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The Effect of Crop Losses during Pre-Harvest and Harvest Periods on Production Costs in Tomato Production in the Ayaş and Nallıhan Districts of Ankara Province*

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Abstract: The aim of this research was to analyze the impact on unit crop cost of crop losses that occur during the pre-harvest and harvest periods. It is understood today that crop losses occurring during these periods have an impact on crop cost and a negative effect on profit. The Ayaş and Nallıhan districts of Ankara province, where tomato production is carried out intensively, were selected as the research areas. Dwarf tomatoes are grown in the Ayaş district and indeterminate tomatoes in the Nallıhan district. A sample size of 74 for Ayaş and 34 for Nallıhan was calculated using a simple random sampling method. The production cost per kilo was $0.09 and $0.12, respectively, for these research areas. The gross margin and net profit per unit area were higher in Ayaş than in Nallıhan. A higher crop loss was seen in Ayaş (14.78%) compared to Nallıhan(12.76%) with respect to the seedling production period, as a fraction of all crop losses that include the pre-harvest and harvest periods. The crop losses during the production period in the field were 5.99% in Ayaş and 4.92% in Nallıhan. For the harvest period, crop losses were 5.15% in Ayaş and 9.83% in Nallıhan. Accounting for crop losses, per kilogram cost to produce tomatoes was $0.06 for Ayaş and $0.09 for Nallıhan.

Key Words: Tomato production, crop losses, production cost, gross margin and net profit.

Ankara İli Ayaş ve Nallıhan İlçelerinde Domates Üretiminde Hasat Öncesi ve Hasat Döneminde Ürün Kayıplarının Üretim Maliyeti Üzerine Etkisi

Özet: Bu çalışmanın amacı hasat öncesi ve hasat sırasında meydana gelen ürün kayıplarının birim ürün maliyetine etkisini ortaya koymaktır. Bilindiği gibi hasat öncesi ve hasat sırasında meydana gelen ürün kayıpları ürün maliyetini etkilemekte ve kara olumsuz etkide bulunmaktadır. Ankara ilinde domates üretiminin yoğun olarak yapıldığı Ayaş ve Nallıhan ilçeleri araştırma alanı olarak seçilmiştir. Ayaş ilçesinde bodur, Nallıhan ilçesinde sırık domates çeşitleri yetiştirilmektedir. Örnek hacmi Ayaş ilçesi için 74, Nallıhan ilçesi için 34 olarak hesaplanmıştır. Araştırma alanında ortalama domates maliyeti sırasıyla 0.09 $ ve 0.12 $ olarak bulunmuştur. Brüt ve net karlar Ayaş ilçesinde Nallıhan ilçesine göre daha yüksek bulunmuştur. Hasat öncesi ve hasat sırasında meydana gelen ürün kayıpları fide yetiştirme döneminde çok yüksek bulunmuş olup, Ayaş ilçesinde % 14.78 ve Nallıhan ilçesinde % 12.76 dır. Üretim döneminde ürün kayıpları Ayaş ilçesinde % 5.99 ve Nallıhan ilçesinde % 4.92 olarak hesaplanmıştır. Hasat döneminde hesaplanan üretim kayıpları sırasıyla % 5.15 ve % 9.83'dür. Ürün kaybının olmaması durumunda 1 kg domates maliyeti Ayaş ilçesinde 0.06$, Nallıhan İlçesinde 0.09 $ olarak bulunmuştur.

Anahtar Sözcükler: domates üretimi, ürün kayıpları, birim ürün maliyeti, brut kar, net kar.

Introduction

The rapid growth of the world's population and the insufficiency of agricultural production to meet the demands of this growth point to a potential future problem in providing adequate food. To solve this problem, to provide sufficient and better quality raw materials for related industries, and to increase the export of agricultural crops, both developed and developing countries have placed a great emphasis on efforts aiming to increase the per unit area yield of crops.

