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Farm Mechanization's Effects on Rural Households' Multidimensional Poverty and Maize Production in Nono District, Oromia

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Abstract

The premise of this study is that agricultural mechanization boosts maize yield and lowers multidimensional poverty. Together with this, attempts have been undertaken to solve the key issues that farmers may face while utilizing agricultural equipment. Primary data for the study was gathered by interviewing 261 farmers utilizing stratification and straightforward random approaches in two kebeles. The data are analyzed using qualitative, descriptive, ordinary least square (OLS), and probit regression techniques. Age and farm mechanization have a statistically significant and favorable impact on maize productivity, according to the results of the regression analysis. Yet, the results of the probit regression analysis indicate that farm mechanization and literacy have a beneficial impact on reducing multidimensional poverty. In the qualitative analysis, issues like the ongoing rise in fuel prices, the high cost of machinery and replacement parts, and the scarcity of qualified technicians in the region are clearly evident. This suggests that in order to boost maize yields and decrease multidimensional poverty, governments must recognize, promote, and encourage rural households' use of agricultural mechanization.

Keywords: *Mechanization, productivity, rural households, poverty, multidimensional poverty*

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Introduction

In England in 1930, Ferguson, an AG engineer, revolutionized the agricultural mechanism of economic development. Instead of being two distinct objects, he pictured the tractor and the implement working as a one, integrated mechanism. Smallholder farmers who cultivate agriculture in Ethiopia, one of Africa's largest countries, are in charge of around 90% of the country's economy (NPC, 2016). With the usage of smallholder farms, agricultural mechanization in Ethiopia started in the 1950s (Siefe, 2022). The employment of motorized tools, machinery, and implements in agricultural processes is known as mechanization (Awoke, 2017). The practice of implanting hand tools and draught animal powers started in the 1960s. Tractor-based farm operations have developed at Setit Humera, Central Awash, and Tendaho Plantation Share Organization. Agricultural mechanization increases timeliness and efficiency while reducing the monotony of farm labour (Kelemu 2015; Mrema, Mpagalile, and Kienzle 2018; Sims, Hilmi, and Kienzle 2016).

In order to speed the accomplishment of national food self-sufficiency and the vital strategic commodities required to meet the demands for food and animal feed, agricultural mechanization has a crucial and strategic function (Fahmid, 2021). Rural farmers' socioeconomic standing has improved as a result of agriculture mechanization, which has made off-farm employment viable. With the use of single axle multipurpose machines, the guide force is gradually changed from land tilling to post-harvest in order to maintain the financial success of small-scale farmers and the welfare of rural farming communities (D.A. Mada and Sunday Mahai, 2013). Mechanization will improve agricultural and farm management systems, increase output, decrease labor expenses, and stabilize farming using the resource of time (Bisrat Getnet, 2017).

Farm mechanization has positive effects on the developing economies of nations like Ethiopia, transforming the livelihoods of farmers and laborers, creating job possibilities, and launching small-scale agro enterprises, as the studies demonstrate. Agriculture-based industries and sectors are impacted by agricultural mechanization, either directly or indirectly. Ethiopia's mechanization today is encouraging. Certain regions of Ethiopia, including Afar, Amhara, Oromia, Somalia, etc., use farm mechanization. Smallholder farmers, governments, and investors are the groups that use farm mechanization. The Nono district was chosen as the study's site. It is situated at the confluence of the Gurage and Gibe Rivers in the north Shewa zone of Oromia. In this district, farm

machinery is used for plowing, pulverizing, sowing, and post-harvesting crops like maize, soya beans, teff, etc.

Problem Statement and Objectives

Increased agricultural productivity and the liberation of smallholder farmers from conventional farming practices are both made possible by agricultural mechanization. The use of powered machinery, tools, and implements as inputs to streamline the agricultural production process in order to attain agricultural production is referred to as "agricultural mechanization" by FAO (1997). It is applicable to the development of agricultural land, crop production, harvesting, storage facility setup, on-farm processing, and rural transportation. Ethiopia's agriculture is the backbone of the nation's economy, contributing more than 50% of its GDP, 83.9% of its exports, and 80% of all employment. The most promising resource for the nation is agriculture. Every year, up to 4.6 million people require food assistance. The Ethiopian economy's primary industry is still agriculture. The Ethiopian highlands' very favorable weather has made it possible to increase irrigation and use other effective agricultural practices. A sickle, an axe, a plough shaft, a ploughshare, a plow, a beam, and animal pressure as machinery make up this equipment.

Mechanized agriculture is the solution for agribusiness traders and farmers to increase plant productivity. Future agricultural production would increase if automation was prioritized, multipurpose machinery was increased, and farmers' labor and tiredness were transferred to machines, according to (D.A. Mada1 and Sunday Mahai, 2013). An essential instrument for controlling financial development is mechanization. They discovered that mechanization boosts the financial advantages of farming land for smallholder farmers. According to Emami, Almassi, and Bakhoda (2018), effective management of agricultural mechanization is crucial for cutting waste and, as a result, improving food safety.

