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MECHANIZATION STATUS, ITS TECHNICAL INDICATORS AND IMPACT ON THE WHEAT CROP PRODUCTION IN IRAQ

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ABSTRACT

Increase of the number of tractors and harvesters working in agriculture improves significantly the number of agricultural land operations, harvest efficiency and eliminates primitive farming methods. The production expansion is either horizontal through exploitation and reclamation of more areas or vertical such as introduction of technological variables in the same unit area. The current study aims to investigate the gap of the ratio of the number of tractors and harvesters to the agricultural area, its technical indicators and its impact on the wheat crop production. Data were obtained from agricultural departments and divisions of the Salah al-Din Agriculture Directorate to calculate some of the indicators of the technological and technical evaluation. Tables were prepared with the numbers of tractors and agricultural harvesters that cover the cultivation and harvest campaign. Their horsepower was proven and then converted to the kilowatt unit, as well as the agricultural areas within the agricultural plan that is implemented by the Directorate for four seasons. The surplus power of agricultural tractors contributed to the increase in the executed agricultural areas and requirements of agricultural operations such as tillage, harrows, and leveling contrary to agricultural harvesters, in which case there was a gap in the decrease of the number of agricultural combines in relation to the implemented agricultural plan, which, as a result, may cause a loss in wheat crop harvesting on the specified date. The mechanical harvest contributed to the increase in the grain received from the wheat by the grain trading company in the province, which brings economic returns to the farmer.

Introduction

The agricultural sector is one of the most important productive sectors in the economy of most countries in general, and the developing ones in particular. Agriculture plays a major role in raising the living and social standard of the population and constitutes a main source of daily income (Abdul-Rahman Alkhalidy, 2007). Wheat is one of the most important cereal crops in terms of its cultivation power and spread and the unique characteristic of some of its varieties in the production of bread, while other types are suitable for production of pastries

(de Sousa et al., 2021). Achieving this goal mainly depends on the method the land is dealt with through proper management and use of scientific methods and as a result gaining control over these resources to ensure the provision of adequate food and sustainable rural development for present and future generations (FAO, 2022). Since the preparation of the land for planting and harvesting is one of the most common operations in which tractors and agricultural harvesters are used, Iraq's interest in agricultural machinery and equipment has increased significantly since the sixties. This is considered one of the main factors that has contributed to the increase in agricultural production and field productivity, especially with regard to tractors and their attachments in agricultural work. They increase work productivity, reduce agricultural workloads, and decrease the need for manual labor. Iraq has relied on imports to provide this agricultural machinery from various sources, in addition to local production of tractors and machinery. These machines are allocated to farmers who produce crops such as wheat, barley, and oats, which are essential in achieving national food security Most of the pullers operating in Iraq are concentrated in the governorates of Nineveh, Tamim, Salah al-Din, Diyala, and Anbar (Al-Aqeedi, 2005). Tractors are utilized for a variety of field works as well as public road transportation in harsh and changing environmental circumstances (Gołębiowski et al., 2022). Wear and tear are a natural occurrence in the operation of all equipment and gadgets, including tractors (Tomczyk and Kowalczyk, 2016; Mattetti et al., 2021). For many years, the number of agricultural machinery utilized in China has been expanding year after year, with the total agricultural mechanization rate and wheat-production mechanization rate in 2020 being 76.7% and 97.2%, respectively (MOA, 2021). Agricultural machines are commonly used for transportation, planting, and harvesting, but they are not technologically sophisticated, have extended service lifetime, consume a lot of fuel, and are poorly maintained (Li et al., 2019; Yu et al., 2023). The development of the number of tractors and harvesters working in agriculture contributes significantly to improving the number of agricultural land operations, improving harvest efficiency, and eliminating primitive methods of agriculture (Xinshen Diao, 2016). The case of expansion of production is either horizontal through the exploitation and reclamation of more areas, or vertical , such as introduction of technological variables in the same unit area (Zanzal et al., 2017). Despite the development of the number of tractors operating in Iraq for the years (1995-2000), the rate of their use in agricultural areas is low, as the ratio of tractors to area was (1:43.5 ha) compared to developed countries (1:12.5 ha) (Al-Aqeedi, 2005). When comparing Iraq to developed countries, we find that the developed countries used one tractor for every (12.5 ha), while Iraq used one tractor for every (38 ha) in 2010, and this figure indicates the large technological gap between Iraq and the developed countries. In terms of the use of harvester combines, Iraq is less than a same level of developed countries in the use of harvester combines. In 2010, Iraq had a ratio of one harvester combine for every 523 hectares, which is much lower compared to advanced countries who use one harvester for every 125 hectares. Moreover, the utilization of technology in developing countries is not as advanced as in advanced countries in wheat farming and technology import and application, which results in higher costs and lower productivity due to unfavorable conditions (Al-fahdawy and Aljumaily, 2017; Gooding, 2009; Akeedy and Mustafa, 2009). The smallest field area that justifies the economic use of the tractor is from (4-7.5 ha), but that depends on several factors such as the type of crops grown and the method of cultivation, and that the area of most of the individual agricultural holdings lies between (2.5-250 ha) in various regions of Iraq. Harvesters are the critical component in most of the grain-producing countries. The number and

