OPEN ACCESS

ORIGINAL ARTICLE

UNAH UNIVERSIDAD AGRARIA DE LA HABANA

Revista Ciencias Técnicas Agropecuarias 34
January-December 2025
ISSN 1010-2760, eISSN 2071-0054
Cu-ID: https://cu-id.com/2177/v34e08

Current Status of Agricultural Machinery in the Mechanization Centers of Bolivar Province, Ecuador

Estado actual de la maquinaria agrícola en los centros de mecanización, provincia de Bolívar, Ecuador

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ABSTRACT: Agricultural mechanization plays an important role in improving productivity and sustainability in agriculture. In Ecuador, mechanization centers were implemented to facilitate access to agricultural machinery in rural areas. However, the lack of information on the current state of the equipment limits its operational efficiency. The objective of this study was to diagnose the technical condition of the agricultural machinery in the mechanization centers of Bolivar province. A total of 17 tractors, 38 power tillers and 35 agricultural implements were evaluated in 10 mechanization centers, analyzing their technical condition, safeguarding conditions, maintenance and mechanization index. The results indicate that 64.71% of the tractors are capable of working, they still show some degree of deterioration and 35.29% are inoperative. 100% of the power tillers are without working capacity. One of the main reasons for the deterioration of agricultural machinery is the lack of adequate preventive and corrective maintenance. Some elements were identified as requiring immediate attention due to their critical condition (high urgency), such as tires (12.50%), the electrical system (6.25%) and certain specific elements (21.88%). Adequate safeguards are in place for 100% of the machinery. The mechanization index varies between 0.32 and 1.1 kW/ha, with an average of 0.61 kW/ha, below the recommended standard. In conclusion, it is necessary to improve maintenance strategies, consider a machinery renewal program and strengthen operator training to ensure greater efficiency in agricultural mechanization in the province.
Keywords: Agricultural Mechanization, Technical Condition, Maintenance, Tractors, Productivity.

RESUMEN: La mecanización agrícola juega un rol importante para mejorar la productividad y sostenibilidad en la agricultura. En Ecuador, los centros de mecanización fueron implementados para facilitar el acceso a maquinaria agrícola en zonas rurales. Sin embargo, la falta de información sobre el estado actual de los equipos limita su eficiencia operativa. Este estudio tuvo como objetivo diagnosticar el estado técnico de la maquinaria agrícola en los centros de mecanización de la provincia de Bolívar. Se evaluaron 17 tractores, 38 motocultores y 35 implementos agrícolas en 10 centros de mecanización, analizando su estado técnico, condiciones de resguardo, mantenimiento y el índice de mecanización. Los resultados indican que el 64,71% de los tractores están con capacidad de trabajo, aún presentan algún grado de deterioro y el 35,29% están inoperativos. El 100% de los motocultores están sin capacidad de trabajo. Una de las principales razones del deterioro de la maquinaria agrícola es la falta de mantenimiento preventivo y correctivo adecuado. Se identificaron algunos elementos que requieren atención inmediata debido a su condición crítica (alta urgencia), como los neumáticos (12,50%), el sistema eléctrico (6,25%) y ciertos elementos específicos (21,88%). El 100% de la maquinaria cuenta con resguardo adecuado. El índice de mecanización varía 0,32 y 1,1 kW/ha, con un promedio de 0,61 kW/ha, por debajo del estándar recomendado. Se concluye que es necesario mejorar las estrategias de mantenimiento, considerar un programa de renovación de maquinaria y fortalecer la capacitación de los operarios para garantizar una mayor eficiencia en la mecanización agrícola de la provincia.
Palabras clave: mecanización agrícola, estado técnico, mantenimiento, tractores, productividad.

INTRODUCTION

Agricultural mechanization plays a fundamental role in the development of the agricultural sector by increasing production efficiency, reducing operating costs and improving the sector's competitiveness (FAO, 2023).

Globally, mechanization has been a major factor in the growth of food production and the improvement of the quality of life of agricultural producers. However, its implementation varies considerably across regions, depending on economic, social and technological factors (Sims & Kienzle, 2015).