According to a study by Ndubuisi, Christian, and coworkers (2019), agriculture is still the only means to guarantee food security in any nation. The only option to revive commercial agriculture through mechanization is to put in the necessary effort to enhance the area in order to prepare a specific diet. A correspondingly larger area of agricultural production is anticipated to be covered by farm mechanization.

Tamrat (2016), FAO (2007), Ahmed, Sagir, Bagal, Yudhishther, and Lakshami (2020), Daum, Thomas, and Adegbola (2020), and Vambe, Lovemore, Khan, and Mohammad (2020) are just a few of the researchers who have come to the same conclusion: Farm mechanization increases the production and productivity of various crops by facilitating timely workflows, bettering the quality of work, and applying inputs with precision. Mechanization led to a significant rise in cultivation intensity due to the use of tractors and irrigation. Research has shown that automated farms had a higher overall production per hectare than non-mechanized farms, according to Peng J., Zhao Z., and Liu D. (2022).

The bulk of studies, as was already mentioned, show how agricultural technology affects farmers' livelihoods and have also tried to show how using modern agricultural machinery affects production. There are restrictions when analyzing cumulative impacts for poverty alleviation. It wasn't obvious whether farmers who used state-of-the-art machinery to increase production also did so while reducing poverty. So, this study's goal is to assess and quantify the impact of agricultural technology use on crop productivity and multifaceted poverty reduction.

To fill in the gaps left by other investigations, the researcher carried out this study. The fact that similar studies haven't been undertaken in the region where this study is conducted may be the reason why the problem hasn't been examined in previous studies or addressed in this one. The study was conducted in one of the prolific regions of Ethiopia where a lot of maize is cultivated and rural families are partially mechanized. The second gap is that there are numerous studies that have been conducted independently to look into the impact of farm mechanization. In other words, some of them have successfully carried out research to determine how agricultural mechanization affects crop productivity.

To comprehend the issue of multidimensional poverty in rural homes, several studies have been conducted by others. The combined impact of farm mechanization on raising maize productivity and lowering multidimensional poverty in rural households was not, however, studied. By examining the impact of mechanization on maize productivity and other aspects of poverty reduction, this study aimed to fill this gap. The primary goal of the study is to determine how agricultural mechanization affects rural households in Ethiopia's Nono district in terms of increasing maize productivity and reducing multidimensional poverty. Examining how farm mechanization affects maize productivity in the research region, how it affects rural communities'

multifaceted poverty, and the challenges farmers encounter while installing and employing farm mechanization in farming operations are some of the specific goals.

Review of Related Literature

Theoretical Literature Review:

Theory of Agricultural Mechanization: -

Using tools, implements, and power equipment as inputs to streamline agricultural production procedures and increase agricultural yield is referred to as agricultural mechanization. Many people only think of tractors and other high-tech equipment when they think of agricultural mechanization. In reality, especially in underdeveloped nations, the word refers to all technological levels, from the most basic to the most sophisticated and potent (Daum, Thomas, & Birner, Regina, 2020). The use of engine-powered machinery in agriculture entailed the partial or total substitution of human labor and animal power. Such devices made it possible for human- and animal-powered equipment to be completely or partially replaced in developed and increasingly emerging countries (McNulty & Grace, 2009).

Theory of Farm Mechanization and Crop Productivity

The general definition of productivity is the volume measure of output divided by the volume measure of input consumption (FAO, 2017). In developing countries, mechanization, a critical component of agricultural output, has long been ignored. Agriculture energy access has historically been associated with poverty, notably in sub-Saharan Africa. To maximize return on investment, rural households should employ agricultural mechanization to increase income and production. Agricultural mechanization has a number of advantages, including less laborious farm work and more free time (FAO, 2007). The use of agricultural machinery significantly increases crop output and agricultural productivity (Ahmed, Sagir & Bagal, Yudhishther & Mahajan, Rashika & Sharma, Lakshami, 2020).

Mechanization in agriculture increased output, according to research. Agriculture productivity has generally increased significantly as a result of mechanization. Agricultural mechanization gradually affects crop intensity concentration. Because to their high productivity, more farmers are adopting these programs and enhancing their food security. Agricultural mechanization initiatives have increased farm productivity and efficiency (Vambe, Lovemore & Khan, Mohammad, 2020).

Theory of Multidimensional Poverty

For many people, poverty might mean different things. A lack of resources or income to meet needs is only one aspect of poverty. The effects of this absence on those living in poverty are multifaceted. According to this description, poverty has many different manifestations, including a lack of resources, material squalor, social exclusion, marginalization, helplessness, and physical and mental sickness (Walker, 2015). A person's ability to earn or consume above what society considers to be their basic requirements is typically used to determine their level of poverty. This method enables measures that can capture a wide range of well-being characteristics, such as dietary habits, housing, transportation, and many other elements. From 2012 to 2014, MDP trends in Ethiopia's rural and small towns revealed that 82% of households were living in chronic poverty (Seff, Ilana, & Jolliffe, Dean, 2017).

Both Alkire and Santos (2014) and Morrell (2011) found that determining poverty involves taking their relationships into account because it is frequently caused by factors other than income and consumption. Poverty is defined as not only not having enough money to purchase a basic range of goods and services, but also not having the fundamental skills required to live honorably in a particular region given the current state of the world economy.

