where agriculture drives the entire economy. Furthermore, understanding the impact of agricultural technology adoption on productivity and farm household welfare is required in order to provide research and development solutions.

2. Literature Survey

In this paper, both theoretical and empirical reviews were made. Regarding the theoretical review, relevant and reputable publications were included. However, the empirical review was based on studies published from 2016 to 2021 in order to bring more recent findings and to represent the current situation in the country. These sources were carefully searched for the impact of the adoption of improved seeds on productivity and the welfare of farm households. The items in this empirical review are full-text articles written in English. All papers published outside of the stated time frame, articles written in a language other than English, review papers, and non-full-text articles were excluded. The method of analysis used in this paper is content analysis of literature, with careful organization and presentation of the results.

3. Literature reviews

3.1. Theoretical reviews

3.1.1. Theory of Adoption of Agricultural Technologies

Improved seeds are an example of a technology that has evolved over time as a result of ongoing research and development. The conversion of scientific knowledge into machinery, tools, mechanical devices, instruments, inventions, methods, and techniques to achieve concrete goals, meet specific demands, or alter the environment for practical reasons is known as technology (Shahin, 2004). New agricultural technology is a collection of many technological features that increase output and productivity, as well as the technical practices and abilities required for their successful implementation (Samy, 1998; and Shahin, 2004).

Agriculture progresses technologically as farmers adopt innovations. The extent to which farmers adopt available innovations and the speed at which they do so determines the impact of innovations in terms of productivity growth (Diederer et al., 2003). The diffusion of a new agricultural technology requires farmers to learn about the existence and benefits of the technology (Alain et al., 2016), and deciding to adopt a technology is based on expected profit or yield.

Adoption, according to Feder et al. (1985), is defined as the long-term incorporation of an innovation into farmers' usual farming practices. Adoption, on the other hand, is defined as a decision to utilize an invention and continue to use it for a reasonable amount of time (Ban and Hawkins, 1996). Adoption is a mental process that takes a person from hearing about an invention to adopting it; it includes phases such as awareness, curiosity, appraisal, trial, and adoption (Bahadur and Siegfried, 2004). It may be thought of as a variable that represents the behavioral changes that farmers go through when they adopt new agricultural ideas and

technologies, anticipating some favorable effects from such ideas and inventions.

Furthermore, the adoption of technological innovations in agriculture has piqued the interest of development economists because the majority of the population of developing countries relies on agriculture for a living, and new technology, which appears to offer opportunities to increase production and productivity, has piqued their interest (Feder *et al.*, 1985). Recent literature indicates that improvements in livestock holdings, farm size, membership in a farmer's cooperative, and frequency of contact with an agricultural research center are positively associated with the adoption of improved seed. Adoption of improved seed was found to be negatively correlated with age, distance from the main market and agricultural extension office, and household head participation in off-farm activities (Zeng *et al.*, 2017, and Berihun *et al.*, 2014).

In fact, compared to past years, the number of new varieties released in Ethiopia increased dramatically between 2000 and 2011 (Firew *et al.*, 2016). The Ethiopian government-affiliated research institute develops and distributes the majority of improved varieties, and it is indicated that the agricultural transformation process may lead to increased availability and promotion of improved crop types. According to Adekambi *et al.* (2009), agricultural development is often considered the most effective means of alleviating poverty in developing countries. Agricultural output growth can help to alleviate food insecurity by increasing the amount of food available for consumption. This is especially crucial for rural customers, whose food entitlement is mostly dependent on their own production.

3.1.2. Impact of Agricultural Technologies

One of the key choices for effective agricultural productivity increase is technological transformation. New technology generally manifests itself as a refinement of one or more of the manufacturing process's inputs. New technologies might have a variety of agricultural implications. As David (2012), indicates an improvement in one of the inputs might raise its marginal product and increase the elasticity of production for that input, causing the slope of the new production function to be greater than the old production function at a given level of input use. One of the key choices for effective agricultural productivity increase is technological transformation.

