Original Research Article

Pioneering Challenges: Exploring Multifaceted Obstacles in Agricultural Mechanization in Tamil Nadu

ABSTRACT

Aim: To comprehend the identified constraints spanning various categories, including economic challenges, environmental issues, extension-related limitations, infrastructural obstacles, informational barriers, operational challenges, technological impediments, and capacity-building constraints faced by farmers utilizing farm mechanization.

Study design: This study adopted a comprehensive approach.

Place and Duration of study: This study was conducted in two distinct regions within Tamil Nadu, specifically Coimbatore and Ramanathapuram, representing high and low irrigation intensity zones, respectively.

Methodology: The study actively involved 120 farmers, with an equal distribution of 60 participants from each district, who participated by responding to questionnaires. The study meticulously applied the Rank-Based Quotient (RBQ) methodology to assess the most prominent constraints hindering effective farm mechanization.

Results: The study identified constraints spanning multiple categories, including economic challenges such as the absence of credit facilities and heightened investment costs, environmental issues like pesticide usage and increased fossil fuel emissions, extension-related limitations including restricted interaction between extension officials and farmers in remote areas, infrastructural obstacles like the unavailability of service centers, informational barriers involving inadequate knowledge of government subsidies, operational challenges such as frequent machinery repairs, policy-related issues like the inadequate implementation of government support programs, situational challenges including farmers' hesitance to embrace mechanization, technological impediments such as a lack of familiarity with advanced technologies, and capacity-building constraints, including insufficient training for both farmers and skilled workers.

Conclusion: These findings emphasize the urgency of targeted policy interventions, increased awareness, enhanced access to training, and the establishment of support mechanisms to surmount these obstacles. Addressing these constraints holds the potential to empower farmers to optimize machinery utilization, augment productivity, and make substantial contributions to agricultural development, providing valuable insights for other developing nations grappling with similar challenges in advancing their agricultural sectors.

Keywords: Advancement, Constraint, Environment,Inadequate, Lack,Mechanization

1.INTRODUCTION

In the realm of agriculture, machines are revolutionizing productivity and prosperity. The fields are alive with the hum of technology, heralding a new era in farming. At the heart of this transformation is agricultural mechanization, a concept that promises bountiful harvests and thriving livelihoods. However, achieving its full potential is hindered by various limitations. As technology advances, mechanized farming is becoming increasingly popular worldwide (McCauley, 2003). It involves using engineering and technology to enhance field productivity (Rahman et al., 2003). Agricultural mechanization involves utilizing equipment and machinery to alleviate production challenges (Folaranmi, 2014). A crucial aspect of the puzzle is the efficient use of mechanization inputs, which encompasses manufacturing, distribution, repair, maintenance, and optimal utilization of tools (Zangeneh and Banaeian, 2014). It's essential to understand that agricultural development involves a trio of approaches: biochemical, socioeconomic, and engineering, with the engineering dimension, focused on providing machines and equipment to optimize economic growth and development (Mrema and Odigboh, 1993; Ani and Onwualu, 2002; Ampratwum*et al*., 2004; Onwualu and Pawa, 2004).

In India, mechanization has transformed from a choice into a necessity. The agricultural landscape has undergone a remarkable shift from traditional methods to a mechanized approach, driven by fossil fuel-powered champions like tractors and diesel engines. This transition isn't just about innovation; it's about efficiency and reduced labour burden (Ravi Kishore*et al*., 2022). As we dive into the statistics, the impact becomes strikingly clear. Embracing proper farm mechanization can yield significant savings—up to 20% on seeds, 30% on fertilizers, 30% on time, and even up to 20% on labour expenses. When combined with a 10-15% increase in crop intensity, this equation results in an astounding 15-20% boost in

overall productivity (Nagraj *et al*., 2013). Although India has made notable strides in the realm of agricultural mechanization, the journey has been uneven.

In Tamil Nadu, the journey towards farm mechanization is met with a multitude of challenges. The study specifically concentrated on identifying the limitations that hinder the efficient implementation of farm mechanization. These obstacles are as diverse as a wide range of factors, spanning economic, technological, extension-oriented, operational, situational, policy framework, infrastructural, information-seeking, capacity-building, and environmental dimensions. Through this investigation, its goal is to offer a profound and thorough comprehension of the circumstances. This comprehension is crucial for crafting strategies that not only foster the development of these farmers but also ensure the enduring viability of agricultural production and the prosperity of the local farming communities. It will also aid policymakers in implementing effective distribution management to ensure all types of farmers benefit from mechanization.

