CUSTOM HIRING VERSUS OWNERSHIP OF AGRICULTURAL MACHINERY SERVICES IN RICE PRODUCTION FARMS IN ALNAJAF AL-ASHRAF PROVINCE

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ABSTRACT

Investments in ownership of agricultural machinery services and access to them, especially for small-scale farmers, may not be the minimum cost option in comparison with hiring these required services through oral or written agricultural hire contracts. The main objective of this research is to test whether the custom hiring status of agricultural machinery services is better for selected sample in comparison with the other potential alternatives. The theoretical framework based on the financial approach of engineering costs analysis of agricultural machineries services, to calculate discounted cash flows. The data were collected by using cross-section data in rice production farms in Alnajaf Al-ashraf province during 2015 farming season. The results indicated that the total costs of the used machineries are lower purchasing price, fixed costs and requires more powered skills than new machineries. Results also pointed out that the values of net present criterion had negative sign and less than zero at 5%, 7% and 10% discount rates because of the costs of financing exceed total revenues earned from agricultural machineries in addition to the results showed that the investments on all new and used agricultural machinery in the study area are unprofitable based on profitability ratio criteria. The custom hire should be encouraged for enhancing the use of agricultural machinery services in the province due to it is highly profitable from the individual investor viewpoint.

Key words: ownership costs, operating costs, rent prices rates, profitability criteria, small scale rice farmers,
***Part of Ph. D. dissertation of author.**

الاستئجار المدفوع مقابل امتلاك خدمات المكائن الزراعية في مزارع انتاج الرز في محافظة النجف الاشرف

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المستخلص

الاستثمارات في خدمات المكائن الزراعية واذونات الدخول اليها، على وجه الخصوص لمزارعي الحيازات الصغيرة، ربما لم تكن هي الخيار الاقل تكلفة بالمقارنة مع استئجار هذه الخدمات خلال عقود استئجار زراعية مكتوبة او شفوية. الغرض الاساسي من هذا البحث هو اختبار فيما اذا كانت حالة الاستئجار المدفوع لخدمات المكائن الزراعية هي الافضل للعينة المبحوثة بالمقارنة مع البدائل المحتملة الاخرى. استند الاطار النظري الى المنهج التمويلي لتحليل التكاليف الهندسية لخدمات المكائن الزراعية لحساب التدفقات النقدية المخصومة. جمعت البيانات والمعلومات باستخدام بيانات مقطعية من مزارع انتاج الرز في محافظة النجف الاشرف خلال الموسم الزراعي 2015. اشارت النتائج بأن التكاليف الكلية للمكائن المستخدمة او القديمة هي اقل سعر شراء وتكلفة ثابتة وتتطلب مهارات قوة اكثر من المكائن الجديدة او الحديثة. اشارت النتائج كذلك بأن اقيام معيار صافي القيمة الحاضرة جاءت مسبوقة بأشارات سالبة وانها اقل من الصفر عند معاملات خصم 5% و7% و10% حيث ان التكاليف التمويلية تفوق الايرادات الكلية المتحصل عليها من المكائن الزراعية قضلا عن ان النتائج قد اوضحت بأنه بالاستناد الى معايير نسبة الربحية فأن الاستثمارات في كل المكائن الزراعية الجديدة والقديمة في منطقة الدراسة هي غير مربحة. يجب ان يكون الاستئجار المدفوع مشجعا لتعزيز استعمال خدمات المكائن الزراعية في المحافظة نظرا لانه مربح بصورة عالية من وجهة نظر المستثمر.

كلمات مفتاحية: تكاليف الامتلاك، التكاليف التشغيلية، معدلات اسعار التأجير، معايير الربحية، صغار مزارعي الرز،
***البحث مستل من اطروحة دكتوراه الباحث.**

***Received:3/6/2018, Accepted:12/8/2018**

INTRODUCTION

The development of any country is measured by the degree of mechanization. Subsequently, agricultural operation improvements, namely, the production of a particular crop, depends on the level of agricultural mechanization used for production (24). Among small-scale farmers, or those with less than three hectares of land, one of the principal causes of poverty is the shortage of farm power (labour-saving tools and equipment and mechanized power). Such a situation faced by smallholder farmers may lead to a significant decline in farm production (12). As an alternative to owning agricultural machinery and equipment, a farmer can hire personnel services to perform specific farm tasks. Choices and comparisons between hiring personnel services and owning machines are key decisions taken by an administrator of a farm as it mostly affects farm profitability (20). Some farmers think it is better to complete a specific service rapidly while decreasing costs (i.e., hire option) compared with spending large capital to purchase machinery (i.e., ownership option). Prior to the 1950s, hiring was widely used in the real estate sector. Throughout the middles of the 20th century, many have proposed the concept of rent as a step towards possessing various types of fixed assets. Hiring or leasehold is a contract wherein a renter (lessee) delivers payment on an agreed-upon deadline to a landlord (lessor) for an asset utilized by the renter or for the services provided by the landlord over a particular period (19). In countryside of many developing states, buyers of hire services are normally small scale farmers within village societies planting less than one hectare of land. Suppliers of hire services in this situation are mainly growers themselves who have invested in machineries, both for their own use and because they have known a possible for hiring services to their domestic markets (14). Accurately the decision that many smallholder growers have is hiring agricultural machinery from neighbours or service contractors. Hiring the power service spreads the cost and brings the machine powered action into the lands of financial option for many smallholder farmers. Small scale farmers hire service initiatives in many societies have been considered by exchange trade where the service is presented in exchange for an individual service or at times based on returning a specific errand (22). In southern and central Iraq hire services are commonly provided by the private sector solely by farmers on neighbours to neighbours basis. Current estimates are that 51% of farmers use their own equipment and 49% use a contractor for undertaking harvesting and seedbed preparation, while 33% of farmers purchase their spare parts requirements through the agency system and 67% from the local market (14). Alnajaf province has a big number of small scale rice farms level with land holding of less than 3 hectares as well as a low level of economic living conditions related to farm income (4). Personal farm ownership and use of agricultural machinery on these small farms is not economically feasible. However, in order to get the benefits of agricultural mechanization, small scale rice farmers make a decision to use the agricultural mechanization services through the custom hiring of these services where the appropriate features to agriculture conditions (1). Shifting of farming is the new term for sustainable agricultural development especially in rice field in Alnajaf province (because of water constraint). Shifting means escapist a large area under rice to other crops. Machinery needed for sowing, planting, crop protection and harvesting and salvage is greatly crop specific. Thus, shifting would require use of a massive type of additional machinery for these operations on limited area especially in the primary stages, making it uneconomic on ownership basis. However, custom hiring through private providers helps to increase annual use of this machinery in that way making them inexpensive. Thus, custom hiring of specialized farm machinery for replacement crops can highly enable modification of farming on level of rice farms in Iraq (16). The main objective of this research is to test whether the custom hiring status of agricultural machinery services is better in comparison with the other potential alternatives.

