Eco. Env. & Cons. 30 (January Suppl. Issue) : 2024; pp. (S256-S262)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i01s.052

A Case Study on Farm Mechanization in the Selected Farms of Sivasagar District, Assam, India

Bhagya Das[1]* and Jayeeta Tamuli[1]

[1]Department of Geography, Cotton University, Guwahati 781 001, Assam, India

(Received 2 June, 2023; Accepted 16 August, 2023)

ABSTRACT

Farm mechanization is the most recent human innovation to boost food grain output. Following the green revolution, mechanization had a huge influence on output and reduced food scarcity. Today, we live in a time when expanding population has produced a scarcity scenario in which increasing agricultural lands appears to be impossible. Farmers are under pressure to adopt new technology that can enhance food crop production as well as income. Farmers are prioritizing the use of modern mechanized tools and equipment in order to save time, effort, and money. The paper attempts to investigate the influence of mechanization on farmer income. This study will calculate the cost of mechanization for each farm and crop. The mechanization intensity was calculated using several recommended scholars and was found that all randomly selected farms have an average of 1.494 hp/ha and nearly 0.895 kW/ha, requiring additional capital investment to boost power and energy supply to the cultivated areas. This affects farmers' farm revenue and demonstrates that mechanization is an important component of modern agriculture.

***Key words**: Farm mechanization, Degree of mechanization, Labour workforce.*

Introduction

Agriculture needs tools, implements, and powered machines as important inputs. Mechanization is typically used to refer to the use of these inputs as a whole (Clarke, 2000; Olaoye and Rotimi, 2010). Agricultural mechanization is controversial in the modern period since it is thought to be the utilization of mechanical power (Maheswari and Tripathi, 2019). There are three main levels of mechanization; manual labour power input, animal power input, and mechanical power input with different levels of application and degrees of use (Rijk, 1985).

The appropriate application of mechanical inputs will give direct and significant results in achievable food productivity and profit to the farmers. The highest degree of application of machinery is capable of achieving expected production and productivity goals. The application of mechanical tools increases the productivity of farm products and also efficiently utilizes human time and labor force. The sustainable use, affordability of machinery, availability of tools, and skilled labor are also major concerns in the agricultural mechanization process (Nwoko, 1990).

Farm mechanization needs the availability of capital investment, a skilled labour force, well-set mechanized tools & technologies, precise management strategies, and good transportation and storage facilities with the existence of nearby market areas or town areas to sell the farm produce. Farm mechanization also needs other aspects including cooperation from many sections of both environmental and economic aspects. The behavior of farmers and actions of market infrastructure are also very crucial for better farm mechanization results (Ou *et al.,* 2002).

Assam is the agro-based state with the highest

[1]Research Scholar

number of people directly or indirectly engaged in the agricultural sector. The land and climate are very much suitable for good farming and agricultural practices. Despite having ecological benefits, Assam state agricultural production has failed to fulfill the expected food grain production due to the lack of technological and mechanical input in the agricultural field.

Statement of the Problem

Farm mechanization refers to the process of application of mechanical power sources and equipment in agricultural farms to increase agricultural productivity and efficiency of inputs. Farm mechanization plays an important role in the development of the agricultural sector of a country along with the economic well-being of people dependent on agriculture for livelihood. The increase in population has created increased demand for agricultural produce, which has further cemented the need for increasing agricultural production and expansion of agricultural land. Increased use of farm machinery allows for the expansion of cropped area, intensification of cropping, and increase in agricultural production on all fronts. Farm mechanization ensures the timely completion of farm operations along with efficient utilization and management of agricultural inputs (Gulati and Juneja, 2020). This leads to an overall increase in agricultural productivity which may improve farmers' income and the overall well-being of the agricultural household. Economic benefits arising out of mechanization encourage farmers to further invest capital in agriculture and allied activities.