2.METHODOLOGY:

This comprehensive study meticulously chose two distinct zones within Tamil Nadu. Within these zones, two districts, specifically Coimbatore (representing a high irrigation intensity zone) and Ramanathapuram (characterizing a low irrigation intensity zone), were deliberately selected for examination. The rationale behind this selection of these districts was purposeful, as they are well-known for their practices related to farm power utilization. Using the random sampling method, primary data was obtained by administering questionnaires to 60 farmers from each district, yielding a total sample size of 120 farmers across two districts. By adopting this approach, the study aimed to directly capture insights from farmers, aiming for a comprehensive understanding of the challenges they face and the strategies they employ to overcome them. The collected data were analyzed using the Rank-Based Quotient (RBQ) method, a tool employed to draw definitive conclusions regarding the constraints that have the most and least significant impact on hindering effective farm mechanization. The RBQ calculation adhered to the provided formula.

$$\text{RBQ} = \frac{\sum_{i=1}^{n}(Fi)(n+1-i)}{N \times n} \times 100$$

Where,

Fi = Frequency of respondents for ith rank

N = Number of respondents

n = Number of ranks

$\sum ni$=1 = it directs to sum multiple factors.

$\sum (Fi)\ (n + 1 - i)\ ni$=1 = F1 × n + F2 × n – 1 + F3 × n – 2 ……. Fn × 1

3.Results& DISCUSSION:

A well-structured and pre–tested interview schedule was formulated. This schedule addressed diverse challenges faced by farmers utilizing agricultural machinery, Respondents were requested to assign rankings to these constraints based on their individual perceptions. The subsequent sections delve into the outcomes and discussions stemming from this process.

3.1 Economical Constraints

From Table 1, it can be inferred that the primary impediment, with an RBQ value of 82.74%, is the "lack of credit facilities, this issue predominantly arises from the farmers with limited assets and insufficient capital. Following closely is the concern of "Elevated investment costs and taxation on machinery," identified by 75.36% of the surveyed individuals. This ranks as the second most significant constraint, particularly since a substantial portion of the farmers fall into the small and marginal category, making hefty investments challenging for them. In third place is the constraint of "higher hiring charges" (62.74%) Farmers who allocate a significant portion of their profits to machinery rental may experience a detrimental impact on their overall revenue. Furthermore, the "lack of institutional credit mechanisms to sustain custom hiring centres"(57.74%) and the "high cost of fuel" (53.81%) contribute to the challenges of embracing farm mechanization. Consequently, employing expensive fuel-based agricultural machinery may not be a feasible option for all types of farmers.

Regarding "high maintenance costs "(49.64%) and" low resale values" (49.05%), older machinery tends to depreciate rapidly, making it less appealing to potential buyers. Older agricultural machinery may require more frequent repairs and maintenance, which can be costly.Prospective purchasers often hesitate to invest in pre-owned machinery that might harbor concealed maintenance issues. Comparable to any other type of equipment, agricultural machinery experiences depreciation over time, leading to a decrease in its resale

worth. These factors occupy the sixth and seventh positions in terms of significance, as highlighted by B. Madhukar *et al*. in 2021.

S.no	Constraints	RBQ	Rank
1	Lack of credit facility	82.74	I
2	Elevated investment cost & taxation on machinery	75.36	II
3	Higher hiring charges	62.74	III
4	Lack of institutional credit mechanism to support & sustain Custom Hiring Centre	57.74	IV
5	High fuel cost	53.81	V
6	High maintenance cost	49.64	VI
7	Low resale value	49.05	VII

Table 1. Economical Constraints

3.2 Environmental Constraints

Table 2 illustrates that the most significant limitation (81.33%) primarily involves the utilization of pesticides and herbicides, leading to negative impacts on human health and water contamination. Farmers who employ these chemicals may face potential health risks such as respiratory issues, skin irritations, and long-term health concerns. Additionally, the operation of heavy machinery can transmit vibrations to operators, potentially resulting in musculoskeletal disorders and other health issues over time. Moreover, the use of agricultural chemicals through sprayers can result in runoff into nearby water bodies, thereby contaminating them. This contamination can have detrimental effects on aquatic ecosystems and the availability of clean water, affecting both agricultural and domestic use. The second most prominent constraint, at 63.50%, is "increased fossil fuel emissions," particularly from vehicles like tractors and harvesters. These machines emit various pollutants into the atmosphere, contributing to air pollution, which can negatively impact the environment and human health. The combustion of fossil fuels releases greenhouse gases like carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), which, when released into the atmosphere, contribute to global warming and climate change. Furthermore, oil spills and