Many studies, including OPHI (2018) and Alkire & Kanagaratnam (2018), demonstrate Ethiopia's high and enduring poverty rates. A wide range of extension services must be offered, with a particular focus on increasing productivity through the adoption of contemporary agricultural practices and technologies, building capacity, and raising awareness due to the detrimental effects of extension worker exposure on household poverty. A policy focus on educational opportunities that provide a foundation for poverty reduction through the creation of better employment opportunities is required due to the negative impact of household education on household poverty.

Additionally, a more effective and productive use of other capital will be required. Land is very plentiful and has a negative impact on multidimensional poverty. This means that more land reduces household multidimensional poverty from the demand side (Kiros, Bizuneh, & Cameron, 2021).

Theory of Challenges of Adopting Farm Mechanization in Rural Households

The current land fragmentation, the geography of much of the region, and the ongoing growth of farmers in rural regions may be the hurdles. Heavy machinery like tractors and combines will continue to have difficulties because of the fragmentation of the land (Tamrat, 2016). Most of the nation's smallholder farmers cannot afford basic production methods and pricey agricultural supplies due to poverty and restricted access to credit, which results in low yields. The evolution of agriculture is dynamically influenced by technology transfer. It was determined that the use of agricultural mechanization has several advantages, including higher productivity, decreased time spent on the farm, maintained production quality, and greater prospects for money generation. The favorable impacts of equipment on sources of income, farm size, agricultural experience, extended visits, access to credit, and adoption of contemporary agricultural automation are firmly supported by this study (Ullah, Sana & Basit, Abdul & Ullah, Inayat, 2021).

Large portions of the SSA have seen limited progress in mechanization over the previous three decades, which has led to mechanization receiving little attention in national agricultural development strategies and being generally ignored by donor organizations and international development agencies (FAO, 2005). Mechanization in agriculture has the potential to significantly increase agricultural productivity and raise farmer living standards. Secondly, mechanization is hampered by the modest size and dispersion of farms. Thus, agricultural equipment is typically underused. Second, according to Clarke and Bishop (2002), the majority of local farmers are indigent and unable to purchase expensive equipment like tractors and combines. Skilled employees are needed for machine maintenance and operation. Another barrier to effective small farm mechanization is the lack of repair and replacement facilities, particularly in isolated rural locations (Amponsah, Shadrack, & Oteng-Darko, 2012). Many intricate and interconnected automation restrictions are placed on the SSA agricultural system. Lack of educated technical competence, inadequate levels of research, the expansion of technology, and unfavorable

government policies and interventions are major barriers to crop production. Farmers should receive training in the application of these methods (Kumi, Francis & Taiwo, Adewunmi, 2014).

Empirical Literature Review

The number of tractors per 100 square kilometers of farmland rises as farms expand in size and become more commercialized. The countries having the most tractors per 100 square kilometers are Kenya and Zambia, with 27 and 21, respectively. This seems to illustrate how these two nations' transition to industrialized, commercialized agriculture. The ABI pilot nations with the fewest tractors per capita are Nigeria (4.0), Ethiopia (4.0), and Rwanda (1.3). (5.7). It is clear how far behind other nations in the world in mechanization when compared to African nations. In Tunisia and Brazil, there are 143 and 129 tractors per 100 square kilometers of arable land, respectively. The average number worldwide is 200. (World Bank, 2014).

Ethiopia: Ethiopia's market for mechanized inputs is competitive; since there is no direct government participation in the importation and distribution of tractors, companies are free to enter and leave the market as they like. Tractor importers and suppliers do not appear to be working together, and they are in intense rivalry. Although there are no import taxes due on the tractor, most buyers won't be able to benefit from these savings because they have six months to buy the tractor duty-free at the port of Djibouti. Tractors continue to be expensive and hard to come by, with high rental costs and protracted wait times. Also, this often causes delays in other agricultural tasks like land preparation. Ethiopia is an agrarian society, with most of the population living in rural areas and making a living from the land. Agriculture has long dominated the economy and accounts for a large portion of the country's GDP. Over the long term, more than half of GDP comes from agriculture. Agriculture, for example, accounted for about 58%, 55%, 52%, 55%, and 48% of GDP in 1981, 1985, 1990, 1995, and 1999 (WB database). This shows that the agricultural sector continued to dominate the country's economy for a long period of time. Furthermore, the Ethiopian economy's heavy reliance on agriculture as the main source of employment and export earnings is reflected in the fact that it accounts for 80% of the total labor force and 71% of the total export earnings from agriculture (Financial Economic Development Ministry of Agriculture, 2013).