According to Andrew and Mark (2010), the net gain to the agent from adoption, including all costs of using the new technology, is an important determinant of adoption, and measuring outcomes is a prerequisite for determining how responsive agents are to variation in the returns from the use of inputs or technologies. One country's long-term goal is to raise people's living standards, which necessitates economic growth, i.e., an increase in production per capita or GDP per capita over time. This increment in production is achieved by increasing inputs or technological progress, which are the two causes of economic growth (Rui, 2020). Because increasing the quantity of input utilized, such as expanding the agricultural production area, is impossible in this instance due to land scarcity, the only choice is to embrace new technology.

The economic theory also argues for the positive role of technologies. They indicate that increasing labor input used and accumulating physical capital were once considered the primary sources of economic growth. But people later realized that population growth limits labor growth and that capital accumulation cannot be the primary driver of modern economic growth, which is characterized by the rapid development of new products and services. In the long run, according to Schumpeter (1961), innovation, or technical advancement, is the most important factor of economic success. Solow (1956) developed one of the very first models to illustrate how long-run economic growth is determined by factors of production and technology. Technology and the knowledge that is behind technology are widely recognized as the primary drivers for sustained economic growth.

Economists have been measuring the contribution of technology to economic growth, especially the increase in per capita output that can be attributable to technical progress, using this aggregate production function since Solow (1957). Data from the past indicates that technology and productivity growth account for a significant share of GDP growth (Sickles and Zelenyuk, 2019).

To realize how technology influences economic activity at the personal and business levels, one must investigate deeper into these economic actors' economic decision-making processes. According to Rui (2020), the primary focus is on how technology creates value via cost-benefit analysis. The economic value of technology has three aspects: First is increased efficiency. This includes reductions in both production and transaction costs. Technology can allow firms to deliver the same product to consumers at a lower cost through improved productivity or reduced transaction costs. The second is product quality. Technology can allow firms to make products better in terms of functionality, ergonomics, build quality, durability, and so on. The third is product variety. New technology can introduce new products and services. These products and services expand the choices available to consumers.

3.1.3. Productivity and Welfare: Definition and measurement

Productivity is an economic measure of output per unit of input. Productivity is the physical relationship between the amount produced (output) and the quantity of resources used in the manufacturing process. Input refers to all the components of production employed, such as capital, labor, and equipment, while output refers to the entire production in terms of units or income. Productivity is an excellent measure of how efficiently a product is running. Higher productivity, or the ability to create more with a given number of inputs, indicates that a company is appropriately utilizing its resources. Different studies measured productivity as the amount of yield obtained from one hectare (Tesfaye *et al.*, 2016; Tesfaye *et al.*, 2018; and Endeshaw, 2021).

The second interest variable is welfare, which can be defined as the material potential to create happiness. Every human being acts in order to maximize his or her own perceived level of happiness. It is not possible to make people happy,

but certain tangible factors can contribute towards the development of an environment that may increase one's natural inclination towards happiness. Generally, the welfare of a household indicates the general wellbeing of the household, indicating the household's state or condition with respect to health, safety, happiness, or prosperity (Edward, 2009). Therefore, a proper understanding of welfare is critical for any economic analysis that deals with the human condition (Joshua, 2011). The major indicators of the welfare of a given household are income, food security, educational welfare, health welfare, and asset holding of the household, which can be classified as monetary or non-monetary welfare indicators.

Monetary welfare indicators

The monetary welfare indicators are income and consumption expenditure of the household.

Income

Income is the amount of money received over a period as payment for work, either goods or services, or as profit on capital (Tesfaye et al., 2016; Wake and Degye, 2019).

