

## Determination of Cost Components Concerning Combine Harvester Use: A Case of Yozgat Province

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### ABSTRACT

In this study, it was aimed to determine the cost components of combine harvester use and investigate combine harvester contractors system in Yozgat province. The main material of this study consisted of surveys conducted to combine harvester contractors determined via a systematic sampling method in the region, and secondary data. In sampling, the sample size was determined as 62. According to the research findings, the annual total income regarding combine harvester use was calculated as 18 416 USD and the annual total cost as 14 699 USD. The annual net profit was 3 717 USD and the annual profitability was 7.45%. Even though the annual profitability was lower than other investment vehicles, it was all right in an economic sense. In the region, it was seen that combine harvester use has taken shape as "a combine harvester contractors system". It was determined that combine harvester contractors have also harvested in the other regions to use combine harvester capacity. The study is important in terms of the role of machine contractors system in agriculture and its results.

## 1. INTRODUCTION

Agriculture is the first sector of the history of humanity. The continuation of humanity depends on agriculture. For, it is the only sector in which nutrients are supplied (Erbaş, 2020a). Thus, agriculture has developed as an important process in terms of socioeconomic and nutrition (Erbaş, 2020b).

But, production resources are limited, and the population is constantly increasing. Agricultural production must be increased to feed constantly increasing population. Increasing agricultural production is possible with using advanced agricultural technologies, namely, mechanization efforts in agriculture. Even though technical issues, such as; the protection, development, irrigation, fertilization, struggle, use properly, research, and demonstration studies of the soil and water resources other than agricultural mechanization, and the use of quality seeds were effective on the yield, agricultural mechanization is of prime importance in applying advanced agricultural technologies (Erbaş, 1999). Therefore, agricultural mechanization has a special importance among production Technologies (Zeren et al., 1995).

There were also important developments in the mechanization of the agricultural sector as in the other fields in the early years of the Turkish Republic, and in particular, growth in mechanization by the implementation of the Marshall Plan in 1948-1951s was more rapid. Likewise, modern combine harvester use has also accelerated after the 1950s (Daylan et al., 1989). Combine harvesters from modern agricultural machinery have economic, technical, and social effects on the agricultural sector (Demirci and Arıkan, 1984).

Combine harvesters from important agricultural machinery consist of a developed harvesting machine and a threshing machine (Keskin and Erdoğan, 1984). They are one of the most modern machines harvesting and threshing simultaneously.

The purchase prices of combine harvesters that are one of the most important components of agricultural production are very high. Purchasing a new combine harvester may not be rational or possible for agricultural enterprises. Thus, the most appropriate method for benefiting the agricultural sector from combine harvesters is machine contractors system.

- There are many reasons why machine use is preferred in rural:
- The fact that enterprises are mainly small enterprises,
- The fact that machine cost is very high in agricultural production,
- The fact that machine capacity can not be evaluated.

Combine harvester contractors system has many indisputable benefits in the agricultural sector. These are:

- Low product loss due to harvesting on time and of good quality,
- The opportunity to grow a second crop due to harvesting in a short time,
- Increase of both operating income and national income due to low product loss and a second product,
- Physical and spiritual comfort created by the ease of harvesting with combine harvester,
- Remaining free time for the farmer and gaining additional profits in this process.

Agricultural machinery contractors system is a science discipline managing acquisition, use, and disposal process from the decision to purchase a machine (Anonymous, 2019d). This system is of great importance in the mechanization of the agricultural sector. Mechanization has four socioeconomic effects in the agricultural sector. These are;

- On increasing production and productivity,
- On improvement of the standard of living,
- On facilitation of works,
- On employment.

In today's modern farming, the biggest and most important cost component of agricultural production is machine cost. Using rationally machinery and benefiting from their annual capacities is important in decreasing machine costs (Kurtulmuş, 2007). Thus, agricultural machinery contractors system is one of the most important matters both in decreasing production cost and machine use cost.

There are various machine contractor models in Turkey. The most applied models are:

- Neighborly assistance,
- Agricultural machinery contractors system (combine harvester contractors system),
- Agricultural machinery partnership,
- Agricultural machinery cooperatives and unions.

