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RESEARCH ARTICLE

Cost Analysis of Different Mixture Rates and Sowing Methods of Anatolian Clover (*Trifolium resupinatum* L.) and Italian Ryegrass (*Lolium multiflorum* Lam.)

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ABSTRACT

The study was carried out between 2015 and 2016 in accordance with the split plots in randomized blocks research design with 3 replications, which aimed to determine the optimal mixture rate for the production design. The results of the research were made into agricultural implementation and cost analysis was performed. Relative profit margin was used in determining the most favorable mixture rate that will be included in the production design. According to the application results, the production threshold was exceeded in all mixtures. The highest gross production value (95.90 USD da^{-1}) and production cost (59.05 USD da^{-1}) was obtained from the sole Anatolian Clover among the forage crop mixtures. Whereas; the lowest gross production value (71.32 USD da^{-1}) and production cost (58.60 USD) was detected in the sole Italian ryegrass application. In addition to this, it was found that the highest relative profit margin (1.62) had been achieved in sole Anatolian clover. 50% Anatolian clover + 50% Italian ryegrass (K_2) (1.40), 25% Anatolian clover + 75% Italian ryegrass (K_3) (1.38) were followed to sole Anatolian clover, in terms of mixture rates. Perdenpedicular row sowing (E_3) had the highest relative profit margin (1.45) in this study according to the sowing methods. As a consequently, perpendicular rows (E_3) and sole Anatolian clover (T), 25A.C + 75 I.R (K_3) were the most suitable sowing method and mixture ratios under Anatolian conditions, respectively.

Introduction

The agricultural product cost results are utilized in formulating agricultural product price policies. Agricultural product costs are also commonly used by establishments in determining the usage levels of physical production inputs, planning of financing facilities and drawing up product budgets (Anonymous, 2001). The main purpose of economic analyses in agricultural establishments is to gain maximum benefit from production activities. Increasing yields in such establishments can be achieved through accurate and proper utilization of

new technologies in production activities. Increasing production and reducing production cost depend on the properties of the product to be grown as well as the technology to be used. In line with these principles, sustainability of agricultural production activities can be achieved by adherence to economic principles. And this, in turn, can be ensured by choosing the optimum production method to be used by the producer in the establishment. However, the economic condition of the establishment and many factors involved in the production design should be properly evaluated when deciding on the production design. These factors can be

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listed as climate conditions and soil structure of the region in which the establishment is located, as well as the geographical location, equipment availability and labor capacity of the establishment.

Producers have to consider financial profit of the product will generate when deciding on which products to be grown in the establishment. Minimizing the costs in agricultural production enables establishments to tolerate low prices in the market by creating a strong competition environment (Bayramoglu et al., 2005). Agricultural product costs need to be consistently analyzed for the evaluation of agricultural production policies, effective use of resources and monitoring of technical developments in the field of agriculture. Cost is defined as the rate of agricultural production costs to the produced yield. As with all other economic sectors, this cost rate also affects the business operation results in agricultural sectors (Karadas, 2016). Agricultural production factors cannot be used at optimum level due to the lack of capital and technical information in the agricultural establishments. This, in turn, adversely affects the product yield and farmer income (Gundogmus, 1998). It is often difficult to employ a standard method for the calculation of agricultural product costs in Turkey. Therefore, care should be taken in accurate calculation of production expenses and costs in the agricultural establishments. Because, costs vary considerably between countries and even establishment. In this respect, one can conclude that there is no single cost price in agriculture and each establishment (Kıral et al., 1999). Calculating agricultural product costs on regional and national basis is vital in respect to input utilization and the production planning. In order to achieve the objectives of cost and income studies, what is needed is to develop a sufficient, viable and up-to-date cost calculation model, which is developed by taking into consideration the current state of domestic agricultural production and the globalizing world economy and its nation-wide application (Ozkan and Yılmaz, 1999). Product costs in agricultural production keep rising with each passing year, thus a conducted cost study may lose its validity next year. Consequently, cost calculations should be conducted periodically to monitor the applicable technologies, evaluate the results of agricultural policy and keep track of the changes in resource utilization (Kızıloglu, 1995). Economic analysis can be used as a tool for making profitability comparisons for the production of different plants and prioritizing the production of the those that prove more profitable (Ziaei, 2015).