power of harvesters must increase rapidly to catch up with the great change in the amount of yield (Hao et al., 2003). Due to the lack of studies in calculating the ratios of tractors and harvesters combine to the cultivated areas in Salah al-Din/Iraq, the aim of the research was to identify the gap in the ratio of the numbers of tractors and harvesters combine to the agricultural area. Moreover, study the technical indicators and their impact on the production of wheat crop in the province of Salah al-Din.

Materials and Methods

This study was conducted in Salah al-Din Governorate, which leads in the production of the strategic wheat crop in Iraq, due to the suitability of weather conditions and the availability of water. Where the arable area is (1,521,483) hectares in Salah al-Din Governorate, and the average percentage of cultivation of the wheat crop constituted (15%) of the total area of four agricultural seasons implemented within the agricultural plan (The agricultural plan constitutes the agricultural areas determined by the Iraqi Ministry of Agriculture and according to the governorates producing strategic agricultural crops (wheat, barley, yellow corn) and providing support for the purchase of fertilizers, seeds and fuel for agricultural machinery) of the Iraqi Ministry of Agriculture (2016-2017, 2017-2018, 2018-2019, 2019-2020) Table No. (1), The average marketing amounted to (71%) of the average total expected production quantity (648,809) tons, while the average marketed quantities for the General Company for Grain Trade / Salah El-Din Branch amounted to (458,218) tons, and the average marketed quantities were distributed (82%, 16%, 2%). First, second and third degree, respectively, according to the criteria for receiving grains by the Ministry of Trade, Table No. (1).

Data were obtained from the agricultural departments and divisions of the Salah al-Din Agriculture Directorate to calculate some of the indicators of the technological and technical evaluation. Tables were prepared with the numbers of tractors and agricultural harvesters that cover the cultivation and harvest campaign. Their horsepower was proven and then converted to the kilowatt unit, as well as the agricultural areas within the agricultural plan that is implemented by Directorate for four seasons and the indicators were calculated according to the following equations (Al-Tahan et al., 1991):

1. Availability of the mechanical power of the implemented area (kilowatts/hectare) = the total available power (kilowatts)/the implemented area (ha).
2. The tractor's share of the executed area (ha/tractor) = the implemented area (ha) / the total number of tractors.
3. Kilowatt share of the implemented area (hectares/kilowatts) = the implemented area (ha) /the total power within the area (kilowatts).

