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Comparison of three primary tillage plows commonly used in Iraq.

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ABSTRACT

Tillage operations are considered one of the largest agricultural operations on most Iraqi farms, and soil tillage requires greater power and energy than any other operation. In this review article, will reviewed three types of most common plows used by Iraqi farmers used in primary (conventional) tillage of the soil are moldboard, chisel and disc plows, which differ in their design, shape, method of work and dealing with the soil, the aim is to review the various studies to help Iraqi farmers choose the most appropriate plow to plough (till) their fields and achieve the best plowing productivity while reducing fuel consumption, process implementation time, cost of operation tillage, saving the power requirement, maintaining healthy soil and increasing productivity yields. Tilling the soil well to prepare the seed bed will produce good plants, which will give a good and healthy yield, and this is the aim of all farmers, not only in Iraq, but worldwide. Farmers in southern and middle Iraq, usually use the moldboard plow (which is most popular tillage plow in Iraq) more than chisel and disk plows, while in the northern regions of Iraq, they use the chisel plow in addition to the disc plow. It can be concluding that choosing the best type of plows depends on the specific requirements that the field needs, therefore, some factors help the farmers make the right choice which are: the size of the farm or the field; the type of soil, the crop to be grown, residue and depth of the tillage requirement.

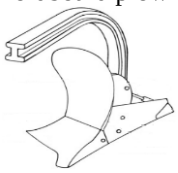
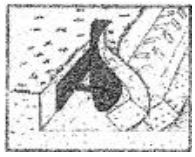
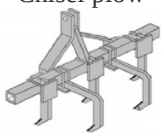
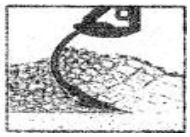
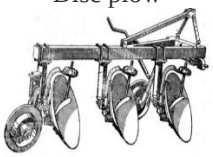
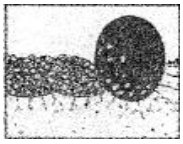
***Keywords*:** Iraqi soil, Plowing, Moldboard, Chisel, Disc.

INTRODUCTION

The ancient Iraqis were the first users of the primitive plow, which was made of wood and pulled by oxen to till the soil without turning and cultivate the soil. Iraq has various agricultural machines and equipment used in primary and secondary tillage, and the first of these machines to enter is the moldboard plow [1]. The most three primary tillage plows in Iraqi fields are moldboard, disc, and chisel [2] [3] [4], and the most widely used is the moldboard plow [5] [6], especially in middle and southern Iraq. The early entry of the moldboard plows in the middle of the twentieth century helped spread this plow in Iraq and make it accepted by most farmers to till of their fields compared to other plows, however, each type of plow has advantages and disadvantages. The primary tillage is the first tilt after crop harvesting or the tilt of new fields. Tillage is reducing and control weeds, help to decomposition plant residue, prepare seed bed and promote growth [7] [8] [9], tillage also change the soil physical properties such as bulk density, porosity, water movement, and aggregate stability [10] [11] [12] [13], studies have concluded the deep tillage help with water movement and aeration in the soil, increasing the penetration of crop roots and growth [14] [15]. Moldboard plow is performing four tasks when plows the field cutting the slice, lifting, turn and inverting the furrow slice [16]. The main component is share, moldboard, landside, frog and stem, moreover, the moldboard considered the most part in the plow, because it receives the furrow slice from the share and does lift, turns and breaks the slice, addition, the quality of plowing depend on the figure of the moldboard [17] [18]. The moldboard plow is one of the most plows which used in the operation tillage [19]. Disc plow is similar to the moldboard plow in terms of work as it cuts the soil and turns it over partially, not completely turning it over, as is the case in the moldboard plow, Moreover, Disc plow reduce the friction by making rolling plow instead of sliding. [21] Concluded in field experiment in silty loam soil there was no-significant affect between moldboard and disc plows in soil bulk density and moisture content when they plowed in 200 mm with different speed tractors. The chisel plow breaks up the soil, but does not overturn the soil, as is the case with the moldboard and disc plows. A chisel plow can be used in saline soil, where the salt on the surface remains on the surface and does not reach the root zone, addition, because the salt is below the surface of the soil, it does not rise to the surface because the chisel plow does not turn the soil. Moreover, it is used in the lands exposed to water and wind erosion, as not turning the soil means that crop and weed residues remain in the soil, which leads to preserving the soil from water and wind erosion [22]. [23] Concluded significant effects of the two factors (speed and depth) on the traction requirements for moldboard, chisel and disk, they founded that the moldboard and chisel required higher draft force. In addition, [24] founded the speed and depth had significant effect in indicators of the study. Moreover, [25] found a difference in the traction force and drawbar, as he found the moldboard plow recorded higher values compared with chisel plow. [26] Concluded that when used reversible