Consumption Expenditure

This denotes money spent on the purchase of consumable items by the household, such as food, drinks, clothes, education, and medication. Consumption expenditure in this study was limited to the expenses that were spent on purchasing food and drinking items due to the lack of private schools and clinics in the study area. In addition, the purchase of clothes for household members is not a monthly expense; rather it is done at the time of harvest. Previous impact assessment studies have used income and consumption expenditure as welfare indicators to measure household wellbeing (see e.g. Jaleta et al., 2018; Ahmed et al., 2017; Shita et al., 2020).

Non-monetary welfare indicators

Welfare is associated not only with income or consumption expenditure of the household but also with outcomes related to health, nutrition, literacy, social relations, insecurity, and low self-confidence and powerlessness. In some cases, it is feasible to apply the tools developed for monetary welfare measurement to non-monetary indicators of wellbeing (Edward, 2009).

Education indicators

Education is a well-known and widely used non-income welfare indicator. One could use the level of literacy as the defining characteristic, and some level judged as the threshold for literacy as the "poverty line". In countries where literacy is close to universal, one might opt for specific test scores in schools or for years of education as the relevant indicators.

Health

Health is another well-known and widely used non-income welfare indicator. One could focus on the nutritional status of a household as a measure of outcome, as well as on the incidence of specific diseases (diarrhea, malaria, respiratory diseases) or life expectancy for different groups within the population (Zeng et al., 2017 and Mengistu et al., 2021).

Household amenities

The first welfare indicator under household amenities is drinking water and the distance of a household from its main source of drinking water, in kilometers. The second type of amenity for which information is available is sanitation.

Lighting source mains, which can be electricity, a generator, kerosene/gas lamp, and candles/torches, are the third type of amenity for which information is available.

Household assets

The amount of assets that a household owns is likely to affect its welfare for two reasons. First, the more assets it owns, the higher its income-earning potential, which raises welfare. Second, the more assets it owns, the greater will be its ability to smooth its consumption level in response to income shocks. To the extent that households are risk-averse, this also increases household welfare (Edward, 2009).

3.2. Empirical Review

3.2.1. Impact of adoption of improved seed on Productivity

The study by Tesfaye et al. (2016) reports the findings of a study that examined the impact of the adoption of improved wheat varieties on productivity in Ethiopia, specifically in the Oromia region, using 177 sample respondents. The relationship between wheat variety adoption and productivity, or yield per hectare, was estimated using a Propensity Score Matching (PSM) model. In comparison to non-adopters, the model output reveals that improved wheat varieties result in 1 to 2.5 tone improvements per hectare. The findings also show that farmers who allocate more area to improved wheat varieties earn the most production benefits.

Likewise, the study conducted by Tesfaye et al. (2018) on the impact of improved wheat varieties on productivity also confirms the promising impact on productivity of farming, which compromised 837 respondents. The propensity score matching result reveals that adopters of improved wheat varieties receive an average of 34% higher productivity than their counterparts, the non-adopters. In their study, they indicate that improved wheat varieties have a huge potential for strengthening the region's agricultural extension system that targets increasing production and productivity. Finally, they suggest expanding the availability of affordable improved wheat technology to all wheat-producing farm households in order to enhance smallholder farmers' lives.

Endeshaw et al. (2021) also conducted research on the impact of common bean variety adoption on production. An inverse-probability-weighted regression adjustment with a multinomial endogenous treatment effects model is used in this study, which includes 1122 sample households. According to the model's findings, fertilizer only boosts output by 34%, while adopting improved varieties only raises yield by 30%. The results also reveal that using improved varieties and fertilizers at the same time enhances output by 42 percent. This research suggests that combining enhanced varieties with additional technology, like fertilizer, might be more productive.

Along with the study by Samuel and Beza (2019), they evaluate the impacts of the adoption of improved coffee varieties on farmers' coffee yields in the Jimma Zone. In this study, they compromised a total of 205 households and employed PSM to quantify the impact of adoption of improved coffee varieties. The model output confirms the

adoption of improved coffee varieties enhances yield from 25.3% to 28.4%, which implies farmers that grow improved coffee varieties attain a significantly higher yield than non-adopters.