Significant to the goal of increasing productivity per unit area is the need to reduce crop losses occurring at

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different stages of production. Crop losses occur during the pre-harvest period mainly due to either the wrong application of cultivation techniques or natural factors such as frost, flood, plant diseases and pests. These are potential losses and generally are reported as low productivity (Güneş, 1982; Kınacı, 1982). The crop losses occurring during the harvest period are mainly due to mechanized harvesting, causing bruising and rotting of the fruit. The farmer directly accounts for crop losses occurring during the pre-harvest and harvest periods. Post-harvest crop losses are mostly related to transportation, storage, marketing, and consumption; these losses are caused mainly by farmers, brokers and consumers. Crop losses that occur during the production, harvest and post-harvest periods have a negative effect on the national economy, resulting in increasing crop costs and reducing the yield of consumable crop products (Özcan et al., 1997; Mohmood, 1998).

Crop and livestock production activities are carried out at farm enterprises in a manner dependent upon climatic, soil and market conditions. Recognition of the real cost and profitability of crops is a vital issue both from the aspect of the farm enterprise and from the aspect of entrepreneurs. The major goals in the calculation of unit crop cost can be noted as follows: to determine whether farm enterprises are operating rationally by a comparison of the different scales of farm enterprises; to determine the sale price of the crop by adding profit to the cost of the product; to put forward the economic results of the activities of the farm enterprise; to determine the usage level of production inputs and techniques used widely by farmers; to create an opportunity for the cost-by-cost calculation of alternative crops; and to put forward differentiation in terms of production process, input-output, price, and cost among regions (Kıral et al., 1999).

The aim of this study was to determine crop losses occurring during the pre-harvest and harvest periods and their unit cost, as well as the effect of losses on crop cost in tomato production, which represents 26% of the total vegetable production of the nation.

Materials and Methods

The data for this research were primarily collected from interviews conducted at farm enterprises intensively engaged in tomato production in the Ayaş and Nallıhan districts of Ankara province. Some 63.63% of the tomatoes grown in Ankara come from in Ayaş and Nallıhan. The data cover the 1999-2000 production period.

Five major tomato-growing villages were selected from each of the 2 districts, with all the tomato producers (781) in those villages included in the sampling poll. A simple random sampling method was used because of the population distribution. The sample sizes were determined according to simple random sampling using the following formula (Güneş and Arıkan, 1988):

$$n = N \delta^2 / (N-1) D^2 + \delta^2 \qquad [1]$$

where N = number of farms in the population

δ = variance of population

$D = (d/t)^2$

d represents the tolerated error in the population average, and t is the z value of the standard normal distribution. Using equation [1], a sample size of 74 was found for Ayaş, and 34 for Nallıhan.

The cost of the crop was calculated by a budget method using physical and financial values related to production activity per unit area, and by dividing the total input use by the total area.

To determine mechanization cost per hectare, local machinery rental prices are taken as a basis, and the wage of the machinery operator is included in the machinery fees category.

Family labor wages are calculated by taking the local current labor wage level as the basis. Overhead cost is calculated as 3% of the total cost. Operating capital interest is a kind of variable cost and represents the opportunity cost of the capital invested in production activity. The interest rate of operating capital is taken as half of the 45% credit rate reported by the Agricultural Bank of Turkey for plant production activity in production year 1999-2000 (Kıral et al., 1999).

Rent of land is a type of fixed cost, and current market prices are taken as its basis, with alternative rental prices included in the calculations for the farmer's own land (Kıral et al., 1999).

In the calculation of crop cost, a simple cost calculation method is used and total production cost is divided by the unit area yield. To evaluate the production success level activity of tomato farm enterprises, the

profitability level per unit production area is determined and used. In the calculation of crop cost, values are taken on a US dollar basis (1 $= 679, 063 TL).

The cost of tomato production activity is designed to show the average production input used per hectare, and the gross margin and net profit levels per unit area are therefore determined (Heady, 1961; Inan, 2001).

The total production cost and unit crop cost are calculated by adding fixed costs (maintenance and repair, depreciation, interest, overhead cost, rent) to the actual cost to tomato growers. Net profit levels calculated per unit area are shown as the economic profit of the selected activity, considering all current and covered cost elements.

