Silage maize production costs and net profit analysis: the case of Tokat Province, Turkey

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Abstract

Production sialge, which is used intensively in the feed of animals and lactating cows in modern livestock producers, meets the aforementioned material supplements at a sufficient level. Protein silage devaid of mineral and life energy is due to high expectations from roughage, but also because of the benefit. Fort his roughage, which is so imortant for animal production, silage corn production and production costs are also important. This study was conducted to put forth the production cost of silage maize cultivation in Yeşilyurt district of Tokat province. While the questionnaire data gathered from 64 agricultural enterprises operating in the central district of Yeşilyurt constituted the primary material, data obtained from domestic and foreign sources and public institutions and organizations constituted the secondary material of the study. The survey data covers the production season of the year 2021. Present enterprises had an average land size of 98.34 decares and silage maize was cultivated in 17.62% of these lands. The cost of 1 kg of silage maize was calculated as 0.00005 USD and the net profit was calculated as 63.85 USD/da.

Keywords: Maize. Silage. Production cost. Tokat. Net profit

1. Introduction

Maize is a cereal grain originated from Central America and Mexico. It is known that this product, which is widely known throughout the world, is used as an important ingredient for human food, animal feed and various industrial products (Hossain et al, 2016).

Maize is one of the four products that make up half of the world's unprocessed product production in 2018 (1.1 billion tons (13%)). With a 36% share, it ranks third in the world's

unprocessed product exports (FAO 2020). By the year 2018, 56% of maize production is used as animal feed. It is expected that this rate will be 58% by the year 2027. It is stated that use of maize as foodstuff will also increase until 2027, but such an increase will come from developing countries (FAO – OECD, 2018).

For animals to be fed adequately and provide certain yield levels, they should be fed in a balanced fashion in all seasons. A balanced nutrition is provided with dry fodder, concentrated feed and green fodder. In winter periods with insufficient green fodder, ensiled forage crops are used to meet green fodder needs. Maize has been produced for green fodder and silage production in recent years and maize silage is highly preferred in dairy operations just because of high nutritional values of the silage (Şahin and Zaman, 2010).

Silage is obtained by chopping and fermentation of green forage crops with high water contents (Şahin and Zaman, 2010). It has high nutritional values and delicious, can be stored for a long time and consumed as fresh and juicy fodder in winter (Turan and Yılmaz, 2000). It can easily be produced in every facility at an affordable cost (Basmacıoğlu and Ergül, 2002).

By the year 2019, worldwide 1 148 million tons of maize was produced and Turkey had a share of 0.52% in this production (FAO 2021). The total agricultural land of Turkey is 23 145133 hectares. Maize is grown in 2.27% of these agricultural lands and silage maize yield is 52260 kg/ha. Maize cultivation area in Tokat province is 5765 hectares and the production quantity is 57674 tons in total. Yeşilyurt district makes maize production a suitable choice due to both the suitability of agricultural production conditions and livestock potential of the district. Accordingly, in 2020, 13 000 tons of silage maize was produced from 260 hectares in the district in 2020 (TUIK, 2021).

For farmers to decide what to produce and how to produce, they need to know the production costs and the income to be gained from the production (Özkan and Kuzgun, 1997). Determining the production cost of silage maize in Yeşilyurt district of Tokat province is important in terms of providing necessary information to the farmers who are or plan to become the producer of this product. From this point of view, this study was conducted to put forth production cost of silage maize. In this sense, gross production value, variable costs and gross margin calculations were made for silage maize.

2. Literature Review

Several studies carried out to conduct an economic analysis of maize worldwide and also in different provinces of Turkey (Alemdar et al., 2014; Brumfield et al., 1996; Çarkacı et

al., 2016; Diniz Faleiros et al., 2020; Khaliq et al., 2019; Paksoy and Ortasöz, 2018; Pishgar et al., 2011; Savaşan, 2007; Tuvanç, 2009; Tuvanç and Dağdemir, 2009).

Production cost of silage maize have been studied by previous researchers in different regions and their findings were summarized below.