Combine harvesters that hold great significance in agricultural machinery contractors system and previously used in State Production Farms were purchased by farmers over time and transformed into combine harvester contractors system (Erbaş,1999). Farm Agricultural machinery contractors system is that the machinery which has a high purchase price is

used in the other farm affairs in return for a certain fee to evaluate the idle capacities and reduce the use costs. In this type of contractors system, there is not jointly machine use like other models and commercial purposes come into prominence more. This model is a suitable method for small farms that cannot purchase a machine and farms that have limited farmland (Yıldız and Erkmen, 2003). In the research, agricultural machinery contractors system has been taking an important place in carrying out agricultural affairs of small family farms.

In Turkey, combine harvester contractors system seen in Central Anatolia and especially in Yozgat province, has been a good type of agricultural machinery contractors system. In Yozgat province, the fact that field farming has been important and that farmers have been more prone to this affairs has played an important part in the development of the "combine harvester contractor system". Combine harvester contractor, which is prevalent in Yozgat province, is conducted by a system formed between supply (harvester owner or manager) and demand (farmer) depending upon market conditions. It has been aimed to reduce combine harvester use cost and evaluate its annual use capacity via combine harvester contractors system. Idle capacity was being evaluated by using more. In short, the aim of this model was an economic use.

In addition, this model have also other advantages. These are:

- The fact that farmers evaluate/evaluated their cashs in other fields,
- The fact that farmers who were limited the economic possibilities are/were benefited from the possibilities of developed technology,
- Because of the use of combine harvester with full capacity, the decline in its usage cost,
- Creating new employment opportunities (operator and mechanic).
- Putting on the market the products earlier.

Combine harvesters have many advantages according to the other harvesting and threshing methods, especially putting on the market the products earlier (Dinçer and Yetkin, 1982). But, use costs of combine harvesters which are an important agricultural machine should be also correctly determined and calculated (Sabancı ve Özgüven, 1986). For, combine harvester use cost gives important ideas regarding if it is rationally used or not.

The total agricultural area of Turkey is 23 094 bin hectares. Share of field land is 81.29% in the total agricultural area (Anonymous, 2019a). This rate shows that combine harvester use holds great importance in harvest and threshing affairs.

According to the data 2019, the number of combine harvesters per 1000 hectares of agricultural land was 1.47 in Yozgat province. It was 0.74 in Turkey, and 0.90 in Konya province known as Turkey's granary. This was the reason why Yozgat province was chosen as a research area (Anonymous, 2019; Anonymous, 2019c).

In this study, it was aimed to analyze economically combine harvester use and investigate combine harvester contractors system. The study holds great importance in revealing the agricultural machinery contractors system and determining the annual profitability.

## 2. MATERIAL AND METHOD

The main material of this study consisted of primary data and secondary data. The data obtained from surveys conducted to combine harvester owners were the primary data of the study. Combine harvester owners surveyed were determined via a systematic sampling method. The data obtained from the Provincial Directorate of Agriculture and Forest, Turkey Statistical Institute (TSI), and other national organizations were also secondary data of the study. The notes kept as a result of the researcher's observations during the surveys were also used as the main material of this study.

The surveys were conducted by meeting face-to-face with combine harvester contractors (Erbaş, 1999). In the study, the survey data conducted in 1996 were reduced to 2019 from the time value formula of money (Erkuş and Demirci, 1996; Ertürk, 2000). The data is still valid today and remains current.

$$[1/(1 + r)^n] \quad (1)$$

In the formula, (r) was bank rate and (n) was fixed date or the number of years. TL was changed to the USD rate of 2019, and one USD was calculated as 5.6709 TL.

In the research, firstly, the main population was determined by using the records of the Provincial Directorate of Agriculture and Forest. But, since it was not possible to conduct a survey to all combine harvester contractors in Yozgat Province, districts and villages where combine harvester contractors have prevailed were determined by a purposed sampling method (through opinions of the technical staff of the Provincial Directorate of Agriculture). Thus, Central, Yerköy and Şefaati districts were determined as the research area.

