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Characteristics and Evaluation of Agricultural Machinery Systems

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ABSTRACT: Agriculture has undergone significant technological advancements over the years, with machinery systems playing a crucial role in modern farming practices. This study provides an analysis of agricultural machinery systems, their characteristics, and evaluation. Key components of these systems include engines, power trains, hydraulic systems, electrical systems, control units, and implements. The evaluation criteria used to assess the effectiveness of these machines depends on factors such as crop type, farm size, soil conditions, economic viability, profitability, ergonomics, safety, ease of use, adaptability to new innovations, operational costs, and long-term sustainability. With this understanding, researchers and policymakers can make informed decisions regarding investments in these critical technologies. Further studies into machine design optimization may bring important insights for cost reduction, energy conservation, greater precision, autonomy, robustness, modularity, environment friendliness, and human welfare augmentation.

Keywords:Farm machinery systems, Productivity, Modern farming, Machine design

I. INTRODUCTION

Agriculture has been the backbone of human civilization since the beginning of time.Advancements in technology have transformed the face of agriculture significantly, ushering in innovative solutions to traditional challenges faced by farmers. One of these developments includes the introduction of Farm Machinery System (FMS) which plays an essential part in modern farming practices. With the growing population and increasing demand for food, the need for efficient and effective farming practices has become more important than ever. Farm machinery systems are an essential component of modern agriculture and they have played a crucial role in increasing agricultural productivity and efficiency. The use of farm machinery has increased over the years, and has revolutionized the way we farm today, making it possible to produce more food with less labor. In this review paper, we will discuss the characteristics of farm machinery systems and evaluate their impact on agriculture and the environment.

II. REVIEW OF LITERATURE

Farm machinery has been found to enhance productivity and reduce human drudgery and cost of cultivation. Mechanization also helps in improving utilization efficiency of other inputs, safety and comfort of the agricultural worker, improvements in the quality and value addition of the produce. Different researchers have concluded that farm mechanization enhances the production and productivity of different crops due to timeliness of operations, better quality of operations and precision in the application of the inputs.
Artificial Intelligence (AI) can enhance the use of farm machinery in several ways. AI-driven tools such as driverless tractors, smart irrigation and fertilizing systems, smart spraying, vertical farming software, and AI-based robots for harvesting are some examples of how farmers can get the work done without having to hire more people[1]. Compared with any human farm worker, AI-driven tools are faster, harder, and more accurate[1]. Advancements in AI and machine learning (ML) also boost prediction accuracy and provide insights into weather events, crop classification, and diseases of plants and animals[4].

Different researchers have concluded that farm mechanization enhances the production and productivity of different crops due to timeliness of operations, better quality of operations and precision in the application of the inputs [14]. Past studies on efficiency of farm mechanization revealed that by mechanization a farmer can save seed (15-20%), fertilizer (20-30%), time (20-30%), labour (5-20%), increasing cropping intensity (10-15%) and higher productivity (15-20%) [7]. The level of mechanization has a significant positive impact on the cost, output value, income and return rate of all types of crops [9]. Mechanization in agriculture enhances production and productivity of crops through timeliness, better management of inputs, improved quality of work and reduction of post-harvest losses [8].

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| Volume 9, Issue 5, September 2022 |

III. DISCUSSION

A. History of farm machinery

The history of farm machinery dates back to the ancient times when humans used simple tools like sticks and stones to till the land. The first agricultural revolution took place around 10,000 years ago when humans started domesticating animals and plants. This led to the development of more advanced tools like plows and sickles. The second agricultural revolution took place in the 18th century with the invention of machines like the seed drill and threshing machine. The third agricultural revolution took place in the 20th century with the development of tractors and other motorized equipment.

The history of farm mechanization in India can be traced back to the early 19th century, when the first agricultural machines were introduced by the British colonial rulers. These machines were mainly used for land clearing, plowing, and harvesting crops. However, the use of these machines remained limited due to their high cost, lack of technical knowledge, and low demand from farmers.