Smallholder farmers who use rain-fed mixed agriculture, conventional methods, and a low-input, low-yield production system make up the majority of Ethiopia's agricultural sector. The quick

economic expansion is a strategy used by the Ethiopian government to reduce poverty. In order to address this issue, the National Development Strategy "Agricultural Development Led Industrialization" (ADLI) was created in the 1960s (World Bank, 2016). Since that agriculture is the greatest industry in terms of production, particularly in terms of employment and exports, this strategy is appropriate. The majority of the impoverished reside in rural areas where agriculture predominates. Many components of human well-being, such health, education, and income, fluctuate significantly between rural and urban settings. The sectors were at first covered by the ADLI plan, particularly smallholder farmers who produce crops (Lulit et al., 2010). To increase agricultural production, the government established policies including better seeds, fertilizers, irrigation, rural roads, and marketing services, as well as technology and better farming techniques for smallholder farmers (GRIPS, 2015).

Growth and Poverty Reduction Program (GPRP), PASDEP (2005–10), Growth and Transformation Program I (GTP I) (2010–15), and Sustainable Development and Poverty Reduction Program (SDPRP) (GTP I) Other programs, such as the Transformation Program II (GTP II), have been added to it (2015-20). But since 2004, the economy has only expanded by double digits. According to the ADLI, this economic growth is the product of wise development policies (MoFED, 2002).

Smallholder agriculture in rural regions was the only focus of the previous agricultural development policy, which included SDPRP. The Ethiopian government created the Plan for Accelerated and Sustained Development to End Poverty (PASDEP) in 2005-2006-2009-2010 as a result of their failure to increase agricultural productivity (MoFED, 2005). Mechanization is becoming increasingly accessible to small farmers, who make up a substantial share of the rural poor. There are now a variety of affordable small farm equipment options available to accommodate most farming situations, crops, and farms. Unknown is the effect on poverty in nations without a strong reform agenda. Nonetheless, agricultural mechanization has not had an influence on poverty reduction through lowering rural wages or agricultural employment in low- and middle-income non-candidate nations (World Bank, 2010).

In certain nations, both agricultural productivity and agricultural machinery are expanding at faster rates. Angola (7.36%), Botswana (3.92%), Ethiopia (5.23%), Malawi (6.17%), Mali (4.66%), Morocco (3.96%), Niger (3.89%), Rwanda (5.55%), Tanzania (6.62%), Togo (4.18%), and Zambia

(8.54%) are among the countries that have the highest rates of poverty. Mechanization fosters agricultural output growth whereas rise in agricultural production is accompanied by mechanization. There is a substantial positive association of 0.52 between agricultural machinery increase and agricultural production growth (and vice versa) (Kirui, Oliver, and von Braun, Joachim, 2018). (Kirui, Oliver, and von Braun, Joachim, 2018).

Research Gaps

The implementation of agricultural mechanization on agricultural tasks has begun in Ethiopia, however it is still in its infancy. Modern farming equipment is being implemented for the effectiveness of farming operations by government agencies, humanitarian organizations, and commercial institutions. It is encouraging to see efforts being made to progressively acclimate rural households to agricultural machinery and tools. Yet, research is required to determine whether farm mechanization genuinely benefits farm operations. This study aims to determine how agricultural mechanization affects maize productivity and other aspects of poverty. As shown above, various literature reviews and empirical studies related to the issue are conducted and published. Many studies have been done both abroad and domestically to show the benefits of farm mechanization.

The fact that similar studies haven't been undertaken in the region where this study is conducted may be the reason why the problem hasn't been examined in previous studies or addressed in this one. The place where this study was conducted is one of the areas where rural homes are largely mechanized in Ethiopia, and it is a productive area where a considerable deal of maize is farmed. The second gap is that there are numerous studies that have been conducted independently to look into the impact of farm mechanization. In other words, some of them have successfully carried out research to determine how agricultural mechanization affects crop productivity. Others have conducted numerous studies to understand the multifaceted nature of rural household poverty. However, they didn’t study the combined effect of farm mechanization on increasing maize productivity and reducing multidimensional poverty in rural households.

Research Methods

Research Approach and Design

This study uses both quantitative and qualitative research design strategies to reach its objectives. The researcher captured numerous people's observations at one time (entities). Based on observations of rural dwellings, a quantitative method was used in conjunction with statistical and numerical analysis techniques. Rural households in the study area that participated in the interviews were those that use agricultural mechanization in the Nono district. The influence of agricultural mechanization was evaluated using Probit regression and Ordinary Least Square (OLS) models.

Data Types, Sources and Methods of Data Collection

Both primary and secondary data are employed in the investigation. Primary data for this study came from interviews with rural households in the Nono district that use agricultural equipment. The information is gathered through the development of a four-section interview questionnaire that covers demographic information, the impact of agricultural mechanization on productivity, the complex ways in which agricultural mechanization reduces poverty, and finally the difficulties faced by rural households when using agricultural equipment for farm work.

The Nono region's rural households that are the focus of this survey. These target groups comprise influential residents of these kebeles as well as farmers who cultivate maize utilizing agricultural machinery. The researcher chose two kebeles at random for sampling in order to determine cost effectiveness. There are 33 kebeles in the Nono district; using the stratification method, two kebeles (traditional and contemporary implement users) were chosen as the sampling unit for this study. After then, respondents are chosen using a straightforward random approach. As a result, the sample size for this investigation was established using Yamane's (1967) condensed sample size calculation formula. In order to choose and employ 264 samples for this investigation, 135 respondents from Nano Kondala and 129 respondents from Beke moti were selected utilizing the aforementioned sampling technique.