Alemdar et al. (2014) calculated the production cost of field crops such as wheat, maize, cotton and sunflower produced in Çukurova Region. The data obtained through questionnaires made with agricultural enterprises in 2011 constituted the primary material of the study. The relative profit of maize was calculated as 1.26 ₺/da and the net profit was calculated as 160.80 ₺/da. Production cost of maize was calculated as 0.45 ₺/kg. In terms of profitability, the greatest gross profit was achieved in silage maize as 423.50 ₺/da.

Brumfield et al. (1996) indicated fertilizer, labor, irrigation, machinery, fuel and marketing costs as variable costs. Researchers calculated the variable costs of organic silage maize as $266.45 and the variable costs of conventional silage maize as $526.01. The total production costs of organic silage maize per decare was calculated as $619.19 and the production costs of conventional silage maize was calculated as $378.74.

Çarkacı et al. (2016) conducted a study on production costs of silage maize in Konya province and calculated soil tillage and sowing costs as 36.40 ₺/da, maintenance costs as 57.96 ₺/da, harvest and transportation costs as 77.65 ₺/da and production costs as 0.06 ₺/kg. It was suggested that powerful enterprises that want to reduce their production costs should turn to combined soil tillage tools and use machine labor rather than human labor.

Diniz Faleiros et al. (2020) conducted a field study for economic analysis of environmental protection system that has been carried out for 10 years in Brazil. Economic analysis of seasonal crops, off-seasonal soybean-maize crops and rotational combination of these crops produced in no-tillage system was carried out. In no-till environmental protection system, soybean and maize rotation in which maize was off-season was identified as the best economic alternative. The ratio of variable costs to total costs for different crop combinations varied between 74.1 - 80.2%.

Khaliq et al. (2019) conducted a field study in Ravalakot (Azad Kashmir, Pakistan) to calculate production costs of maize with different applications. Economic analysis was conducted over the experimental data. Among the experimental applications, poultry manure application under urea nitrogen and rain-fed conditions was identified as the most profitable fertilization regime. The highest crop value was generated by urea nitrogen (US$2375) and it was followed by poultry manure applied in combination with urea nitrogen (US$2365).

Paksoy and Ortasöz (2018) calculated variable costs of silage maize as 83.44% and fixed costs as 16.56%. Average yield of silage maize was identified as 5 188.89 kg/da, cost of 1 kg of silage maize as 0.11 ₺/kg, sales price as 0.122 ₺/kg, government support as 0.014 ₺/kg and net profit as 0.0136 ₺/kg. When the grain and silage maize production costs were compared with product sales prices, it was determined that farmers had difficulty in meeting high input prices without agricultural supports.

Pishgar at al. (2011) conducted a study in Iran and calculated the total production cost as 1 973 $/ha. Production cost was higher in large farms, but silage maize had a better cost-benefit ratio in these farms. The benefit-cost ratio was calculated as $1.57 and net return as $118.

Savaşan (2007) calculated production costs of the enterprises as 7 967.04 ₺, of which 75.69% consisted of variable costs and 24.31% of fixed costs. It was indicated that machine bollard pull costs had the highest share with 21.09% among the production costs and variable costs in silage maize cultivation. Maize yield was calculated as 4 400 kg/da, production costs per decare as 247.88 ₺ and the cost of 1 kg of silage maize was calculated as 0.06 ₺.

Tuvanç (2009) analyzed the production cost of silage maize cultivation and calculated the cost of 1 kg of silage maize as 0.066 ₺. Average gross margin was calculated as 52.32 ₺/da and net profit as -20.72 ₺/da. With the state supports to silage maize-growing farmers, the cost of 1 kg of silage maize was calculated as 0.051 ₺, gross margin as 62.68 ₺/da and net profit as 55.95 ₺/da.

Tuvanç and Dağdemir (2009) conducted a study to analyze production costs of silage maize in Pasinler town of Erzurum province and indicated that variable costs had a 78.58% share in production costs and harvest, transportation and silage production costs had the greatest share (25.58%), respectively. They were respectively followed by seed, fertilizer, water, nylon and salt costs (23.52%) and maintenance (14.32%) and soil tillage costs (10.36%).