A total of 455 combine harvesters in these districts formed the population of this research, and the sample size was determined by a systematic sampling method. The map of the research area was given in Figure 1.

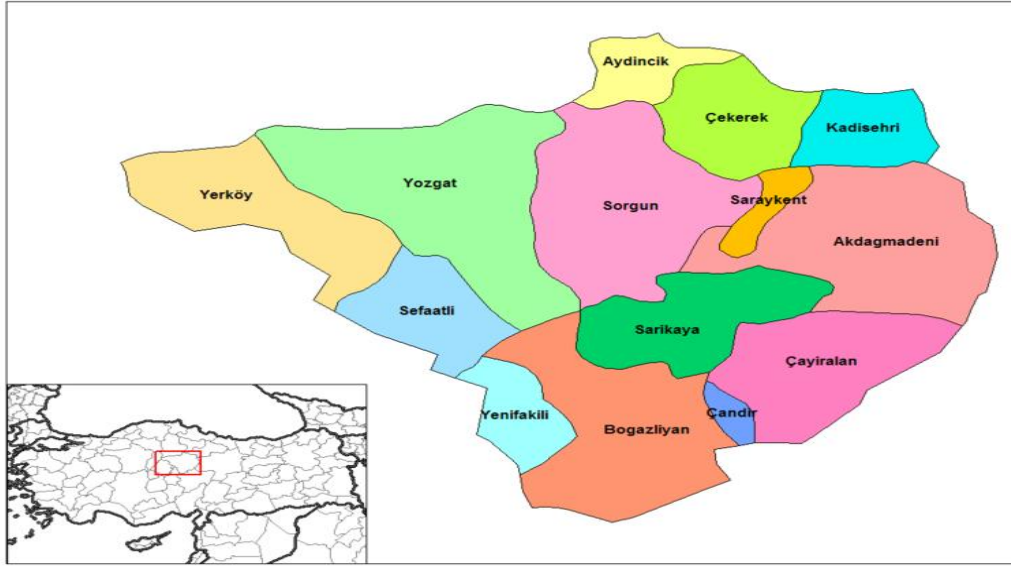


Figure 1. The research area

By a systematic sampling method ( $n = N \times \text{sampling rate}$ ), which is a frequently used method in researches related to agricultural economics, 62 combine harvester contractors were included in the sample. Combine harvester contractors surveyed were chosen randomly. The distribution of the surveys by districts; Central district was 13, Yerköy was 22 and Şefaati was 27. The questions about the survey consisted of the general situation of the research area; age and education status of combine harvester contractors; the number of combine harvesters according to Engine Power (kW); annual average harvest period; harvest cost, profit and profitability for the unit area and features of combine harvester contractors system (Erbaş, 1999). After surveys were completed and reviewed separately, the data obtained from surveys were entered into the computer. According to the purpose of the research, summary tables were formed, commented, and evaluated.

In the study, combine harvester use cost was examined as fixed and variable costs. Fixed costs consisted of depreciation, fixed capital interest and protection expenses, and variable costs also fuel and oil, repair and maintenance, operator and mechanic and operating capital interest.

$$\text{Fixed costs} = \text{Depreciation} + \text{Fixed capital interest} + \text{Protection} \quad (2)$$

$$\text{Variable costs} = \text{Fuel and Oil} + \text{Repair and Maintenance} + \text{Operator and Mechanic} + \text{Operating Capital Interest} \quad (3)$$

The correct line method was used in the calculation of annual depreciation share, and calculated by dividing combine harvester value to the remaining useful life. Depreciation is an annual depreciation incurring overtime in fixed capital on a farm. As with other fixed capital components, the depreciation of a combine harvester comes out for reasons such as its use, aging and technological change.

The fixed capital interest is calculated by multiplying half the current value of combine harvester with the annual fixed return of active capital of 5% and given in formula (4) (Kıral, 1995).

$$\text{Fixed capital interest} = \frac{\text{Combine harvester value}}{2} \times 0.05 \quad (4)$$

Protection expense is an expense made to protect combine harvester from rigors of the weather. In the study, it was determined that combine harvesters were protected by using tent cover, open or closed porch, and garage. It was calculated annually.

