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ECONOMICAL EVALUATION IN TWO HARVESTING METHODS WITH STRIPPER HEADER AND CONVENTIONAL HEADER

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ABSTRACT

Two common harvesting methods, stripper header and conventional header were studied economically. Wheat harvest operations, cutting residual stems on the field, Rake then packing for stripper field and wheat harvest, rake operations and also without rake then packing for conventional header were compared. To obtain harvest costs, all parameters affecting on harvesting was measured and calculated. Results showed that residual straw on the stripper field was so minimal and next tillage operations can be done easily. Harvest speed with stripper header was 41% more than conventional. Fuel consumption in wheat harvest with stripper header $5.68 \text{ l}\cdot\text{ha}^{-1}$ has decreased and for collecting straw has increased $23.53 \text{ l}\cdot\text{ha}^{-1}$ than conventional header. Net income from conventional harvesting with rake operations has increased 30% and 35% without rake operation. Totally harvesting income with stripper header 307 000 tom (1100 tom = 1\$) and 344 000 tom per hectare was more than conventional header with rake and without rake operation.

Key words: harvesting income, collecting straw, rake, stripper header, combines

INTRODUCTION

Use of any technology and new methods at first level require economically justification and then cultural and social promotion. Stripper header on extensive research which been done in the entire world has been evaluated for grain and technically. The main goal is answering reflection and effects of technology on economic development and cultural and social needs. Remaining straw was one of the issues and problems that this header left for farmer. Using stripper header has been promoted commensurate with Europe particular conditions by Shelbourne Company and for more than thirty countries has been evaluated and studied [4, 5, 10]. Comments of farmers and researchers show that in same conditions, benefits of stripper header were more than conventional header [9]. Research shows that

British farmers with using stripper header since 1987 have increased rate of wheat and barley harvest between 40% to 100% without any yield loss and between 80% and 90% straw and stem of crop are remained on the ground. In Italy the minimum loss for harvesting rice with this type of header has been reported 0.4% [1, 2]. Assessment done on this header in Italy and U.S. shows that stripper header, without increasing yield loss can be increased harvesting capacity between 50% and 100% compared with conventional heads. Also, this type of header for harvesting cereals and other crops with average stem diameter and height has had an effective efficiency [2, 6, 7]. In 1991 stripper header and conventional header has been evaluated and compared in America. The result of this research showed that the use of stripper header with 4.2 m cut width, harvesting capacity in comparison with conventional header with 4.5 m width cut has increased 60%. The most important result in this research increasing Combine capacity as well as grain loss was reduced. This header was tested in more than thirty countries, including: in Germany, for barley and wheat 70–90% increasing efficiency, 30% less straw than conventional headers and was highly dependent on operator skill. In Sweden: in harvesting pea increasing speed up to 11 km·h⁻¹ and increasing efficiency up to 50% have been reported. In America, wheat harvest was done with 25 combine and results indicate that increasing speed 5–8 km·h⁻¹, over speed of header cause to make it more cargo for harping. In Thailand, using stripper header instead of conventional for rice cause to decreasing loss until 4% and the efficiency was 74% [6, 9, 10]. Although in the world, residual straw is good for increasing nutritional value and preventing soil erosion. In Iran are used straw for livestock different applications to simplify digestive system and also in other industries. Another point is that residual straw cause delaying for next planting operations. In harvesting cost, calculations just for rice harvest have been done [3]. So conventional header was compared with stripper header method and harvesting costs from wheat crop until packing straw were measured and calculated.

MATERIALS AND METHODS

Stripper header and combine. In this survey used John Deere 955 combine Model 75 was that a combine had worked for 10 years. The stripper header was Shelburne Reynolds; model SR4200, 4 m harvesting width, rotor speed 450–860 rpm and 8 row teeth. After installing stripper on the head, rotor speed settings and other setting was carried out on it. Header used for combine model 955 is suitable. Figure 1 shows combine and stripper header installed on it for setting.



Fig. 1. John Deere 955 Combine with headers installed on it

Tractor and equipments. For harvesting straw remained in both conventional and stripper header methods used John Deere tractor model 3140, two plates Mower, four rows of solar rake, Class Baler and also equipment were behind tractor (Fig. 2).



