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ECONOMICS OF PLOWING PRODUCTIVITY (APPLICATION STUDY FOR BARELY CROP)

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ABSTRACT: *This study aimed to find out the plowing method which maximize the profit of barely planting, and the proper plowing methods which minimize the tractor fuel consumption. The study was conducted at the College of Agricultural in Mu'tah university in Karak, located south Amman at the growing seasons (2001/2002). The disk plow has been used to plow a sandy clay loam soil with 10% moisture using three operating speeds (5.5, 7.0, and 9.0 km/hr), three disk angles (35, 55 and 45 degrees), three tilt angles (15, 20 and 25 degrees) and two plowing depths (15 and 25 cm). The study showed that the optimum plowing method which maximized the profit (387.0 JD/ha) was at speed of about 5.5 km/hr, 45° disk angle, 15° tilt angle and at 25 cm plowing depth. The regression model indicated that the significant factors decreasing the costs with R^2=87% and with significant model about 1% were plowing depth, disk angle and tilt angle. The study recommended to take into consideration the significant results when plowing to seed barely and to repeat the study in different locations of Jordan with different crops and plows.*

Key Words: Barely production , Profit, Plowing methods.

INTRODUCTION

Jordan concerned with supports and encourages the development plans in the agricultural sector through many programs and policies of completing the agricultural infrastructure and by using technology in agricultural production. This lead to a significant increase in quantity and quality of the agricultural products (Department of Statistics (DOS), 1998).

Karak which located at the southern part of Jordan, is considered one of the important areas for field crop production specially barely. Karak barely planted area forms about 15.3% of the total barely planted area in Jordan (DOS, 1998), whereas the attention has been given for the barely crop in Karak governorate.

Barely productivity is dependent on many factors as the used tools, implements and farm equipment, and its optimum usage fits for the agricultural conditions and the planted crop. The interest of increasing crop productivity using different methods of plowing will lead to optimum usage of the available resources. Minimizing the usage of agricultural resources is considered as one of the principal factor that affect the growth of the agricultural sector (Al Najafee, 1985). Accordingly, the importance of increasing production raised through the usage of different methods of

plowing. The disk plow is considered one of the common farm tools used in southern part of Jordan. It is characterized as a proper plow for the dry and hard soils full of stones and it reserves soil moisture after plowing better than the moldboard plow (Mamkagh, 2002). The disk plow can be used in very hard soils (Ali L.H. and T.F. Demian, 1978) and for soils with high organic matter, as it does not convert the soil surface completely resulting of efficient use of organic matter (Ghnaim A.Y. and Al-Shareef, 1984).

The plowing depth considers as one of the major factors affect the growth rate and energy requirements. One cm deeper plowing means impact of 100 m^3 of soil in one hectare. This impact means more work which needs more energy that needs fuel supply, it leads to the increase of production costs (Mamkagh, 2002). Plowing two different locations using different plows at plowing depth ((10-15 cm) and (20-25 cm)) Al Tahan found that the plowing at 10-15 cm depth using disk plow significantly surpasses the other treatments in the production of total cereals in the first location and the average of the two locations (Al Tahan, 1990).

The disk and the tilt angles were considered as the important factors affecting the fuel consumption. Bukhari et al. (1992) reported that the fuel requirements were increased with increasing in disk and tilt angles. Increasing disk and tilt angles lead to the pulverization of soil and improving its aeration, this improved there productivity (Bukhari, S., L. et al. 1992). Moreover, Plouffe et al. (1995) found that the draft components increased with speed due to the greater acceleration of soil, while the vertical force component remains nearly constant.

Forages, specifically barely, is considered as one of the most important products for the livestock fortune. The demand on forages is connected with the final demand on meat and yogurt. Despite the fact that researches studied the cost of forages and field crops production, most economic researchers and economical decision makers in Jordan suffer of the lack of data and scarcity of studies deal with the cost production of barely using different plowing methods.

Due to the scarcity of published data, it is necessary for this case study to give necessary information for farmers, investors and decision makers for improvement.