3. Material and Methods

The primary data obtained through the questionnaires made with 64 enterprises producing silage maize in Yeşilyurt district of Tokat Province constituted the main material of the present study. Total Count method was used to determine the number of enterprises from which the data will be compiled. From the records of the District Directorate of Agriculture and Forestry, it was determined that 90 enterprises of the selected study area were dealing with silage maize production. All of these enterprises were tried to be reached, questionnaires

were not able to be made with some of the enterprises for various reasons and 64 enterprises were interviewed. Besides the primary data obtained from the interviewed producers, results of previous scientific studies conducted in different regions on the subject constituted the secondary material of the study. The questionnaire forms used in data collection were prepared in accordance with the purpose of the research and the data obtained covers the production season of the year 2021.

To express the workforce of the enterprises in a common unit, workforce of the farmer family was converted into Male Labor Unit (MLU) and calculations were made assuming that a male worker worked an average of 10 hours a day, 300 days a year or 10 months. Family labor wage equivalent was determined as alternative wages over foreign labor wages.

While determining product cost, production costs were calculated for a production season; plant production interest rate (8%) of R.T. Ziraat Bank was used in interest calculations, it was assumed that variable costs were spread over the production period and calculations were made over half the interest rate (Kıral et al., 1999). The bare land value was calculated by taking 5% of the land purchase-sale value (Fidan, 2001). General administrative expenses consisted of the expenses incurred for the management and administration of the enterprise, social services and common services related to all production activities of the enterprise. In silage maize production, 3% of the production costs were taken as the general administrative expenses (Özkan and Kuzgun, 1997). Seed, fertilizer and the other costs used in production of silage maize were calculated by multiplying the amounts used in production with the relevant cost to the farm. The data used in cost analysis of silage maize were arranged as to represent the production inputs for 1 decare area.

4. Results and Discussion

Some demographic characteristics of the producers were determined and the data related to demography were given in Table 1.

Table 1: Some demographic characteristics of the producers participated in the survey

		Frequency	Percent
Distribution of producers by age	30-40	24	37.50
	41-55	24	37.50
	56-+	16	25.00
	Total	64	100.00
Distribution of producers by gender	Man	62	96.87
	Women	2	3.13
	Total	64	100.00

Distribution of producers by level of education	Primary	32	50.00
	Secondary	21	32.81
	High	8	12.50
	Literate	2	3.13
	University	1	1.56
	Total	64	100.00

The average age of surveyed farmers was about 48 years and almost all of them were male (99.78%). Enterprises are generally the men. Half of the farmers (50.00%) were primary school graduates, while the rest (32.81%) were secondary school graduates and some (12.50%) were high school graduates, only 1 person was university graduate and 3 people were literate. The average land size of the enterprises interviewed was 98.34 da and maize was grown on an average of 17.62% of these lands. The average experience in maize cultivation was 5.30 years. Based on self-declarations of the producers, annual agricultural income was 9847 USD and about 40% of this income was obtained from maize production.

As the primary objective of the study, silage maize production cost was calculated for Yeşilyurt district of Tokat province and information regarding this calculation are provided in Table 2.

The total production cost was calculated as $141.88. The ratio of variable costs to total costs was determined as 75.19%. While harvest (20.72%) had the highest share in total production costs, the ratio of seed and planting (20.26%) costs was quite close to harvest costs.

Table 2: Production costs of silage maize growing enterprises surveyed (USD da[1]) and proportional distribution (%)

COST ITEMS	Value	%	%
Primary Tillage	3.09	2.18	2.90
Secondary Tillage	2.55	1.80	2.39
Tertiary Tillage	2.32	1.64	2.18
Seed + Sowing	28.74	20.26	26.94
Fertilizer + Fertilization	14.08	9.93	13.20
Water + Irrigation	17.12	12.07	16.05
Pesticide + Disinfestation	5.14	3.62	4.82
Harvest	29.40	20.72	27.56
Transport	2.13	1.50	2.00
Circulating Capital Interest (0.04)	2.09	1.47	1.96
VARIABLE COSTS TOTAL (A)	106.68	75.19	100.00

General Administration Expenses (A/2*%3)	3.20	2.26	9.11
Interest equivalent of bare land value	32.01	22.56	90.89
FIXED COSTS TOTAL (B)	35.21	24.82	100.00
TOTAL OF PRODUCTION COSTS (A + B)	141.88	100.00	

The results of previous studies conducted in different regions and countries on production costs of silage maize cultivation are provided below.