Fig. 2. John Deere tractor with mower, baler and solar rake implements

Field and crop. Wheat field with the center pivot irrigation system was located in Shiraz. Conditions for stripper header according to combine 10-year-old and rough field were stringent. Type of soil was City clay and varieties of wheat were “Cross Azadi”. All of properties of field and crop were measured.

RESULTS

Economic evaluation, harvesting cost and value of two common or traditional types of harvesting methods with stripper header were studied. Harvesting costs, including fuel consumption, machine rental costs, operation and value of harvested crop like wheat and straw were calculated. In this comparison, efficiency hours of each machine are measured per hectare. Also, fuel consumption in two separate processes is obtained, one for wheat harvest and another for straw harvest until packing.

Stem remained on the field is the main problem with two type of harvesting method. Figure 3 shows condition of field in both types. In harvesting with stripper header, clusters are picked up from stem and then moved into combine and stems and 80% of substances remained on the field [8, 11].



Fig. 3. Residual stems conditions on the field: a) harvesting with conventional header, b) harvesting with stripper header

However in harvesting with conventional header only stems with 30–50 cm height remained on the field.

Straw harvesting and removing straw from the field is very serious for our country. It is used for livestock and other industrial expenditure. On the other hand harvesting straw quickly, prepare field for next cultivation. Therefore this issue can be viewed from two sides, one collecting straw and other firing field which addition of environmental pollution, microorganisms and nutrients are damaged in the soil seriously (Fig. 4). While in harvested field with common methods, minimum height of residual straw in the field is between 30 up to 50 cm which Even with harvesting straw, cultivation problems and firing straw remained still.



Fig. 4. Straw conditions after harvesting with common methods: a) rake then gathering, b) firing

Ready condition and clean field for next operation in comparison with conventional header was remarkable point obtained from stripper field. In this method the amount of straw remained on the stripper field is minimal and in addition to starting next operation fast, cultivation can be performed easily. So costs due to operations such as preparing field like handling discs, removed in this way and can be said even energy used for tillage is reduced. So for harvesting with stripper method can be used utilization management and field timing optimally.

Harvesting costs, including wheat harvest, fuel consumption, harvesting straw from cut stems until packaging and crop net income of wheat and straw were obtained in three steps. Table 1 shows harvesting costs with stripper header from the wheat harvest until collecting and packing straw.

As shown in Table 1 total of harvesting cost had been 101 756 tom·h⁻¹ and the value of harvested crop including wheat and straw 1 429 900 tom and net income from harvesting in a hectare was 1 328 135 tom. Fuel consumption in harvesting with stripper header for wheat and straw was obtained 51.57 l·ha⁻¹ totally.

Table 1. Harvesting costs with stripper header (with rake)

Fees	Value	Unit Price	Prices
Combine	1.13 h·ha ⁻¹	35 000 tom·h ⁻¹	39 550
Fuel consumption	11.36 l·ha ⁻¹	16 tom·l ⁻¹	182
Mower	1.25 h·ha ⁻¹	15 000 tom·h ⁻¹	18 750
Rake	1.27 h·ha ⁻¹	12 000 tom·h ⁻¹	15 240
Baler	1.37 h·ha ⁻¹	20 000 tom·h ⁻¹	27 400
Fuel consumption of collecting straw	40.20 l·ha ⁻¹	16 tom·l ⁻¹	643
Total of harvesting costs Of harvested crop			101 765
Wheat	4.310 t·ha ⁻¹	250 000 tom·t ⁻¹	1 077 500
Straw	3.12 t·ha ⁻¹	120 000 tom·t ⁻¹	374 400
Loss	88 kg·ha ⁻¹	250 tom·kg ⁻¹	-22 000
Total crop income			1 429 900
Net income			1 328 135
Total fuel consumption	51.57 l·ha ⁻¹		

To calculate costs and harvest income with stripper header was conducted two measuring and computing. One without rake operations similar to common methods and the other with rake operations.