Received: 15/07/2024
Accepted: 28/01/2025
The authors of this work declare no conflict of interests.
AUTHOR CONTRIBUTIONS: Conceptualization: L. Shkiliova, L. Verdezoto, M. Gaibor. **Data curation:** L. Shkiliova, M. Gaibor. **Formal Analysis:** L. Shkiliova, M. Gaibor. **Investigation:** L. Shkiliova, M. Gaibor, L. Verdezoto. **Methodology:** L. Shkiliova, L. Verdezoto, M. Gaibor. **Supervision:** L. Shkiliova, M. Gaibor. **Validation:** L. Shkiliova, L. Verdezoto. **Visualization:** L. Shkiliova, L. Verdezoto. **Writing-original draft:** L. Shkiliova. **Writing-revision and editing:** L. Shkiliova, L. Verdezoto, M. Gaibor.

In Latin America, agricultural mechanization has advanced in countries such as Argentina, Brazil and Mexico, where the use of tractors and specialized machinery is common in medium- and large-scale farms (Donoso, 2007; Elverdin *et al.*, 2018; Paneque *et al.*, 2019). However, in other nations, such as Ecuador, significant challenges persist related to equipment availability, training in its use, and machinery maintenance (Loor *et al.*, 2019). FAO (2022) highlights that, despite technological advances, limited access to mechanized equipment in developing countries remains a major barrier to agricultural modernization.

In Ecuador, agriculture is one of the main economic activities, providing employment to more than 30% of the working population (INEC, 2022). Its contribution to Gross Domestic Product (GDP) varies between 7% and 9%, which underlines its relevance within the national economy (BCE, 2021). However, the lack of adequate mechanization has restricted the growth of the sector, especially in small and medium agricultural production units.

Aware of this problem, in 2015, the Ecuadorian state implemented a program to deliver agricultural machinery in order to strengthen mechanization in rural areas. Through the Ministry of Agriculture, Livestock, Aquaculture and Fisheries (MAGAP), mechanization centers were established in several provinces, including Bolivar, to facilitate access to agricultural equipment for small and medium-sized producers (Cusme *et al.*, 2017). These centers were designed to provide mechanization, maintenance and training services, with the aim of improving productivity and reducing agricultural production costs.

However, despite these efforts, there is no updated and detailed information available on the condition of the machinery in these centers. Lack of preventive maintenance, inadequate use of equipment and lack of spare parts can compromise the operability of machinery, reducing its useful life and efficiency (Segura, 2009). According to previous studies in other regions of Ecuador, a high percentage of tractors and agricultural equipment have technical deficiencies that limit their performance (Shkiliova *et al.*, 2014).

Agricultural mechanization not only influences the efficiency of agricultural work, but also impacts the sustainability of the sector. The use of machinery in good condition allows for a more uniform distribution of inputs, less waste of resources and a reduction in soil compaction (Pacheco & Melo, 2015). In addition, proper mechanization can contribute to the adaptation of agriculture to climate change, facilitating the implementation of conservation practices and reducing the vulnerability of crops to extreme weather events (FAO, 2022).

In Bolívar province, the implementation of mechanization centers was a key strategy for improving agricultural productivity. However, the current state of the equipment, its degree of use and maintenance needs are unknown. A detailed diagnosis is essential to determine the technical condition of the machinery and establish strategies for its optimization (Castro & Hetz, 2004).

Several studies have shown that lack of maintenance and insufficient training are factors that negatively affect the useful life of agricultural equipment (Donoso, 2007; Paneque *et al.*, 2019; Feijoo *et al.*, 2020).The absence of technical training programs for operators and the lack of incentives for the renewal of the machinery fleet represent additional challenges for the sustainability of the mechanization process in the region (López, 2018). The objective of this study is to diagnose the current state of agricultural machinery in the mechanization centers of the province of Bolivar. To this end, technical aspects such as the state of conservation of the equipment, the frequency and type of maintenance performed, and the mechanization index in each center will be analyzed. The results of this research will serve as a basis for the formulation of strategies to improve the efficiency and sustainability of agricultural mechanization in the region.