Electrical and motor power, machinery and tools (tractors, harvesters, sprayers, etc.), adequate technical know-how and skills to operate machinery, resources, and capital are crucial inputs for the farm mechanization process. It is also influenced by the farmer's income, price of tools and machinery, cost of farm labour, size of agricultural land holding, affordable agricultural credit, and agricultural profitability (Gulati and Juneja, 2020). Many small farmers have limited access to production inputs and profitable markets and therefore have low levels of productivity (Sims *et al.,* 2016). Farm mechanization along with the development of agricultural markets and infrastructure is closely linked with the development of the agricultural sector.

Assam is an agrarian economy, where a majority of its population is dependent on agriculture and allied activities for their livelihood. The plain physiography and agro-climatic conditions of Assam are conducive to agricultural activities. Despite the state's high potential in the agricultural sector, it is important to study the levels of farm mechanization to properly assess the factors that influence the accessibility and adoption of mechanization by farmers in Assam.

Materials and Methods

With the use of a questionnaire, all randomly chosen farms in the Sivasagar area of Assam are surveyed. The questions are based on the many agricultural products, and all sources of revenue have been looked into. It combines an observational approach with direct interviewing. The chosen farms are denoted by the letters A, B, C, D, and E. Animal products and crop cultivation make up the two main categories of agricultural output. Poultry and cattle agricultural practices are included in the animal products. Meat, milk, and egg production are also included in this. However, crop cultivation also covers the growing of horticulture and food grains. The most common horticulture crops are betelnut, banana, and sugarcane. Additionally, food grain crops include the production of rice and vegetables. To provide accurate farm revenue statistics from all sources, all sources of income have been thoroughly examined. It will be useful in analyzing each farm's economic situation.

Study Area

Sivasagar is an Assam district in northeast India. Sivasagar is located between 26°45′N and 27°15′N, and 94°25′E and 95°25′E, and is surrounded by the state of Nagaland. The farms were chosen at random and are located in the northern section of the district, close to the huge Brahmaputra River. With the presence of alluvial soil, the research regions have an abundant supply of water. The rainfall is also highly suited for agricultural purposes, with more than 250 mm of rainfall on average during the monsoon months.

Measurement of Farm Mechanization

Degree of Mechanization

Zangeneh *et al.* (2010) have given the equation by assessing the Mechanization Index by summing the overall energy used in the cropping area with com-

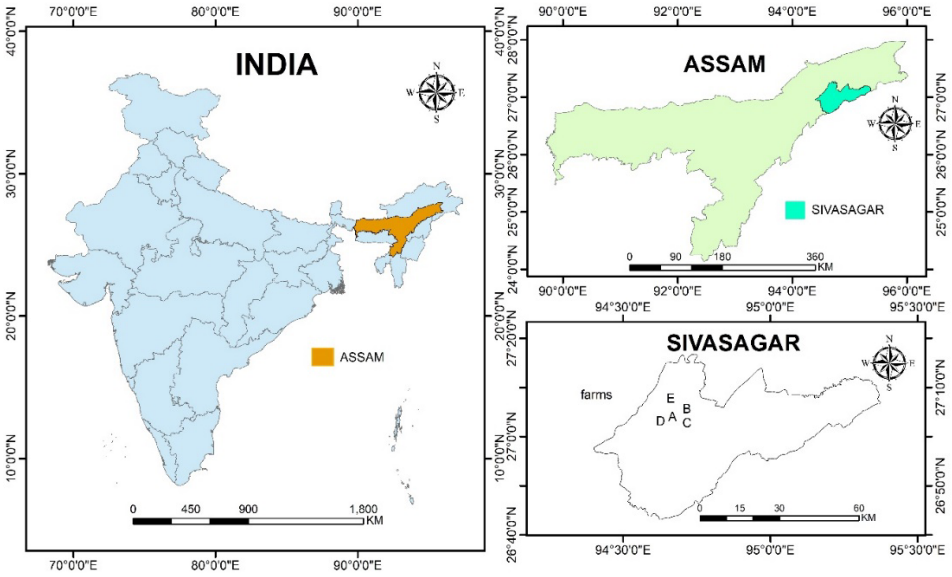

Fig. 1. Showing study area map

pared to the average energy used for each cropping practice.