Table 2 and table 3 show harvesting costs with conventional header from wheat harvest time until gathering and packing straw with rake and without rake operations respectively.

Table 2. Harvesting costs with conventional header (with rake operation)

Fees	Value	Unit Price	Prices
Combine	1.92 h·ha ⁻¹	35 000 tom·h ⁻¹	67 200
Fuel consumption	17.04 l·ha ⁻¹	16 tom·l ⁻¹	273
Mower	-	-	-
Rake	1 h·ha ⁻¹	12 000 tom·h ⁻¹	12 000
Baler	0.83 h·ha ⁻¹	20 000 tom·h ⁻¹	16 666
Fuel consumption of collecting straw	16.67 l·ha ⁻¹	16 tom·l ⁻¹	267
Total of harvesting costs of harvested crop			96 406
Wheat	4.06 t·ha ⁻¹	250 000 tom·t ⁻¹	1 015 000
Straw	1.5 t·ha ⁻¹	120 000 tom·t ⁻¹	180 000
Loss	308 kg·ha ⁻¹	250 tom·kg ⁻¹	-77 000
Total crop income			1 118 000
Net income			1 021 594
Total fuel consumption	33.71 l·ha ⁻¹		

Table 3. Comparing of harvesting final costs with conventional header (without rake operation)

Fees	Value	Unit Price	Prices
Combine	1.92 h·ha ⁻¹	35 000 tom·h ⁻¹	67 200
Fuel consumption	17.04 l·ha ⁻¹	16 tom·l ⁻¹	273
Mower	-	-	-
Rake	-	-	-
Baler	0.78 h·ha ⁻¹	20 000 tom·h ⁻¹	15 556
Fuel consumption of collecting straw	16.67 l·ha ⁻¹	16 tom·l ⁻¹	267
Total of harvesting costs of harvested crop			96 406
Wheat	4.06 t·ha ⁻¹	250 000 tom·t ⁻¹	1 015 000
straw	1.08 t·ha ⁻¹	120 000 tom·t ⁻¹	129 600
Loss	308 kg·ha ⁻¹	250 tom·kg ⁻¹	-77 000
Total crop income			1 067 600
Net income			984 304
Total fuel consumption	33.71 l·ha ⁻¹		

Figure 5a shows result of machine efficiency comparison and Figure 5b shows fuel consumption in two type of harvesting methods.

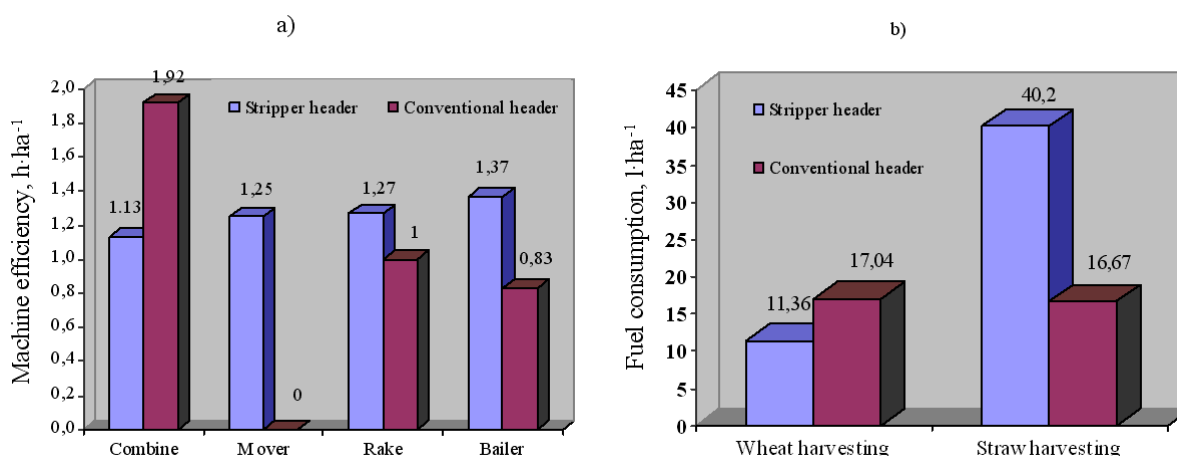


Fig. 5. Comparing of two harvesting methods: a) machine efficiency, b) fuel consumption