moldboard plow that the vertical and horizontal forces are increased as depth and speed tractor increased, in addition, the effect of tillage depth was higher values than speed. [27] Found the slippage was 21.32 % which exceeded the limited levels when plowing silty clay soil down at depth of 30 cm, also the fuel consumption was 68.67 l. ha^{-1}. [28] Making simulation on draft force for moldboard, chisel and disk plows, founded when till the soil at 250 mm the traction force was 18.27, 15.47 and 12.07 kN, respectively, addition, the depth of tillage was more effected in speed of the tractor, moreover, when the depth increased from 150 mm to 200 mm draft force increase to 114%, also the traction increased to 80% when the tractor speed increase from 1.94 to 5.50 $km.h^{-1}$. Table 1. Show the parts and characteristics of the primary tillage plows.

Table 1. Parts and characteristics of the most primary tillage plows [29]

Type of plow	Interaction between the plow and soil	Main parts and characteristics
Moldboard plow * 		Frame-moldboard- beam -frog-landside- share - point of share- points of hitch- heel- wheel depth- front & rear wheel. - Till with revers furrow - Working width : 25 – 45 cm - Working depth : 15 – 30 cm
Chisel plow 		-Frame- share- stem or shank- three point hitch. - Execute soil loosing, without reversing furrow - Working width : 8 – 16 cm - Working depth : 15 – 40 cm
Disc plow 		- Frame- disk- disk hup- three point hitch- scraper- rear wheel- depth wheel. - Execute soil loosing, with partial furrow reversing. - Working width : 15 - 20 cm - Working depth : 15 – 30 cm

*. Reversible moldboard plow is consist of the same parts and does the same work, except that it is double

Which primary tillage plows are more suitable for Iraqi soils?

Choosing the right plow for tilting or plowing the fields is occupying the minds of many farmers in countries around the world, and even farmers in Iraq ask this equation. In addition, the researchers also carry out field research in which they use the primary tillage equipment in soils of different textures, regions and field conditions (soil moisture, plowing operations, speed of the tractor, tire pressures, depth of the tillage, etc.). The plows used for primary tillage differ in their design, shape, parts, size, method of performance their work, the relationship between them and the soil, and their purpose. This applies to the three plows targeted in this article review, which are moldboard, chisel and disk plows. Before answering this, the farmer and those matter must know of the advantages and disadvantages of these three plows moldboard, disc and chisel (Table 2).

Table 2. Some advantages and disadvantages of the most plows used in the primary tillage

Plows	Advantage	Disadvantage
Moldboard	Turn the furrow slice 180 and prevent the growth the weeds until the next season.	Make compaction layer at the depth which treatment.
	Exposing the soil to the sun light and air.	Higher power requirement.
	Break the clods and new soil in the soil.	Reduce traction efficiency.
	Buries the weeds that tend to sprung up after harvesting and help the aeration soil.	Reduce tillage depth.
	Protect the field from the pests.	Effect of tillage quality.
	Buries the crop residue.	Increasing fuel consumption.
		Most energy-intensive tillage plow.
Disc	Penetrates and plowing the soil that is difficult for a moldboard plow.	Not useful for covering surface trash and weeds and effect of the yield.
	Works good in sticky or compacted soil.	Leaves the soil rough and cloddy.
	More useful for deep plowing.	Heavy plow because the penetration is affected in the weight.
	Used in rough, stony, loose and stumpy soils.	

	Disc plow work even disc worn out. Mixing reminds of crops and weeds. Mixing fertilizer and compost into the soil. Less power requirement comparing.	Must keep the disc edges sharp. Must adjustment tilt and disc angle. Needs apply extra weights to reach a require depth and leave large clods.
Chisel	Useful in tilling soil that contains salts on its surface and reduce effect of compaction. Used for deep tillage up to a depth 45 cm. Break the hardpan and requires less power. Conserve soil moisture, improve aeration, drainage and prevent the crust formation. Keep organic matter in the surface of soil.	Does not turn the soil. Seed bed become rougher, then reduce crop stand. Increase pest, residue clogging in the plow. Slow crops growth become reduce soil temperature.

Many researchers have conducted researches about primary tillage in different regions of Iraq for evaluation the field performance for the moldboard, disc and chisel plows [30] [31] [32] [33] [34] [35] [36] [37] [38]. Moreover, studies and research by specialists are still continuing to achieve the goals, and a review is presented in table (3) of the most important results obtained by Iraqi researchers when they used moldboard, chisel and disc plows in varies Iraqi soil textures and different conditions

Table 3. The most findings of some researchers on Iraqi soils of different textures and regions.