Similarly, [Ahmed et al. \(2017\)](#) found that the adoption of improved maize varieties has a positive influence on agricultural productivity, which is quantified by technical efficiency. This research was carried out in Ethiopia's Eastern Hararghe zone, using data from 355 farm households. According to the PSM model's findings, farmers that adopted improved maize varieties had a 4.42 percent increase in technical efficiency over their non-adopter counterparts.

Furthermore, [Fitsum \(2017\)](#) investigates the influence of improved wheat variety adoption on productivity in Ethiopia. A propensity score matching approach was used on a sample of 1,611 farm households from four of Ethiopia's major administrative regions (Oromia, Tigray, Amhara, and SNNP (Southern Nation Nationality Peoples)). The findings suggest that improved wheat variety adoption had a substantial impact on productivity growth that ranged from 23–43 percent. This confirms that adoption of wheat varieties has a substantial influence on productivity increase, even if there is a difference from one region to another. Finally, he recommends that the country's agricultural research and extension systems be strengthened to better account for regional differences in order to develop and scale-up improved wheat varieties, as well as other appropriate improved agricultural technologies and information, that are tailored to the specific needs of all wheat-producing farm households across the country.

Similar studies were also undertaken by [Shita et al. \(2020\)](#) on the productivity effects of agricultural technologies, which focused on maize-producing households in Ethiopia using the PSM approach. This study was undertaken in the Amhara region's Awi Zone, which consists of a total of 337 maize producer households for its analysis. The result of PSM indicates that the increase in maize productivity due to simultaneous adoption ranges from 9.11 to 9.95 quintal/hectare based on alternative matching algorithms. Finally, they conclude that suitable and continuous extension services that enhance farmers' awareness and motivation should be given to farmers to adopt technologies as a package. In addition, farmers should be encouraged to adopt fertilizer and improved maize varieties through the provision of adequate and timely credit for the same purpose. Through productivity improvement, these efforts could in turn tackle the challenge of food insecurity.

3.2.1. Impact of adoption of improved seed on Welfare of Households

[Wake and Degye \(2019\)](#) conducted a study with 174 sample respondents on the impact of the adoption of high-yielding wheat varieties on the income of smallholder farmers in Ethiopia using the propensity score-matching method of impact evaluation. The result indicates that the propensity of adoption decisions of high-yielding wheat varieties has resulted in a positive and statistically significant income effect. The model results indicate that the adoption decision

of households for high-yielding wheat varieties has generated about a 9% increase in the income of adopter households over non-adopters. Similarly, [Tesfaye et al. \(2016\)](#) discovered that adopters of improved wheat varieties earn between 35 and 50 percent more than non-adopters. Farmers who allocated 20-80% of their wheat land to improved wheat varieties earned twice as much as non-adopters.

In addition, [Jaleta et al. \(2018\)](#) investigated the impact of improved maize adoption on maize-producing smallholder farmers' household food security in Ethiopia. The sample for this research comes from a stratified random sample of 2327 maize-producing farm households from 39 districts across Ethiopia's five regional states (Tigray, Amhara, Oromia, Benishangul-Gumuz, and SNNP). According to an endogenous switching regression (ESR) model, improved maize variety adoption in Ethiopia has substantial food security implications. If the adopters had not adopted, their average per capita food consumption would have declined by Ethiopian Birr (ETB) 313. Non-adopters' per capita food intake would have grown by ETB 127 if they had adopted. They also estimate the continuous treatment effects of adoption (area under improved maize variety) and verify the positive impact of improved maize variety adoption on per capita food consumption expenditure and household food security.

Similarly, [Endeshaw et al. \(2021\)](#) investigate the impact of the adoption of improved common bean varieties on farm household welfare. This study uses inverse-probability-weighted regression adjustment with a multinomial endogenous treatment effects model to demonstrate that when farmland is replaced with improved varieties alone (i.e., without fertilizers), per capita expenditure rises by 24%, and by 36% when improved varieties have been used with fertilizers. Finally, they indicate that welfare effects are higher when varieties and fertilizers are adopted simultaneously.