According to the data from Turkish Statistical Institute; the national forage crop production in Turkey is about 55.5 million tons. While grassland- and pasture-based production is about 11.7 million tons (Anonymous, 2019). Improving sowing conditions or increasing the number of cultivation areas alone may fall short in boosting forage crop production. Such measures also need to be backed by increasing the yield per unit area. In plant production, one of the solutions proposed for increasing yield is the adoption of the intercropping system for plant growth (Acar et al., 2006). Intercropping can also make it possible to meet the diverse nutrient needs of animals Intercropping of poaceae and leguminous forage crops prove more advantageous compared to sole stand cropping. The

advantages of intercropping includes increased dry matter yield, higher protein content and forage quality and reduced fertilizer consumption need for plants. Providing necessary grazing conditions, high rate of forage production, prevention of soil erosion are the qualities that particularly distinguish different plant mixtures from others. Also, inclusion of legumes in intercropping enhances the palatability and digestibility of the forage. Providing economic benefits in regard to nutrient use of plants and soil moisture and preventing soil exhaustion are the distinct major benefits of intercropping. The greater part of the Turkish forage crop agriculture is provided by the production from alfalfa, silage corn, vetch, sainfoin farming. In addition to this production, high-quality, high-yield, and high-profit alternative forage crops should be adapted into forage crop farming. No studies on the mixture of Anatolian clover and Italian ryegrass have been conducted for different regions of Turkey. This study aims to increase the production of Anatolian clover and Italian ryegrass through the assessment of the cost analysis for different mixture rates and sowing methods of these crops under Ankara conditions. This research will also enable the forage crops producers to compare the production activities of Anatolian clover and Italian ryegrass with the main products in terms of cost and profitability.

Materials and Methods

The research was conducted in between 2015 and 2016 in Ankara University, Faculty of Agriculture, Field Crops Research and Application area. The soil of the experimentation field has an argillaceous-loamy structure, is alkaline (7.37), calcareous (5.66%), harmless total salt level (0.042%), moderate in phosphorus (5.52 kg da^{-1}), rich in potassium (192 kg da^{-1}) and insufficient in organic matter (1.05%). The experimentation field also has good drainage and does not have any groundwater problems. Ankara province is one of the leading provinces of our country in terms of plant production. Total agricultural area on Ankara is 1.233.043 ha and constitutes 48% of the its total area. The total land area in the total field agricultural area is 842.659 ha and it has a share of 68%. 8.6% of its agricultural land can be irrigated. The most important plant produced in field agriculture is wheat. The most important wheat market in Turkey is Ankara. Ankara is one of the provinces with the highest uses of certified seeds in Turkey. Approximately 25% of the its population is living in rural areas to deal with agricultural activity in Turkey, where the share of agriculture in gross value added of Ankara's level is 8.5%. The location of Ankara in Turkey is presented in the figure 1.

The materials used in the study were 'Demet-82" Anatolian clover and "Hellen" Italian ryegrass varieties. The research was carried out in Ankara University, Faculty of Agriculture, Field Crops Research and Application area. Also, it was based on the split plots in randomized blocks experimental design with 3 replications in between the years of 2015 and 2016. Different sowing methods [same rows (E_1), alternate rows (E_2), perpendicular rows (E_3) and broadcast (E_4) sowing method] were employed for the main plots; different mixture rates [Anatolian clover (T) and Italian ryegrass (L) as sole, and 75%

Anatolian clover + 25% Italian ryegrass (K_1), 50% Anatolian clover + 50% Italian ryegrass (K_2) and 25% Anatolian clover + 75% Italian ryegrass (K_3)] were employed for the sub plots as mixture. The amount of seeds per decare were 2 kg for both Anatolian clover and Italian ryegrass and the seeds used were estimated based on the sowing method and the mixture ratio for each plot (Genckan, 1995). The sowing and harvest times were April 12-July 15 in 2015 and April 15-July 17 in 2016, respectively. The results obtained from the research were

calculated by using the average values of 2015 and 2016. The cultivated plots had an area of 2m × 2m = $4m^2$ and the row spacing was 20 cm in 10 rows. For both years of the experiment, 20 kg of diammonium phosphate (20:20) fertilizer had been applied per decare one week prior to sowing. Both experimentation years involved three irrigations each. In both experimentation years, hoeing was done for weed control purposes where necessary.