Study Objectives: According to the introduction, this study aimed to achieve the following objectives:

1. Studying the effect of plowing angle, disk angle, and plowing depth on the profitability of barely production.
2. find the optimum combination of disk angle, tilt angle, plowing depth and operating speed to get the complete use of the tractor power and save energy loss in order to decrease the plowing costs for barely planted areas.

MATERIALS AND METHODS

This experiment was conducted in the 2001/2002 growing season in the Agricultural Research Station managed by Mu'tah University in Al Raba area which follows Karak governorate south Jordan. This district is, known as a semi-arid region depends on rainfall, famous with planting the cereals. The average annual rainfall in the study area is about 300mm and the soil in the location was a sandy clay loam soil.

The disk plow attached with a 60 kilowatts Kubota tractor model M8030 (4WD) manufactured in 1993, with four strokes, four cylinders diesel engine model V4300-1A capacity 4292 cm^3. During the experiment rear wheels were drivers only. The plow has three disks with 43 cm diameter for each disk and has a 112 cm width.

The design of this experiment were a complete randomized block design, with four replicates for each treatment. The treatments factors were: the plowing depth (15 and 25cm), the operating speed (5.5, 7.0 and 9.0 km/hr), the disk angle (35, 45, and 55 degrees)the tilt angle (15, 20 and 25 degrees). The blocks were planted with barely. The seeds were harvested to find out the average of production.

Statistical Package for Social Studies (SPSS) was used to analyze the data. The descriptive analysis were run using the simple statistical indicators. Spearman correlation using stepwise regression to determine five mathematical models (Log-Log regression common effect linear, multiple logarithmic, square model, and common effect model). The Log-Log regression was the best one which represented the relationship between the operating speed, plowing depth, disk angle and tilt angle as a dependent variables with the fuel consumption.

RESULTS AND DISCUSSION

The optimum plowing method which maximize the profit

The level of input which maximizes the profit, can be determined through the quantitative analysis through the determination of the returns from the productions and determination of the costs for each level of input to find the level which maximize the profit. The quantitative analysis needs to know the input quantities used which is presented through the fuel consumption and the total production of barely. And it needs to know the price of inputs, which was 0.12 JD/liter for diesel, and the production unit price 0.0927 JD/kg. The total costs is the result of the multiplication of the price unit with quantity of input. The total returns calculated through the multiplication of the product quantity with the production unit price. The net profit value is the maximum positive difference between the total returns and the total costs. Table (1) shows the input quantity of diesel used, the total production of barely, and the optimum combination of plowing factors which lead to maximize the profit. The maximum positive difference between the returns and costs (which means the profit) was 386.61 JD/hectare which achieved by a

combination of disk angle 45 degrees, tilt angle 25 degrees, plowing depth 25 cm, and operating speed 5.5 km/hr. using this method of plowing the production of seeds was the maximum where it was 4190 kg/hectare. Diesel cost using this method was 1.80 JD/hectare. The average profit in the experiment was 285 JD/hectare, the median of the profit was 281.2 JD/hectare, while the minimum profit was 29.2 JD/hectare and the maximum was 386.6 JD/hectare. This is as a result of deep plowing of 25 cm, large disk and tilt angles which produced the best quality of plowing to increase the productivity in despite of the increasing of fuel consumption.