The annual fuel and oil consumption of the combine harvester was obtained from the declaration of the combine harvester owners, and the price of fuel and oil was also determined according to their annual average sales price. The annual fuel and oil consumption was multiplied by their unit prices and the annual fuel and oil expenses were calculated.

Repair and maintenance expenses are expenses made for the maintenance and repair of a combine harvester in a year and vary depending on combine harvester use period, use conditions, maintenance possibilities, and the ability of the driver. As combine harvester is used and ages, repair, and maintenance expense also increases. Repair is an expense incurred for the replacement of broken or broken parts, and maintenance is an expense incurred for lubrication, cleaning, and painting.

Personnel expenses consist of wages paid for driver and mechanic concerning combine harvester use in a year.

In calculating the operating capital interest in combine harvester use, harvest period, fuel and oil, repair and maintenance and personnel expenses are considered (Erkuş and Demirci, 1996). The operating capital interest was calculated by the following formula (5).

$$\frac{(Fuel\ and\ oil\ +\ repair\ and\ maintenance\ +\ personnel) \times (Harvest\ period) \times (Credit\ interest)}{365} \quad (5)$$

The annual profitability of combine harvester was calculated by the proportion of the annual profit of that period to the current value of combine harvester and multiplied by 100 (formula 6).

$$Profitability = \frac{Profit}{Combine\ harvester\ value} \times 100 \quad (6)$$

### 3. RESULTS AND DISCUSSION

#### 3.1. Annual Harvest Data of Combine Harvesters According to Horsepower

The annual harvest periods of combine harvesters were calculated, and given in Table 1.

Table 1. Annual harvest periods of combine harvesters

Engine Power kW	Combine harvester number	Harvest period (days/year)
72.32	18	48
75.27	8	53
76.75	1	66
81.92	11	47
84.87	23	46
86.34	1	53
<b>General</b>	<b>62</b>	<b>48.09</b>

According to Table 1, it was determined that a combine harvester harvested between 46 days and 66 days and, it was 48.09 days in general.

Annual fields harvested by combine harvesters and their harvest periods were given in Table 2. As could be also seen from the table, the field harvested was between 748 ha and 876.50 ha in a year, and it was 829.50 ha according to combine harvesters average. The results of some studies on this subject were close to the results of the research. In a study carried out by Işık and Sabancı (1988) in Adana, it was stated that a combine harvester harvested 825 ha in a year and in a study conducted by Çiftçi (1987) in Central Anatolia also, it was 749 ha.

Table 2. Harvest data of combine harvesters

Harvest data	Unit	kW						General
		72.32	75.27	76.75	81.92	84.87	86.34	
Harvested field	(ha/year)	796	781	748	834	876.50	771.50	829.50
Harvest period	(days/year)	48	53	66	47	46	53	48.09
Yearly usage	(h/year)	612	650	680	595	584	643	605.09
Field capacity	(ha/h)	1.3	1.2	1.1	1.4	1.5	1.2	1.37
Daily harvested field capacity	(ha/day)	16.6	14.8	11.3	17.6	18.9	14.6	17.28
Daily working hours	(h/day)	13	12	10	12	13	12	12.63
<b>Width of cut (working)</b>	<b>(mm)</b>	<b>4 572</b>	<b>4 572</b>	<b>4 250</b>	<b>4 572</b>	<b>4 572</b>	<b>4 250</b>	<b>4 561.61</b>

#### 3.2. Determination of Cost Components Regarding Combine Harvester Use

Whether in the research area, combine harvester use was economical was possible with the determining correctly the cost components. In this part of the research, annual cost components were examined and the annual profitability rate was determined.

The most important factor determining the net profit regarding combine harvester use was its use cost. In order to determine the use cost, primarily the cost components should be revealed. In the study, these were examined in two groups as fixed and variable costs.

### 3.2.1. Fixed costs

Fixed data is calculated as annual primarily and it change depending on usage period (Türkey, 1993; Şimşek, 2002). In the study, even though the combine harvester was not driven, the expenses incurred were included in fixed cost.