MATERIALS AND METHODS

The research was carried out during the months of October, November and December 2023 in the province of Bolivar, located in the inter-Andean region of Ecuador. This province is home to approximately 199,078 inhabitants and has an area of approximately 3,945 km² (INEC, 2022). It is characterized by its agroecological diversity, which ranges from paramo zones to subtropical lowlands. Its economy is based primarily on agricultural and livestock production, with corn, potatoes, barley, and wheat being the most representative crops.

Geographically, Bolivar Province is located in the central-western part of the Inter-Andean Region. It occupies the Chimbo River basin. It is located between the following geographic coordinates: from 1°8'59.4" to 2°12'9.9" south latitude and from 79°23'41.7" to 78°49'2.2" west longitude. It is bordered to the north by the provinces of Cotopaxi and Los Ríos, to the south by Chimborazo, to the east by Tungurahua and to the west by Guayas. The altitude in the province ranges between 180 and 4,000 meters above sea level, which generates diverse climatic conditions, with temperatures that vary between 2 and 26 °C and rainfall ranges in the province from 500 to 3,000 mm per year, according to the humidity and temperature regimes of the existing zones of GADP Bolivar (Aguilar & Barragán, 2024).

The mechanization centers evaluated are located in the cantons of Guaranda, San Miguel, Las Naves, Chimbo and Chillanes, where mechanization units have been established to provide support to small and medium-sized agricultural producers. These centers were implemented as part of the agricultural modernization program promoted by the Ecuadorian government in 2015.

The agricultural sector in the province faces challenges related to soil degradation, erosion and limited access to modern technology, which justifies the need for studies on the efficiency of mechanization centers and their impact on local agricultural production.

The research adopted a quantitative-descriptive approach, with a non-experimental and cross- sectional design. A technical diagnosis of the condition of the agricultural machinery was made based on visits to the mechanization centers, where technical evaluation forms were applied, structured surveys of the operators and managers of the centers, and direct observation of the condition of the equipment.

The technical evaluation sheets were used to collect information on the general condition of the agricultural machinery, considering the following parameters: technical condition of the engine, condition of the hydraulic system, operation of the braking system, condition of the electrical system, conservation of the chassis and structure, condition of the tires and associated agricultural implements.

The structured surveys aimed at operators and managers of the centers addressed aspects such as: frequency of use of the machinery, types of agricultural work carried out with the machinery, preventive and corrective maintenance applied and training received by the operators.

During the direct observation, an on-site inspection of the machining center facilities and the physical condition of the equipment was carried out, complementing the information obtained through the other instruments.

To calculate the value of the agricultural mechanization index, information was requested from MAG on mechanized surface area reports for the year 2023. For this purpose, the methodology proposed by Larqué *et al.* (2012) for each mechanization center and dividing it by the number of hectares worked:

$$PD - Aviable \quad power \quad (kW) IM = PD/HL \qquad (1)$$

Where:
IM- Mechanization index
HL- Hectares harvested (ha)

The data collected were organized and processed using descriptive statistical analysis. The results obtained were interpreted considering the recommended standards for agricultural mechanization, and were compared with previous studies conducted by other authors.

RESULTS AND DISCUSSION

General characteristics and technical condition of agricultural machinery at mechanization centers

A total of 17 tractors were identified in the 10 machining centers under study, distributed between two main brands: seven YTO (41%) and ten Sonalika (59%) (Figure 1). The YTO- X704 model from the year of manufacture 2009 has a power of 70 hp with a 4x2 traction system, while the Sonalika DI-90RXTURBO4ED model manufactured in 2015, has a power of 90 hp and a 4x4 traction system. All of the tractors began operating in agricultural production in 2015. The preference for these brands is due to the fact that they were acquired as part of the agricultural mechanization program promoted by the Ecuadorian state in 2015.

FIGURE 1. Types of tractors in mechanization centers.

It was observed that 11 tractors (64.71%) are in poor technical condition, but with working capacity, and seven tractors are without working capacity (35.29%). In the case of agricultural machinery, it is difficult, in operating conditions, to find it in good technical conditi on. Generally, it is impossible to keep the paint of the machinery without scratches, the bodywork suffers some bumps and dents appear, but all this does not prevent the fulfillment of the main work (Shkiliova *et al.*, 2017).