leaks from machinery can contaminate soil and water bodies. The next significant limitation is "soil compaction" (57.17%). Contemporary agricultural machinery, such as tractors and combines, frequently exerts substantial pressure on the soil due to their considerable weight during operation. This weight can result in soil compaction, particularly in areas where machinery is frequently used. This pressure reduces the natural gaps in the soil, making it harder for water and air to enter. resulting in slower growth and smaller yields. It also leads to the loss of nutrient-rich topsoil, crucial for plant growth. The fourth constraint is "chemical residues in the soil" (55.17%). Farmers frequently employ pesticides and herbicides to manage pests and weeds. These chemicals can leave residues in the soil, with enduring implications for soil quality and ecosystem health. and can persist in the soil for extended periods. It has adverse effects on soil-dwelling organisms, beneficial insects, and other elements of the ecosystem, disrupting natural ecological balances. The last constraint is "increased waste generation due to the disposal of plastic mulch, containers, and machinery parts" (53.83%). Discarded plastic mulch poses significant environmental risks as it decomposes slowly, potentially contributing to soil and water pollution and posing threats to wildlife. The use of pesticides, herbicides, and fertilizers often involves plastic containers, which can accumulate as waste on farms.as highlighted by Reynolds*et al*. in 2015

S.No	Constraints	RBQ	Rank
1	Negative impact on human health and contaminateswater bodies	81.33	I
2	Increased fossil fuel emits pollutants	63.50	II
3	Soil compaction	57.17	III
4	Chemical remnants in soil	55.17	IV
5	Increased waste generation due to discarded plastic mulch, containers & machinery parts	53.83	V

Table 2. Environmental Constraints

3.3 Extension Constraints

Based on Table 3, it is evident that the most significant challenge faced by 87.77% of the respondents is the "limited interaction between Extension officials and farmers in remote areas", leading to a lack of information transfer regarding innovative technologies. The second most notable constraint, as reported by 58.88% of the respondents, is the insufficient follow-up support for farmers who embrace farm mechanization. After the initial introduction of machinery, farmers may be left without adequate assistance and guidance. Without continuous support, farmers may not fully understand how to use the machinery to its fullest, and they often require ongoing guidance and support to maximize the benefits of these technologies. Furthermore, 55.00% of the respondents expressed concerns about inadequate outreach activities. This lack of awareness can dampen their enthusiasm for adopting modern farming equipment and techniques. These findings are consistent with those presented by Kavinya in 2019.

S.No	Constraints	RBQ	Rank
1	Extension officials have limited interaction with farmers in remote areas	87.77	I
2	Limited follow-up support	58.88	II
3	Inadequate outreach activities	55.00	III

Table 3.Extension Constraints

3.4 Infrastructure Constraints

It was observed from Table 4 that 83.33% of the respondents felt the non-availability of service centers nearby was a major hindrance, followed by 65.42% of the respondents who felt a scarcity of nearby shops for spare parts. Because rural areas often have a lower population density compared to urban centers, this lower customer base can make it economically unviable for spare part shops to operate in these regions, and 56.88% of the respondents felt a shortage of fuel stations nearby; they found it difficult to purchase spare parts and fill petrol or diesel for their machines, and 52.71% of the respondents felt a lack of custom hiring centers in the vicinity. These points are relevant to the studies of Hemasankari (2017) and Kavinya (2019).

S.No	Constraints	RBQ	Rank
1	Nonavailability of service centers in nearby	83.33	I
2	Scarcity of nearby shops for spare parts.	65.42	II
3	Shortage of fuel stations nearby	56.88	III
4	Lack of custom hiring centers in the vicinity.	52.71	IV

Table 4. Infrastructure Constraints

3.5 Informational Constraints

Based on Table 5, it can be inferred that the most significant hindrance is insufficient knowledge of government subsidies and benefits, which is reported by 81.04% of the respondents. This deficiency arises from insufficient communication channels, and farmers are facing difficulties in understanding the eligibility criteria, application procedures, and the specific benefits they are entitled to receive. Following this, the second major constraint is the "limited understanding of mechanization choices for their crops" (61.04%). Different crops have diverse requirements for planting, cultivation, and harvesting techniques, making it challenging for farmers to determine which mechanization tools and equipment are most suitable for their specific crops. Lastly, the third constraint is poor awareness of after-sale services" (53.13%), which leads to neglect of maintenance tasks and delays in addressing mechanical issues. Consequently, this results in a reduced equipment lifespan and increased downtime.These points are relevant to the studies of Hemasankari (2017).