Alike, the study by [Samuel and Beza \(2019\)](#) evaluates the impacts of the adoption of improved coffee varieties on the welfare of farm households in the Jimma Zone. In this study, they compromised a total of 205 households and employed PSM to quantify the impact of the adoption of improved coffee varieties. The model output confirms that the adoption of improved coffee varieties results in a 33.6%-46.6% coffee income increment for adopters over non-adopters. Their study also confirms that the adoption of improved coffee varieties increases the total income of the farmer by 25.8%–44.1%. Finally, they concluded that the use of improved coffee varieties has significantly increased coffee income and total income, which could help smallholder coffee producers attain an optimum income and maximum margin for their livelihood.

Likewise, [Zeng et al. \(2017\)](#) used 1,554 sample homes with 1,216 children in Tigray, Amhara, Oromia, and SNNP to investigate the influence of improved maize variety adoption on child nutrition. They use the IV-Generalized Method of Moments (GMM) and quantile instrumental variable regressions to measure the impact of adoption. According to the model results, adoption of improved maize varieties

reduced child malnutrition by 17.36 percent to 25.88 percent. They confirm that the introduction of modified maize varieties has a large and favorable influence on child nutrition and malnutrition reduction.

A similar study was also undertaken by [Verkaart et al. \(2017\)](#), which examined the welfare impacts of improved chickpea adoption in the Amhara and Oromia regions by using three rounds of panel data from 700 sample households. They employ fixed effect models that provide evidence on the relationship between improved chickpea adoption and our various welfare indicators. Controlling for all other factors, a 10% increase in the area planted with improved chickpeas is associated with a 12.6% increase in income per capita and a 12.3% increase in total income. Considering the impact on poverty, the fixed effects linear probability model indicates that adopting improved chickpea varieties can reduce the probability of a household being below the \$2.00 poverty line but is unable to reduce the probability of a household being below the \$1.25 poverty line. A 10% increase in the area planted with improved chickpeas reduces the likelihood of living in poverty by 3.9%. They indicate that understanding the effects of improved chickpea adoption on household welfare is an important step in developing policies for chickpea growing areas in Ethiopia.

Similarly, a study on the adoption of improved maize varieties as a sustainable agricultural intensification in Eastern Ethiopia ([Mengistu et al., 2021](#)) demonstrates the importance of improved variety adoption. Using simple descriptive statistics, this study calculated the adoption impact of improved maize varieties based on data obtained from 129 farm households. Adopters of improved maize varieties had higher food and nutrition security, according to descriptive findings. In terms of dietary diversity scores (DDS) categories, 82.4 percent of those with low DDS were non-adopters, while 17.6 percent were adopters, despite the fact that the difference in DDS scores between the two groups was not statistically significant. Furthermore, a percentage of individuals who experienced food shortages were non-adopters of improved maize varieties, whereas 32% were adopters. In addition, the adopters are also endowed with better livestock holding and receive a better income.

Furthermore, [Verkaart et al. \(2019\)](#) use fixed effects estimation in Minjar-Shenkora, Gimbichu, and Lume-Ejere to assess the impact of improved chickpeas on net return. They employed three rounds of panel data in this study, limiting their analysis to homes questioned in all three rounds of the survey, yielding a balanced sample of 606 households. The findings support the considerable positive impact of improved chickpea adoption on chickpea returns, with

improved chickpeas yielding 38% greater returns. Although their findings suggest that returns are effective indicators of adoption, such returns are influenced by a range of external factors outside the control of technology transfer initiatives.

Finally, they advocate providing appropriate and adequate extension services, as extension services are the major tools for promoting demand for contemporary technology. The impact of adopting improved Teff varieties on farm household income is estimated by [Natnael \(2019\)](#). This study employs cross-sectional data collected from a randomly selected 163 sample households from North Eastern Ethiopia. The analysis was conducted using a multivariate regression model, and the estimated result of a linear regression confirmed that adopter farmers received 23.7–23.9% higher farm income from an increase in agricultural output due to adoption.