Table 3. Annual fixed cost components regarding combine harvester use

kW	Depreciation (USD/ha)	Fixed capital interest (USD/ha)	Protection (USD/ha)	Total fixed cost (USD/ha.)
72.32	6.83	1.71	0.17	8.71
75.27	7.74	1.16	0.15	9.05
76.75	5.05	0.76	0.10	5.91
81.92	7.02	1.40	0.13	8.55
84.87	6.55	1.64	0.15	8.34
86.34	5.87	1.03	0.12	7.02
<b>General</b>	<b>6.68</b>	<b>1.50</b>	<b>0.15</b>	<b>8.33</b>
<b>(%)</b>	<b>80.1</b>	<b>18.0</b>	<b>1.9</b>	<b>100.0</b>

These expenses were examined as depreciation, fixed capital interest, and protection expenses (Erbaş, 1999). Fixed costs were given in a mass in Table 3. As could be also seen from the Table 3, the total fixed cost was between 5.91 USD and 9.05 USD for ha. It was 8.33 USD according to general. 80.1% of fixed cost consisted of depreciation, 18.0% of it fixed capital interest and 1.9% of it protection expenses. Changings of fixed cost for the unit area according to the annual usage was given in Figure 2. Accordingly, as Engine Power (kW) increased, fixed cost calculated for the unit area also increased.

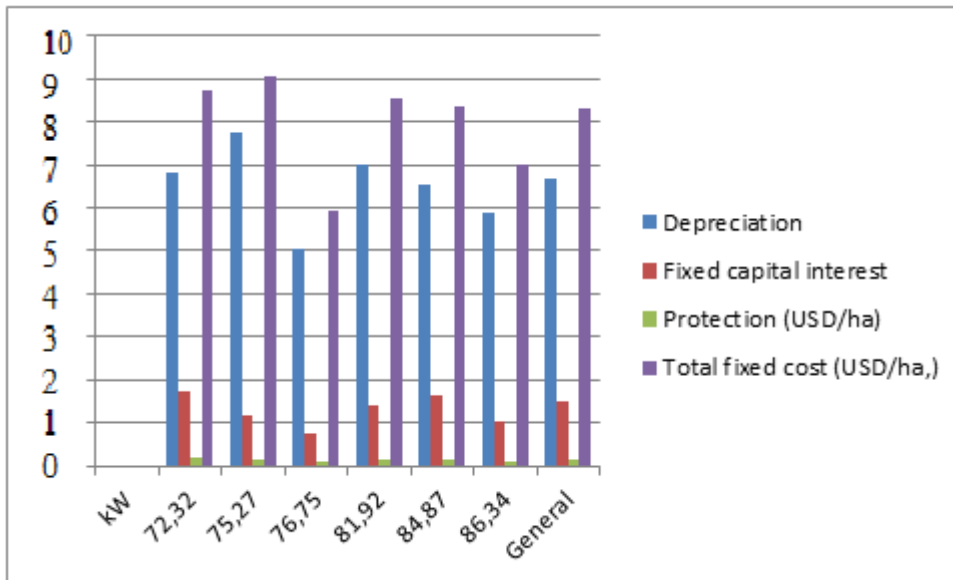


Figure 2. Changings of fixed cost for the unit area according to the annual usage

### 3.2.2. Variable Costs

Variable cost consists of the expenses incurring with the production activity and increasing or decreasing depending on the production quantity of the farm (Ülgen, 1993). In the study, these were fuel and oil, repair and maintenance expenses, personnel (operator and mechanic) expenses and operating capital interest. In Table 4, variable cost components were given in a mass. As could be also seen from the table, the total variable cost was between 9.01 USD and 13.51 USD for ha, and it was 9.39 USD according to general. Fuel and oil expense constituted 57.8% of variable expenses, personnel expenses 18.6% of them, repair and maintenance expenses 16.8% of them and the operating capital interest 6.8% of them.