In addition to tractors, the mechanization centers own 38 power tillers and 35 different agricultural implements, including disk plows, harrows, furrowers and trailers. The amount of agricultural equipment varies between organizations, this could be due to factors such as the amount of land, the crops they produce, the subsidies provided, etc. The power tiller is the agricultural equipment that is most repeated among the organizations, 100% of them are of the YTO brand, with 16 hp, mechanical transmission, two wheels and a single axle, these are in poor technical condition with no working capacity.

Machinery safeguarding conditions

The shelter and storage of machinery is an important factor in its conservation. The ten mechanization centers have sheds to protect the machinery; 100% of them are in good condition (Figure 2). Both the agricultural machinery and the infrastructure were provided to the organizations through a total subsidy from MAG. Previous studies indicate that prolonged exposure to the elements can reduce the useful life of tractors by up to 40% due to the degradation of key components (García *et al.*, 2023).

Table 1 presents an analysis of the condition of the main systems of agricultural tractors, including the condition of tires, which directly influences the productivity of agricultural units.

The engine analysis shows that, although oil levels and belt condition are not critical, a significant proportion of tractors (more than 56%) are in fair condition for the parameters analyzed. This suggests the need to improve the frequency and quality of preventive maintenance to avoid

FIGURE 2. Machinery guarding at the machining centers.

premature wear. In addition, although there are no serious fluid leaks, their presence in regular condition in more than half of the tractors indicates the possibility of small leaks that may worsen over time.

The hydraulic system has a high incidence of leaks in regular condition (81.25%), which could be affecting the operational efficiency of the tractors. Half of the tractors have regular hydraulic fluid levels, suggesting that they are not being replenished as often as necessary. In addition, the functioning of cylinders and hoses requires more rigorous inspection to avoid unexpected failures during operation.

While most tractors have smooth shifting, a small percentage have difficulties (6.25%), which could be indicative of wear in the clutch or synchronizers. The presence of abnormal noises in more than one third of the tractors indicates the need to inspect gears and bearings to prevent further damage. Transmission fluid level is acceptable in most cases, but the percentage in regular condition indicates the need for follow-up to prevent progressive deterioration.

The brake system is generally in good condition, but the presence of tractors with regular braking (12.5%) suggests that some components may be at the limit of their useful life. Although the brake fluid level is adequate in most cases, those in fair condition (25%) should be monitored to ensure operational safety.

Deficiencies are observed in the electrical system, especially in the condition of the cables (56.25%) and in the operability of the working lights (37.50%). These problems can lead to failures during night use or in poor visibility conditions. It is recommended to inspect connections and replace defective components to avoid interruptions in operation.

The condition of the tractors' chassis and structure is generally adequate, with no presence of cracks or corrosion in most of the equipment. However, 30% of the tractors show signs of structural wear in regular condition, suggesting that, although there are no critical failures, some components could be progressively deteriorating due to working conditions and time of use. The condition of the cables in the structure does not present relevant problems, since 100% are in good condition. However, it is advisable to maintain periodic inspections to avoid premature wear or failures in the connection points. Since the chassis is a fundamental part of the stability and safety of the tractors, it is recommended to reinforce the corrosion and structural fatigue evaluations, especially in older equipment or equipment operating in demanding conditions.