The agricultural tractors with a power capacity of less than (52.2) kilowatts, which constituted (11%) and were operating in horticultural holdings were excluded from the total number of agricultural tractors. Meanwhile, the medium agricultural tractors with a power capacity ranging from (71-52.2) kW represented (61%) of the total number of agricultural tractors. The large tractors with a power capacity ranging from (89.5-74.6) kW accounted for (28%) of the total. The agricultural areas were distributed within the agricultural plan for wheat crop cultivation the according to the holdings in Table 2.

Table 1.
The agricultural plan for four seasons in Salah al-Din Governorate

Season	Executed area (ha)	Yield (kg/dunam)	Expected productivity (tons)	Marketed quantities for trade (tons)				
				First degree	Second degree	Third degree	Total Marketing	Market-ing ratio
2016-2017	209,307	560	468,863	91,720	81,655	14,195	187,570	40%
2017-2018	198,968	598	476,140	225,575	45,367	4,697	275,639	58%
2018-2019	239,290	799	764,920	567,728	90,051	7,927	665,706	87%
2019-2020	265,382	834	885,313	614,099	79,695	10,164	703,958	80%

Table 2.
Agricultural holdings and numbers of farmers within the agricultural plan for four seasons

Holdings type	Area (ha)	Numbers of farmers	The percentage of the number of farmers
Small holdings	1.25 – 12.5	10,645	59%
Medium holdings	12.75 – 25	5,486	31%
Large holdings	25.25 and up	1,819	10%
Total		17950	100%

The percentages of classifying tractors according to the ownership of agricultural holdings in the governorate are to 55% of tractors owners who own agricultural holdings and 45% of tractors owners who don't own agricultural holdings.

Results and discussion

Cultivation seasons, numbers, and horsepower of the agricultural tractors used

Table 3 shows the cultivation seasons, numbers and horsepower used in the agricultural plan in the governorate. In the first season, the number of agricultural tractors reached (3,093) tractors, meaning that more than half of the number of agricultural tractors operating under the agricultural plan ranged from (52.2-71) kW, a rate of (68%) as well as in all seasons. This indicates that farmers in the governorate want to obtain agricultural tractors of this size. Additionally, 90% of farmers in the region have small to medium-sized farms, as per Table (2). The total number of agricultural tractors for the first season with a power capacity ranging from (74.6-89.5) kW was 1,451 tractors, accounting for 32% of all seasons. Farmers who own small or some medium-sized farms avoid buying such tractors because they are classified as having large power. This classification results in higher costs for their purchase, maintenance, and operation, which increases both fixed and variable production costs, including fuel and oil consumption costs for agricultural tractors. These costs depend on the horsepower of the engines (Al-Tahan et al., 1991). However, these tractors did not help to

increase the agricultural area, but they have contributed to an increase in the average productivity and production under the Ministry of Agriculture's approved plan.

Table 3.
Number of agricultural tractors with their powers during the farming seasons in the governorate

Horsepower of tractors	Season	Area (ha)	Season	Area (ha)	Season	Area (ha)	Season	Area (ha)
	2016-2017	209,307	2017-2018	198,968	2018-2019	239,290	2019-2020	265,382
	No.	Total power kW	No.	Total power kW	No.	Total power kW	No.	Total power kW
Tractors 70	945	49,307	1,326	69,214	1,137	59,353	1,316	68,682
Tractors 75	301	16,844	423	23,645	363	20,276	420	23,463
Tractors 80	479	28,584	673	40,124	577	34,407	667	39,816
Tractors 90	876	58,801	1,230	82,541	1,055	70,781	1,220	81,907
Tractors 95	493	34,913	692	49,009	593	42,026	686	48,632
Tractors 100	534	39,813	749	55,887	643	47,924	744	55,458
Tractors 120	917	82,076	1,288	115,213	1,104	98,798	1,278	114,328
Total	4,545	310,337	6,380	435,633	5,471	373,565	6,331	432,287