MATERIALS AND METHODS

Conceptual framework: A financial approach by using cost– benefit principle is used in this research as a theoretical framework. Cost–

benefit principle is a logical financial approach to estimate the alternatives powers and weaknesses of different economic activities; it is used to decide alternatives that provide the best approach to reach benefits while protective savings (11). The cost–benefit approach is also defined as a logical procedure for computing and comparing costs and benefits of decisions, government policy or assignment (14). Cost–benefit principle is often used by administrations to evaluate the attraction of a given plan. It is an analysis of the predictable equilibrium of costs and benefits, including a justification of predictable alternatives and the status quote (9). In general, correct cost–benefit approach identifies selections that increase benefit from a useful viewpoint. The steps that contain a common cost–benefit approach can be displayed as below (7):

1) Determine the objectives of the economic activities (products or services).

2) List alternative projects/programs and list investors.

3) Select measurement (s) and measure all cost/benefit elements.

4) Predict outcomes of costs and benefits over relevant time period

5) Compare between alternatives and adopt recommended choice.

Estimated costs and benefits can be different, and financial costs tend to be most methodically represented in cost-benefit analyses due to relatively plentiful market information (8). Per unit model is commonly used to estimate predictable costs or benefits of products or services alternatives. This model uses a "per unit" factor, such as cost per product, land or time; to develop the estimate wanted (17). Per unit model is a very basic useful technique, especially for developing estimates of the uneven or order-of-amount type, in which estimate of costs (or benefits) is made for a sole unit, then the estimate of total costs (or benefits) results from multiplying the predictable costs per unit times the number of units (3).

Sample and questionnaire

This research is based on an empirical case study done in Alnajaf province which located in the southern central region of Iraq. In this province a lot of contractual bargains to hire agricultural mechanization services especially in scope of tractors, farm sprayers, and rice combine harvesters have already appeared by small scale rice farmers. A randomized sample by 10% (6) was made to test whether the custom hiring decision of agricultural machinery services is better in comparison with the other potential alternatives. A total of 391 respondents from 3,898 rice farmers in Alnajaf province were interviewed face-to-face, and the data was collected by using a standardized questionnaire with open and closed questions applied on visits to mentioned farms during 2015 planting season.

Methods of analysis

An engineering costs analysis by using discounted cash flows technique has been followed to find out the profitability of agricultural field machineries from owners of these machineries. This technique however, is based on the following assumptions (15):

1) All the machineries are purchased with cash.

2) Operation skill is remaining unchanged throughout the machine life.

3) All inputs and outputs prices are given and constant throughout the machine life.

4) Discount rates used reflect the minimum amount can be earned on other investment.

Cash flow diagram graphically characterizes income and costs over some time intervals. The diagram contains of a horizontal line with indicators at a series of time intervals (18). At suitable times, expenditures and revenues are presented (Figure 1).

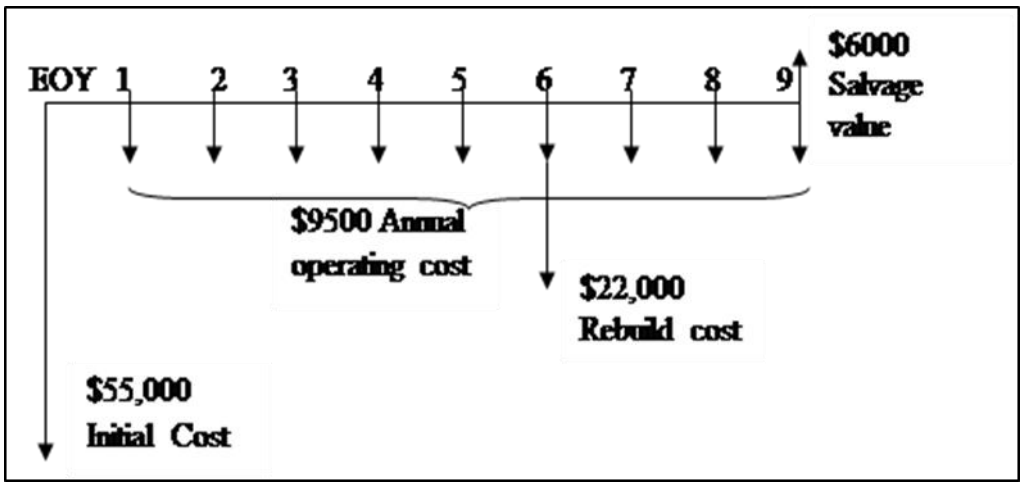

Figure 1. Cash Flow Diagram

Source: Newnan et al., 2015

Commonly there are three alternative discounting measures are applied for evaluation of agricultural machineries services, which are (12):