4. Discussion

4.1. Productivity Impact of Improved Seed

The results of empirical reviews indicate that adoption of improved wheat results in an increment in yield that ranges from 1 to 2.5 tons per hectare ([Tesfaye et al., 2016](#)), and adoption of improved maize results in 9.1 to 9.95 quintals per hectare ([Shita et al., 2020](#)). This finding confirms that improved seeds have contributed to the livelihoods of farm households by increasing the yield that the farmers harvest (Table 1).

In addition, empirical research also confirms that adoption of improved wheat leads to higher productivity rates that range from 23% to 43% ([Tesfaye et al., 2018](#); [Fitsum, 2017](#)). Furthermore, the results indicate that improved maize also contributes to the technical efficiency of production, which is estimated to be 4.42%. In addition, the findings of [Samuel and Beza \(2019\)](#) confirm that adoption of improved coffee varieties results in 25.3% to 28.4% higher productivity. Likewise, the finding of [Endeshaw et al., \(2021\)](#) indicates the adoption of improved common beans brings 30% higher productivity and the impact of improved common beans on productivity is raised by 12% if it is combined with fertilizer.

All of these findings indicate that adopting improved seed increases productivity. The level of productivity is the most fundamental and important factor in determining one's standard of living. Raising it allows people to get what they want faster or more in the same amount of time. This suggests that improved seed adoption is one of the ways Ethiopia can achieve self-sufficiency. As a result, all necessary measures, such as raising awareness about the potential benefits of using improved seeds, should be increased.

Table 1: Summary of Empirical Reviews on Productivity impact of improved seed

Authors with its year of publication	Crop Type	Estimated Impact on Productivity
Tesfaye et al. (2016)	Wheat	1 to 2.5 tons per hectare improvement
Tesfaye et al. (2018)	Wheat	34% higher productivity
Endeshaw et al. (2021)	Common bean	30% higher productivity and 42% if it combined with fertilizer
Samuel and Beza (2019)	Coffee	25.3% to 28.4% higher productivity

Fitsum (2017)	Wheat	23–43 percent
Ahmed <i>et al.</i> (2017)	Maize	4.42% increase in technical efficiency
Shita <i>et al.</i> (2020)	Maize	9.11 to 9.95 quintal/ha

Source: Own summary from Empirical reviews

4.2. Welfare Impact of Improved Seed

The table below summarizes the review of empirical research on the influence of improved seeds on farm household welfare. The welfare of the households is captured by indicators like income and returns (Wake and Degye, 2019; Tesfaye *et al.*, 2016; Samuel and Beza, 2019; Verkaart *et al.*, 2017; Natnael, 2019), consumption expenditure (Jaleta *et al.*, 2018; Endeshaw *et al.*, 2021; Ahmed *et al.*, 2017; Shita *et al.*, 2020), food security (Zeng *et al.*, 2017; Mengistu *et al.*, 2021); and reduction in poverty (Verkaart *et al.*, 2017).

As indicated in the Table 2 below, adoption of improved wheat results in a minimum of 9% increment in income and a maximum of 50% increment in income for farm households (Wake and Degye, 2019; Tesfaye *et al.*, 2016). This Table 2: Summary of Empirical Reviews on welfare impact of improved varieties