In evaluating the effect of agricultural crop production of selected crops on the income of farmers, some indicators are utilized, such as net (economic) profit per unit area, the difference between gross production value and production cost of crops, the ratio of net profit per unit crop to average sales price reported by the farmer, the ratio of net profit to gross production value, and the ratio of net profit to the time (hours) of labor used in production.

Results

Total crop loss to tomato farmers in the Ayaş district represented 25.92% of production, whereas in the Nallıhan district it represented 27.51%. This crop loss occurred in spite of the use of hybrid seeds intended to increase plant protection to control pests, disease, and weeds. The breakdown of this total crop loss for Ayaş involved 14.78% loss during the seedling period, 5.99% during the field production period, and 5.15% during the harvest period. In the harvest period crop loss a subtotal of 3.79% loss occurred as a result of fruit cracking, and 1.36% as fruit rotting. The breakdown for Nallıhan was 12.76% for the seedling period, 4.92% for the field production period, and 9.83% for the harvest period, with the harvest period breakdown being 4.44% represented by fruit cracking, 2.9% by fruit rotting, and 2.49% by sun scalding.

The crop loss analysis shows that a significant part occurs during the seedling period (14.78% loss for Ayaş and 12.76% for Nallıhan). Fifty-six percent of tomato growers do nothing to prepare or improve the soil for seedlings. Seventy-two percent of growers in Ayaş reported that they obtain more than 75 seedlings from 100 seeds, and 28% of Nallıhan growers stated that they obtain 50-75 seedlings from 100 seeds.

Crop losses during the field production period represented a significant part of total crop loss, with 4.92% in Nallıhan and 5.99% in Ayaş. Of all tomato growers 66.67% do not employ a crop rotation system. Studies have firmly established that continued production within the same plot in successive years will sustain and increase the density or titer of disease-causing agents. A crop rotation system thus represents a method of plant protection by reducing the density of pathogens in the soil.

Crop loss during the harvest period was a greater part of total crop loss (5.15% in Ayaş and 9.83% in Nallıhan). This crop loss occurred during the harvest period in spite of efforts made from the beginning of the production season to avoid such types of losses. Tomato growers should be informed to take necessary measures during the harvest and post-harvest periods at least to keep crop losses at a minimum or ideally to eliminate this completely as a factor in crop loss.

Seedling production is adopted by all tomato-growing enterprises where interviews were held in the Ayaş district. The inputs used and cost values per hectare for seedling period for these enterprises are presented in Table 1. The data show that during the seedling production period per hectare 9880 seeds, 1489 kg of soil, 448.2 kg of turf, 1198 kg of manure, 3.5 kg of Triple Super Phosphate, 1.9 kg of ammonia phosphate fertilizers were used. Per hectare labor time was 118.8 h of labor, with 0.7 h of tractor power during the seedling period in the research area. The total cost per hectare for the seedling period was $478.9, with a per seedling cost of $0.06. Some 58.18% of the total cost per hectare for the seedling period consisted of material cost, and labor cost represented the second greatest cost, with 28.44%.

The unit cost and physical production input used per hectare during the field production period for tomato-growing enterprises in Ayaş are given in Table 2.

In the research area 1198.6 h of labor and 70.3 h of tractor power were needed per hectare of tomato production. Of this, 63.42% of the labor is used for harvesting and transportation activities, 28.58% for cultivation, and 8% for soil preparation and planting

Table 1. Tomato seedling production costs per hectare in the Ayaş district.