Net Present Value Criterion (NPV)

Net present value is an economic criterion to calculate the present value of cash flows, both inflows and expenditures of an investment suggestion, using a discount factor and deducting the present value of expenditures to find the net present value. Net present value represents the difference between the present value (P.V) of both inflows of cash and outflows of cash (2) and (10), thus it is calculated by using the following formula:

N.P.V = (P.V) of cash inflows – (P.V) of cash outflows

N.P.V = KΣ P.VN = k(P.V)0 + k(P.V)1 + k(P.V)2 + k(P.V)3 +…….+ k(P.V)i

P.V = D.F x C.F

Where:

P.V = Present Value of Investment/ year

D.F = Discount Factor = Present Value of One Dollar = (1÷ (1+ K))

C.F = Cash Flow

K = Rate of Interest

N = number of years (1……i).

The decision to accept or reject the investment (buying) based on net present value criterion can be stated as below (5) and (10):

If N.P.V > 0 accepts the investment

N.P.V < 0 rejects the investment

Or N.P.V = 0 the investment is marginal

Profitability Ratio Criterion (B.C.R)

Ratio of benefit-cost also is an economic criterion can be defined as the ratio of benefits to costs (expressed either in present or yearly value). The analysis of benefit-cost criterion is simple in principle. It follows the logical approach used in deciding of economic investments alternatives. Benefit- cost ratio is calculated by using the following formula (2):

B/C = Σ Net Present of Benefits ÷ Σ Net Present of Costs

OR B.C = Total of Discounted Cash Inflows ÷ Total of Discounted Cash Outflows

If the benefit-cost ratio is more than unity, then it will be economically accepted. In general, the decision to accept or reject the investment (buying) based on Benefit-cost ratio criterion can be listed as below (2) and (5):

If B.C.R > 1 the investment is attractive,

B.C.R < 1 the investment is unattractive,

Or B.C.R = 1 the investment is marginal

Net Profitability Ratio Criterion (NB.C.R)

The net profitability ratio is used to measure both the quantitative and the qualitative factors, since sometimes the benefits and the costs cannot be measured exclusively in financial terms. When possible, the qualitative factors should be translated into quantitative terms for the results to be easily understandable and tangible (18). Net benefit-cost ratio is calculated by using the following formula (7):

NB/C = NPV ÷ Σ Net Present of Total Costs

The decision to accept or reject the investment (buying) based on net benefit-cost ratio criterion can be explained as below (7) and (11):

If NB.C.R > 1 accepts the investment,

NB.C.R < 1 rejects the investment

Or NB.C.R = 1 the investment is marginal

RESULTS AND DISCUSSION

Analysis of total costs for purchasing a machine

Total costs of agricultural machinery include two types of costs (21). Fixed costs or called ownership costs which are experienced unrelatedly of use yearly of the units of area or time. They contain of premium of annual depreciation, rate of interest, premium of annual insurance, housing, and taxes and licenses fee (if any). Variable costs or called operating costs which are usually related with the hours of machinery use. Operating costs contain of oil and fuel, lubricants, repair and maintenance and labor wages (23).

Analysis of total fixed costs (TFC) of field machinery

Table 1 shows categories of total fixed costs and their valves of different types of agricultural field machinery in Alnajaf Province during 2015 season.

Table 1. Total Fixed Costs of Different Agricultural Field Machinery

Type of Machine / Items of Fixed Cost	Tractor and Machinery of Soil Preparation		Farm Sprayer		Combine Harvester	
	New*/$	Old*/$	New*/$	Old*/$	New*/$	Old*/$
$US/ Yearly						
Depreciation[1]	2400	1440	28.80	28.80	6240	8640
Interest[2]	2000	400	24	8	5200	2400
Insurance[3]	100	20	1.20	0.40	260	120
Shelter[4]	400	80	4.80	1.60	1040	480
Total fixed cost	4900	1940	58.80	38.80	12740	11640

Source: survey, 2015

Where:

1- (Original cost minus salvage value: 10% of original cost) / Useful life years.

2- 5% of original cost (amount can be earned on other investment).

3- 0.25% of original cost

4- 1% of original cost.

*(Original purchasing costs in the study area are: 40000, 8000, 480, 160, 104000, and 48000 US$, respectively)

As can be shown in table 1, total fixed cost is a higher value of new harvesting machinery ($12740) than tractors and farm sprayers' machinery. While total fixed cost of the machinery is lowest value for machinery of old farm sprayers ($38.80). Regarding to the items of fixed cost of new tractor machines and machinery of soil preparation, the value of depreciation was $2400, followed by rate of interest ($2000), shelter ($400), and insurance cost ($100). Similarly, with respect to the items of fixed cost of old tractor machines and machinery of soil preparation, the value of depreciation was $1440, followed by rate of Interest ($400), shelter ($80) and insurance cost ($20). In addition the largest value of items of fixed cost of both new and old farm sprayers was $28.80 (depreciation cost), while the smallest values were $1.20 and $0.40 for insurance cost. On the topic of items of fixed cost of new combine harvester, the largest value was $6240 for depreciation cost, while the smallest value was $260 for insurance cost. Similarly, the largest value of items of fixed cost of old combine harvester was $8640 for depreciation cost, while the smallest value was $120 for insurance cost.