Here, MI= Mechanization Index

$$MI = \frac{1}{n}\sum_{i=1}^{n}\frac{Me\ (i)}{Mav} \times \frac{Li}{TLi}$$

Me (i)= Overall energy used
Mav= Average energy used
Li= Total land area of Cultivation
TLi= Total farmlands
n= Number of farms

Andrade and Jenkins (2003) have also given the equation for the calculation of the level of mechanization in farm operations by computing the used mechanical tools. They have given their emphasis on the available or used machines like; tractors, powertilers, and other automatic and manual tools.

Here, LOM= Level of Mechanization

$$LOM = \sum_{i=1}^{N}\frac{Pi * N}{Li}$$

Pi= Power of tractors and other mechanical input
N= Correction factor (total cultivated area/total area)
Li= total cultivated area

Almasi *et al.*, (2000) have also put forward the method of calculating mechanization using the total power used in the farm field operation in the total cultivated lands.

$$\text{Mechanization}\begin{pmatrix}\text{hp}\\ \text{ha}\end{pmatrix} = \frac{\text{Total power used}}{\text{Total Cultivated lands}}$$

After all these, the following equation were adopted to calculate the overall mechanization in the farm operation in recent times.

$$MI = \frac{TMP + TAP + TIL + WD + TEC + TMC}{6n}$$

Here, MI= Mechanization Index
TMP= Total mechanical power(hp)
TAP= Total animal power (hp)
TIL= Total irrigated cultivated lands
WD= Total number of working hours
TEC= Total energy consumed
TMC= Total costs of mechanical input
n= Total cultivated area

As per this equation, the total cultivated area was multiplied by six as to match the expenditure on each variables. The higher value will denote higher mechanization in the farm operation and the lower value denotes the low level of mechanization. Almasi *et al.* (2000) have also forwarded the method for the calculation of the Degree of Mechanization (DM);

$$DM = \frac{\text{Total mechanised area}}{\text{Total area of be mechanised}}$$

Calculation of the overall human workforce for a year

The human workforce is a crucial deciding factor in farm agriculture. Human supervision and management can also be taken as the workforce applied in the farm operation. The more hours in a day employed in the field can have greater the chances of increasing crop production and productivity.

$$\text{Human Work force} = \frac{\text{Total no. of hours of labour}}{\text{No. of labour} \times 365}$$

Calculation of mechanization for each farming/cropping operation

Almasi *et al.* (2000); Andrade and Jenkins (2003) have given their emphasis on the calculation of mechanization in farm operations on the basis of power and energy that are used for different tasks and farming practices. The power consists of animal and mechanical power which are calculated in Horsepower (hp) and the energy that is used to operate various machines iscalculated in KiloWatt (KW). More power and energy used in farm operations denoted better farm production.

$$\text{Power (Hp)} = \frac{\text{Total mechanical input for the crop}}{\text{Total cropping lands under that crop}}$$

$$\text{Energy (KW)} = \frac{\text{Total no. of units consumed for the crop}}{\text{Total cropping lands under that crop}}$$

Calculation of surplus and profit margin from each and overall mechanization

Investigating the profit and surplus margin of any farm can be done by deducting all the costs that are used for the whole production process. It includes the initial cost of the seeds, maintenance costs, mechanical input costs, and electrical energy costs with upto the transportation and storage facility costs. This will help the farmers to study the efficiency of mechanical tools and equipment in the recent age of mechanization in farm operations.

Profit(surplus)
= Total incomes by selling of all farm produces – (Initial cost + labour cost + mechanical input cost + power consumption cost + depreciation + transportation cost + storage cost + others)

Results and Discussion

Degree of Mechanization

Depending on the stage of technological advancement, the mechanization of agricultural output is continually evolving. Because of this, it is necessary to periodically assess the state of the mechanization progress in the agricultural sector (Özpinar and Anýl, 2018).