		Labor and Machinery Use					Material Used			
		Labor		Machinery						
Seedling Production Process	Process Date	Hour	Value ($)	Hour	Value ($)	Equipment	Kind	Quantity (kilos and no.)	Values ($)	Total Costs ($)
1. SOIL PREPARATION										
a. Soil/turf supply	Feb-March	9.0	6.4	0.6	4.3	trailer	soil>	kilos 1489	7.2	17.9
							turf>	kilos 448.2	18.6	18.6
b. Seed-bed preparation	March	14.6	11.9			shovel	manure	kilos 1198	11.8	23.7
							TSP>	kilos 3.5	0.7	0.7
							DAP>	kilos 1.9	0.2	0.2
c. Sowing	March	38.6	74.5			by hand	seed>	no. 9880	207.3	281.8
							nylon bag	no. 3077	10.1	10.1
							egg tray>	no. 17.7	5.2	5.2
d. Watering	March	5.5	4.2							4.2
II. CULTURAL PRACTICES										
a. Irrigation	April	19.8	15.6							15.6
b. Chemical use	April	0.9	1.1			shoulder pump.	chemicals		14.0	15.1
c. Weed picking	April	23.8	18.5			by hand				18.5
d. Fertilizer application	April	1.0	0.8			shoulder pump.	leaf fert.	kilos 0.1	3.6	4.4
e. Seedling transportation to field	May	5.6	3.2	0.1	1.1	trailer				4.3
f. Repair and maintenance of greenhouse										5.4
g. Interest on current costs										31.9
A-VARIABLE COSTS FOR SEEDLING PRODUCTION										457.6
a. Management costs (Ax3%)										13.7
b. Depreciation on greenhouse investment										6.1
c. Interest on greenhouse investment										1.5
B- TOTAL FIXED COSTS										21.3
C- TOTAL COSTS (A+B)										478.9
D- TOTAL AMOUNT OF SEEDLING PRODUCTION (no.)										8420
E- TOTAL COSTS PER SEEDLING (C D^{-1})										0.06

activities. The labor used for cultivation consisted of 48.12% used for irrigation and 33.84% used for turning the soil and hoeing activities.

The per hectare breakdown of tractor power needed for tomato production consisted of 45.66% for cultivation, 33.29% for transport to the market, and 21.05% for soil preparation.

The total tomato production cost was $4122.7 per hectare in the research area. With an average yield of 47,120 kg of tomatoes, the per kilogram cost of tomatoes is $0.09. With the average per kilogram sale price of tomatoes being $0.11, the ratio of profit to the sale price is approximately 18% per unit crop.

Table 2. Tomato production costs per hectare in the Ayaş district.

Production Costs	Process Date and Number	Labor and Machinery				Material Used			Total Costs ($)
		Labor		Machinery					
		Hour	Value ($)	Hour	Value ($)	Equipment	Kind	Quantity (kilos and no.)	Values ($)	
1. FIELD PREPARATION										
a. First plowing	Nov.	5.7	4.3	5.7	53.0	plow				57.3
b. Second plowing	Apr.	5.2	3.7	5.2	35.7	plow				39.4
c. Third plowing	May	1.8	0.8	1.8	8.2	spiketooth harrow				9.0
d. Lining (furrowing)	May	4.4	6.9	2.1	11.1	plow				18.0
e. Planting+watering	May	78.8	86.0			by hand	Seedling	8420 units	479.0	565.0
II. MAINTENANCE										
a. Fertilizer application	May-June (3)	17.9	22.4	1.6	6.2	hand+fert. sprader	Fertilizer		123.6	152.2
b. Irrigation trench	May-June (1)	16.0	11.9	11.6	33.6	hand+plow				45.5
c. Hoeing	June-July	115.9	164.4			by hand				164.4
d. Plowing	July (1)	14.6	13.2	14.6	20.8	hoeing mach.				34.0
e. Chemical application	May-July (3)	13.3	19.5	4.3	3.7	PTO driven sprayer	Chemicals		51.5	74.7
f. Irrigation	June-Sept. (13)	164.8	176.9				Water		45.9	222.8
III. HARVEST										
a. Harvest	July-Oct.	736.8	879.4			by hand				879.4
b. Transportation to market	July-Oct.	23.4	22.3	23.4	263.1	trailer				285.4
c. Variable costs of Irrig. Equipment							Diesel oil		375.0	375.0
d. Interest on Current Costs										657.5
A- TOTAL VARIABLE COSTS										3579.6
a. Management costs (Ax3%)										107.4
b. Rent of land										421.2
c. Depriciation on Irrig. Equipment										11.6
d. Interest on Irrig. Equipment										2.9
B-TOTAL FIXED COSTS										543.1
C-TOTAL PRODUCTION COST (A+B)										4122.7
D-TOMATO PRODUCTION (kg ha^{-1})										47120
E-TOTAL COSTS per KILO of TOMATO (C D^{-1})										0.09

All tomato-growing enterprises in Nallıhan produce their own seedlings. These enterprises generally (74% of them) use the soil of the region in the production of seedlings. Some tomato growers use turf in seedling production. The cost elements and input use values per hectare for the tomato-growing enterprises during the seedling period are presented in Table 3. An average of 13,090 seeds, 3942 kg of soil, 156 kg of turf, 1714 kg of manure, 0.8 kg of potassium sulfate fertilizer, and 264 unit trays were used by these enterprises.