Reference	Plows	Investigation	Soil and Moisture	Most Findings
[39]	Moldboard	Performance indicators of moldboard plow	Silty clay 16-18 %	Increase the speed and depth causes increased the slippage, draft force and reduce the field efficiency.
[40]	Moldboard	Performance the machinery unit (tractor & plow)	Silty clay loam, multy level of moisture	Increasing depth and moisture give higher slippage, fuel consumption and draft. Increase speed led to high productivity and bulk density.
[41]	Moldboard Disc	Study of some indicators	Silty clay loam 17.15	Moldboard plow get lower slippage, number of clods, fuel consumption and cost of operation, also, get best productivity compare with disc plow.
[42]	Disc	Study some of mechanized characteristics	Silty clay 18.2 %	Adding water to tractor tiers led to reduce slippage and productivity. Increase depth increase slippage and reduce productivity.
[43]	Moldboard Chisel Vertical disk	The effect of the plows on soil physical properties	Clay loam 16 – 18 %	Vertical disc achieved the best bulk density, porosity and moisture content and soil penetration resistance. Moldboard plow superior in all indicators compare with chisel.
[44]	Disc	Measuring of the Performance indicator	Silt clay loam 14.3 %	Disc tilt angle, speed 7.27 $km.h^{-1}$ and depth 10 cm were recorded least slippage, fuel consumption, number of clods and higher field efficiency.
[45]	Moldboard Disc	Study of the performance and comparison of moldboard and disc.	Silty clay loam 14% 18% 21%	Moldboard recorded a higher field efficiency, productivity and volume of disturbed soil. Disc plow reach to require depth of tillage. Speed and soil moisture were significant effects on all indicators.
[46]	Moldboard	Some indicator for machinery unit	Silty clay 17-19 %	Higher speed 6.32 $km.h^{-1}$ and depth 15-20 cm recorded best productivity, field efficiency, fuel consumption and soil volume disturbs.
[47]	Moldboard Disc Chisel	Study of the fuel consumption, cost and productivity	Silt clay loam 18 %	Chisel plow get higher productivity 0.719 $ha.h^{-1}$, least fuel consumption 10.652 $L.ha^{-1}$ and costs 16866 $Di.ha^{-1}$ compare with other plows.

[48]	Moldboard Chisel Disc	Effect the plows on some performance indicators	Gypsfreous soil 14-15 %	Chisel plow achieved lower slippage, fuel consumption, lost power due to slippage and efficiency use of energy. Moldboard get least draft force and higher tractive efficiency.
[49]	Moldboard Disc	Study of some performance indicators for the plows	Silty clay 17 – 19 %	Moldboard superior on disc plow on get best productivity, slippage, field efficiency, soil volume distribute and fuel consumption.
[50]	Moldboard	Evaluate the performance of tillage when using moldboard plow	Silty loam + Clay 14.63 &15.25	Moldboard was recorded high draft, soil porosity and pulverization index. Increase speed led to increase draft, productivity, field efficiency and soil porosity and decrease bulk density.
[51]	Moldboard Disc Chisel	Measuring the draft force	Silty clay 17 %	Increasing draft 114% and 80% when depth increase from 15 to 25 cm and tractor speed from 0.54 to 1.53 $m.s^{-1}$. Moldboard needed higher draft.
[52]	Moldboard Chisel	Effect of the plows in some machinery unit	Sandy Loam 17 %	Chisel give lower slippage, fuel consumption. Also give higher productivity and Corn stem high.
[53]	Disc	Study of some indicators	Silty clay 9-12 % 13-16 % 17-20%	Increasing the moisture and depth of tillage led to increase the slippage and net drowning, addition, bulk density increasing when increase the depth.
[54]	Chisel	Measure draft, slippage & fuel consumption	Silty loam 13-15 % 16-19 %	Increasing soil moisture and depth of tillage led to increased draft, slippage and fuel consumption.
[55]	Moldboard Chisel	Influence tillage on Maize	Silty clay loam	Tillage by moldboard was improved growth and yield of maize and decreased weed comparing to chisel.
[56]	Chisel	The effect of tire pressure and on some indicators	Silty clay loam 17- 19 %	Increase tire pressure led to increase the slippage and fuel consumption, and reduce the drawbar and productivity.
[57]	Chisel Moldboard	Determine the puling force	Silty clay loam 16-18 %	Chisel plow recorded best traction efficiency. Moldboard needed lower draft, drawbar power and break horse power. Speed and depth tillage were significant effect on all indicators.