As shown in Figure 5a, wheat harvest efficiency in conventional header was 1.92 h·ha⁻¹ and 1.13 h·ha⁻¹ for stripper header. So we can conclude that harvesting time with stripper header has been 0.79 h·ha⁻¹ less than conventional and this shows harvesting speed with stripper header has been 41% higher than conventional. With comparing collecting straw machines efficiency can be said that stems cutting operation until packing them with stripper header was 53% more conventional header totally. Of course it should be considered that in cutting process, 32% of harvesting operations, has been removed with conventional header.

With checking fuel consumption in two methods, Figure 5b, fuel consumption rate in harvesting wheat with stripper header has been decreased 5.68 l·ha⁻¹. This expenditure for collecting straw in stripper header ratio to conventional, 23.53 l·ha⁻¹ has increased. This fuel consumption growth is due to increasing operations and much straw in harvesting with stripper header.

With comparing Table 1 and 3, net income from harvesting wheat and straw with rake operations per hectare 1 021 594 tom and 934 304 tom for no raking. Increasing crop income in stripper header method was due to decreasing loss and increasing straw harvest. Table 4 shows results of this comparison. Also figure 6 shows comparing between consumed cost and net income of harvesting in three methods.

Table 4. Comparing of harvesting final costs with conventional and stripper header

Harvest method	Total harvest costs (Toman)	Harvest net income (Toman)	Harvest efficiency	Total fuel consumption l·ha ⁻¹	Wheat t·ha ⁻¹	Straw t·ha ⁻¹
	Harvesting costs with two headers per hectare					
Stripper header	101 000	1 328 000	13.1 (1 328 000/101 000 = 13.1)	51.57	4.310	3.12
Conventional header with rake	96 000	1 021 000	10.6 (1 021 000/96 000 = 10.6)	33.71	4.06	1.5
Conventional header without rake	83 000	984 000	11.8 (984 000/83 000 = 11.8)	33.71	4.06	1.08
Margin difference with rake	307 000 tom·ha ⁻¹					
Margin difference without rake	344 000 tom·ha ⁻¹					

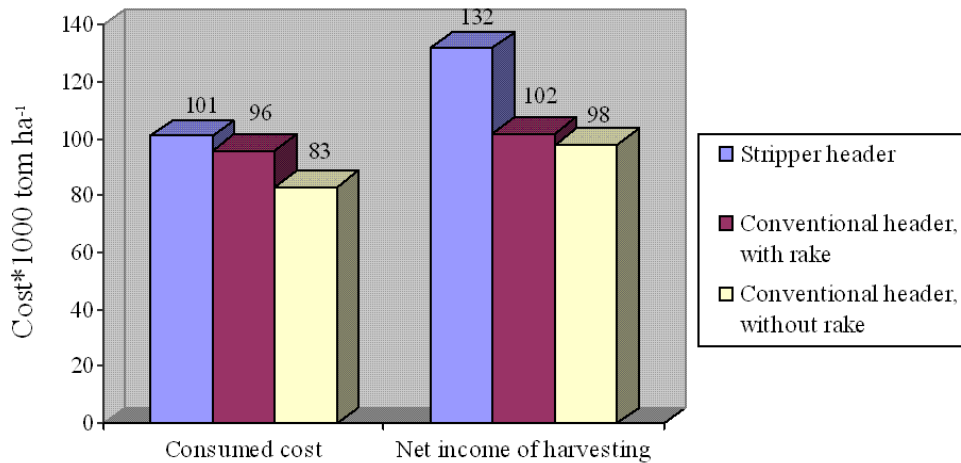


Fig. 6. Consumed cost and net income of harvesting with stripper header, conventional header with rake and without rake

Figure 6 shows cost per harvest 21% and 5% stripper header comparison with conventional with and without rake, net income from harvesting in common methods 30% and 35% respectively with rake and without rake operations has increased. According to the calculations in Table 4 can be said that harvesting with stripper header 307 000 tom and 344 000 tom has more income per hectare than conventional header respectively with and without rake. In a 50-hectare field, the amount of extra income is 17 200 000 tom. This increasing of income compared with conventional header due to low header loss and gathering further straw.