Analysis of total variable costs (TVC) of field machinery

Table 2 shows categories of total variable costs and their valves of different types of agricultural field machinery in Alnajaf province during 2015 season.

Table 2. Total Variable Costs of Different Agricultural Field Machinery

Type of Machine / Items of Variable Cost	Tractor and Machinery of Soil preparation		Farm Sprayer		Combine Harvester	
$US/ Hectare	New/$	Old/$	New/$	Old/$	New/$	Old/$
Fuel[1]	27.2	32	1.6	2.4	11.2	12.8
Lubricants and oil[2]	4.08	4.8	0.24	0.36	1.68	1.92
Repair and maintenance[3]	1.6	1.92	0.32	0.48	12.8	22.4
Operators labour[4]	6.4	6.4	1.6	1.6	16	16
Total variable cost	39.28	45.12	3.76	4.84	41.68	53.12

Source: survey, 2015

Where:
1- Consumed amount of fuel for each machine x buying price per liter of fuel in the study area
2- Estimated at 15% of fuel costs
3- Obtained directly from survey data
4- Obtained directly from survey data

As can be shown in table 2, total variable cost is more value for both new and old harvesting machines ($53.12, 41.68) than for soil preparation and crop protection equipment. While total variable cost of the machinery is lowest for machinery of new farm sprayers ($3.76). Regarding to the items of variable cost of new tractor machines and machinery of soil preparation, the value of fuel was $27.2, followed by operators' labour ($6.4), lubricants and oil ($4.08) and repair and maintenance ($1.6). Similarly, with respect to the items of variable cost of old tractor machines and machinery of soil preparation, the value of fuel was $32, followed by operators' labour ($6.4), lubricants and oil ($4.8) and repair and maintenance cost ($1.92). In addition the largest value of items of variable cost of old farm sprayers was $2.4 (fuel cost), while the smallest value was $0.24for lubricants and oil cost of new farm sprayers. On the topic of items of variable cost of old combine harvester, the largest value was $22.4 for repair and maintenance cost, while the smallest value was $1.92 for lubricants and oil cost. Similarly, the largest value of items of variable cost of new combine harvester was $16 for operators' labour cost, while the smallest value was $1.68 for lubricants and oil cost

Prices rates of hiring of different field machinery in Alnajaf province

Custom hire is an important practice in some area of operations such as applying chemicals and harvesting grain or forages. The decision of whether to own a machine or custom hire the service depends on the costs involved, the skills needed and the amount of works to be done. For machine that will be used very little, it is often more economical to hire the work done on a custom basis (20). Table 3 shows various prices of custom hire for different types of agricultural field machinery of study sample during 2015 planting season.

Table 3. Prices of Custom Hire for Different Agricultural Field Machinery

Field Machinery	Custom Rate of Tractor Services	Custom Rate of Sprayer Services	Custom Rate of Harvester Services
Custom Rate: $US/ Per Hectare	**112**	**12.80**	**272**

Source: survey data, 2015

Table 3 indicates that rates of custom hire prices in Alnajaf Province of each of tractor and machinery of soil preparation, farm sprayer and combine harvester services were $US 112, 12.80 and 272 per hectare, respectively (survey, 2015). The high cost of rice hired combine harvester services belongs to the high investment value of this machinery. Figure 2 explains the ratios of prices rates for hiring different kinds of agricultural field machinery in the study region based on data of table 3

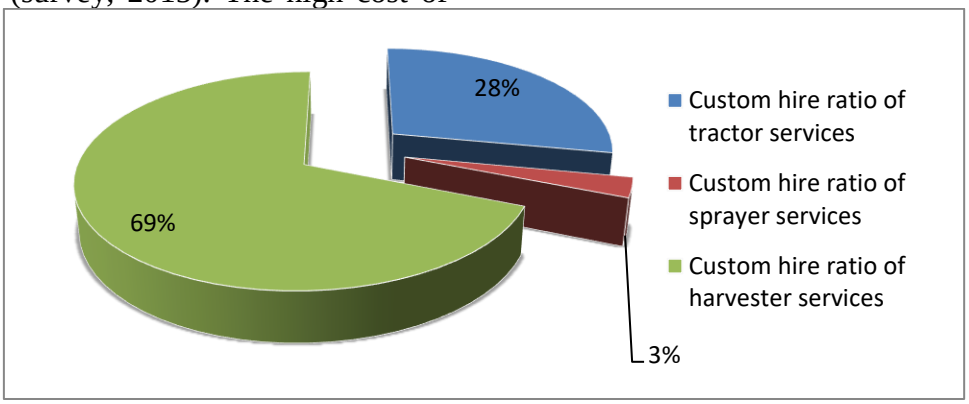

Figure 2. Ratios of Custom Hire Prices of Agricultural Field Machinery in the Study Region
Source: data of table 3

Discounted cash flows analysis

In scope of agricultural machineries services, the main purpose of this analysis is to find considerable uses for evaluating the profitability of some suggested decisions in the farm using discounting methods. In this analysis, only those cash flows which would be changed as a consequence of some suggested decisions in the farm are included. By discounted cash flows analysis an alternative evaluation of use of agricultural machinery, which is evidently a little more acceptable, can be done using internal and external cash flows joined with the measures of net present value, ratio of profitability and net benefit cost ratio (12).