Figure 1. Research area

Method applied in data analysis used in the study represent 2015-2016 production period. The unit product costs were estimated using budget approach based on the physical and financial data obtained from the study. The production cost calculation for the crops were based on the data related to the input utilization levels for the production activities, product, input prices and production amount. The expense and income for the forage crop mixture under Ankara province conditions in terms of employed cultivation techniques are given in Table 1. 3% of the total cost under Ankara conditions was established as overall administrative expenditures (Erkus and Demirci, 1996). In Table 1, the use of seed plant is a significant variable and the fact that the sowing cost of perpendicular row sowing is two times higher than other sowing methods. The cost analysis of the forage mixtures used in the experiment was conducted using Relative Profit margin. The optimum mixture amount to be included in the forage crop production under Ankara conditions was identified through comparison of Relative Profit margin. In plant production activities, costs were regulated in a way to show the utilization level of average production inputs per decare and net profit levels per unit area were provided according to products. These following formulas were used in the calculation of gross and net profits.

Gross profit = Gross production value - varying costs   1

Net profit = Gross production value - production costs   2

Relative profit margin = Gross production value/production costs   3

The amounts used in intercropping by the producers for input utilization were taken as basis. The calculation of machinery costs were based on the local unit machinery rental fees. The general administrative expenses were calculated as 3% of the total varying costs. In fodder crop production, the government supports provided to the producers were not included in calculation. In this study, the production costs and incomes are calculated in Turkish Lira (TL) and converted to US Dollar (USD) (1 Dollar= 5.3 Turkish Liras). Some values in this study are used as abbreviation (decare=da, kilogram=kg, Turkish Lira=TL, US Dollar=USD).

The agricultural application method been used by the producers in forage crop production under Ankara conditions was identified. The data obtained from the study were evaluated in consideration of the agricultural application and the cost items were created. In the research, the data obtained from the plot area of 4 m² was converted to decare (4 m² × 250). This allowed for more comprehensible

parameters for the agricultural application. The amounts in other cost items were also converted to decare for the

calculations. The expense and income table was created according to these calculations.

Table 1. Expenses and incomes relating the forage crop mixture

Serial No	Expenses	Unit	Amount	Unit Price (USD)	Amount (USD)
1	First ReleaseFee (Plow)	da	1	6.15	6.15
2	Doubling Fee (Sweep)	da	1	3.07	3.07
3	Sowing Cost (Grain Drill)	da	1	1.55	1.55
4	Seed Plant	kg da^{-1}	2	6.64	13.28
5	Bottom Fertilizer (DAP)	kg da^{-1}	20	0.35	6.90
7	Fertilization Workmanship	da	1	1.31	1.31
8	Fighting Amount (Herbicide)	da	1	0.92	0.92
9	Fighting Workmanship	da	1	0.92	0.92
10	Woodsman Wage	da	1	0.92	0.92
11	Harvest (Mowing)	da	1	6.19	6.19
12	Transport	da	1	0.80	0.80
13	Bailing Fee	da	1	4.15	4.15
14	Exchange-Portage-Loading-Stoppage	da	1	1.29	1.29
15	Irrigation	da	3	2.04	6.13
		Total			53.99
16	Other Expenses	3%			1.61
		Total			55.60
17	General Administrative Expenses	3%			1.65
18	Interest on Capital	4%			2.21
	PRODUCTION COSTS				59.05
			Yield (kg da^{-1})	Price (USD da^{-1})	Amount (USD)
	GROSS PRODUCTION VALUES (Mixture Amount kg da^{-1})		781.95	0.13	95.90
	NET PROFIT				36.85

Results and Discussion

In agricultural production activities, making use of the scarce resources available to the establishment is vital for sustainable agricultural production. The study aimed to determine the optimum forage crop mixture amount to be included in the production design in the establishment under Ankara conditions by using relative profit margins. The expense and income, which was listed to establish the Relative Profit margins for the forage crop mixture under Ankara conditions in terms of in the study area cultivation techniques, are given in Table 1.