Table 3. Tomato seedling production costs per hectare in the Nallıhan district.

		Labor and Machinery Use					Material Used			
		Labor		Machinery						
Seedling Production	Process Date	Hour	Value ($)	Hour	Value ($)	Equipment	Kind	Quantity (kilos no.)	Values ($)	Total Costs ($)
1. SOIL PREPARATION										
a. Soil/turf supply	March	23.3	17.0	4.0	13.8	trailer	soil	kilos 3942	78.9	109.7
							turf	kilos 156	39.5	39.5
b. Seed bed preparation	March	41.6	33.2			shovel	manure	kilos 1714	23.1	56.3
							pot. sulph.	kilos 0.8	0.4	0.4
c. Sowing	March	105.4	85.3			by hand	seed	no. 13090	821.5	906.8
							tray w. holes	no. 264	87.0	87.0
d. Watering	March	25.9	16.0			by hand				16.0
II. MAINTENANCE										
a. Irrigation	March-Apr.	40.1	17.8							17.8
b. Chemical application	March-Apr.	2.3	1.6			shoulder pump	chemicals		17.9	19.5
c. Planting	March-Apr.	52.3	30.5			by hand				30.5
d. Fertilization	March-Apr.	1.5	1.1			shoulder pump	leaf fert.	kilos 0.7	1.2	2.3
e. Planting in the field	Apr.-May.	8.0	7.4	5.3	24.2	trailer				31.6
f. Repair and maintenance of greenhouse										66.0
g. Interest on variable costs										103.8
A-TOTAL VARIABLE COSTS										1487.2
a. Management Costs (Ax3%)										44.6
b. Depreciation of greenhouse										68.4
c. Interest on greenhouse investment										17.1
B- TOTAL FIXED COSTS										130.1
C-TOTAL COSTS (A+B)										1617.3
D- NUMBER OF TOTAL SEEDLINGS PRODUCED (no.)										11,420
E-TOTAL PRODUCTION COSTS PER SEEDLING (C D^{-1})										0.14

During the seedling period 300.4 h of labor and 9.3 h of tractor power were needed per hectare. The per hectare costs during the seedling period amounted to $1617.30 and the number of seedlings planted was 11,420 per hectare, with a calculated seedling cost of $0.14. This represents a value 3 times higher than the per seedling cost in Ayaş. This greater seedling cost can be attributed to excessive seed use per hectare and the higher market price for seed in the district.

Of the total cost of the seedling period 66.14% consisted of material cost. Labor cost and operating capital interest followed, representing 12.98% and 6.44% of the total, respectively.

The values for physical production input use and the unit cost of tomato-growing enterprises during the field cultivation period in Nallıhan are presented in Table 4. Some 2286.7 h of labor and 85.2 h of tractor power were required by tomato growers. Of the total labor

Table 4. Indeterminate type tomato production costs per hectare in the Nallıhan district.