After India gained independence in 1947, the government launched various initiatives to promote mechanization in agriculture. In the 1950s, the government introduced the Farm mechanization Scheme to provide subsidies to farmers for purchasing tractors. This scheme helped to increase the adoption of tractors in agriculture, especially in the northern and western parts of the country.

In the 1960s, the Green Revolution brought about a significant change in Indian agriculture. The government introduced high-yielding varieties of seeds, fertilizers, and irrigation facilities, which increased crop productivity. The use of machinery also increased during this period, as farmers needed to cultivate larger areas of land to meet the growing demand for food.

During the 1980s and 1990s, the private sector began to play a more significant role in the development and distribution of farm machinery. Many Indian and multinational companies started manufacturing and marketing tractors, harvesters, and other agricultural machines.

In the 1994, Small Farmers Agribusiness Consortium (SFAC), an Autonomous Society promoted by Ministry of Agriculture, Cooperation and Farmers' Welfare, Government of India was formed. The SFAC is implementing the central schemes of Government of India namely Venture Capital Assistance (VCA) and Equity Grant and Credit Guarantee Fund Scheme (EGCGS) for the economic inclusion of small and marginal farmers in agribusiness activities.
In recent years, the government has launched various initiatives to promote sustainable agriculture and reduce the adverse impact of mechanization on the environment. These initiatives include promoting the use of solar-powered machines, encouraging the adoption of precision farming techniques, and providing subsidies for purchasing eco-friendly machinery.

Today, farm mechanization has become an essential part of Indian agriculture, with tractors, harvesters, and other machines being used extensively across the country. However, there is still a need to promote sustainable and eco-friendly mechanization practices to ensure the long-term viability of Indian agriculture.

B. Meaning of farm machinery systems

Farm machinery systems refer to the combination of various farming machines and equipment that are used to perform different agricultural tasks. These systems typically include a range of machinery, such as tractors, plows, cultivators, planters, harvesters, and irrigation systems, among others. The machines within these systems are designed to work in conjunction with one another, allowing farmers to perform tasks such as preparing the soil, planting, and harvesting crops with greater efficiency and accuracy. Modern farm machinery systems are often equipped with advanced technologies such as GPS, sensors, and automated controls, which improve their functionality and performance. Overall, farm machinery systems are essential for modern agriculture as they help farmers to increase productivity, reduce labor costs, and minimize environmental impact.

C. Types of farm machinery

There are different types of farm machinery, each designed to perform a specific function or task:

1. Tractors: Tractors are versatile machines that are used to pull various types of farm equipment, such as plows, cultivators, and seeders.

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2. Combine harvesters: Combine harvesters are large machines that are used to harvest grain crops, such as wheat, corn, and soybeans.
3. Planters: Planters are machines that are used to plant seeds in rows or in a specific pattern.
4. Sprayers and Dusters: Sprayers and dusters are used to apply pesticides, herbicides, and fertilizers to crops.
5. Balers: Balers are machines that are used to compress and bind hay, straw, or other crops into bales for storage or transport.
6. Mowers: Mowers are machines that are used to cut grass, hay, or other crops.
7. Tillers: Tillers are machines that are used to prepare soil for planting by breaking up and loosening the soil.
8. Irrigation equipment: Irrigation equipment, such as pumps, pipes, drippers and sprinklers, are used to deliver water to crops.
9. Grain carts: Grain carts are used to transport harvested grain from the field to storage.
10. Spreaders: Spreaders are machines that are used to spread fertilizer, lime, or other materials over a large area.
11. Conveyors: These machines are used to transport crop produce from on place to another.
12. Motors and Engines: They are source of power to drive other farm machinery and equipment.