Table (1): The optimum combination of using different plowing methods

Profit (JD/hectar)	Total Diesel Costs (JD/hectar)	Total income (JD/hectar)	Barely Production (kg/hectar)	Fuel consumption (l/hectar)	Operating speed (km/hr)	Plowing depth (cm)	Disk angle (degree)	Tilt angle (degree)	Treatment no
235.81	1.50	237.31	2560	13	5.5	25	35	15	1
340.56	.96	341.51	3684	8	5.5	15	35	15	2
240.74	1.76	242.50	2616	15	5.5	25	45	15	3
269.91	1.14	271.06	2924	10	5.5	15	45	15	4
350.09	2.17	352.26	3800	18	5.5	25	55	15	5
332.02	1.32	333.35	3596	11	5.5	15	55	15	6
306.35	1.42	307.76	3320	12	5.5	25	35	20	7
361.18	1.09	362.27	3908	9	5.5	15	35	20	8
240.82	1.68	242.50	2616	14	5.5	25	45	20	9
331.25	1.18	332.42	3586	10	5.5	15	45	20	10
237.21	1.96	239.17	2580	16	5.5	25	55	20	11
288.44	1.53	289.97	3128	13	5.5	15	55	20	12
322.84	1.61	324.45	3500	13	5.5	25	35	25	13
273.87	1.27	275.13	2968	11	5.5	15	35	25	14
386.61	1.80	388.41	4190	15	5.5	25	45	25	15
382.30	1.48	383.78	4140	12	5.5	15	45	25	16
296.65	2.03	298.68	3222	17	5.5	25	55	25	17
268.32	1.62	269.94	2912	14	5.5	15	55	25	18
230.87	1.62	232.49	2508	14	7	25	35	15	19
244.26	.84	245.10	2644	7	7	15	35	15	20
324.49	1.81	326.30	3520	15	7	25	45	15	21
367.83	1.02	368.85	3980	8	7	15	45	15	22
317.41	2.04	319.44	3448	17	7	25	55	15	23
348.19	1.10	349.29	3768	9	7	15	55	15	24
29.24	1.54	30.78	332	13	7	25	35	20	25
367.20	1.00	368.20	3972	8	7	15	35	20	26
374.47	1.90	376.36	4060	16	7	25	45	20	27
299.69	1.21	300.90	3246	10	7	15	45	20	28
328.13	2.25	330.38	3564	19	7	25	55	20	29
285.60	1.40	287.00	3096	12	7	15	55	20	30
248.22	1.70	249.92	2696	14	7	25	35	25	31
234.15	1.31	235.46	2540	11	7	15	35	25	32
306.68	2.01	308.69	3330	17	7	25	45	25	33
267.32	1.51	268.83	2900	13	7	15	45	25	34
230.38	2.48	232.86	2512	21	7	25	55	25	35
202.80	1.88	204.68	2208	16	7	15	55	25	36
202.36	1.58	203.94	2200	13	9	25	35	15	37
236.81	.87	237.68	2564	7	9	15	35	15	38
307.66	1.77	309.43	3338	15	9	25	45	15	39
325.05	.89	325.93	3518	7	9	15	45	15	40
276.81	2.03	278.84	3008	17	9	25	55	15	41
266.89	1.08	266.96	2880	9	9	15	55	15	42
295.53	1.48	297.01	3204	12	9	25	35	20	43
250.95	.83	251.77	2716	7	9	15	35	20	44
212.57	1.75	214.32	2312	15	9	25	45	20	45
268.79	.87	269.67	2908	7	9	15	45	20	46
331.19	2.53	333.72	3600	21	9	25	55	20	47
229.96	1.42	231.38	2496	12	9	15	55	20	48
323.14	1.86	325.01	3506	16	9	25	35	25	49
270.27	1.15	271.43	2928	10	9	15	35	25	50
250.55	1.96	252.51	2724	16	9	25	45	25	51
272.47	1.18	273.65	2952	10	9	15	45	25	52
274.84	2.51	277.36	2992	21	9	25	55	25	53
323.45	1.56	325.01	3506	13	9	15	55	25	54

The effect of plowing methods on the fuel consumption:

Through studying the relationship between the amount of fuel consumption and the other variables, it was found that there is direct significant relationship at probability 100% between the fuel consumption with disk angle and the plowing depth.

By the usage of regression, the Log-Log regression that shown in equation (1) was the best function which represents the relationship between the consumed diesel (liter/hectare) as a dependent variable with plowing depth, operating speed, disk angle and the tilt angle as Independent variables.

$$LogY = -1.133 + 0.883LogX_1 + 0.72Log X_2 - 0.09938LogX_3 \dots (1)$$
$$(t) \quad (-7.225)^{**} \quad (14.826)^{**} \quad (8.754)^{**} \quad (-5.452)^{**}$$
$$R^2 = 0.867 \qquad \text{Adjusted } R^2 = 0.859 \quad F = 108.723^{**} \quad DW = 2.338$$

Whereas;

X_1 = plowing depth

X_2 = plowing angle

X_3 = tilt angle

Y = The diesel used quantities per hectare planted with barely.