Net present value criterion of agricultural machinery services (NPV)

NPV means translates cash flows in the future into a single current value. This criterion uses to evaluate the investments alternatives (like machinery services) and the effects of the timing of cash flows and opportunity costs on the decisions. Justification for net present value analysis is related to the "value of the farm". If accept an investment with NPV less than zero, value of the farm decreases and the owners will be worse off. However, if accept an investment with NPV more than zero, then the value of the farm increases and the owners will be better off. Generally, the steps of net present value criterion calculating can be specified as below:

1) Computing discount factor (rate of interest on borrow money for buying a machine);
2) Calculating annual net cash flows of machine use;
3) Calculating present value of net cash flows;
4) Calculating present value of cash expenditure (Purchase price of a machine);
5) Computing net present value;
6) Deciding which way to go: Accept or reject investment (buying option).

Considering a ten years of useful age for new agricultural field machinery, five years for old agricultural field machinery (survey, 2015) and 10% of original purchasing cost of specific machine as the salvage value, the net present value of different agricultural machinery in the study region with existing inflation conditions in Iraq was estimated at 5%, 7% and 10% discount rates (Tables 4, 5, 6, 7, 8 and 9), where the minimum percentage of interest rate associated with agricultural loans to purchase farming machinery was 5% during 2015 year. As can be seen in below tables, the negative sign of net present value (NPV < zero) of all farm machineries indicates that the investments in these machineries (buying) are unaccepting because of the costs of financing exceed total revenues earned from agricultural machineries, thus these machineries cannot considered financially comprehensive and the hiring option maybe is economically feasible.

Table 4. Net Present Value (at 5%, 7% and 10% discount factors) of New Agricultural Tractors

years	Discount Factors (Present Value of $1)			Discounted Cash Inflows of New Tractor/ $			Discounted Cash Outflows of New Tractor/ $			Discounted Net Cash Flows of New Tractor/ $		
	5%	7%	10%	5%	7%	10%	5%	7%	10%	5%	7%	10%
1	0.952	0.934	0.909	106.62	104.61	101.81	37.39	36.69	35.71	69.23	67.92	66.10
2	0.907	0.873	0.826	101.58	97.78	92.51	35.63	34.29	32.45	65.96	63.48	60.07
3	0.863	0.816	0.751	96.66	91.39	84.11	33.90	32.05	29.50	62.76	59.34	54.61
4	0.822	0.762	0.683	92.06	85.34	76.50	32.29	29.93	26.83	59.78	55.41	49.67
5	0.783	0.712	0.620	87.70	79.74	69.44	30.76	27.97	24.35	56.94	51.78	45.09
6	0.746	0.666	0.564	83.55	74.59	63.17	29.30	26.16	22.15	54.25	48.43	41.01
7	0.711	0.622	0.513	79.63	69.66	57.46	27.93	24.43	20.15	51.70	45.23	37.31
8	0.677	0.582	0.466	75.82	65.18	52.19	26.59	22.86	18.30	49.23	42.32	33.89
9	0.645	0.544	0.424	72.24	60.93	47.49	25.34	21.37	16.65	46.90	39.56	30.83
*10	0.615	0.508	0.385	2528.88	2088.90	1583.12	24.16	19.95	15.12	2504.72	2068.94	1568.00
Total				3324.75	2818.13	2227.79	303.28	275.71	241.22	3021.47	2542.42	1968.57

Present Value of Purchase Price of New Tractor = 40,000 US$

NPV of New Tractor = Total Discounted Net Cash Flows of New Tractor - Present Value of Purchase Price

NPV of New Tractor at 5% = 3021.47 - 40,000 = - 36,978 US$ → NPV < Zero

NPV of New Tractor at 7% = 2542.42 - 40,000 = - 37,457 US$ → NPV < Zero

NPV of New Tractor at 10% = 1968.57 - 40,000 = - 38,031 US$ → NPV < Zero

Reject Ownership

Source: calculated by the researcher based on

1- Discount factors equation = Present Value of \$1 = 1 ÷ (1 + R) ^{N}: where R = 5%, 7% or 10%, N = number of years
2- Discounted cash inflows of new tractor = specific discount factor × cash inflows of new tractor (custom rate = 112 \$/ha).
3- Discounted cash outflows of new tractor = specific discount factor × cash outflows of new tractor (TVC = 39.28 \$/ha).
4- Discounted net cash flows of new tractor = Discounted cash inflows of new tractor − Discounted cash outflows of new tractor.
5- Salvage value of new tractor (40000 × 0.10 = 4000 \$) was added to the cash inflows of new tractor in last year (112 \$).

Table 5. Net Present Value (at 5%, 7% and 10% discount factors) of Old Agricultural Tractors

years	Discount Factors (Present Value of \$1)			Discounted Cash Inflows of Old Tractor/ \$			Discounted Cash Outflows of Old Tractor/ \$			Discounted Net Cash Flows of Old Tractor/ \$		
	5%	7%	10%	5%	7%	10%	5%	7%	10%	5%	7%	10%
1	0.952	0.934	0.909	106.62	104.61	101.81	42.95	42.14	41.01	63.67	62.47	60.79
2	0.907	0.873	0.826	101.58	97.78	92.51	40.92	39.39	37.27	60.66	58.39	55.24
3	0.863	0.816	0.751	96.66	91.39	84.11	38.94	36.82	33.89	57.72	54.57	50.23
4	0.822	0.762	0.683	92.06	85.34	76.50	37.09	34.38	30.82	54.98	50.96	45.68
*5	0.783	0.712	0.620	714.10	649.34	565.44	35.33	32.13	27.97	678.77	617.22	537.47
Total				1111.02	1028.46	920.37	195.23	184.86	170.96	915.79	843.61	749.41