Executed areas and calculating the total power, and power index

Table (4) shows the area executed for the four seasons, the number of working tractors, and the total power available for the cultivation operation. Where the second season had the highest total available power (435,633) kilowatt, the highest number of tractors (6,380) and the least executed area (198,968) hectares. Whereas, the indicator of the availability of mechanical power was the highest, which amounted to (2.19) kW/ ha, and this reflects the surplus in the existing power in that season due to the decrease in the executed area, as well as the decrease in the indicator of the execution of wheat crop cultivation by (15%) of the total area of the governorate. While the first season recorded the lowest indicator of mechanical power, which amounted to (1.48) kW/ha, and the indicators for the four seasons are considered high, meaning there is an increase in the gap for mechanical power compared to the United Nations estimates of mechanical power of (0.5) kW/ha (Al-Tahan et al., 1991). The reason may be that (55%) of the owners of tractors own agricultural holdings, in addition to (45%) of the owners of tractors do not own agricultural holdings, and their tractors are available for leasing for agricultural purposes, and this reflects the possibility of increasing the area executed for the cultivation of the wheat crop in the governorate without increasing the number of agricultural tractors. Table 4 shows that the indicator of power availability is inversely proportional to the area executed and directly to the number of tractors and their powers.

Table 4.
Cultivated areas and power index for the cultivation seasons

Seasons	Cultivated areas, (ha)	Numbers of available tractors	Total powers available, (kW)	Power index (kW/ha) for the cultivated area
2016-2017	209,307	4,545	310,337	1.48
2017-2018	198,968	6,380	435,633	2.19
2018-2019	239,290	5,471	373,565	1.56
2019-2020	265,382	6,331	432,287	1.63

Indicators of the tractor share and the kilowatt share of the executed area

Table 5 shows the share of the tractor and the share of kilowatts of the executed area for the four seasons and at the governorate level, where the second season recorded the lowest share of the tractor from the executed area amounted to 31.19 ha/tractor, while the first season recorded the highest share of the tractor from the executed area amounted to (46.05) ha/tractor, where the tractor (1:43.5 ha) compared to the developed countries reached (1:12.5 ha). While the second season recorded the lowest share of the tractor from the executed area, which amounted to 31.19 ha/tractor. In terms of comparing Iraq with the developed countries, we find that the developed countries use one tractor for every (12.5 ha), while Iraq used one tractor for every (38 ha) in 2010. This figure indicates the large technological gap between Iraq and the developed countries, this confirms to us the lack of exploitation in the full capacity of agricultural tractors due to the ownership of tractors by agricultural landowners and their use only on their farms. The third and fourth season recorded a share for the tractor from the executed area (43.74) and (41.92) ha/tractor, respectively. These results indicate an increase in the number of agricultural tractors in the implementation of the agricultural plan for the wheat crop and for all seasons. While the second season recorded the lowest kilowatt share of the executed area, which amounted to (0.46) kW/ha due to the decrease in the executed area and the difference in the total capacity available in kilowatts for agricultural tractors, and the first season recorded the largest kilowatt share of the executed area, which amounted to (0.67) kW/ha. The third and fourth season scored (0.64) and (0.61) kW/ha, respectively.

Table 5.
Indicators of the available power for the farming seasons

Seasons	Share tractors ha/tractor	Share kilowatt kW/ha
2016-2017	46.05	0.67
2017-2018	31.19	0.46
2018-2019	43.74	0.64
2019-2020	41.92	0.61

Harvest seasons, numbers and horsepower of the combine harvesters used

Table 6 presents that (227) combine harvesters for the first season showed that more than (30%) of their total number working in the agricultural plan of (125.28) kilowatts was (76%) in all seasons, which reflects the desire of farmers in the province to acquire this size of combine harvesters. In addition (41%) of the farmers own medium and large holdings, while the number of combine harvesters with capacities reaching (192.39) kilowatts was (72) combine harvesters. In the first season, there were 72 combine harvesters with a capacity of up to 192.39 kilowatts, accounting for 24% of all seasons where farmers choose not to buy them. This is because they are classified as high-capacity combine harvesters and farmers with small or medium-sized holdings cannot afford the costs associated with their purchase, maintenance, and operation. As a result, fixed and variable production costs increase, including fuel and oil consumption costs for agricultural tractors that rely on the horsepower of their engines (Al-Tahan et al., 1991).