Method of Data Analysis

In this study, the continuous variable maize productivity and the dummy multidimensional poverty are modelled using the OLS (Ordinary Least Squares) and probit regression methods, respectively. The following describes the specific model for maize productivity (MP) and multidimensional poverty (MPi):

$$mp = \beta_0 + \beta_1 ag + \beta_2 gn + \beta_3 edl + \beta_4 fms + \beta_9 fm + e$$
$$mpi = \beta_0 + \beta_1 ag + \beta_2 gn + \beta_3 edl + \beta_4 fms + \beta_5 hl + \beta_6 edu + \beta_7 ls + \beta_8 ep + \beta_9 fm + e$$

Where mp stands for "maize Production," mpi for "Multidimensional Poverty," edu for "Education," fm for "farming mechanization," hl for "health," ep for "empowerment," and ls for "living standard" Family size is fms, age is ag, gender is gn, and education level is edl.

Result and Discussion

In-depth descriptions of the qualitative, descriptive, and econometric analyses are included in this section, along with explanations of the response rate, demographic data, a presentation of farming tools and equipment, and explanations of the response rate. The results and conclusions are then discussed after the gathered data has been analyzed. In order to conduct this study, 264 questionnaires were distributed among the two kebeles for interviews. 261 of the 3 absent families were willing to be interviewed. In light of this, it can be shown that 98.86% of surveys are returned.

Table 1 displays the summary statistics of the household characteristics that took part in the survey. The poll comprised 261 respondents in total. The respondents were between the ages of 19 and 76. The age range of the respondents, which made up the majority, was 30-62. Family members range in age from 15 to 64 in excess of 52.94%, with 42.88% of them being under the age of 15. The remaining 4.47% are older than 64. 88.51% of those surveyed had male heads, with the remaining heads being female.

Table 1
Household Characteristics

Variables	Obs.	Mean	Std. Dev.	Min	Max
Age	261	46.96935	12.46036	19	76
Family size below 15 ages	261	2.151659	1.136299	1	6
Family size 15-64 age	261	3.579151	1.657877	1	8
Family size above 64 ages	261	0.118774	0.444271	0	4
Highest schooling in the house	261	2.35249	1.820366	0	6
House quality	261	2.02682	0.475606	1	3

Source: study output (2022)

More than 80% of the people interviewed in this study live in houses made of mud floors, wood with mud walls, and corrugated iron sheet roof covers. The rest live in a house made of grass and various materials. 78.08% of the respondents own a one-bedroom house, of which 68.20% live in one bedroom with more than three occupants. According to their own opinions, more than 80.84% of people live in a high-quality home. According to the survey, most of the interviewees tried to educate their children, of whom 17.24% had a degree and 22.99% had no educated family member. 0.38% have an educated family member up to a master's degree.

Farm Land and Production Equipment

The respondents are mostly private landowners, some of whom aren't private landowners and are engaged in rental land farming activities. According to the study, the minimum land area for a farmer is null, and the maximum is 17 hectares. Thus, one farmer owns an average of 3.26 hectares of farm land. Most of the land that farmers own or rent out is used for maize production; 71.59% of their total land is used to grow maize, and the rest is used for various crops. An average of 2.33 hectares of land per household was used.

In order to raise maize, rural people use both modern and traditional agricultural apparatus, and farmers who use modern agricultural machinery nevertheless use some traditional agricultural technology. The most popular agricultural equipment in the area include tractors with motor pumps, sprayers, and implements, while maize production calls for more conventional tools like sickles, hoes, axes, and shovels. Agricultural tools are used. On average, each household has one to three sickles, hoes, spades, shovels, and axes, as shown

in Table 2. Of the 261 households surveyed, 36 owned a tractor with a farm implement, and some rented a tractor with a farm implement for use on the farm. Usually, smallholders and farm owners with scattered land cannot use tractors, in which case cattle plows are preferred. A survey conducted to document the indigenous tools used by tribal builders in Orissa and West Bengal states recorded a total of 81 tools, including krupa, spade, axe, sieve, sickle, dhow, and silnora. Kula, Juri, Nanda, and Paniki were found in all households (Sarkar, 2015).

Table 2
Farm Land and Production Equipment

Variable	Obs.	Mean	Std. Dev.	Min	Max
Total Land size	261	3.26069	2.363215	0	17
Land size for maize	261	2.334444	4.197289	0.25	65
Sickle	261	2.195402	2.386689	0	30
Hoe	261	1.425287	2.814655	0	40
Spade	261	1.35249	1.332394	0	10
Axe	261	2.287356	2.434881	0	20
Sprayer	261	0.48659	0.830206	0	5
Ox plough	261	0.923372	0.842312	0	3
Manual pump	261	0.007663	0.087369	0	1
Motorized pump	261	0.455939	0.90881	0	12
Tractor	261	0.137931	0.36708	0	2

Source: Stata output (2022)

Challenges Facing Modern Farm Machinery Users

261 rural households in Nano Kebele were polled to find out more about the difficulty's farmers have when implementing modern farming equipment. Nine potential issues were given a severity rating out of high, moderate, and low from the participants. Rising fuel prices were identified as the top issue by the 261 respondents with the highest mean value. The cost of maintaining and repairing farm gear and tools is the second major impediment.