After reviewing the work of three plows which are moldboard, chisel and disc in this article review, I recommend following the steps or factors below for the purpose of choosing the appropriate plow for plowing the field soil. Moreover, when farmers want to choose the appropriate plow to tilt their fields, they must know the requirement and specific need, which are the most important factors consider before purchasing or using the plows:

1- **Size of the field (farm)**: The size of the field holding determines the type and number of plows required, as small farms do not need a large number of plows.

2- **Texture of the soil**: Knowing the type of soil is one of the most important thinks for the field owner. There are heavy, medium and light soils, and soil that contains salts, weeds, and previously unplowed soil… etc. For example, the heavy soil or the soil that contain a hardpan layer under the soil surface, the wright choice for them is the chisel plow.

3- **Crops to grow**: Before the tillage, it is better for the farmer know what crop will be planted after plowing operation and prepare the seed bed. Some crops are not sensitive about the tillage such as sorghum, so the fine tilt will be increase the costs, on the other hand, some crops and roots such as sugarcane need deep tillage.

4- **Required depth of the tillage**: The primary tillage which exceeds 30 cm is carried out using a chisel plow, it is possible to use a deeper chisel plow up to 50 cm, but it is taken into consideration not to turn the soil over and to provide the horsepower of the tractor. When plowing from 15 to 30 cm, it is possible to plowing by using the moldboard and disc plows, with soil completely or partially turned.

5- **Suitable Tractor**: Agricultural tractors are designed with different horsepower capacities, so there must be a compatibility between the tractor and the plow in terms of their working width and the depth required for the plowing. Otherwise, there will be a loss in horsepower and fuel consumption.

6- **Residue**: The presence of residue (plant remains) on the surface of the soil from the crop that was harvested last year, the farmer must use the moldboard plow to tilt the field because it turns the soil completely and at an angle of 180 degrees.

Conclusion

The plow is necessary agricultural equipment in the field and has many benefits such as improve soil health, reduce soil aeration and increasing yield. Choosing the appropriate type of the plow for plowing fields remains a priority for all farmers not only in Iraq, but also in all the world, the best type of plow depends on the specific requirements that the field needs, therefore, some factors help the farmer to make the right choice which are the size of the farm or the field, the type of soil, the crop to be grown, depth require and tractors horsepower. Also conclude that the moldboard plow is more widely used by farmers in plowing Iraqi soils, addition, the moldboard plow is found in most fields in northern, southern, western and central Iraq. Moreover, the most important factors influencing the choice of the appropriate type of plow for plowing the field is the type of soil and the crop to be grown.

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مقارنة بين ثلاثة محاريث للحراثة الأولية شائعة الاستخدام في العراق.

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الخلاصة

تعد عملية الحراثة أكبر العمليات الزراعية عند أغلب المزارعين العراقيين، وحراثة التربة تتطلب قدرة وطاقة كبيرة من اي عملية زراعية اخرى. في هذه المقالة سوف نستعرض ثلاثة انواع من المحاريث الأكثر استخداماً لدى الفلاحين العراقيين وهي المحراث المطرحي والحفار والقرصي والتي تختلف في التصميم والشكل وطريقة العمل والتعامل مع التربة، تهدف المقالة الى استعراض مختلف الدراسات والبحوث لمساعدة المزارعين العراقيين وغيرهم على اختيار المحراث الملائم لحراثة الحقول وتحقيق افضل انتاجية وتقليل استهلاك الوقود والوقت وتكاليف عملية الحراثة والقدرة المطلوبة والمحافظة على التربة وزيادة غلة الانتاج. حراثة التربة وتحضير مهد البذرة جيداً ينتج نباتات جيدة ذات ثمار سليمة وهذا ما يطمح أليه كل المزارعين ليس فقط في العراق بل في العالم أجمع. المزارعين في جنوب ووسط العراق عادة يستخدمون المحراث المطرحي (اكثر محراث شائع في العراق) مقارنة مع المحراث الحفار والقرصي، بينما في مناطق شمال العراق يستخدمون المحراث الحفار أضافة الى المحراث القرصي. نستنتج أن أفضل نوع من المحاريث يعتمد على المتطلبات النوعية لما يحتاجه الحقل، لذلك هناك بعض العوامل التي تساعد المزارعين للاختيار المناسب والتي هو حجم المزرعة أو الحقل ونوع التربة ونوع المحصول المراد زراعته وبقايا المحصول السابق على التربة وعمق الحراثة المطلوبة.

الكلمات المفتاحية : تُرب العراق، الحراثة، محراث مطرحي، محراث حفار، محراث قرصي. .