Table 5, separately total income of harvesting straw, wheat for two headers has been compared. Table 5 shows economic evaluation of the overall harvest with two headers to separate wheat and straw per hectare. Table 5 shows that net income for wheat harvest with stripper header is 145 000 tom·h⁻¹. Income of harvesting straw per hectare with stripper header is 200 000 tom more than conventional header. This is a remarkable number for harvesting per hectare.

Table 5. Economic evaluation with two headers for wheat and straw separately per hectare generally

Harvest method	Net income of wheat harvest tom·ha ⁻¹	Net income of straw harvest tom·ha ⁻¹	Net income of total harvest tom·ha ⁻¹
Stripper header	1 015 768	312 367	1 328 135
Conventional header with rake	870 527	151 067	1 021 594
Conventional header without rake	870 527	113 777	984 304
Margin difference with rake	145 241	161 300	306 541
Margin difference without rake	145 241	198 590	343 831

Stripper header influence on market of combine, Baler and Mower. Stripper header can be introduced a convenient substitute for customers initially. This header after using by farmers in different areas in water and field and different crops and moisture as a new crop can be considered. Considering that straw didn't pass through internal parts of combine, on the reduction of part depreciation these which with passing time this significant effect is identified for the consumer. So it can have a positive influence on optimum internal parts of combine designing like stubble systems and cleaning system. Therefore has direct effect on combine Sales. Also selling stripper header can be considered as objectivity and independent crop, and can be said does not have another direct effect on combine sales. Direct effect of stripper header is more on the Baler and mower that according to studies and data noted in report, for harvesting straw either with stripper header or conventional header, need is to collect straw.

Stripper header sales affect on production market and national income. Cereals sale and national income is based on two principles. One, productive crop quality and other net income of production. Crop quality apart from of seed type, refer to true harvesting and post harvesting process. Because of stripper header didn't import straw with wheat or cereals into pounding parts and separation and cleaning units, so wheat grains had a smaller fracture and quickly passes different parts. So there will be half-pounded and fractured grains and less straw eventually. Also according to high altitude of stripper header harvesting and cutting seeds, low weeds will enter to reservoir which has remarkable affect on crop quality and ultimately the next crop (especially for cereals seeds). All of these cases have been studied in diagram form and wheat in reservoir in two headers.

Another principle in selling cereals and national income is net income of harvesting. Net income of harvest depends on harvesting cost and total income. Whatever with less cost can earn more income, national income raise due to increasing net income of harvest. In this research net income of harvest in two methods has been compared separately. But significant points in harvesting with stripper headers which have affect on national income and has not been considered are : reduction of crop loss, fuel consumption reduction, reducing of combine parts depreciation, harvesting straw fired by farmer, increasing of harvest speed, harvest period reduction according to stripper header capability in harvesting crop up to 35% moisture, field preparation for tillage operation : means that less costs for preparing field after harvesting with conventional header and harvest more straw in comparison with conventional header.

CONCLUSION

Two common harvesting methods (conventional header and stripper header) were studied economically. To obtain harvest costs, all parameters affecting on harvesting was measured and calculated. Results showed that harvesting with stripper header could be replaced with conventional header because: residual straw on the stripped field was so minimal and next operations can be started faster and also tillage operations are performed easily. Harvest speed with stripper header was 41% more than conventional. Fuel consumption in wheat harvest with stripper header $5.68 \text{ l}\cdot\text{ha}^{-1}$ has decreased. This consumption for collecting straw in stripper method has increased $23.53 \text{ l}\cdot\text{ha}^{-1}$ than conventional header. Net income from harvesting has increased 30% ratio to harvesting with rake operation and 35% with conventional header and without rake operation. Harvesting with stripper header 307 000 tom and 344 000 tom dollars had more income per hectare ratio to conventional header with rake and without rake operation.

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