Besides those already mentioned, the third barrier is the high cost of modern farming equipment and spare parts, which makes it difficult for farmers to simply purchase farm machinery. Another problem is that there is a serious shortage of farm equipment in the area, which prevents the farmers from being able to hire it. The scarcity of mechanics and maintenance workers who can maintain farm equipment in remote regions ranks as the fifth largest challenge. The study also discovered that agricultural mechanization is not commonly used in the rural Peshawar district, which is due to the land tenure system, a lack of

implements, a lack of funding to hire machines, a lack of trained machinery operators, and a lack of access to extension services, which are the main barriers preventing farmers in the study area from utilizing agricultural mechanization in their farming process (Ullah, Sana, & Basit; Abdul & Ullah, Inayat, 2021).

Multidimensional Poverty

The MPI is an index designed to measure acute poverty. First, it includes persons who do not meet the minimal standards for basic functioning that have been internationally agreed upon, such as having access to clean water, enough nutrition, and education. Second, it describes people who live in situations where they fall short of the basic requirements in a number of areas at once. In other words, the MPI assesses those who suffer from numerous deprivations, such as those who are underweight and lack access to clean water, sanitary conditions, or clean fuel. The MPI combines two key pieces of information to measure acute poverty: the incidence of poverty, or the proportion of people (within a given population) who experience multiple deprivations, and the intensity of their deprivation, or the average proportion of (weighted) deprivations they experience. Both the incidence and the intensity of these deprivations are highly relevant pieces of information for poverty measurement.

The MPI consists of three dimensions made up of ten indicators. Each indicator has a minimal degree of satisfaction attached to it that is based on global agreement (such as the Millennium Development Goals, or MDGs). Deprivation cut-offs are used to describe this minimal level of enjoyment. The MPI is then calculated in two steps: Each individual is first evaluated based on family accomplishments to see if they fall below the deprivation cut-off for each indicator. In that indicator, people who fall below the cutoff are seen as being disadvantaged. The weight of the indicator is then applied to each person's deprivation. A person is deemed to be multidimensionally poor if the total of their weighted deprivations is 25 percent or more of all potential deprivations. Multidimensional Poverty Indicators:

Four dimensions of poverty
- **Education** {years of schooling, school attendance}
- **Health {**Nutrition, Child mortality}
- **Living standard** {cooking fuel, sanitation, water, electricity, floor, assets}
- **Empowerment** {cooperative membership}

The MPI has eleven indicators: two for health, two for education, six for living standards and one for empowerment.

Multidimensional Poverty Measurement

The indicators' deprivation cut-offs: The MPI and any multidimensional poverty measure of its type require a deprivation cut-off for each indicator. Usually, the indicators' deprivation cut-offs are noted as z_i, so that person i is considered deprived if the persons achievement in that indicator x_i is below the cut-off, that is, if $x_i < z_i$. In the case of the MPI, most of the deprivation cut-offs are based on the internationally agreed upon MDG standards. When designing a national measure, different cut-offs may be set based on current policy priorities in the country and what is considered to be non-deprived according to the culture.

The indicators' weights: Once the indicators and their corresponding cut-offs have been selected, the next step is to define the weights each indicator will have in the measure. In the MPI the four dimensions are equally weighted, so that each of them receives a 1/4 weight. The indicators within each dimension are also equally weighted. Thus, each indicator within the health and education dimension receives a 1/8 weight, each indicator within the living standards dimension receives a 1/24 weight (1/4 ÷ 6), and an indicator within empowerment receives 1/8.
Here we note the indicator i weight as w_i, with $w = \sum_i^d w = 1$

The poverty cut-off (to identify the poor): Next, each person is assigned a deprivation score according to his or her deprivations in the component indicators. The deprivation score of each person is calculated by taking a weighted sum of the number of deprivations, so that the deprivation score for each person lies between 0 and 1. The score increases as the number of deprivations of the person increases and reaches its maximum of 1 when the person is deprived in all component indicators. A person, who is not deprived in any indicator, receives a score equal to 0. Formally:
$C_i = W_1 I_1 + W_2 I_2 + \ldots + W_d I_d$
Where $I_i = 1$ if the person is deprived in indicator i and $I_i = 0$ otherwise, and w_i is the weight attached to indicator i with $w = \sum_i^d w = 1$

A second cut-off or threshold is used to identify the multidimensionally poor, which in the Alkire Foster methodology is called the poverty cut-off. The poverty cut-off as the share of (weighted)

deprivations a person must have in order to be considered poor, and we will note it with k. In this way, someone is considered poor if her deprivation score is equal or greater than the poverty cut-off. Formally, someone is poor if $c_i \geq k$. In the MPI, a person is identified as poor if he or she has a deprivation score higher than or equal to 1/3. In other words, a person's deprivation must be no less than a third of the (weighted) considered indicators to be considered MPI poor. For those whose deprivation score is below the poverty cut-off, even if it is non-zero, this is replaced by a "0"; what we call censoring in poverty measurement. To differentiate between the original deprivation score from the censored one, we use for the censored deprivation score the notation $c_i(k)$. Note that when $c_i \geq k$, then $c_i(k) = c$, but if $c_i < k$, then c_i (k) = 0. $c_i(k)$ is the deprivation score of the poor.