The data given in Table 1 was obtained by adapting the study results to the agricultural conditions. The calculations in Table 1 were based on the forage crop production design under Ankara conditions. The total production cost for forage crop mixture per decare was estimated as 53.99 USD da^{-1} in the establishments whose unit product costs were evaluated. This value constitutes 90.7% of the total production cost. Among the production costs in forage crop cultivation, the largest share was claimed by machinery pulling power costs (plowing and sowing) with 20.2%. Similar previous studies showed that almost half of wheat production costs comprise of machinery pulling power and fertilizer costs and diesel fuel constitutes a significant part of machinery pulling power costs (Alemdar et al., 2014).

In the calculations, the yield of forage crop mixture rate was determined as 781.95 kg da^{-1} and total production expense per decare was found to be 59.05 USD da^{-1}. In forage mixture

production, net profit per decare was estimated to be 36.85 USD da^{-1}. Accordingly, profit thresholds were exceeded, the varying and total costs of production activities are met. Under these circumstances, the production of forage crop mixture will be sustainable and economically consistent. The gross production values and the production costs of other mixture rates and sowing methods were calculated separately. The results of calculations are given in the Figure 2.

The highest gross production value (95.90 USD da^{-1}) and the production cost (59.05 USD da^{-1}) was obtained from the sole Anatolian Clover among the forage crop mixtures (Figure 2). Whereas; the lowest gross production value (71.32 USD da^{-1}) and the production cost (58.60 USD) was detected in the sole Italian ryegrass application. In terms of sowing applications, the highest gross production value (87.68 USD da^{-1}) and the production cost (60.42 USD da^{-1}) was obtained in perdendicular row sowing application (E$_3$). The lowest gross production value (58.29 USD da^{-1}) was detected in broadcast sowing application (E$_4$). As a result of the evaluation of the gross production values and the production costs obtained in the research, the relative profit margins were calculated and given in the Figure 3.

The relative profit margins in the the production values obtained from the implementation of mixture and sowing methods were all positive (Figure 3). This shows that the profit threshold is exceeded regardless of the method employed by the producer. Pursuant to the economic principles in the production, the producer needs to choose the method to provide the highest level of relative profit in these applications. In the study, the highest profit (1.62) was

generated by sole Anatolian clover in forage crop mixture applications. It shows that when the application is chosen by the producer, an income of 1.62 USD is generated per 1 USD cost. This coefficient also shows that a profit of 0.62 USD can be generated per 1 USD cost in the production of mixture application. In mixture applications, the lowest profit margin