TABLE 1. Technical Condition of Agricultural Tractor Systems

System	Evaluated Parameter	Technical Status				Classification of Urgency in Repair or Replacement			
		Good (%)	Regular (%)	Bad (%)	Total (%)	Average (%)	Low (%)	High (%)	Total (%)
Engine	Oil level	37.50	62.50	0.00	100.00	18.75	81.25	0.00	100.00
	Belt condition	37.50	62.50	0.00	100.00	18.75	75.00	6.25	100.00
	Absence of fluid leaks	43.75	56.25	0.00	100.00	31.25	68.75	0.00	100.00
Hydraulic System	Hydraulic fluid levels	50.00	50.00	0.00	100.00	25.00	75.00	0.00	100.00
	Cylinder and hose operation	50.00	50.00	0.00	100.00	43.75	56.25	0.00	100.00
	Absence of leaks	18.75	81.25	0.00	100.00	50.00	50.00	0.00	100.00
Transmission System	Smooth gear shifts	68.75	25.00	6.25	100.00	12.50	87.50	0.00	100.00
	Transmission fluid levels	68.75	31.25	0.00	100.00	12.50	81.25	6.25	100.00
	Abnormal noises	56.25	37.50	6.25	100.00	26.25	62.75	10.00	100.00
Brake System	Efficient braking	87.50	12.50	0.00	100.00	18.75	81.25	0.00	100.00
	Brake fluid levels	75.00	25.00	0.00	100.00	6.25	93.75	0.00	100.00
	No squeaking or vibrations	68.75	31.25	0.00	100.00	18.75	81.25	0.00	100.00
Electrical System	Operational work lights	62.50	37.50	0.00	100.00	25.00	68.75	6.25	100.00
	Cable condition	43.75	56.25	0.00	100.00	37.50	56.25	6.25	100.00
	Battery	31.25	68.75	0.00	100.00	50.00	43.75	6.25	100.00
Chassis and Structure	Cracks and corrosion	70.00	30.00	0.00	100.00	9.75	90.25	0.00	100.00
	Cable condition	100.00	0.00	0.00	100.00	6.25	93.75	0.00	100.00
Tires	Uniform wear	25.00	50.00	25.00	100.00	6.25	68.75	25.00	100.00
	Adequate pressure	56.25	37.50	6.25	100.00	18.75	75.00	6.25	100.00
	No cuts or damage	25.00	62.50	12.50	100.00	18.75	75.00	6.25	100.00

Irregular tire wear is a significant problem, with 25% of tires in critical condition. This can affect the stability and traction of tractors, increasing fuel consumption and reducing operating efficiency. It is essential to evaluate soil conditions and inflation pressure to optimize performance and prolong tire life. In this regard, Ferrari & Ferrari (2011) mention that tire design, inflation pressure, type of construction and weight have an impact on greater or lesser use of powertraction , greater or lesser equipment wear and greater or lesser consumptionfuel. When the minimum treadwear level is not respected, there is a risk of direct damage to the internal structure of the agricultural tire, i.e. when 75% treadwear is reached (Firestone, 2023).

Type of maintenance applied

Maintenance is a determining factor in the useful life of agricultural machinery. Ninety-four percent of the presidents and administrators surveyed said they knew what preventive and corrective maintenance was, while 6% said they did not. 100% mentioned that they have always carried out preventive and corrective maintenance on agricultural machinery. However, despite the fact that the respondents claim to comply with the maintenance processes, it is evident that it has not been carried out correctly. In two mechanization centers, the tractors delivered are out of working capacity, and in all of these centers, the power tillers are also inoperative, for various reasons mentioned above. Sixty-five percent mentioned that preventive and corrective maintenance was carried out by specialized technicians and local mechanics, while 35% indicated that maintenance was carried out by specialized technicians. Finally, 100% mentioned that there are no specialized repair shops in the locality. According to MAG technicians, preventive and corrective maintenance of agricultural machinery was provided by MAG for 3 consecutive years after the grant was awarded.

Mechanization rate in mechanization centers

The mechanization index was calculated considering the total power of the tractors and the machinable area in each mechanization center. For the calculation of the mechanization index, the information was provided by the District Directorate of MAG Bolivar, highlighting that the mechanization centers of the Association of Agricultural Producers and Marketing of Industrialized Products based on Potato "ASOPAPA" and the Association of Producers "San Francisco de Cochabamba La Laguna", do not have information on the mechanized area because the machinery has not been in operation for 3 and 4 years, respectively. Table 2 shows the results obtained.

The results show that the mechanization index varies between 0.32 and 1.10 kW/ha, with the average value equal to 0.61 kW/ha, a value below the recommended range of 0.75 to 1.0 kW/ha for efficient crop mechanization (FAO, 2022). This result is due to the fact that in five mechanization centers the available power is insufficient to cover agricultural demand.