According to the economical theories concepts, and the statistical and measurement tests, the indication of the determined variable are in harmony with the economical theory and the scientific logic. The factor determination R^2 was 87%, which indicates that the variable of the model explain about 87% of changes in diesel consumption in the plowed area unit. The significance level (1%) was used in (t) test and the total significant value at (1%) also for (F) test. The value of Darben-Watson factor is located in the inconclusive area at significant level 1% which indicates that there no final decision concerning the phenomenon of the Autocorrelation and there is no significant correlations between the model variables.

Through the stepwise regression, the variable which maximum affect the fuel consumption was the plowing depth, which explains about 58.4% of the differences in the quantities of fuel consumption and has direct relationship in the model. This means as the depth of plowing increased it increases the fuel consumption.

The second important variable that affect the quantity of fuel consumption was the disk angle which explains about 20.4% of the difference caused. It has direct relation which means that increasing of disk angle caused increasing in fuel consumption. This is in agreement with Mamkagh (2002) who reported a significant effect of some variables on fuel consumption when using disk plow.

The third factor was tilt angle which explained 7.9% of the differences, with diverse relationship in the model, with increasing the tilt angle the fuel consumption decreased. This could be explained by the increase of tilt

angle which deckease the disk penetration and decreased the disk surface exposed to soil.

RECOMMENDATIONS

According to the previous results, maximum profit could be achieved for barely farms at Al Karak area by using the disk plows with tilt angle 25 degrees, disk angle 45 degrees, plowing depth 25 cm, and operating speed 5.5 km/hr. But if the objective is to decrease fuel consumption, the study recommended to use plowing depth at 15 cm with 35 degrees disk and 25 degrees tilt angle.

Further studies recommended at different locations of Jordan, with different crops and plows.

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اقتصاديات إنتاجية الحراثة
(دراسة تطبيقية على محصول الشعير)

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الملخص العربي

استهدفت الدراسة تحديد أسلوب الحراثة المعظم لربح زراعة محصول الشعير وتحديد طرق الحراثة المثلى المخفضة لتكاليف استهلاك الوقود في محافظة الكرك جنوب الأردن خلال الموسم الزراعي ٢٠٠١/٢٠٠٢، حيث تم إستخدام المحراث القرصي القلاب لحراثة التربة المزجية الرملية الطينية ذات رطوبة ١٠% عند ثلاث سرعات للحراثة (٥,٥، ٧، ٩)كم/س، وعند ثلاث قيم لزاوية الحرث (٣٥، ٤٥،٥٥) درجة، وثلاث قيم لزاوية ميل القرص (١٥، ٢٠، ٢٥) درجة، وضمن عمقين للحراثة (١٥، ٢٥)سم، وتوصلت الدراسة أن المستوى الأمثل المعظم للربح كان بمقدار٣٨٧ دينار/هكتار، عند سرعة حراثة ٥,٥كم/س، و٤٥ درجة لزاوية الحرث، و١٥ درجة لزاوية الميل، وعمق حراثة حول ٢٥ سم، بينما توصل نموذج الانحدار إلى أن المتغيرات المعنوية ذات الأثر في تخفيض التكاليف وعند مستوى تفسير٨٧%، ودرجة ثقة ١%، كانت في المرتبة الأولى وبعلاقة طردية عمق الحراثة، وفي المرتبة الثاني بعلاقة طردية زاوية الحرث، وفي المرتبة الأخيرة وبعلاقة عكسية زاوية الميل. وتوصي الدراسة بأخذ النتائج المعنوية بعين الاعتبار عند حراثة محصول الشعير، وإعادة الدراسة في مواقع مختلفة من الأردن وعلى محاصيل ومحاريث مختلفة.