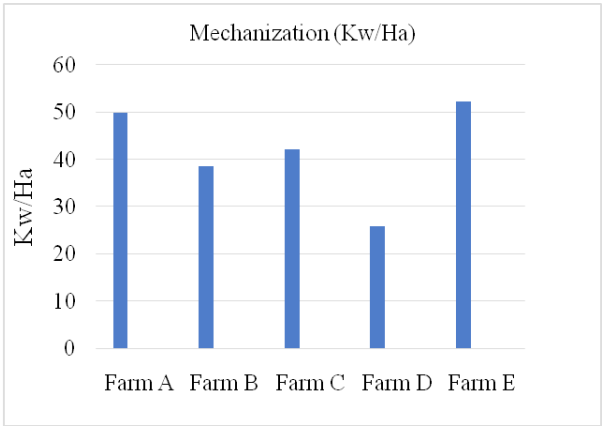

Fig. 2. Showing the Mechanization of each farm (Kw/Ha)

In farms, electricity is used to run irrigation motors and pumps as well as to keep the farm's perimeter secure. The degree of mechanization in farms may be determined by looking at the electrical power consumption per hectare (Kw/Ha) of cultivated land. The farm with the greatest power use per cropped hectare is Farm E (52.3 Kw/Ha), followed by Farm A (49.808 Kw/Ha) and Farm C (42.10 Kw/Ha). In comparison to the other farms, Farm D has the lowest electricity use at 25.8 Kw/Ha. Only a small amount of Farm D's farmland is used for crop cultivation and other agricultural activities, which will affect the farm's production and efficiency. Farm C has the most cropped land out of all the farms, yet it uses less electricity than Farm A and

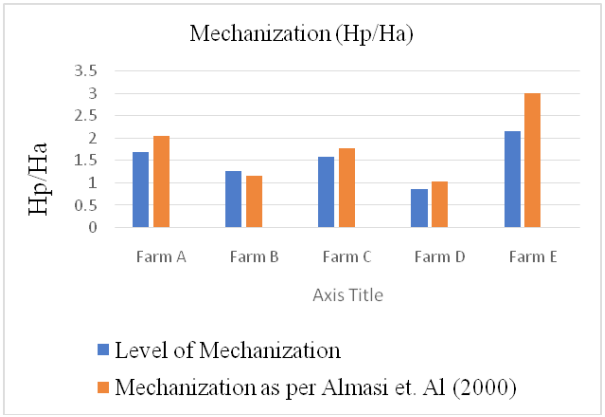

Fig. 3. Showing Mechanization of each farm (Hp/Ha)

Farm E, which can be a sign of the effective use of electricity.

The farms that use the most horsepower per hectare of cultivated land are Farm E (2.16 Hp/Ha), Farm A (1.69 Hp/Ha), and Farm C (1.58 Hp/Ha). Due to the availability of subsidized tractors and power tillers, which demand more horsepower for agricultural activities, Farm E, Farm A, and Farm C have high levels of horsepower consumption. Farm D uses fewer farm vehicles and machinery than the other farms, hence its 0.87 Hp/Ha horsepower use is the lowest of all the farms.

According to Almasi *et al.* (2000), Farm E has the greatest horsepower usage at 3.6 Hp/Ha, followed by Farm A at 2.04 Hp/Ha. This is because Farms A and E have less cropping space than Farm E due to the availability of mechanized tools like tractors and power tillers. The farm with the lowest horsepower usage per hectare of cultivated land is Farm D (1.03 Hp/Ha).

A comparison of the degree of mechanization as per Andrade and Jenkins (2003) and the level of mechanization of the farms as per Almasi *et al.*, (2000), shows that Farm E has the highest horsepower consumption and Farm D has the lowest horsepower consumption per hectare of cropped area. Both are calculated in horsepower consumption per hectare area, but as per Andrade and Jenkins (2003), they have a correction factor that includes the differences between the total cultivated area and the total area of farms.