CONCLUSIONS

- The results obtained show that in the mechanization centers of Bolivar province64.71% of the tractors are in poor technical condition, but with working capacity, while 35.29% are without working capacity, and 100% of the power tillers are inoperative. One of the main reasons why agricultural machinery is not being used because of its technical condition is the lack of adequate preventive and corrective maintenance.
- The analyzed components of the agricultural tractors present a general condition that varie s between good and fair, most of their components were classified as having a low urgency of repair. However, some elements were identified as requiring immediate attention due to their critical condition (high urgency), such as the tires (12.50%), the electrical system (6.25%) and certain specific elements (21.88%). These components represent a risk to operator safety and the efficiency of farming operations.
- The mechanization index of agricultural mechanization centers varies between 0.32 and 1.1 kW/ha, with an average of 0.61 kW/ha.
- It is concluded that it is necessary to improve maintenance strategies, consider a machinery renewal program and strengthen operator training to ensure greater efficiency in agricultural mechanization in the province.

TABLE 2. Mechanization rate in mechanization centers

Mechanization Center	Total Power (kW)	Mechanizable Area (ha)	Mechanization Index (kW/ha)
Social and Integral Development Association of the Santo Domingo de Simiátug Community	66.20	105	0.63
Agricultural Producers and Marketing Association "22 de Marzo"	51.49	75	0.69
Agricultural Producers and Marketing Association "Nuevo Conventillo"	117.69	190	0.62
Agricultural Producers and Marketing Association "Santa Marianita de Jesús"	66.20	82	0.81
Agricultural Producers and Marketing Association "Yagui"	66.20	60	1.10
Agricultural Producers and Marketing Association "San José de Las Palmas"	117.69	120	0.98
Agricultural Producers and Marketing Association "Dr. Guillermo Flores González"	66.20	210	0.32
Agricultural Association "24 de Junio"	117.69	250	0.47
Total	**669.36**	**1,092**	**0.61**

REFERENCES

AGUILAR, M.L.G.; BARRAGÁN, V.P.: Estrategias de comunicación interna para el mejoramiento del clima laboral del Gobierno Autónomo Descentralizado Municipal del cantón San José de Chimbo, provincia Bolívar, Universidad Estatal de Bolívar. Facultad de Ciencias Administrativas, Tesis, publisher: Universidad Estatal de Bolívar. Facultad de Ciencias Administrativas Gestión …, 2024.

BCE: Informe anual del PIB agropecuario 2021, Ed. Banco Central del Ecuador, Quito, Ecuador, 75 p., publisher: Banco Central del Ecuador, 2021, ISBN: 978-9942-10-491-3.

CASTRO, R.J.L.; HETZ, E.: Análisis del parque de tractores agrícolas en el Ecuador, [en línea], Inst. Universidad de Concepción, Chillán, Chile, Concepción, Chillán: Universidad de Concepción, Chile, publisher: Universidad de Concepción, 2004, Disponible en: https://www.worldcat.org/title/analisis-del-parque-de-tractores-agricolas-en-el-ecuador/oclc/503366543#borrow.

CUSME, Z.Y.; CALDERÓN, M.M.G.; CEDEÑO, A.K.K.A.; ZAMBRANO, H.M.K.: "La gestión productiva agrícola en el sector minorista del cantón Bolívar de la provincia Manabí, Ecuador", Mikarimin. Revista Científica Multidisciplinaria, 3(3): 43-58, 2017, ISSN: 2528-7842.

DONOSO, J.: "Situación del sector de maquinaria agrícola en América Latina", En: Strat Consulting, 6º Seminario PROpymeS-TECHINT, Rosario-Argentina, pp. 1-44, 2007.

ELVERDIN, P.; PIÑEIRO, V.; ROBLES, M.: Agricultural mechanization in Latin America., IFPRI., Documento de debate del IFPRI n.º 1740. Washington D. C.,, USA, 2018.

FAO: "Leveraging automation in agriculture for transforming agrifood systems", En: Ed. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, publisher: FAO Rome, Italy, 2022, DOI: https://doi.org/10.4060/cb9479.