S.no	Constraints	RBQ	Rank
1	Insufficient knowledge on government subsidies and benefits	81.04	I
2	Limited understanding on choice of mechanization for their crops	61.04	II
3	Poor awareness of after-service	53.13	III

Table 5. Informational Constraints

3.6 Operational Constraints

The analysis from Table 6 reveals that the foremost challenge, as indicated by the data, is the frequent need for repairs and servicing (83.19%), especially during peak farming seasons like planting and

harvesting. The continuous use of machinery in tough conditions, such as muddy fields and extreme temperatures, accelerates wear and tear, resulting in more frequent breakdowns and repairs. Financial constraints often force farmers to stick with older, less reliable equipment, exacerbating the repair burden. Following closely at 71.25%, "frequent power cuts" pose the second challenge, particularly in rural areas lacking proper electricity infrastructure. These interruptions disrupt farming operations, reducing efficiency and productivity. Farmers may resort to costly and less efficient alternatives like diesel generators, increasing expenses and lowering profits. The next issue, at 61.25%, is the scarcity of skilled labour proficient in modern machinery operations. Skilled workers often opt for better-paying opportunities in non-agricultural sectors, aggravating the shortage of capable farm labour. " Inefficiency in farm machinery testing (54.48%) represents the fourth constraint. Farmers may not have easy access to the specialized testing facilities or equipment required for comprehensive machinery testing. This limitation can hinder their ability to conduct thorough evaluations. Lastly, "fragmented land holdings" (51.11%) present a challenge for farmers with small, scattered fields, as owning individual machinery is not cost-effective, as highlighted by Ravikishore M. *et al.* (2022).

S.No	Constraints	RBQ	Rank
1	Frequent repair and serviceability with high cost	83.19	I
2	Frequent power cut	71.25	II
3	Lack of skilled labour to operate efficient Machines	61.25	III
4	Inefficiency in farm machinery testing	54.58	IV
5	Fragmented land holdings	51.11	V

Table 6. Operational Constraints

3.7 Policy Related Constraints

Table 7 indicates that the poor implementation of government support programs (65.00%) is caused by a lack of effective government strategies to promote machinery. The second constraint, identified by 52.92% of respondents, is poor coordination among different government agencies responsible for implementing support programs. This leads to inefficiencies and gaps in service delivery, resulting in delays in providing necessary support to farmers. The third constraint, accounting for 10.21% of responses, is the ineffective distribution of direct benefits and subsidies due to inadequate monitoring and evaluation mechanisms.

Without proper oversight, it becomes challenging to identify and rectify issues. These constraints represent the policy-related hindrances faced by farmers utilizing farm mechanization.as highlighted by Ravikishore M. et al. (2022).

S.No	Constraints	RBQ	Rank
1	Poor implementation of government support programs	65.00	I
2	Lack of effective government strategies to promote machinery use among farmers	52.92	II
3	Ineffective distribution of direct benefits and subsidies.	10.21	III

Table 7. Policy Related Constraints

3.8 Situational Constraints

According to Table 8, the primary constraint that ranked at the top of the table is farmers' reluctance to embrace mechanization, with 82.92% of respondents expressing hesitation due to traditional practices that discourage the adoption of machinery. Some farmers prefer manual labour and are also resistant to changing their traditional farming methods, despite the potential benefits of mechanization. Followed by the second constraint, the scarcity of affordable skilled labour for machine operation was reported by 72.36% of respondents. There is a lack of skilled workers who can effectively operate machinery at affordable wages. The third constraint, identified by 54.86% of respondents, is the delay in obtaining necessary equipment at the right time. This is caused by high demand during peak seasons and the limited availability of farm mechanization equipment, particularly in rural or remote areas. Suppliers or Custom hiring centers often have limited machinery, resulting in delays, especially when machines are owned by a few large farmers in the village, leaving others dependent on them. The fourth constraint, highlighted by 54.17% of respondents, is the inadequate availability of women-friendly equipment. Many farm implements and machinery are designed without considering women's specific needs and physical characteristics. This can lead to inefficiencies and potential health issues, as the equipment may not be ergonomically suitable or comfortable for women to operate. Lastly, another significant constraint is the lack of quality machinery and limited subsidization for premium brands (49.86%), Premium brands offer superior quality, advanced features, and durability but come at a higher price. Here, Small-scale or resource-constrained farmers often cannot afford these brands, and the limited subsidization or financial

support for purchasing such machinery further adds to the cost constraints they face.These points are relevant to the studies of Hemasankari (2017).