Computing the Multidimensional Poverty Index (MPI)

As mentioned above, the MPI combines two key pieces of information: (1) the proportion or incidence of people (within a given population) who experience multiple deprivations and (2) the intensity of their deprivation: the average proportion of (weighted) deprivations they experience. Formally, the first component is called the multidimensional headcount ratio (H):

$$H = \frac{q}{n}$$

Here q is the number of people who are multidimensionally poor and n is the total population. The second component is called the intensity (or breadth) of poverty (A). It is the average deprivation score of the multidimensionally poor people and can be expressed as:

$$A = \frac{\sum_{i=1}^{n} Ci(K)}{q}$$

Where $c_i(k)$ is the censored deprivation score of individual i and q is the number of people who are multidimensionally poor.

The MPI is the product of both: MPI = H × A

The calculated results are:

The number of total populations = 1,412

The number of total poor population where the household poor ($c \geq 1/3 = 0.333$) = 658

Multidimensional headcount ratio (H) = 0.29.67

Intensity of poverty (A) = 0.4669

MPI = H × A = 0.4660*0.2705 = 0.1385

The survey results are easy to interpret. 29.67% of persons in this society are MPI poor. Mekonin and Almas conducted a multidimensional poverty analysis research in Ethiopia's rural and small towns, finding that 45% of the sample population was overall poor (Barsisa & Hashmati 2016). This indicates, according to MPI, that they are extremely poor. They at least have a disadvantage in every index in a single dimension or when combined with other dimensions. a family with one underweight member, no running water, filthy floors, and inadequate sanitation.

We can also see that the poor here are deprived with a weighted index of 46.69% and a multidimensional poverty index of 0.1385. The Oxford Poverty and Human Development Initiative (OPHI) national-level survey in Ethiopia in 2017 found a multidimensional poverty index of 0.564 and a poverty rate of 87.3% (OPHI, 2017). The MPI represents the proportion of the multidimensionally poor population adjusted for the level of deprivation experienced. This adjustment is necessary because looking at H alone tells us that 29.67% of the population is poor. But are they all equally poor? Are you 100% deprived of everything you consider deprived? Not in this society. The average poor is deprived at 46.69% of the weighted index, so the strength is 46.69%. These are called 'weighted' measures because each deprivation is entered according to its relative weight to form the deprivation score C_i.

According to World Bank data indicators and country data statistics, the poverty rate at the national poverty line in 1995 was 45.5%. This represents almost half of the country's population, and even in 1999, when the country's poverty rate was 44.2% of population; poverty levels did not drop significantly. Poverty rates were very high in rural areas where agriculture was the main source of income. In 1995 and 1999 they were 47.5% and 45.4% respectively. The figure of 29.67% is 'adjusted' for the degree of poverty; hence the MPI is what Alkire and Foster (2007, 2011) call the adjusted headcount ratio. The use of agricultural mechanization makes a big difference in poverty alleviation, as can be seen from the results of previous studies conducted by different researchers using random data from different time periods.

The estimated regression equation can be used to predict the value of the dependent variable given values for the independent variables. The dependent variable here is maize productivity, and

gender, education level, age, cooperative membership, family size, health, education, standard of living, and state-of-the-art agricultural equipment predict maize productivity.

The above results are summarized as follows: The results of the regression analysis show that the increase in age and the use of modern agricultural equipment have a positive effect on the increase of maize production. The two independent variables are statistically significant and have a positive effect on maize productivity at the 1% level of significance, holding other independent variables constant at their average value. The result shows that as the rural households get older, they gain better experience in maize production, which in turn increases the productivity of maize. "The aging of China's rural labor force may affect efficiency and productivity in crop production. Household technical efficiency increases until maximum efficiency is reached at the average age (Li, Min, & Sicular, 2013). Also, the results show that using modern agricultural equipment has a significant effect on increasing maize productivity. This indicates that the maize yield increased when the rural households used modern farming equipment for agricultural operations (see Table 3).

Table 3

Regression Results for Factors Affecting Maize Productivity

Maize productivity	Coef.	Std. Err.	t	P>t
Gender of the house hold head (Male or Female)	-0.0458546	0.1322954	-0.35	0.729
Education level household head (Literate or Illiterate)	-0.0253207	0.0946514	-0.27	0.789
Age of the household head (19-76)	0.0187553	0.0048693	3.85	0.000
Family size (number of families in the household	0140114	0.026161	0.54	0.593
Membership to cooperative	-.027383	0.1065004	-0.26	0.797
Health of the children	-.011084	0.0751307	-0.15	0.883
Education of the children	-.0433638	0.0554053	-0.78	0.435
Living Standard of the household	0.0577149	0.0493262	1.17	0.243
Farm mechanization (Number)	0.1112735	0.0385308	2.89	0.004
_cons	3.298499	0.2562644	12.87	0.000

Source: Stata output (2022)

Being educated and employing modern farming equipment have a favorable impact on lowering multidimensional poverty of rural households, according to the probit regression analysis of the dependent variable multidimensional poverty. The usage of modern farming equipment and one's degree of education both contribute to a decrease in poverty, according to a marginal impact after probit regression. The attainment of education increases one's earning capacity, and as a result, higher earnings will undoubtedly assist one in escaping poverty (Awan, Malik, Awan, & Waqas, 2011). The adoption of modern agricultural equipment for farming operations enhanced maize productivity and decreased rural households' multidimensional poverty, according to both regression and probit regression results (see table 4).