Table 6.
The number of combine harvesters with their powers during the harvest seasons in the governorate

The horse power	2016-2017		2017-2018		2018-2019		2019-2020	
	No.	Total power kW	No.	Total power kW	No.	Total power kW	No.	Total power kW
125.28	227	28,438	240	30,067	296	37,082	426	53,368
192.39	72	13,852	108	20,778	160	30,782	272	52,330
Total	299	42,290	348	50,845	456	67,865	698	105,699

Harvested areas and calculation total power, and power index

Table 7 shows the area harvested for the four seasons, the number of working combines and the total available power for the harvest process. It is noted that there is a gradual increase from the first season to the fourth season in the total available capacities (42,290), (50,845), (67,865) and (105,699) kilowatts, with a noticeable increase. during the second, third and fourth seasons at rates of (14%), (24%) and (35%), respectively. This had the effect of increasing the total power available in kilowatts due to what is provided to the combine harvesters through the branch of the State Company for agricultural supplies in the governorate, in addition to import by the private sector, and the desire of farmers to secure the requirements of mechanical harvesting on time, in addition to the economic return from leasing them, which was achieved of the positive returns to it as a result of the marketing of the crop and the state's interest in supporting the prices of the output of grain crops. The table also shows that there is a gradual increase from the first season to the fourth season in the power index for the harvested area (0.20), (0.26), (0.28) and (0.40) kW/ha, while the first season recorded the lowest power index of (0.20) kW/ha. While the fourth season recorded the highest indicator of the availability of mechanical power of (0.40) kW/ha due to the increase in the total power available in kilowatts, and the indicators for the four seasons consider that there is a gap for the mechanical power compared to the United Nations estimates of the mechanical power of (0.5) kW/ha (Al-Tahan et al., 1991). Despite the development in the

number of combine harvesters operating in the country for the years (1995 - 2002), the rate of their use of agricultural areas is low, as the combine harvester had (1:452 ha) compared to developed countries (1:375 ha) of the combine harvester. This reflects the need for the departments of specialization to adopt more combine harvesters to reach the ideal value and to meet the harvesting operation at the specified date for the requirements of the wheat harvesting operation when the crop matures.

Table 7.
Harvested areas and power index for harvest seasons

Season	Area harvested, (ha)	Numbers of combine harvesters	Total available power, (kW)	Power index, (kW/ha)
2016-2017	209,307	299	42,290	0.20
2017-2018	198,968	348	50,845	0.26
2018-2019	239,290	456	67,865	0.28
2019-2020	265,382	698	105,699	0.40

Indicators of the share of the combine harvester and the share of kilowatts of the harvested area

Table 8 shows the share of the combine harvester and the share of kilowatts of the harvested area for four seasons and at the governorate level, where the four seasons recorded a decrease in the share of the combine harvesters from the harvested area from the first season to the fourth season, which amounted to (700.02), (571.75), (524.76), and (380.20) ha/harvester, respectively. These results indicate an increase in the number of combine harvesters in harvesting the harvested area of the agricultural plan for the wheat crop, while the four seasons recorded a gradual decrease in the kilowatt share of the harvested area, which recorded (4.95), (3.91), (3.53) and (2.51) kW/ha, respectively, and this is a good indicator of reaching the actual need that requires the mechanical harvesting operation on the dates specified for the wheat crop.

Table 8.
Indicators on the reality of the available power for the harvest seasons

Season	Share combine harvester (ha/harvester)	Share kilowatt (kW/ha)
2016-2017	700.02	4.95
2017-2018	571.75	3.91
2018-2019	524.76	3.53
2019-2020	380.20	2.51

Table 9 makes it evident that there has been a significant surge in the number of combine harvesters during the four seasons in the governorate when compared to previous years. There has been a noteworthy and upward trend during the study years, which resulted in a considerable increase of 242 harvesters during the 2020 season, representing a 35% rise.