D. Importance of farm machinery systems in modern agriculture

Farm machinery systems are of utmost importance in modern agriculture for several reasons. Firstly, they increase agricultural productivity by allowing farmers to cultivate more land and increase crop yields. By using machinery such as tractors, planters, and harvesters, farmers can perform tasks much more efficiently than using traditional methods by hand. Secondly, farm machinery systems help to reduce labor costs and manual labor requirements, which is especially important given the decreasing availability of farm labor in many regions. Thirdly, the use of farm machinery systems often leads to reduced soil erosion, as well as reduced dependence on chemical inputs like herbicides, pesticides, and fertilizers. Farm machinery plays a critical role in increasing productivity on farms in following ways:

1. Efficiency: Farm machinery is designed to perform specific tasks more efficiently than manual labor. For example, a tractor can plow a field much faster than a team of horses, allowing farmers to cover more ground in less time.
2. Precision: Many types of farm machinery, such as planters and sprayers, are designed to apply inputs, such as seeds and fertilizers, at a precise rate and in a specific pattern. This precision can help reduce waste and improve crop yields.
3. Speed: Farm machinery allows farmers to work more quickly and complete tasks in a shorter amount of time, which can be especially important during critical periods, such as planting or harvesting.
4. Labor savings: Using farm machinery can also reduce the need for manual labor, allowing farmers to focus their time and resources on other important tasks.
5. Consistency: Farm machinery can perform tasks more consistently than manual labor, which can help ensure that crops are planted, harvested, and processed consistently and efficiently.
6. Safety: Farm machinery can also help improve safety on farms by reducing the need for manual labor and allowing farmers to perform tasks from a safe distance.

Overall, farm machinery can significantly increase productivity on farms by allowing farmers to work more efficiently, effectively, and safely. This can help farmers produce more food with fewer resources, which is essential for meeting the world's growing demand for food.

E. **Characteristics of Farm Machinery Systems**

Farm machinery systems are complex systems that consist of several components, such as tractors, implements, and equipment. These machines are designed to perform specific functions and are often used in combination with other machines to carry out a particular farming operation. The characteristics of farm machinery systems can be described as follows:

1. *Functionality:* Farm machinery systems are designed to perform specific functions, such as plowing, planting, and harvesting. These machines are built to handle different types of crops and various terrain conditions.
2. *Compatibility:* The different components of farm machinery systems are designed to work together seamlessly. This ensures that the machines operate efficiently and effectively, without any compatibility issues.
3. *Durability:* Farm machinery systems are built to withstand harsh operating conditions, such as extreme weather, rough terrain, and heavy loads. These machines are designed to last for many years, with proper maintenance.
4. *Safety:* Farm machinery systems are equipped with safety features, such as roll-over protection structures, seat belts, and warning signals. These safety features are designed to protect the operator and other personnel from accidents and injuries.

5. *Efficiency:* Farm machinery systems are designed to perform tasks quickly and efficiently, to maximize productivity and reduce labor costs. These machines are equipped with advanced technologies, such as GPS and precision farming systems, to optimize their performance.

Evaluation of Farm Machinery Systems:
Farm machinery systems are evaluated using various methods, such as field experiments, laboratory tests, and computer simulations. The objective of evaluating farm machinery systems is to determine their efficiency, effectiveness, and reliability. The following methods are commonly used to evaluate farm machinery systems:
1. *Field Experiments*: Field experiments involve testing the performance of farm machinery systems in real-world conditions. These experiments are conducted on farms, and the machines are evaluated based on their performance, fuel consumption, and labor requirements.
2. *Laboratory Tests*: Laboratory tests are conducted to evaluate the mechanical properties of farm machinery systems. These tests involve measuring the strength, durability, and wear resistance of machine components, such as tires, blades, and bearings.
3. *Computer Simulations*: Computer simulations are used to evaluate the performance of farm machinery systems under different operating conditions. These simulations involve using mathematical models to simulate the behavior of machines and their components, and to predict their performance.

F. Considerations in designing Farm machinery systems

In designing farm machinery, several considerations must be taken into account from both engineering as well as usage perspectives so that they meet safety standards and effectively serve farmers who use them.