Table 1. Showing Degree of Mechanization as per Almasi *et al.* (2000)

Farms	Total mechanized area (hectare)	Total area to be mechanized (hectare)	Degree of Mechanization
A	50	10	5
B	43	7	6.14
C	70	8	8.75
D	30	5	6
E	40	15	2.66

As per Almasi *et al.* (2000) the degree of mechanization shows the total area under mechanized tools and equipment. The farm C has the highest land area under mechanized tools (8.75) and Farm E has less ratio of area under mechanization and it shows the less degree of mechanization needs more implementation of farm equipment. Farm E needs 15 hectares of lands to be mechanized because of lack of capital.

To calculate the real time cost of mechanization and calculation of all cost of inputs per hectare of land. The farm A, B, C, D and E have the cost of Rs. 3461, Rs. 2850, Rs. 3865, Rs. 2450 and Rs. 3135 per hectare respectively. It shows the farm C and A have more cost of mechanization than other farms.

Overall human workforce

Agriculture requires a finite number of components of production, which are further split into physical (such as labour and capital) and intangible (such as land and capital) resources (Kurbatova *et al.,* 2020). Considerable agroindustrial potential opens vast chances for the sustainable economic growth of the country, which may be achieved at a price of growing efficiency of agricultural output based on the expansion of labour efficiency (Babenko, and Vasilyeva, 2017). By using labor-intensive farming techniques and effectively integrating current technology, human labour may be used while simultaneously being able to save time and money (Sidhu, and Grewal, 1990).

Table 2. Showing average working hours of each farm

Farms	Average hours per day
A	2hr 52 min
B	2hr10 min
C	5hr 38 min
D	3hr 13 min
E	4hr 20 min

One of the most important factors in agriculture is labour. The effective use of workers plays a significant part in profitable agricultural practices. The employability of labour has an impact on agricultural production output. Farm A employs three labourers on 50 hectares of farmed land, with an average workday of two hours and 52 minutes. Farm B has three labourers and an average working day of two hours and ten minutes. Farm C is significantly larger than the other farms, necessitating more time than the other farms. Farm E has identical cropping areas to farms A and B, however, they work longer hours than farms A and B. Despite having a lower agricultural land size, farm D has an average working hour of 3 hours and 13 minutes. It has a direct influence on farm output, productivity, and resource efficiency.

Cost of mechanization in each crop

Different varieties of crops have fundamental differences in terms of their qualities and conditions required for their production which leads to differences in their mechanization. Each crop has different needs which will play as a deciding factor in determining the level of investment and cost of production of the crop. Crops have different lengths of growing seasons ranging from quarterly, semi-annual to annual production of crops.