(1.34) was found in 75% Anatolian clover + 25% Italian ryegrass application (K_1). It shows that 75% Anatolian clover + 25% Italian ryegrass application (K_1) provides an income of 1.34 USD per 1 USD cost when the application is chosen by the producer. According to these results, this application should be preferred as a last resort by the producer.
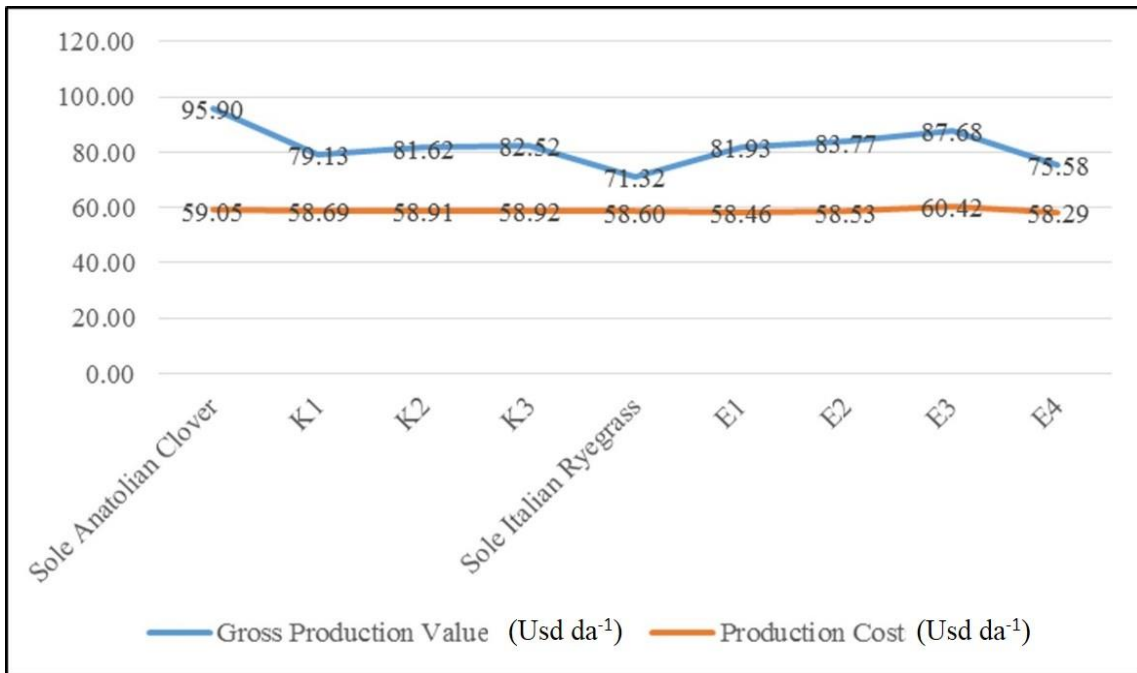

Figure 2. Distribution of gross production values and production costs according to the different mixture rates and sowing methods (K1: 75 Anatol/ian clover: 25 Italian ryegrass, K2: 50 Anatolian clover:50 Italian ryegrass, K3: 25 Anatolian clover:75 Italian ryegrass, E1: Same rows, E2: Alternate rows, E3: Perpendicular rows, E4: Broadcast)
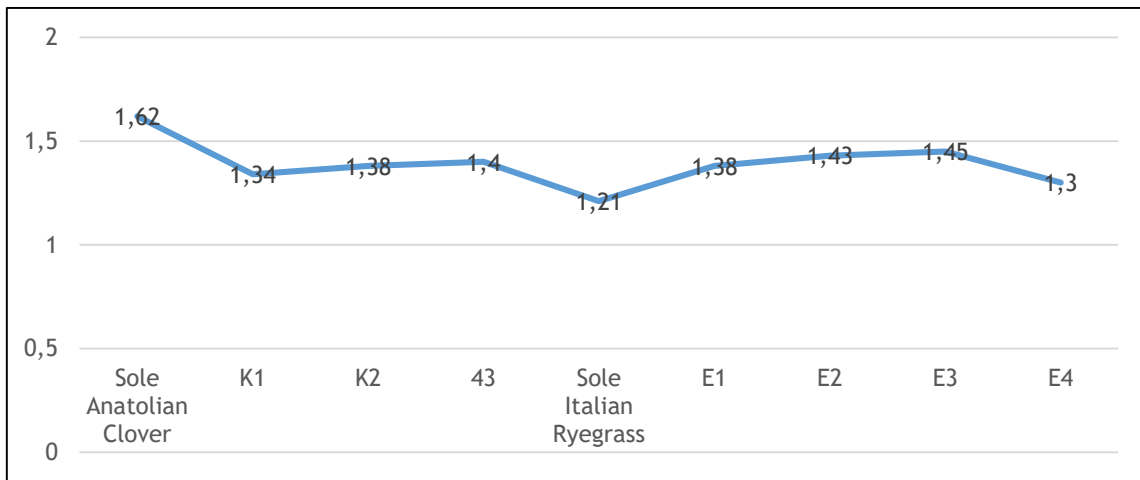