- ***Engineering Considerations***:

1. *Mechanical structure:* The mechanical design and structural integrity of farm machinery is essential to ensure stability and rigidity under load and prevent damage during normal operations.
2. *Electronics integration*: Modern farm equipment often requires electronics integration and automation capabilities, from sensor arrays to precise positioning control systems. This demands expertise in hardware development, signal processing, and digital logic programming.
3. *Control System Optimization*: Combined optimization principles must guide design decisions regarding power train performance, hydraulics management, transmission settings, and driver interface preferences during use.
4. *Thermodynamic Analysis*: The energy conversion processes inherent to farm machine propulsion systems receive significant attention. Thermal and fluid dynamic considerations surrounding lubricant and fuel viscosity in extreme weather conditions is crucial for proper working of machines..
5. *Mechanical Structure*: Ensuring a strong and reliable mechanical structure helps prevent breakage during operation and prolongs the life of the machine. Careful selection of materials and quality construction also contributes to durability.
6. *Power Transmission Systems*: Designing efficient and robust power transmission systems ensures effective transfer of power from engine/motor to ground drive wheels for improved functionality and performance.
7. *Operator Interface*: Designing the operator interface to accommodate different skill levels, providing good ergonomics, comfort and safety features.
8. *Maintenance Accessibility*: Good access and serviceability of vital components, such as belts, filters, bearings, fluids, electrical connections etc., enable low-cost easy upkeep by the owner; reduces downtime & simplifies repairs, thus extending asset lifecycle.
9. *Farm Machinery Certifications & Regulations*: Machinery should comply with local certification requirements and national regulations.

- ***Safety Considerations***:

1. *Operator visibility and safety*: Adequate vision is needed around moving parts and critical areas, including warning devices to protect nearby workers. The design should ensure maximum safety for the operator, including visibility of working area, emergency stopping measures, and intuitive controls. Danger zones, such as sharp edges or pinch points, should be eliminated.
2. *Fire hazards mitigation*: Prevention of sparks and flammable gases through material choice, proper sealing, ventilation and fire suppression strategies.
3. *Operational Control*: Ensure clear visibility around equipment for operational control and monitoring surroundings.
4. *Exposure Protection*: Use covers, guards, or protective barriers to physically isolate moving parts and electrical components.

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5. *Prevent Accidental Starts*: Provide secure stops/brakes, lockouts at start button/switch, neutral return until seat retracted, key to operate, separate keys for different functions.
6. *Protect Bystanders*: Establish danger areas by coned off workspaces using safety personnel to implement and monitor, enclosed cab design reduces potential for throwing debris towards individuals walking nearby.
7. *Lift Trucks safety Considerations*: Since they're used in confined spaces or for loading heavy objects on vehicles, lift trucks require specific safety precautions, like lower travel speeds indoors, bright lights to enhance viewing, boom stop or backrest to avoid swinging beyond vertical position during placement/removal of loads.

IV. CONCLUSION

In conclusion, farm machinery systems are a critical component of modern agriculture, and their characteristics and performance are essential for enhancing the efficiency and productivity of farming operations. The evaluation of farm machinery systems is crucial to ensure their reliability, effectiveness, and safety. The methods used to evaluate these machines include field experiments, laboratory tests, and computer simulations, which provide valuable insights into their performance and capabilities. The development of advanced technologies, such as precision farming systems and eco-friendly machines, will continue to drive the evolution of farm machinery systems, ensuring sustainable and efficient farming practices for years to come.

REFERENCES

[1] Columbus, L. "10 Ways AI Has The Potential To Improve Agriculture In 2021". Forbes. https://www.forbes.com/sites/louiscolumbus/2021/02/17/10-ways-ai-has-the-potential-to-improve-agriculture-in-2021/2021.

[2] GolnooshRasoulifar, C. E. and Guy, P. "Communicating consumer needs in the design process of branded products," *Journal of Mechanical Design*, vol. 137, no. 7, 2015.