Alemdar et al. (2014) indicated that 70.79% of the production cost per decare in second-crop maize was composed of variable costs and 29.21% of fixed costs. Within variable costs, land machine bollard pull constituted the most important cost item with 27.52% share in total cost.

Brumfield et al. (1996) indicated that variable costs of organic silage maize had a share of 84.95% in production costs.

Paksoy and Ortasöz (2018) conducted a study in Pazarcık district of Kahramanmaraş province and calculated the share of variable costs in total cost per decare in silage maize production as 83.44%. It was determined that fertilizer and fertilization labor had the greatest share (22.25%) in variable costs.

Savaşan (2007) conducted a study in Central District of Kahramanmaraş province on silage maize production and determined the total production costs as 7 967.04 ₺, of which 75.69% constituted by variable costs.

Selvi (2019) calculated the cost of organic and conventional silage maize production in Kelkit district of Gümüşhane province and reported the ratio of variable costs within the production costs as 77.03% in conventional production and 70.77% in organic production.

Tuvanç and Dağdemir (2008) calculated the cost of silage maize production in Pasinler District of Erzurum province and determined the share of varying costs within production costs as 78.58%. Harvest, transportation and silage making processes had the most important share in variable costs.

In present study, maize yield was determined as 5143.28 kg/da. Slightly different yields were reported in previous studies. Maize yield was reported as 4400 kg in Central district of Kahramanmaraş province (Savaşan, 2007); 4790 kg for conventional production and 3920 kg for organic production in Kelkit district of Gümüşhane province (Selvi, 2019); 5188.89 kg in Pazarcık district of Kahramanmaraş province (Paksoy and Ortasöz, 2018) and 5166 kg in Pasinler district of Erzurum province (Tuvanç and Dağdemir, 2008).

Data on profitability of silage maize are provided in Table 3.

Table 3: Profitability data for maize cultivation

		Value
1	Variable costs total	106.68
2	Fixed costs total	35.21
3	Total of production costs (1 + 2)	141.88
4	Sales price (USD/kg)	0.04
5	Yield (kg/da)	5 143.28
6	Gross production value (USD/decare) (4*5)	205.73
7	Unit cost (USD/kg)	0.00005
8	Net profit per decare (USD/decare) (6-3)	63.85

Net profit of silage maize production was calculated as 63.85 USD / da. Alemdar et al. (2014) reported the net profit of maize production in Çukurova Region as 160.80 ₺/da. Paksoy and Ortasöz (2018) calculated the average cost of 1 kg of silage maize as 0.11 TL and the net profit as 0.012 TL. Savaşan (2007) reported the cost of 1 kg of silage maize as 0.06 ₺ and indicated that there was a loss of 0.01 ₺ per kilogram among the average prices obtained by the farmers.

5. Conclusion

This study was conducted to determine the cost of silage maize production in Yeşilyurt district of Tokat province. In this sense, gross production value, variable costs and gross margin were determined with the use of questionnaire data gathered from 4 farmers dealing with silage maize production.

Present findings revealed that silage maize with a net profit of 63.85 USD per decare was a profitable product for the enterprises. Maize yield per decare for the research area was 5243 kg.

The total production cost was calculated as 141.88 USD. The ratio of variable costs within the total costs was determined as 75.19%. Harvest had the highest share (20.72%) in total production costs and constituted one-fifth of production costs. With almost equal shares in total production costs, seed and sowing had the second place with a share of 20.2%.

When compared with the results of previous research in different regions, it is possible to state that the present research area was an advantageous region in terms of yield and profit. It was understood that the cost item standing out among the variable costs may vary from

region to region. For Yeşilyurt district of Tokat province, harvest, seed and sowing costs were identified as prominent variable cost items.

It can be stated based on present findings that silage maize should continue to be included in production planning of villages of Yeşilyurt district of Tokat Province. Assuming sustainability of livestock operations of the district, local farmers should continue the silage maize production and state supports should be provided to maize producers.

Further research is recommended to reduce production costs and to make silage maize production more profitable. With comparative research, advantages of different regions and production systems in production of any product could be put forth and validity of such advantages for the other regions could be investigated. For instance, identification of cost items in regions with lower cost items in silage maize production will aid in reducing production costs in the other regions.

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