Author with year of Publication	Crop Type	Estimated Impact
Wake and Degye (2019)	Wheat	9% increase in the income
Tesfaye <i>et al.</i> , 2016	Wheat	35 to 50% increase in income
Jaleta <i>et al.</i> (2018)	Maize	Increase by ETB 127 in Consumption expenditure if non-adopter adopt
Endeshaw <i>et al.</i> (2021)	Common bean	24% rises per capita expenditure and 36% if it combined with fertilizer
Samuel and Beza (2019)	Coffee	33.6%-46.6% coffee income increment 25.8%–44.1% total income
Zeng <i>et al.</i> (2017)	Maize	17.36%–25.88% reduced child malnutrition
Verkaart <i>et al.</i> (2017)	Chick Pea	For 10% increase in area planted 12.6% increase in income 12.3% increase in total income per capita 3.9% reduction in likelihood of living in poverty
Mengistu <i>et al.</i> , 2021	Maize	82.4 % with low DDS were non-adopters 78% of non-adopter experience food shortage
Ahmed <i>et al.</i> (2017)	Maize	14.4% to 19.2% rise in consumption expenditure per AE(Adult Equivalent)
Shita <i>et al.</i> (2020)	Maize	1021–1297 ETB rise in consumption expenditure if it combined with fertilizer
Verkaart <i>et al.</i> (2019)	Chick Pea	38% greater returns
Ahmed <i>et al.</i> (2016)	Ground Nut	7.8%–8.6% greater consumption per AE
Natnael (2019)	Teff	23.7–23.9% higher farm income

Source: Own summary from Empirical reviews

The findings by Shita *et al.*, 2020 indicate that adoption of improved maize brings better results if it is combined with fertilizer that is 1021–1297 ETB increment in consumption expenditure. It is also confirmed by Endeshaw *et al.* (2021) that adoption of improved common bean varieties results in a 24% rise in per capita expenditure, but the effect is boosted to 36% if it is combined with fertilizer. This result indicates that adoption of improved seed varieties comes with better results if it is combined with other agricultural technologies like fertilizer

indicates that adoption of improved seeds can contribute to the welfare of households since income is a central resource for ensuring good living conditions, which is important for the health and well-being of farm households.

In addition, adoption of improved maize is estimated to increase consumption expenditure by 127 ETB (Jaleta *et al.*, 2018), and it can also improve consumption expenditure from 14.4% to 19.2% (Ahmed *et al.*, 2017). Adoption of improved maize also enhances child malnutrition by a minimum of 17.36% and a maximum of 25.88% (Zeng *et al.*, 2017), and the majority (82.4% and 78%) of non-adopters have low DDS and experience food shortages respectively (Mengistu *et al.*, 2021). The chance of living in poverty is also reduced by 3.9% as the farmers allot at least 10% of their land for improved chick peas (Verkaart *et al.*, 2017).

In general, the findings of this critical review point to the positive and promising role of improved seed adoption in increasing both productivity and household welfare. However, with the exception of a few (for example, Verkaart *et al.*, 2017), all impact evaluations consider adoption as a binary decision, such as adopt or not adopt, which may lead to oversimplification even though farmers adopt improved seed on varying amounts of land. Furthermore, all empirical findings do not evaluate the role of improved seeds at the intra-household level. For example, it does not indicate how women and children living within the household enjoy the benefit. As a result, it is essential to consider the role of

improved seed adoption by considering adoption intensity, and it is beneficial to evaluate the impact of adoption at the intra-household level in order to suggest more practical policies and promote sustainable development.

5. Conclusion

To conclude, the adoption of improved seeds boosts output greatly. Farmers become self-sufficient and also have a marketable surplus as their production rises. Farmers may utilize the money they earn from selling their surplus to meet their basic requirements, such as food items, health care, and educational costs for their family members. If all of these conditions were met, the well-being of Ethiopian farm households, which account for roughly 75% of the population, would improve. In general, technical breakthroughs in agricultural methods, as well as their implementation, have benefited Ethiopia's economic progress. Because agriculture is such a large component of the economy, raising awareness about the potential benefits of using improved seeds should be a top priority. Finally, this review revealed that, even if adoption rates are low, adoption of improved seed has a significant impact on farm household productivity and welfare. As a result, there is an urgent need to increase the adoption of improved seeds in a more concerted and targeted manner.

Competing Interests

Authors declare no competing interests.

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