Figure 3. Distribution of relative profit according to different mixture rates and sowing methods (K1: 75 Anatolian clover: 25 Italian ryegrass, K2: 50 Anatolian clover:50 Italian ryegrass, K3: 25 Anatolian clover:75 Italian ryegrass, E1: Same rows, E2: Alternate rows, E3: Perpendicular rows, E4: Broadcast)

In the study, the highest income (1.45 USD) was obtained in perpendicular row sowing application (E_3) in terms of sowing applications. It shows that when the application is chosen by the producer, an income of 1.45 USD is generated per 1 USD cost. This coefficient also shows that an income of 0.45 USD will be generated per 1 USD cost in forage crop sowing

applications. Sole Italian ryegrass was found to be the method with the lowest level of income in sowing applications. In this application, the profit to be generated per 1 USD cost was found as 0.21 USD.

An examination of the studies on the economic analysis of forage crop mixture rates revealed a lack of adequate analysis on the subject. Therefore, our findings were compared to the economic analysis findings from other plant products employing the same sowing method and mixture rates, and the comparison results were discussed in the study. A study showed that, in Tokat province, a profit of 0.29 USD is generated per 1 USD cost in wheat production (Bayramoglu et al., 2005). This finding was quite lower than the profit (0.62 USD) generated from the forage crop mixture rates. Accordingly, from business administration point of view, the producer is suggested to prefer sole Anatolian clover forage crop mixture over wheat production. Another study found that a wheat producer in Agri province spends 0.83 USD for 1 kg wheat and sell it at price of 0.58 USD, incurring a loss of -0.26 USD per kg (profit threshold not exceeded). Under these circumstances, it can be argued that wheat farming is not financially feasible (Karadas, 2016). There is no difference between the findings among present studies and this. Because, the profit threshold obtained from the findings of this study was positive in all mixture and sowing methods. The net income was found to be negative (-20.72 USD da^{-1}) for the study conducted for silage corn production costs in Pasinler district of Erzurum province. It is argued that producers continuing their farming activities through such method may financially cripple the establishment (Akay Tuvanc and Dagdemir, 2009). The net profit from this study findings was found to be positive, which revealed a difference between our findings and that of the researchers. A study conducted in Ardabil, Iran showed that 20% of the the production costs comprise of machinery pulling power, and that a profit of 0.88 dollar is generated per decare (Mohammedi et al., 2009).

Conclusion

This study compared the average values of different mixture rates and sowing methods of Anatolian clover and Italian ryegrass under Ankara conditions. According to the comparison, perpendicular rows (E$_3$) sowing application stood out among others in terms of relative profit. In terms of relative profits of mixture rate, sole stand Anatolian clover ranked number one. It was followed by 25% Anatolian clover + 75% Italian ryegrass (K$_3$), 50% Anatolian clover + 50% Italian ryegrass (K$_2$), 75% Anatolian clover + 25% Italian ryegrass (K$_1$) and sole Italian ryegrass, respectively. In sole Anatolian clover, the gross profit per decare was estimated as 95.90 USD da^{-1}, gross profit as 36.85 USD da^{-1} and relative profit as 1.62. The above-mentioned sowing methods and mixture rates should be preferred in terms of sustainable production. No loss was incurred from all these mixture rates and sowing methods, and the study results were satisfactory. Also, the level of gross profit per decare was found to be high in forage crop mixture rates used by establishments. Accordingly, the production threshold is exceeded and the varying costs of production activity are met. It can be argued that using the five forage crop mixture rates in the production activities in the experiment area is effective in terms of business management principles. This study finding is crucial and exemplary for the establishments that carry out mixed forage crop production

activities. Because in this way, the forage crop producer will decide on which mixture rate to be preferred, how much expense will be made for this mixture, how much profit will be generated for this cost, and how the establishment revenue will be increased. Under these circumstances, the production of forage crop mixture will be sustainable and financially feasible. It can also be argued that this will prove useful in making the production decision by making a comparison with other vegetable products in the establishment. This study finding is crucial and exemplary for agricultural establishments that carry out agricultural activities.

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