Production Costs	Process Date and Number	Labor and Machinery Use: Labor Hour	Labor Value ($)	Machinery Hour	Machinery Value ($)	Equipment Used	Material Used: Kind	Amount kilos/ number	Values ($)	Total Costs ($)
1. SOIL PREPARATION										
a. First plowing	Nov.	8.3	5.8	8.3	52.7	plow				58.5
b. Second plowing	April	7.3	5.1	7.3	47.9	plow				53.0
c. Furrowing (lining)	May	7.6	6.5	7.6	42.4	plow				48.9
d. Planting+watering	May	282.6	231.2			by hand	seedling	no. 11,420	1617.2	1848.4
II. MAINTENANCE										
a. Sticking	May	156.6	122.6			by hand	stick*>	no. 976	131.5	254.1
b. Wiring	May-June	13.3	7.8			by hand	wire>	kilos 59.2	34.7	42.5
c. Fertilization	May-June	31.9	21.6	2.4	6.3	by hand + fert. spreader	fertilizer>		330.8	358.7
d. Hoeing	June-July (3)	101.8	92.3			by hand				92.3
e. Plowing (inter line)	July (1)	10.7	8.7	10.7	43.1	hoeing machine				51.8
f. Rope tieing	June-July	266.3	225.6			by hand	rope>	kilos 88.2	41.6	267.2
g. Axil removal	June-July	216.6	208.8			by hand				208.8
h. Tapping	July	33.1	24.4			by hand				24.4
i. Chemical application	May-July (3)	17.3	14.8	5.6	9.5	shoulder pump+ atomizer	chemicals>		121.3	145.6
j. Irrigation	June-Sept. (12)	149.5	126.1				water cost>		79.3	205.4
III. HARVEST										
a. Harvest	July-Oct.	904.2	676.0			by hand				676.0
b. Transportation (to market)	July-Sept.	43.3	32.6	43.3	190.6	trailer				223.2
c. Pulling up the sticks	Oct.-Nov.	36.3	34.3			by hand				34.3
d. Variable costs of machinery							diesel oil>		79.5	79.5
e. Interest on var. costs										1051.3
A- TOTAL VARIABLE COSTS										5723.9
a. Management costs (Ax3%)										171.7
b. Land rent										280.9
c. Irr. Equipment depreciation										21.4
d. Interest on irrigation equipment										5.3
B-TOTAL FIXED COSTS										479.3
C- TOTAL PRODUCTION COSTS (A+B)										6203.2
D- TOMATO PRODUCTION (kg ha^{-1})										51,080
E-TOTAL PRODUCTION COSTS PER KILO OF TOMATO (C D^{-1})										0.12

•Stick costs per year are taken into account

power utilized, 43.61% was for cultivation, 43.02% for harvesting, and 13.37% for soil preparation and planting. Of the total tractor power needed per hectare, 50.82% was utilized for transportation to market, 27.23% for soil preparation, and 21.95% for cultivation.

For the 1999-2000 production season, the per hectare total cost for tomato enterprises was $6203.20. With a per hectare yield of 51,080 kg, the per kilogram cost was $0.12, a cost 33% higher compared to Ayaş.

The average per kilogram price obtained by farmers in Nallıhan was $0.14, with a resulting per kilogram profit of $0.02. The ratio of profit to selling price per kilogram was 14.29%, a value lower than for Ayaş.

The per hectare total tomato production cost was $4122.70 for Ayaş and $6203.20 for Nallıhan. Variable costs accounted for 86.83% of the total production cost in Ayaş, and while Nallıhan had a higher proportion, 92.27% (Table 5).

Higher material costs and a relatively lower rent for land accounted for this value for indeterminate tomato production. Material costs represent the highest proportion of production costs in Nallıhan; these are followed by the share of labor cost at 29.72%, operating capital interest at 16.95%, and machinery cost at 6.33%. The cost of rent for land is 4.53% as a proportion of production cost. The rental cost in Nallıhan is lower than in Ayaş in both relative and absolute (10.22%) terms. The proportion of production costs for the tomato-growing farms in Ayaş were distributed as follows: labor at 34.24%, material at 24.96%, operating capital interest at 15.95% and machinery at 10.56%.

The per hectare gross production value for tomato is $5285.4 in Ayaş and $7172.0 in Nallıhan. The per hectare gross margin, one of the most significant indicators obtained in an evaluation of individual production activities, is higher in Ayaş, at $1705.8, than in Nallıhan, at $1448.1 (Table 6). Gross margin as a proportion of the per hectare gross tomato production value is 32.27% for Ayaş, and 20.19% for Nallıhan.

Table 6. Gross margin and net profit per hectare on tomato production.