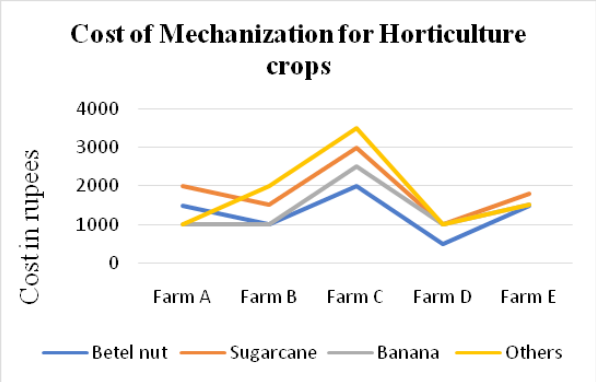

Fig. 4. Showing the Cost of Mechanization for horticulture crops

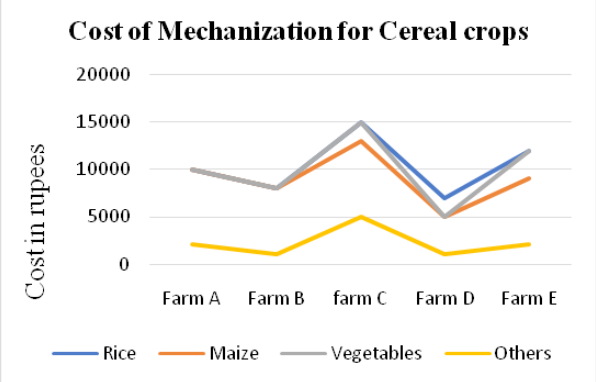

Fig. 5. Showing the cost of Mechanization for Cereal crops

Farm C has the highest mechanization cost for horticultural crops, cereal crops, and animal output of any farm. Horticultural crops in the Others category (precious timber trees) have the greatest mechanization cost, whereas rice and vegetables have the highest cereal crop mechanization cost, and meat has the highest animal produce mechanization cost in Farm C. Farm D, on the other hand, had the lowest mechanization costs for horticultural crops, cereal crops, and animal output of any of the farms.

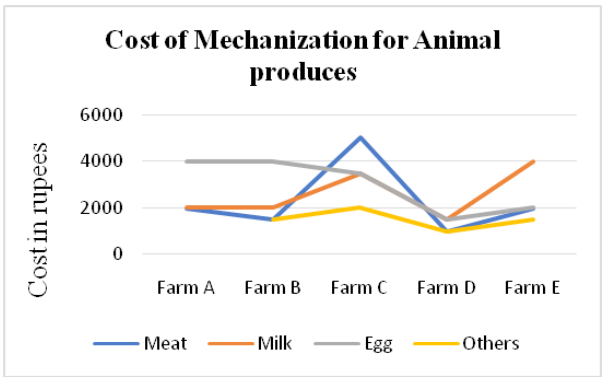

Fig. 6. Showing the cost of mechanization for animal produces

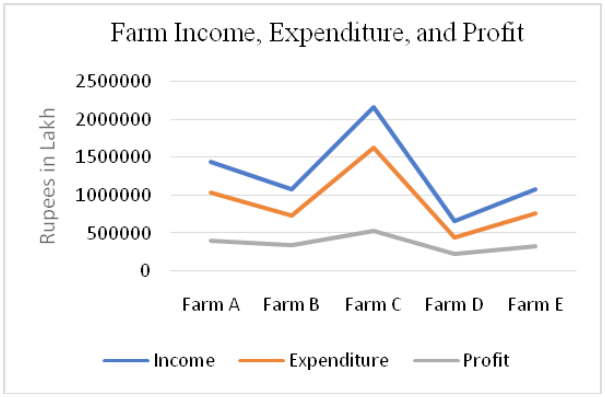

Fig. 7. Showing the farm income, expenditure, and profit

Farmer's income and surplus

In addition to being a crucial step in helping farmers in the modern period to improve their farming practices, raising agricultural operating earnings is also a potent means of fostering rural development and socio-economic development of farmers (Peng *et al.*, 2022).

According to a farm spending survey, farm C has the greatest expenditure of all the farms with Rs. 16,23,300, followed by farm A with Rs. 10,38,300. Farm D, on the other hand, has the lowest outlay of Rs. 441000. Farm C has the largest income among the farms, with Rs. 21,54,800, while Farm D has the lowest income, with Rs. 6,63,500. The profit from the agricultural output, computed as the difference between revenue and expenditure, shows that among the farms, farm C has the largest profit of Rs. 5,31,500, and farm D has the lowest profit of Rs. 2,22,500.

Conclusion

The increasing trend of mechanization affects farmers' agricultural choices because there is a favorable relationship between the installation of mechanized technology and production outputs and income generation. Farms A, B, C, and E have higher energy and energy consumption than farm D, implying that irrigation opportunities may be lacking in this farm. However, average consumption lags far behind that of agriculturally developed states such as Punjab and Haryana. In addition, the capital investment of all farms is quite low compared to these and other agro-based states. For profitable agricultural practices, the average working hours should be between 6 and 8 hours per day. Only farms C and E have better average working hours, but income levels show the lack of proper utilization of the labour force. But farm A shows the proper utilization of labor. The cost of mechanization on agro-farms is much lower, which affects the productivity of the crops. After calculating the farmer's budget, we noticed that capital investment and farm incomes are positively correlated.