S.no	Constraints	RBQ	Rank
1	Hesitant to embrace mechanization	82.92	I
2	Scarcity of affordable skilled labor for machine operation	72.36	II
3	Delay in getting necessary equipment at the right time	54.86	III
4	Inadequate women-friendly implements	54.17	IV
5	Lack of quality machineries and limited subsidization for premium brands	49.86	V

Table 8.Situational Constraints

3.9 Technological Constraints

Table 9 reveals that the primary constraint, identified as the top obstacle, is the "lack of familiarity with recent advanced technologies," which has a ranking of 1st place with 86.72%. Farmers who have already embraced mechanization might not be well-informed about the latest advancements due to restricted access to information and resources. This unfamiliarity can impede their ability to make well-informed decisions regarding equipment upgrades or the adoption of more efficient practices. Followed by the second significant constraint is "Manufacturing defects" (56.52%). These defects can range from minor malfunctions to severe failures, rendering machinery non-functional or unsafe for use. Farmers may encounter difficulties in addressing such defects, leading to costly repairs, downtime, and reduced productivity.Lastly, the third constraint is the "Limited understanding and ability to utilize apps such as uzhavan, e-vadagai, and Jfarm services, as well as other communication channels" (53.53%). Many farmers may have limited exposure to digital technologies and lack the necessary skills to effectively employ apps and communication channels. Insufficient access to smartphones, internet connectivity, or a lack of familiarity with digital platforms can hinder their capacity to comprehend and utilize these tools effectively.These points are relevant to the studies of Hemasankari (2017).

S.No	Constraints	RBQ	Rank
1	Lack of familiarity with technology.	86.72	I

2	Manufacturing defects	56.52	II
3	Limited understanding and ability to utilize apps like uzhavan, e-vadagai, and Jfarm services	53.53	III

Table 9. Technological Constraints

3.10 Capacity Building Constraints

From Table 10, it is recorded that the primary constraint is insufficient training in operating machines for 82.32% of the respondents. This is because many farmers may not have access to proper training programs and workshops on how to operate farm machinery and tools effectively. This is due to a lack of awareness about such opportunities and events, and the cost of attending training sessions can be a significant barrier, especially for small-scale and limited-resource farmers. followed by the second constraint with 58.82%, "inadequate training for skilled workers and trained machinery operators". This constraint happens due to a scarcity of specialized training programs that focus on developing the necessary skills for operating farm machinery. Many existing training programs do not adequately cover the technical aspects of operating complex machinery, resulting in a shortage of skilled workers. The third constraint, at 54.42%, is the "lack of availability of trainers for live demonstrations and extended field coaching. This constraint arises from a shortage of trainers who possess the expertise and knowledge required to train farmers in operating farm machinery. Finding qualified trainers who can provide hands-on training and guidance can be challenging, particularly in rural areas.These points are relevant to the studies of Hemasankari (2017) and Kavinya (2019).

S.No	Constraints	RBQ	Rank
1	Insufficient training in operating farm tools, equipment, and machinery.	86.32	I
2	Inadequate training for skilled workers & trained machinery operators	58.82	II
3	Lack of availability of trainers for live demonstration & extended field coaching	54.42	III

Table 10. Capacity Building Constraints

4. Conclusion:

The primary aim of this study was to pinpoint the challenges that farmers encounter when trying to make use of farm mechanization. The research gathered a diverse array of hindrances and classified them into several categories, including economic, environmental, extension-related, infrastructural, informational, operational, policy-related, situational, technological, and capacity-related obstacles. The study's findings uncovered a number of significant impediments that farmers face within each category. Among these challenges is the absence of financial support, which hampers farmers' ability to invest in mechanization. Another pressing concern is the adverse effects on human health and water contamination. In remote areas, limited interaction between extension officials and farmers results in restricted access to information and assistance. The lack of nearby service centers poses difficulties for farmers in terms of machinery maintenance and repair. Additionally, insufficient awareness of government subsidies and benefits presents a constraint. Other issues encompass frequent breakdowns and serviceability problems, inadequate implementation of government support initiatives, farmers' reluctance to adopt mechanization, unfamiliarity with technology, and insufficient training in operating farm equipment and machinery.