Present Value of Purchase Price of Old Tractor = 8,000 US\$

NPV of Old Tractor = Total Discounted Net Cash Flows of Old Tractor - Present Value of Purchase Price
NPV of Old Tractor at 5% = 915.79 - 8,000 = - 7,084 US\$ → NPV < Zero
NPV of Old Tractor at 7% = 843.61 - 8,000 = - 7,156 US\$ → NPV < Zero **Reject Ownership**
NPV of Old Tractor at 10% = 749.41 - 8,000 = - 7,251 US\$ → NPV < Zero

Source: calculated by the researcher based on
1- Discount factors equation = Present Value of \$1 = 1 ÷ (1 + R) ^{N}: where R = 5%, 7% or 10%, N = number of years
2- Discounted cash inflows of old tractor = specific discount factor × cash inflows of old tractor (custom rate = 112 \$/ha).
3- Discounted cash outflows of old tractor = specific discount factor × cash outflows of old tractor (TVC = 45.12 \$/ha).
4- Discounted net cash flows of old tractor = Discounted cash inflows of old tractor − Discounted cash outflows of old tractor
5- Salvage value of old tractor (8000 × 0.10 = 800 \$) was added to the cash inflows of old tractor in last year (112 \$).

Table 6. Net Present Value (at 5%, 7% and 10% discount factors) of New Farm Sprayers

years	Discount Factors (Present Value of \$1)			Discounted Cash Inflows of New Sprayer/ \$			Discounted Cash Outflows of New Sprayer/ \$			Discounted Net Cash Flows of New Sprayer/ \$		
	5%	7%	10%	5%	7%	10%	5%	7%	10%	5%	7%	10%
1	0.952	0.934	0.909	12.19	11.96	11.64	3.58	3.51	3.42	8.61	8.44	8.22
2	0.907	0.873	0.826	11.61	11.17	10.57	3.41	3.28	3.11	8.20	7.89	7.47
3	0.863	0.816	0.751	11.05	10.44	9.61	3.24	3.07	2.82	7.80	7.38	6.79
4	0.822	0.762	0.683	10.52	9.75	8.74	3.09	2.87	2.57	7.43	6.89	6.17
5	0.783	0.712	0.620	10.02	9.11	7.94	2.94	2.68	2.33	7.08	6.44	5.60
6	0.746	0.666	0.564	9.55	8.52	7.22	2.80	2.50	2.12	6.74	6.02	5.10
7	0.711	0.622	0.513	9.10	7.96	6.57	2.67	2.34	1.93	6.43	5.62	4.64
8	0.677	0.582	0.466	8.67	7.45	5.96	2.55	2.19	1.75	6.12	5.26	4.21
9	0.645	0.544	0.424	8.26	6.96	5.43	2.43	2.05	1.59	5.83	4.92	3.83
*10	0.615	0.508	0.385	37.39	30.89	23.41	2.31	1.91	1.45	35.08	28.98	21.96
Total				128.35	114.23	97.08	29.03	26.39	23.09	99.32	87.84	73.99

Present Value of Purchase Price of New Sprayer = 480 US\$

NPV of New Sprayer = Total Discounted Net Cash Flows of New Sprayer - Present Value of Purchase Price
NPV of New Sprayer at 5% = 99.32 – 480 = - 381 US\$ → NPV < Zero
NPV of New Sprayer at 7% = 87.84 – 480 = - 392 US\$ → NPV < Zero **Reject Ownership**
NPV of New Sprayer at 10% = 73.99 – 480 = - 406 US\$ → NPV < Zero

Source: calculated by the researcher based on

1- Discount factors equation = Present Value of \$1 = $1 \div (1 + R)^{N}$: where R = 5%, 7% or 10%, N = number of years
2- Discounted cash inflows of new sprayer = specific discount factor × cash inflows of new sprayer (custom rate = 12.80 \$/ha).
3- Discounted cash outflows of new sprayer = specific discount factor × cash outflows of new sprayer (TVC = 3.76 \$/ha).
4- Discounted net cash flows of new sprayer = Discounted cash inflows of new sprayer − Discounted cash outflows of new sprayer
5- Salvage value of new sprayer (480 × 0.10 = 48 \$) was added to the cash inflows of new sprayer in last year (12.80 \$).

Table 7. Net Present Value (at 5%, 7% and 10% discount factors) of Old Farm Sprayers

years	Discount Factors (Present Value of \$1)			Discounted Cash Inflows of Old Sprayer / \$			Discounted Cash Outflows of Old Sprayer / \$			Discounted Net Cash Flows of Old Sprayer/ \$		
	5%	7%	10%	5%	7%	10%	5%	7%	10%	5%	7%	10%
1	0.952	0.934	0.909	12.19	11.96	11.64	4.61	4.52	4.40	7.58	7.43	7.24
2	0.907	0.873	0.826	11.61	11.17	10.57	4.39	4.23	4.00	7.22	6.95	6.57
3	0.863	0.816	0.751	11.05	10.44	9.61	4.18	3.95	3.63	6.87	6.50	5.98
4	0.822	0.762	0.683	10.52	9.75	8.74	3.98	3.69	3.31	6.54	6.07	5.44
*5	0.783	0.712	0.620	22.55	20.51	17.86	3.79	3.45	3.00	18.76	17.06	14.86
Total				67.91	63.83	58.42	20.94	19.83	18.34	46.97	44.00	40.08