References

Almasi, M., Kiani, S. and Loui-mi, N. 2000. *Principles of Agricultural Mechanization.* Ma Soumeh (PBUH) Publication. Ghom, Iran. PP. 19-44.

Andrade, P. and Jenkins, J. 2003. Identification of patterns of farm equipment utilization in two agricultural regions of central and northern Mexico.

Babenko, A. and Vasilyeva, O. 2017. Factors of labour productivity growth in agriculture of the agrarian region. *Baltic Journal of Economic Studies*. 3(4): 1-6.

Clarke, L. J. 2000. Strategies for Agricultural Mechanization Development: The roles of the private sectore and the Government.

Gulati, A. and Juneja, R. 2020. Farm mechanization in Indian agriculture with focus on tractors. *ZEF-Discussion Papers on Development Policy*. (297).

Kurbatova, S. M., Aisner, L. Y. and Naumov, O. D. 2020. Labor resource as a factor of modern agricultural production. In: *E3S Web of Conferences* (Vol. 161, p. 01088). EDP Sciences.

Maheshwari, T. K. and Tripathi, A. 2019. Determination of Agricultural Mechanization Parameters for Western Region of Uttar Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*. 8(9): 132-140.

Min, S. H. I., Paudel, K. P. and Chen, F. B. 2021. Mechanization and efficiency in rice production in China. *Journal of Integrative Agriculture*. 20(7): 1996-2008.

Nwoko, S. G. 1990. Agricultural mechanization at a crossroad in Nigeria. *AMA, Agricultural Mechanization in Asia, Africa and Latin America*. 21(3): 79-82.

Olaoye, J. O. and Rotimi, A. O. 2010. Measurement of agricultural mechanization index and analysis of agricultural productivity of farm settlements in Southwest Nigeria. *Agricultural Engineering International: CIGR Journal*. 12(1).

Obaia, A. R. and Ghazy, M. I. 2017. The study of agricultural mechanization indicators in eastern Libya. *Misr Journal of Agricultural Engineering*. 34(2): 567-580.

Ou, Y. G., Yang, D. T., Yu, P. X., Wang, Y. X., Li, B. X. and Zhang, Y. L. 2002. Experience and analysis on sugarcane mechanization at a state farm in China. Paper number 028048. In *2002 ASAE Annual Meeting*.

Özpinar, S. and Anýl, Ç. A. Y. 2018. The role of agricultural mechanization in farming system in a continental climate. *Tekirdað Ziraat Fakültesi Dergisi*. 15(2): 58-72.

Peng, J., Zhao, Z. and Liu, D. 2022. Impact of agricultural mechanization on agricultural production, income, and mechanism: evidence from Hubei province, China. *Frontiers in Environmental Science*. 10: 53.

Rijk, A. G. 1989. *Agricultural mechanization policy and strategy: The case of Thailand*. Wageningen University and Research.

Sims, B. G., Hilmi, M. and Kienzle, J. 2016. Agricultural mechanization: a key input for sub-Saharan Africa smallholders. *Integrated Crop Management (FAO) eng v.* 23 (2016).

Sidhu, R. S. and Grewal, S. S. 1990. Factors affecting demand for human labour in Punjab agriculture: An econometric analysis. *Indian Journal of Agricultural Economics*. 45(902-2018-2754): 125-133.

Vortia, P., Nasrin, M., Bipasha, S. K. and Islam, M. M. 2021. Extent of farm mechanization and technical efficiency of rice production in some selected areas of Bangladesh. *Geo Journal*. 86: 729-742.

Zangeneh, M., Omid, M. and Akram, A. 2010. Assessment of agricultural mechanization status of potato production by means of artificial neural network model. *Australian Journal of Crop Science*. 4(5): 372-377.