Based on these findings, it is recommended that the government devise policies to encourage farmers to consolidate small-scale plots into larger, high-quality farmland suitable for mechanized processes. Furthermore, offering better training in machinery operation, fostering cooperative endeavors, and providing financial aid or procurement subsidies for agricultural machinery and equipment purchases are suggested. Additionally, training, demonstration, and advisory programs should be initiated to enhance farmers' skills and keep them informed about recent innovations and techniques. To promote the use of farm machinery in intermediate processes, it is advisable to develop customized machines and equipment and establish a targeted subsidy system. These recommendations have the potential to benefit other developing nations facing similar social and economic challenges in the realm of agricultural progress. By addressing these obstacles and implementing appropriate measures, farmers can enhance their proficiency in operating farm tools and machinery, leading to heightened productivity, efficiency, and overall agricultural advancement.

References

- Ampratwum, D., A. Dorvlo and L. Opara. 2004. Usage of tractor and field machinery in agriculture in Oman. Agric. Eng. Int. CIGR J. Sci. Res. Dev. Invit. Overview Paper, 6: 41-48
- Ani, A.O. and A.P. Onwualu. 2002. Agricultural mechanization: A Pre-requisite for food security in West Africa. 1st International conference of the West African society of agricultural engineering, Abuja, Nigeria
- Folaranmi, A.G., 2014. The role of agricultural mechanization in the enhancement of sustainable food production in Nigeria. https://www.linkedin.com/pulse/20140617225331-162049572
- Hemasankari, K.2017." Socio-Economic Impact of Farm Mechanization among Paddy Growers in Thanjavur District." Unpub. M.Sc. (Ag) Thesis,AC& RI, TNAU ,Coimbatore
- Kavinya, M.2019."A Study on Utilization Behaviour of Paddy Growers on Farm Mechanization in Villupuram District .".M.Sc.(Ag) Thesis AC & RI, TNAU ,Coimbatore
- Madhukar, B., Reddy, P. B. H., Lakshmi, T., & Ramu, Y. R. (2021). Constraints in the adoption of farm mechanization and suggestions to overcome the constraints. The Pharma Innovation. Article availableat https://www.researchgate.net/profile/P-Bala Reddy/publication/363266505_Constraints_in_adoption_of_farm_mechanization_and_suggestions_to_overcome_the_constraints/links/6314e36c5eed5e4bd1478b32/Constraints-in-adoption-of-farm-mechanization-and-suggestions-to-overcome-the-constraints.pdf
- McCauley, J.F., 2003. Plowing Ahead: The Effects of Agricultural Mechanization on Land Tenure in Burkina Faso. J. Public Int. Aff., 14: 6-27.
- Mrema, G.C. and E.U. Odigboh. 1993. Agricultural development and mechanization in Africa: Policy perspectives. Network for Agricultural Mechanization in Africa (NAMA) Newsletter, 1(3): 11-50
- Nagaraj, P. S., Swamy, D., Madhushree, A., & Vidyadhara, B. (2013). A study on knowledge and adoption of farm mechanization by paddy grower in Tungabhadra project area, Karnataka. *International Journal of agriculture and food science technology*, *4*(4), 385-390.
- Onwualu, A.P. and N.P. Pawa. 2004. Engineering infrastructure for the manufacture of agricultural engineering machines in Nigeria: The role of NASENI. Proc. 2nd Int. Conf. West Afr. Soc. Agric. Eng., Kumasi, Ghana.

- Rahman, S.A. and A.B. Lawal. 2003. Economic analysis of maize-based cropping Systems in Giwa Local Government Area of Kaduna State, Nigeria. Int. J. Agric. Sci. Sci. Environ. Technol., 3: 139-148.
- Reynolds, T.W., Waddington, S.R., Anderson, C.L. et al. Environmental impacts and constraints associated with the production of major food crops in Sub-Saharan Africa and South Asia. Food Sec. 7, 795–822 (2015). https://doi.org/10.1007/s12571-015-0478-1
- Ravikishore M, Supriya P &Ramasbbiah K (2022). Farm mechanization: Policies, challenges, and strategies. The Agriculture Magazine,2(1), 118-126.Article available at https://www.researchgate.net/profile/Ravikishore-Modem/publication/366356313_Farm_Mechanisation_Policies_Challenges_and_Strategies/links/639cc430e42faa7e75cb10ed/Farm-Mechanisation-Policies-Challenges-and-Strategies.pdf
- Zangeneh, M., and N. Banaeian. 2014. Investigation of agricultural mechanization status in corn production of Iran. Agric. Eng. Int. CIGR J., 16(1): 191-197