Table 9.
Amount of increase in the number of combine harvesters

Season	Numbers of combine harvesters	The increase in the number of combine harvesters	The percentage of increase in the number of combine harvesters, (%)
2016-2017	299	0	0%
2017-2018	348	49	14%
2018-2019	456	108	24%
2019-2020	698	242	35%

The average marketed quantities (82%, 16%, 2%) were distributed among the first, second and third-degree criteria, respectively, from the marketed quantities, which depend on the cleanliness of the marketed grain and came as a result of farmers adopting mechanical harvesting. This means that the increase in the number of harvesters was not the determining factor in the higher classification of the received grain. There may be other factors that have a greater influence, such as the use of grain cleaners after mechanical harvesting.

Conclusions

This study shows an increase in the power level represented by the number of agricultural tractors. It proves that there is a gap in the decrease in the number of combine harvesters in relation to the implemented agricultural plan. The surplus power of agricultural tractor contributed to increasing the agricultural areas implemented and the requirements of the agricultural operations of plowing, harrows, and leveling, on the contrary, for agricultural combines, which may cause a loss in the yield on the specified date in harvesting the wheat crop. The mechanical harvest contributed to the high classification of the grain received from the wheat by the General Company for Grain Trade in the governorate, which yields an economic return to the farmer. We recommend that the competent authorities and experts guide farmers to study, calculate and develop the economic factors and the horsepower of agricultural holdings when purchasing agricultural tractors. Establishment should be encouragerf to lease stations for tractors, combine harvesters and agricultural equipment of different horsepower, which meet the requirements of the agricultural operations in the governorate, in order to reduce costs, especially for small holdings, and to reduce energy waste.

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STOPIEŃ ZMECHANIZOWANIA, JEGO TECHNICZNE WSKAŹNIKI ORAZ WPŁYW NA PRODUKCJĘ PRZENICY W IRAKU

Streszczenie. Wzrost ilości traktorów i kombajnów pracujących w rolnictwie istotnie wpływa na zwiększenie liczby operacji polnych, wydajności plonu i eliminuje prymitywne metody uprawiania roli. Ekspansja produkcji może być pozioma poprzez wykorzystanie i odzyskanie większej ilości obszarów lub pionowa polegająca na wprowadzeniu technologicznych zmiennych na tym samym obszarze jednostkowym. Niniejsze opracowanie ma na celu zbadanie różnicy pomiędzy wskaźnikiem ilości traktorów i kombajnów a obszarem rolniczym, jego wskaźników technicznych i wpływu na produkcję plonu pszenicy. Dane uzyskano z wydziałów rolniczych Dyrektoratu ds. Rolnictwa w Salah-al-Din w celu obliczenia niektórych wskaźników oceny technologicznej i technicznej. Przygotowano tabele z liczbą traktorów i kombajnów użytych do uprawy I zbioru. Potwierdzono ich moc i przeliczono na jednostkę kilowata. Potwierdzono także obszar rolniczy objęty planem rolniczym, który został wdrożony przez Dyrektoriat na cztery sezony. Nadwyżka energetyczna traktorów przyczyniła się do zwiększenia obszarów rolniczych i wymogów związanych z operacjami rolniczymi, takimi jak orka, bronowanie, wyrównywanie, w przeciwieństwie do kombajnów, w przypadku których istniała luka w redukcji liczby kombajnów w związku z wprowadzonym planem rolniczym, co w rezultacie może powodować straty w zbiorze pszenicy w określonym terminie. Uprawa mechaniczna przyczyniła się do wzrostu ilości ziaren otrzymanych z pszenicy przez firmę zajmującą się sprzedażą ziarna, co przynosi zwroty finansowe rolnikom.

Słowa kluczowe: traktory, kombajny, obszary uprawne, dostępna moc, wskaźnik mocy