Table 4

Probit Regression Model Analysis

Variables	dy/dx	Std. Err.	z	P>z
Gender of the household head (Male, Female)	-0.0002744	0.03752	-0.01	0.994
Education level of the household head (Literate or Illiterate)	0.0082245	0.01855	0.44	0.657
Age of the household head (19-76)	-0.0002769	0.00067	-0.41	0.679
Family size of the house hold	-0.0016262	0.00339	-0.48	0.631
Household head Membership to cooperative	-0.9999994	0	.	.
Health of the children	-0.0933307	0.14182	-0.66	0.51
Education of the children	-0.0686021	0.10511	-0.65	0.514
Living Standard of the household	-0.0334858	0.04994	-0.67	0.503
Farm mechanization (Number)	0.0031205	0.00829	0.38	0.707

Source: Stata output (2022)

The results of this study demonstrate that rural households encountered a variety of difficulties when operating agricultural equipment, with the rise in fuel prices ranking as the biggest issue. Second, when farm equipment malfunctions, the expense of repair and maintenance is significant. The fourth-highest challenge in this study has a direct correlation with this problem. It made the problem worse because there aren't many repair professionals in the area and spare parts are difficult to find nearby. The third significant issue is the rising cost of agricultural tools and equipment, which farmers find difficult to afford.

Conclusion, and Recommendation

The experiment to determine the effects of several independent variables on maize productivity benefited by the use of modern agricultural machinery. This indicates that using modern farming equipment will boost a farmer's output. Another independent element that favorably affects maize productivity is age. The regression results of this study show that maize productivity increases with age. As a result of their enhanced labor experience from regularly planting, weeding, tending to, and harvesting maize, this suggests that farmers are more productive. The results of the regression analysis show that age and the use of modern agricultural equipment have a statistically significant effect on maize productivity.

The probit regression model is another model employed in this study to assess multidimensional poverty. A probit regression model was used to examine the effects of each independent variable on multidimensional poverty. Using contemporary agricultural equipment and having a good education have a favorable impact on lowering poverty, according to the results of the probit regression analysis. This indicates that the production of maize increased when they used contemporary agricultural equipment for farming operations, which improved their living standards. When examining how education affects poverty, we find that literate farmers are more productive than illiterate ones. The poverty rate has dropped as a result. Both regression and probit regression results show that the use of modern agricultural equipment for farming operations increased maize productivity and reduced multidimensional poverty in rural households.

This study also covers the assessment of the challenges experienced by users of modern agricultural equipment. A qualitative study was conducted to find out more about the challenges rural households encounter when utilizing agricultural equipment. The survey's results show that rural households had a number of challenges when using agricultural equipment, with the rise in fuel prices standing out as the main problem. Second, the cost of repair and maintenance is high when farm equipment breaks down. This issue is directly related to the fourth-highest challenge in the survey. Because there aren't many repair and maintenance specialists in the area and it's challenging to locate replacement components close by, the problem escalated.

It is common knowledge that Ethiopia's economy rests largely on the sale of agricultural products. We have been engaged in agriculture for many centuries, but we have not modernized as much as

we ought to have. Farmers in rural areas continue to use the ancient farming equipment that was in use hundreds of years ago. Due to the failure of agriculture to increase crop productivity, the nation remains in poverty. We lack a sustainable agricultural industry while having a lot of very fertile agricultural land. The main reason for this is that employing modern farming techniques has its drawbacks.

The results of this study also show that employing contemporary agricultural equipment significantly increases grain productivity and decreases poverty. Furthermore, the bulk of farmers in the country lack the education and literacy necessary to adopt and use cutting-edge farming instruments and equipment. Using high-tech agricultural equipment and instruments is one of the finest ways to eradicate poverty in the country, enhance the standard of living for rural people, and increase agricultural exports.

Planning and executing a project that would support rural households in implementing agricultural mechanization is one of the primary techniques to increase crop yield and bring the country out of poverty. The results of this study showed that literate farmers had higher productivity and larger maize yields than illiterate farmers. As a result, it is advantageous for the government to assist rural households without access to education and to produce farmers who are literate. Farm mechanization poses a variety of challenges for rural people. Fuel prices are increasing, the cost of purchasing and maintaining agricultural equipment and implements has increased, there aren't many repair and maintenance specialists in the area, and there aren't any nearby providers of replacement parts. It would be good if the government addresses the major problems faced by mechanized farmers.

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