Present Value of Purchase Price of Old Sprayer = 160 US\$

NPV of Old Sprayer = Total Discounted Net Cash Flows of Old Sprayer - Present Value of Purchase Price

NPV of Old Sprayer at 5% = 46.97 – 160 = - 113 US\$ → NPV < Zero

NPV of Old Sprayer at 7% = 44.00 – 160 = - 116 US\$ → NPV < Zero **Reject Ownership**

NPV of Old Sprayer at 10% = 40.08 – 160 = - 120 US\$ → NPV < Zero

Source: calculated by the researcher based on

1- Discount factors equation = Present Value of \$1
$1 \div (1 + R)^{N}$: where R = 5%, 7% or 10%, N = number of years
2- Discounted cash inflows of old sprayer = specific discount factor × cash inflows of old sprayer (custom rate = 12.80 \$/ha).
3- Discounted cash outflows of old sprayer = specific discount factor × cash outflows of old sprayer (TVC = 4.84 \$/ha).
4- Discounted net cash flows of old sprayer = Discounted cash inflows of old sprayer − Discounted cash outflows of old sprayer
5- Salvage value of old sprayer (160 × 0.10 = 16 \$) was added to the cash inflows of old sprayer in last year (12.80 \$).

Table 8. Net Present Value (at 5%, 7% and 10% discount factors) of New Agricultural Harvesters

years	Discount Factors (Present Value of \$1)			Discounted Cash Inflows of New Harvester/ \$			Discounted Cash Outflows of New Harvester/ \$			Discounted Net Cash Flows of New Harvester/ \$		
	5%	7%	10%	5%	7%	10%	5%	7%	10%	5%	7%	10%
1	0.952	0.934	0.909	258.94	254.05	247.25	39.68	38.93	37.89	219.26	215.12	209.36
2	0.907	0.873	0.826	246.70	237.46	224.67	37.80	36.39	34.43	208.90	201.07	190.24
3	0.863	0.816	0.751	234.74	221.95	204.27	35.97	34.01	31.30	198.77	187.94	172.97
4	0.822	0.762	0.683	223.58	207.26	185.78	34.26	31.76	28.47	189.32	175.50	157.31
5	0.783	0.712	0.620	212.98	193.66	168.64	32.64	29.68	25.84	180.34	163.99	142.80
6	0.746	0.666	0.564	202.91	181.15	153.41	31.09	27.76	23.51	171.82	153.39	129.90
7	0.711	0.622	0.513	193.39	169.18	139.54	29.63	25.92	21.38	163.76	143.26	118.15
8	0.677	0.582	0.466	184.14	158.30	126.75	28.22	24.26	19.42	155.93	134.05	107.33
9	0.645	0.544	0.424	175.44	147.97	115.33	26.88	22.67	17.67	148.56	125.29	97.66
*10	0.615	0.508	0.385	6563.28	5421.38	4108.72	25.63	21.17	16.05	6537.65	5400.20	4092.67
Total				8496.11	7192.37	5674.35	321.81	292.55	255.96	8174.30	6899.82	5418.40

Present Value of Purchase Price of New Harvester = 104,000 US\$

NPV of New Harvester = Total Discounted Net Cash Flows of New Harvester - Present Value of Purchase Price

NPV of New Harvester at 5% = 8174.30 - 104,000 = - 95826 US\$ → NPV < Zero

NPV of New Harvester at 7% = 6899.82 - 104,000 = - 97100 US\$ → NPV < Zero **Reject Ownership**

NPV of New Harvester at 10% = 5418.40 - 104,000 = - 98582 US\$ → NPV < Zero

Source: calculated by the researcher based on:

1- Discount factors equation = Present Value of \$1 = 1 ÷ (1 + R) ^{N}: where R = 5%, 7% or 10%, N = number of years
2- Discounted cash inflows of new harvester = specific discount factor× cash inflows of new harvester (custom rate = 272 \$/ha).
3- Discounted cash outflows of new harvester = specific discount factor × cash outflows of new harvester (TVC = 41.68 \$/ha).
4- Discounted net cash flows of new harvester = Discounted cash inflows of new harvester − Discounted cash outflows of new harvester
5- Salvage value of new harvester (104000 × 0.10 = 10400 \$) was added to the cash inflows of new harvester in last year (272 \$).

Table 9. Net Present Value (at 5%, 7% and 10% discount factors) of Old Agricultural Harvesters

years	Discount Factors (Present Value of \$1)			Discounted Cash Inflows of Old Harvester/ \$			Discounted Cash Outflows of Old Harvester/ \$			Discounted Net Cash Flows of Old Harvester/ \$		
	5%	7%	10%	5%	7%	10%	5%	7%	10%	5%	7%	10%
1	0.952	0.934	0.909	258.94	254.05	247.25	50.57	49.61	48.29	208.37	204.43	198.96
2	0.907	0.873	0.826	246.70	237.46	224.67	48.18	46.37	43.88	198.52	191.08	180.79
3	0.863	0.816	0.751	234.74	221.95	204.27	45.84	43.35	39.89	188.89	178.61	164.38
4	0.822	0.762	0.683	223.58	207.26	185.78	43.66	40.48	36.28	179.92	166.79	149.50
*5	0.783	0.712	0.620	3971.38	3611.26	3144.64	41.59	37.82	32.93	3929.78	3573.44	3111.71
Total				4935.34	4531.99	4006.61	229.85	217.63	201.27	4705.49	4314.35	3805.34