Table 4. Variable cost components regarding combine harvester use

kW	Fuel and oil (USD/ha)	Repair and maintenance (USD/ha)	Personnel expenses (USD/ha)	Operating capital interest (USD/ha)	Total variable cost (USD/ha)
72.32	5.34	1.57	1.90	0.64	9.45
75.27	5.36	2.28	1.45	0.73	9.82
76.75	6.68	3.19	2.42	1.22	13.51
81.92	5.49	1.74	1.54	0.62	9.39
84.87	5.41	1.21	1.81	0.58	9.01
86.34	6.28	2.68	1.86	0.86	11.68
<b>General</b>	<b>5.43</b>	<b>1.58</b>	<b>1.75</b>	<b>0.63</b>	<b>9.39</b>
<b>(%)</b>	<b>57.8</b>	<b>16.8</b>	<b>18.6</b>	<b>6.8</b>	<b>100.0</b>

### 3.2.3. Total costs

By the sum of the fixed and variable costs mentioned above, the total cost was found. As could be also seen in Table 5, the total cost was between 17.35 USD and 19.42 USD for ha, and it was 17.72 USD according to general. Fixed costs constituted 46.98% of the total cost and variable costs constituted 53.02% of it.

Table 5. Total costs regarding combine harvester use

kW	Fixed costs		Variable costs		Total cost (USD/ha)
	(USD/ha)	(%)	(USD/ha)	(%)	
72.32	8.71	47.9	9.45	52.1	18.16
75.27	9.05	47.4	9.82	52.6	18.87
76.75	5.91	30.4	13.51	69.6	19.42
81.92	8.55	47.7	9.39	52.3	17.94
84.87	8.34	48.1	9.01	51.0	17.35
86.34	7.02	37.5	11.68	62.5	18.70
<b>General</b>	<b>8.33</b>	<b>46.98</b>	<b>9.39</b>	<b>53.02</b>	<b>17.72</b>

### 3.2.4. Profit and profitability rates regarding combine harvester use

In the research, it was determined that net profit earned in combine harvester use was between 0.97 USD and 5.31 USD for ha, and it was 4.48 USD according to combine harvesters average.

Whether the combine harvester contractors profited depended that annual income should be more than annual expenses incurred. The annual total income was 18 416 USD and it was 22.20 USD for ha. The annual total expense was 14 699 USD and it was 17.72 USD for ha. These data showed that combine harvester owners profited.

To determine whether combine harvester use was economical or not, it was benefited from the annual profitability rate. In the research area, the yearly profitability rate regarding combine harvester use was calculated and given in Table 6. When the table was examined, it was seen that the yearly profitability rate was between; 3.20% and 8.11% and it was 7.45% according to general. Even though the profitability rate was lower than the annual interest rate, it was positive and was all right in an economic sense. The yearly profitability of the farm capital is compared by the annual interest rate. Thus, whether combine harvester use is profited or not is determined (Erkuş et al., 1995).

On the other hand, the fact that profitability ratios are lower than the annual interest rate is accepted normal (İnan, 2016). Because fixed capital gains value depending upon runaway inflation, managers and farmers could have low profitability. The annual average profitability rate of combine harvester contractor was 7.45%. This rate was 6.58% for combine harvester with 72.32 kW, 4.89% for combine harvester with 77.27 kW, 3.20% for combine harvester with 76.75 kW, 7.06% for combine harvester with 81.92 kW, 8.11% for combine harvester with 84.87 kW and 4.11% for combine harvester with 86.34 kW. The annual interest rate was 15.95%, the annual yield of stock exchange 25.37%, and that of foreign currency 10.36% (Anonymous, 2019d). However, given long-term aims, the profitability rate was very important: For, combine harvester is one of the factors of production and has an investment feature. It is directly effective in production increase, productivity, and economic growth. Securities are a change of an aspect of money. There is no contribution to production and economic growth.