Costs and Income Items	AYAŞ Value ($ ha^{-1})	NALLIHAN Value ($ ha^{-1})
Gross Production Value	5285.4	7172.0
Variable Costs	3579.6	5723.9
Production Costs	4122.7	6203.2
Gross Margin	1705.8	1448.1
Net Profit	1162.7	968.8

A per hectare net profit of $1162.7 for Ayaş and $968.8 for Nallıhan is calculated for one production season. The net profit per hour of labor is $0.97 for Ayaş and $0.42 for Nallıhan for tomato production in the research area.

Discussion

Dwarf type tomatoes are grown in Ayaş and indeterminate type tomatoes are grown in Nallıhan. Similar techniques for soil preparation are used in both districts: deep plowing in fall and superficial plowing in spring. Although F1 hybrid seed varieties are used in the region, open-pollinated seed varieties in particular are also used in Ayaş. Seedling production has been adopted in Ayaş and Nallıhan, and farmers mostly grow their own

Table 5. Tomato production costs per hectare on the farms studied.

Production Costs	AYAŞ Value ($ ha^{-1})	AYAŞ Percentage (%)	NALLIHAN Value ($ ha^{-1})	NALLIHAN Percentage (%)
TOTAL VARIABLE COSTS	3579.6	86.83	5723.9	92.27
- Labor costs	1411.7	34.24	1844.2	29.72
- Machinery	435.5	10.56	392.5	6.33
- Material used	1029.0	24.96	2356.4	37.99
- Other var. costs	45.9	1.12	79.5	1.28
- Interest	657.5	15.95	1051.3	16.95
TOTAL FIXED COSTS	543.1	13.17	479.3	7.73
- Management costs	107.4	2.60	171.7	2.77
- Land rent	421.2	10.22	280.9	4.53
- Other fixed costs	14.5	0.35	26.7	0.43
TOTAL PRODUCTION COSTS	4122.7	100.00	6203.2	100.00

seedlings. The cultural practices applied in tomato production are pruning, fertilization, irrigation, hoeing, and spraying.

At the beginning of October, harvesting is conducted in 3 different periods: the first period to obtain pink tomato, then ripened, and finally green mature fruit. The harvested crop is marketed directly without any standardization. In the late harvest periods beyond early October when the first frost is seen, tomatoes are ripened to the green mature stage and left in the fields with PVC plastic covers, a practice used particularly in Ayaş.

With respect to differences in cultivation practices applied during the field production period, great differences were seen because of the different varieties grown in the 2 districts (dwarf in Ayaş and indeterminate in Nallıhan).

If low rates of tomatoes are planted on the same plot of land every year in both districts, the potential for diseases originating from the soil is intensified with successive annual plantings. A policy of crop rotation should be followed by farm enterprises whenever disease is encountered, as this is an effective method for reducing the levels of plant pathogens.

A sampling tomato farm enterprise indicates that crop losses occur at different phases of production. Reduction or elimination of crop losses in the pre-harvest period is possible with more attention to proper and to timely cultural practices by the tomato growers. As for losses during the harvest period, these occur because farmers remain unaware of proper harvesting techniques. Similar findings for these 2 research areas and for others have been extensively reported (Aksoy, 1986; Özel and Kerimoğlu, 1989; Çetin, 1990; Koral and Altun, 2000; Gündogmuş et al., 2001; Tanrıvermiş et al., 2001) with respect to physical production input use in terms of labor hours, machinery hours and tomato production cost per hectare tomato production during the field production period. The general recommendation is that more hours should spent in the use of machines. Frequent transport of product to the market during the post-harvest period indicates this need.

A study performed in the San Joaquin Valley in the USA found a higher than usual use of seedlings (14,330 seedlings ha^{-1}) and fertilizer (392.7 kg ha^{-1}). The product yield was 4480 kg ha^{-1}, and 72% of this was packed, and the crop loss rate was 28%. This crop loss portion is higher than the crop losses that occur in Ayaş and Nallıhan. The average tomato price was \$0.49 kg^{-1} in the San Joaquin Valley study, and varied between \$0.11 and 0.14 kg^{-1} in this study. US tomato growers obtained a higher price than Turkish tomato growers. Unit crop cost was \$0.44 kg^{-1} in the San Joaquin Valley report. The ratio of profit to selling price per kilogram of tomato was 10.20% for San Joaquin Valley tomatoes, and 18% in Ayaş, and 14.29% in Nallıhan (Strange et al., 2000)