Present Value of Purchase Price of Old Harvester = 48,000 US\$
NPV of Old Harvester = Total Discounted Net Cash Flows of Old Harvester - Present Value of Purchase Price
NPV of Old Harvester at 5% = 4705.49 - 48,000 = - 43295 US\$ → NPV < Zero
NPV of Old Harvester at 7% = 4314.35 - 48,000 = - 43686 US\$ → NPV < Zero **Reject Ownership**
NPV of Old Harvester at 10% = 3805.34 - 48,000 = - 44195 US\$ → NPV < Zero

Source: calculated by the researcher based on
1- Discount factors equation = Present Value of \$1 = 1 ÷ (1 + R) ^{N}: where R = 5%, 7% or 10%, N = number of years
2- Discounted cash inflows of old harvester = specific discount factor × cash inflows of old harvester (custom rate = 272 \$/ha).
3- Discounted cash outflows of old harvester = specific discount factor × cash outflows of old harvester (TVC = 53.12 \$/ha).
4- Discounted net cash flows of old harvester = Discounted cash inflows of old harvester − Discounted cash outflows of old harvester
5- Salvage value of old harvester (48000 × 0.10 = 4800 \$) was added to the cash inflows of old harvester in last year (272 \$).

Profitability ratio criterion of agricultural machinery services (B.C.R): The ratio of benefit cost is an important criterion to test the profitability of using of agricultural machineries. Benefit cost ratio also was estimated at 5%, 7% and 10% discount rates, and the results of analysis were summarized in table 10.

Table 10. Benefit Cost Ratio Criterion (at 5%, 7% and 10% DF) of Different Agricultural Field Machinery

Type of Machine	Tractor and Machinery of Soil preparation		Farm Sprayer		Combine Harvester	
Benefit Cost Ratio /US\$	New	Old	New	Old	New	Old
B/C at 5% D.F.	0.08	0.14	0.25	0.38	0.08	0.10
B/C at 7% D.F.	0.07	0.13	0.23	0.35	0.07	0.09
B/C at 10% D.F.	0.06	0.11	0.19	0.33	0.05	0.08
Decision by B/C Ratio	B.C.R < One → Reject Ownership					

Source: calculated by the researcher based on B.C.R equation = total discounted cash inflows of specific machine ÷ total discounted cash outflows including present value of purchase price of specific machine The results offered in table 10 show that the benefit cost ratio (at 5% discounted factor) of each of new tractor, old tractor, new farm sprayer, new farm sprayer, new combine harvester and old combine harvester is 0.08, 0.14, 0.25, 0.38,

0.08 and 0.10, respectively, that are below accepting (< 1), which further suggests that the investment option (buying) in agricultural machineries field is unattractive. This result supported that investments on all main agricultural machinery in the study area are unprofitable (similarly at 7% and 10% discounted factors).

Net benefit cost ratio criterion of agricultural machinery services (NB.C.R)

The NB.C.R is calculated by dividing the net present value (NPV) by the total discounted value of the costs. Considering the discount rates of 5%, 7% and 10%, the net benefit cost ratio of different agricultural machinery in the study region also was estimated, and the results of analysis were summarized in table 11

Table 11. Net Benefit Cost Ratio Criterion (at 5%, 7% and 10% DF) of Different Agricultural Field Machinery

Type of Machine	Tractor and Machinery of Soil preparation		Farm Sprayer		Combine Harvester	
Net Benefit Cost Ratio /US$	New	Old	New	Old	New	Old
NB/C at 5% D.F.	-0.92	-0.86	-0.75	-0.62	-0.92	-0.90
NB/C at 7% D.F.	-0.93	-0.87	-0.77	-0.65	-0.93	-0.91
NB/C at 10% D.F.	-0.95	-0.89	-0.81	-0.67	-0.95	-0.92
Decision by NB/C Ratio	NB.C.R < One (negative signs) → Reject Ownership					

Source: calculated by the researcher based on NB.C.R equation = NPV of specific machine ÷ total discounted cash outflows including present value of purchase price of specific Machine

The results obtainable in table 11 show that the net benefit cost ratios (at 5% discounted factor) of each of new tractor, old tractor, new farm sprayer, old farm sprayer, new combine harvester and old combine harvester are -0.92, -0.86, -0.75, -0.62, -0.92 and -0.90, respectively, that are below accepting (negative signs), in other words the investment option (buying) in agricultural machineries field is rejected (similarly at 7% and 10% discounted factors). Since the investments' NB.C.R is less than one, the investments' costs outweigh the net benefits and it should not be considered.From the above results, it can conclude that overall costs of the used or old machineries are lower purchasing price (investment) and fixed costs (ownership costs), higher repair and maintenance costs, lower reliability and requires more powered skills than new machineries. The results of other financial criteria such as NPV, B.C.R and NB.C.R were found negative sign and less than unity, respectively, for all agricultural machineries, which further suggests that the investments in such machineries (buying) are rejecting due to the costs of financing exceed total revenues earned from agricultural machineries. In this research, the financial analysis of investments alternatives in aspect of agricultural machinery uses had found that the hiring option could be adopted under current farm conditions. This option should be encouraged by rice farmers in the study area to enhance the use of agricultural machinery services due to it is highly profitable from the individual investor viewpoint.

ACKNOWLEDGMENT

The author would like to thank the workers in subdivision of agricultural statistics and extension, department of Alnajaf agriculture, Iraq for their assistance in providing and collecting the data which were required to conduct this research.

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