FAO, F.: La agricultura mundial en la perspectiva del año 2050, [en línea], ser. Cómo alimentar al mundo en 2050, Inst. FAO, Roma, Italia, 4 p., publisher: Secretaría del Foro de Alto Nivel de Expertos Italia, Roma, 2023, Disponible en: https://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/Issues_papers_SP/La_agricultura_mundial.pdf.

FEIJOO, J.C.; ESTUPIÑÁN, G.S.B.; MORA, T.D.B.; GRANADOS, P.J.D.: "Balanza comercial y producto interno bruto en Ecuador", Revista Venezolana de Gerencia: RVG, 25(3): 602-616, 2020, ISSN: 2477-9423.

FERRARI, H.; FERRARI, C.: Manual de equipos para la siembra de granos, [en línea], Ed. INTA, INTA ed., Argentina, 2011, Disponible en: https://aulavirtual.agro.unlp.edu.ar/pluginfile.php/26767/mod_resource/content/1/Manual%20de%20Equipos%20para%20la%20Siembra%20-%20Ferrari.pdf.

FIRESTONE: ¿Cuál es la presión correcta para cualquier neumático de tractor?, [en línea], Firestone-Agriculture, 2023, Disponible en: https://www.firestone-agriculture.es/blog/qu%C3%A9-nivel-de-desgaste-indica-que-tengo-que-cambiar-los-neum%C3%A1ticos-de-mi-tractor.

GARCÍA, A.F.; SHKILIOVA, L.; CARVAJA, R.A.: "Diagnóstico del uso de la maquinaria agrícola por los prestadores del servicio de mecanización", Revista Ciencias Técnicas Agropecuarias, 32(2), 2023, ISSN: 2071-0054.

INEC: Resultados del Censo de Población y Vivienda 2022, [en línea], Ecuador en cifras, 2022, Disponible en: https://www.ecuadorencifras.gob.ec/censo-de-poblacion-y-vivienda-2022/.

LARQUÉ, S.B.S.; CORTÉS, E.L.; SÁNCHEZ, H.M.Á.; AYALA, G.A.V.; SANGERMAN, J.D.M.: "Análisis de la mecanización agrícola de la región Atlacomulco, Estado de México", Revista mexicana de ciencias agrícolas, 3(SPE4): 825-837, 2012, ISSN: 2007-0934.

LOOR, S.O.A.; CEVALLOS, M.R.X.; SHKILIOVA, L.: "Diagnóstico de la mecanización agrícola en cuatro comunidades de la provincia de Manabí, Ecuador", Revista Ciencias Técnicas Agropecuarias, 28(1), 2019, ISSN: 2071-0054.

LÓPEZ, J.: "La Ingeniería agronómica y la mecanización agrícola en Ecuador", Revista de Ingeniería Agronómica, 37(1): 1-12, 2018.

PACHECO, F.M.; MELO, P.Y.E.: "Recursos naturales y energía. Antecedentes históricos y su papel en la evolución de la sociedad y la teoría económica", Energética, (45): 107-115, 2015, ISSN: 0120-9833.

PANEQUE, R.P.; FERNANDES, H.; MIRANDA, C.A.; MOREJÓN, M.Y.; GÓMEZ, Á.M.V.: "Current Situation of Agricultural Mechanization and Conservation Agriculture in Latin America", AMA, Agricultural Mechanization in Asia, Africa and Latin America, 50(2), 2019.

SEGURA, L.J.: "Más y mejores apoyos para los campesinos mexiquenses", Programa de mecanización del campo del Estado de México, 2009.

SHKILIOVA, L.; CEVALLOS, R.; NÚÑEZ, W.: Fiabilidad de la Técnica Agrícola, Ed. Ediciones UTM-Universidad Técnica de Manabí, Portoviejo,Manabí, Ecuador, 2017, ISBN: 978-9942-948-11-3.

SHKILIOVA, L.; FUNDORA, R.; JARRE, C.: "La mecanización en la Intensificación Sostenible de la Producción Agrícola (ISPA)", La Técnica, (13): 32-43, 2014, ISSN: 1390-6895.

SIMS, B.; KIENZLE, J.: "Mecanización rural: ¿dónde estamos ahora y hacia dónde deberíamos ir?", Rural 21, 49(2): 6-9, 2015.

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