[3] Greene, W.H. Econometric Analysis, 5th ed.; Prentice Hall: Upper Saddle River, NJ, USA, 2003; ISBN 978-0-13-0661890.

[4] Intellias. (n.d.). "AI in Agriculture: Challenges, Benefits, and Use Cases". https://intellias.com/artificial-intelligence-in-agriculture/

[5] Jianjun, Liu. "The Study on Agricultural Machinery Design and Modeling Method". International Journal of Advancements in Computing Technology. 4. 678-684. 10.4156/ijact.vol4.issue22.78, 2012.

[6] Jian-wei Wangand Jian-min Zhang. "Research on Innovative Design and Evaluation of Agricultural Machinery Products". Mathematical Problems in Engineering. Volume 2019 | Article ID 8179851 | https://doi.org/10.1155/2019/8179851, 2019.

[7] Kariuki, J., & Mburu, J. "Impact of Agricultural Mechanization on Production, Productivity, Cropping Intensity, Income Generation and Employment of Labour in Kenya". Journal of Agricultural Science and Technology A, 2(8), 832–840, 2012.

[8] Kumar, A., & Singh, R. "Farm Mechanisation 2.0 - The future of Indian agriculture". (pp. 1–8). ResearchGate, 2019.

[9] Liang, X., & Zhang, Y. "Impact of Agricultural Mechanization on Agricultural Production, Income and Employment in China: Evidence from a Provincial Panel Data Analysis". Frontiers in Environmental Science, 10(1), 838686. https://doi.org/10.3389/fenvs.2022.838686, 2022.

[10] Liu, Y., Ma, X., Shu, L., Hancke, G. P., & Abu-Mahfouz, A. M. "From Industry 4.0 to Agriculture 4.0: Current status, enabling technologies, and research challenges". *IEEE Transactions on Industrial Informatics*, *17*(6), 4322-4334, 2020.

[11] Quan, Xiuhao, and Reiner Doluschitz. "Factors Influencing the Adoption of Agricultural Machinery by Chinese Maize Farmers" *Agriculture* 11, no. 11: 1090. https://doi.org/10.3390/agriculture11111090, 2021.

[12] Qing, Y.; Chen, M.; Sheng, Y.; Huang, J. "Mechanization services, farm productivity and institutional innovation in China". China Agric. Econ. Rev., 11, 536–554, 2019.

[13] Schmitz, A., & Moss, C. B. "Mechanized agriculture: Machine adoption, farm size, and labor displacement", *AgBioForum*, 18(3): 278-296, 2015.

[14] Singh, R., Singh, S., & Kumar, A. "Impact of Farm Mechanization on Crop Productivity in Sub-Tropical Region of India". International Journal of Current Microbiology and Applied Sciences, 9(5), 2316–2322, 2020.

[15] Takeshima, H. "*Overview of the evolution of agricultural mechanization in Nepal: A focus on tractors and combine harvesters".* (Vol. 1662). Intl Food Policy Res Inst., 2017.

[16] Velazquez-Miranda, Elsa & Silva-Navarro, Gerardo & Bory-Reyes, Juan. "On the design methodologies for agricultural machines in Mexico". 14th International Conference on Electrical Engineering, Computing Science and Automatic Control (CCE) 1-6. 10.1109/ICEEE.2017.8108901, 2017.

| ISSN: 2395-7852 | www.ijarasem.com | |Bimonthly, Peer Reviewed & Referred Journal|

| Volume 9, Issue 5, September 2022 |

[17] Yunhua, L. I. U., & Xiaobing, W. A. N. G. "Technological progress and Chinese agricultural growth in the 1990s". *China Economic Review*, *16*(4), 419-440, 2005.

[18] Zhang, N., Wang, M., & Wang, N. "Precision agriculture—a worldwide overview". *Computers and electronics in agriculture*, *36*(2-3), 113-132, 2002.