Crop costs were calculated for 3 different levels of production in another study, conducted in Missouri, USA, and were as follows: for the production of 9080 kg of tomatoes, the unit crop cost was \$0.96 kg^{-1}. At a level of 11,350 kg of tomato production, the unit crop cost was \$0.83 kg^{-1}. When the production level was 13,620 kg, the unit crop cost was \$0.73 kg^{-1}. The tomato price was \$1.32 kg^{-1}. The ratio of profit to selling price per kilogram of tomato for the 3 different production levels was 27%, 37% and 45%, respectively. These rates were higher than those (18% and 14.29%) determined in our study (Brees, 2002).

Higher profit is obtained in greenhouse tomato production due to hybrid varieties and technological development in Romania. In spite of a 34% decrease in tomato production area, average yield increased 53.33% by the use of high-yield hybrid varieties. The average profit rate was 13%. The ratio of profit to selling price was 15% (Popescu, 2002). Similar findings were found in this study.

The per seedling cost was 3 times higher in Nallıhan than in Ayaş for the sample of farm enterprises interviewed. The 2 primary factors accounting for the higher cost were excessive seed use and the higher market seed prices in the district.

Several visits were made to the research area in order to determine crop losses during the pre-harvest and harvest periods and to conduct surveys in different seasons starting with the period of soil preparation. Observations and data collection in both districts show that crop losses take place mostly during the seedling growing period. The main reason for crop losses in this period was insufficient circulating air under the PVC covers. Additional crop loss occurred during the field production period because of the inattention of growers, leading to sun scald. Crop losses during the harvest period were also due to sun scald, as well as fruit crack and fruit rot.

If crop losses are excluded from the calculations, the unit crop cost is lower for this research area. Of course, it is very difficult to carry out required growing activities without any crop loss occurring during the production season. There is a customary consideration for (the amount of) crop loss that is estimated in all crop production. No research reports to date have presented findings with values related to typical crop losses for the different phases of tomato production. Greater efforts should be made to analyze the different phases of production and to evaluate typical or customary crop losses in order to provide data for realistic unit crop cost calculations.

In light of these research findings, it will be useful to describe the existing problems and to make some recommendations with respect to solutions to these problems. These are as follows:

- Some professional training is required (educational programs) to inform growers about what has been achieved in the applied science of tomato production. Growers are beset by avoidable problems, namely crop losses in the pre-harvest and harvest periods, because of malpractice in growing techniques, especially during the seedling and field production periods. This should be a high priority.
- A common practice in this country is to prepare for cultivation without having conducted any soil analysis. Thus soil enrichment materials (nutrients, chemicals, fertilizers) are added without consideration that some chemicals or nutrients in excess will become a part run-off that pollutes underground and surface water resources. Encouraging growers to perform soil analyses will likely result in a reduction of expenses for fertilization supplies as well as help in promoting sustainable growth in the research area.
- The results of this research also show that tomato growers lack information related to agricultural protection methods. Tomato growers are unable to implement integrated chemical protection in a timely and efficient way. Thus resulting crop losses lead to high economic losses. Moreover, misapplication of protection methods can lead to the presence of chemical residues that could endanger public health. Farmers should be made aware of the need to adopt the practice of leaving a time interval between the last chemical spraying and the commencement of harvesting to minimize any potential impact on human health. Emphasis should be given and the necessary measures should be taken to achieve this goal. A way to prevent crop losses originating from the malpractice of tomato growers is training and education, maintained by extension services and by farmers' organizations.
- In order to reduce unit crop cost of tomato growers and to increase the return per unit area, the means to reduce crop losses and provide efficient input use should be offered. Achieving these goals is highly dependent on eliminating the insufficient communication network that exists between universities, research institutions, the Ministry of Agriculture, non-governmental organizations (NGOs), and farmers. Priority should be given to the provision of an efficient and participatory flow of information between stakeholders.

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