Table 6. Annual profitability regarding combine harvester use

kW	Income		Cost		Profit		Capital (USD)	Profitability (%)
	(USD/year)	(USD/ha)	(USD/year)	(USD/ha)	(USD/year)	(USD/ha)		
72.32	18 032	22.65	14 455	18.16	3 577	4.49	54 369	6.58
75.27	16 512	21.14	14 737	18.87	1 775	2.27	36 246	4.89
76.75	15 250	20.39	14 526	19.42	724	0.97	22 654	3.20
81.92	18 263	21.90	14 962	17.93	3 301	3.97	46 818	7.06
84.87	19 856	22.65	15 207	17.34	4 649	5.31	57 389	8.11
86.34	15 730	20.39	14 427	18.70	1 303	1.69	31 715	4.11
<b>General</b>	<b>18 416</b>	<b>22.20</b>	<b>14 699</b>	<b>17.72</b>	<b>3 717</b>	<b>4.48</b>	<b>49 838</b>	<b>7.45</b>

### 3.3. Combine Harvester Contractors System

In this study, it was determined that combine harvester contractors in Central, Yerköy ve Şefaati districts have come into harvest season in Çukurova Region in May and then moved to Southeastern Anatolia Region in June after completing the harvesting in Çukurova Region, and afterward, they harvested in the research area by moving to Yozgat. In the research, it was seen that combine harvester contractors completed the harvest of the year in 2.5 months.

In the research, it was determined that the direction of moving of combine harvester contractors was Research Area-Neveşehir-Adana-Hatay-Gaziantep-Şanlıurfa-Adiyaman-Kozaklı-Şefaati-Yerköy-Yozgat (Figure 3).

Since in the research area, most farms had a small farm status, it was more convenient for them contractor system.

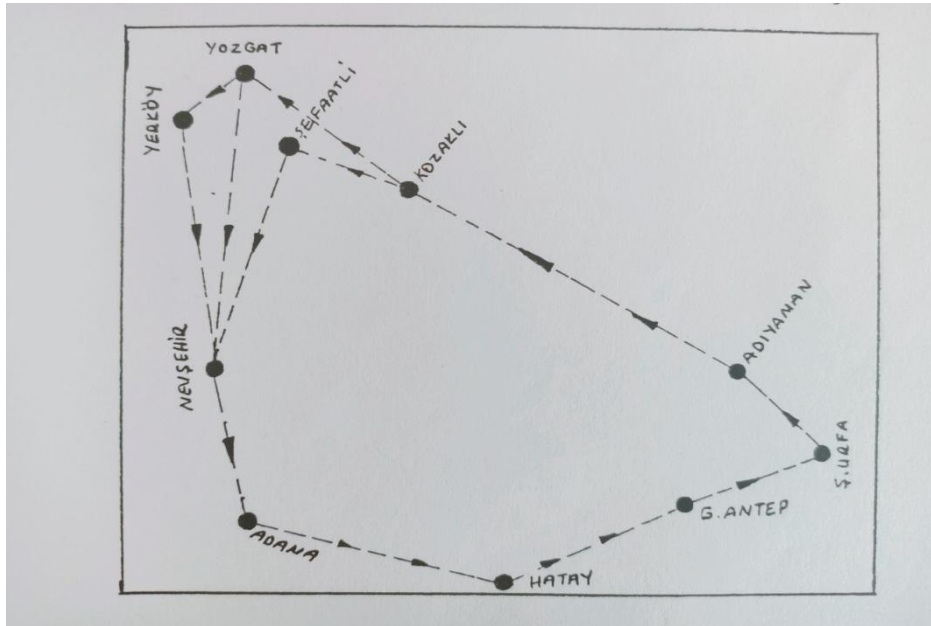


Figure 3. Working regions of combine harvesters

## 4. CONCLUSION

Regarding the number of combine harvester per 1000 hectares, it was determined that the research area was the most advantageous region in Turkey. While in Yozgat province, the number of combine harvesters per 1000 hectares was 1.47, it was 0.74 in Turkey, and 0.90 in Konya province.

In the study, it was determined that thanks to combine harvester contractors, it was harvested 829.50 ha in a year. Harvested area was 1.37 ha per hour and 17.28 ha in a day.

46.98 % of the total cost regarding combine harvester use consisted of fixed costs and 53.02% of them variable costs. Depreciation took an important place in fixed costs, and fuel and oil expenses in variable costs.

It was determined that combine harvester contractors had a total cost of 17.72 USD per ha. Harvesting income per ha was 22.20 USD, and the net profit was 4.48 USD.

In the research area, it was determined that combine harvester contractors system has held great importance in combine harvester use. For, it was the best method for combine harvester contractors.



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