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O. Murat KOÇTÜRK[1]
Sait ENGİNDENİZ[2]

[1] Celal Bayar University, School of Applied Sciences, 45140, Manisa / Turkey

[2] Ege University Faculty of Agriculture Department of Agricultural Economics, 35100, Izmir /Turkey

corresponding author: kocturkom@hotmail.com

Economic Analysis of Pesticide Use on Grape Growing: A Case Study for Manisa-Turkey

Üzüm Yetiştiriciliğinde İlaç Kullanımının Ekonomik Analizi: Türkiye'de Manisa Örneği

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Grape, production economics, pesticide economics, cost analysis, farm analysis

ABSTRACT

Turkey have been trying to decrease pesticide residues in vegetables and fruits. There is firstly a growing desire to reduce pesticide usage in vineyards to decrease the risk of pesticide residues. Today, farm-level costs include the costs of the pesticides, and their application. This study was conducted to analyse the farmlevel economics of pesticide use on grape growing in a selected regions from Turkey. Data was collected from 72 grape farmers. According to results of the study, the variable and total costs per hectare for grape production is 3,497.85 $/ha and 4,923.35 $/ha, respectively. The biggest share for total costs are pesticide (19.88%), land rent (19.66%), fertilizer (11.56%) and irrigation (11.31%). However, these figures can change depending on the climatic conditions and variation in input prices each year. According to the results of this study, average costs for pests and average grape price were $978.70/ha and $0.32/kg, respectively. Therefore, break-even yield was calculated to be 3,058.44 kg/ha.

Anahtar Sözcükler:

Üzüm, üretim ekonomisi, ilaç ekonomisi, maliyet analizi, işletme analizi

ÖZET

Türkiye sebze ve meyvelerde ilaç kalıntılarını azaltmanın yollarını araştırmaktadır. Bağlarda ilaç kalıntıları riskini azaltmak için öncelikle ilaç kullanımının azaltılması hedeflenmektedir. Günümüzde işletme düzeyindeki masraflar ilaç ve ilaçlama masraflarını da kapsamaktadır. Bu araştırmada Turkiye'den seçilmiş bir bölgede üzüm yetiştiriciliğinde ilaç kullanımının işletme düzeyinde ekonomik analizi gerçekleştirilmiştir. Araştırma verileri 72 üreticiden derlenmiştir. Araştırma sonuçlarına göre üzüm yetiştiriciliğinin hektara değişken masrafları 3,497.85 $, hektara toplam üretim masrafları ise 4,923.35 $'dır. Toplam üretim masrafları içerisinde en önemli payı ilaç masrafları (%19.88) almakta, bunu sırasıyla arazi kirası (%19.66), gübre (%11.56) ve sulama masrafları (%11.31) izlemektedir. Ancak girdi kullanımı iklim koşulları ve girdi fiyatlarındaki değişmelere bağlı olarak değişebilmektedir. Hektara yapılan ilaç masrafı 978.70 $ ve ortalama üzüm fiyatı 0.32 $/kg olarak saptanmıştır. Dolayısıyla kar eşiği 3,058.44 kg/ha olarak hesaplanmıştır.

INTRODUCTION

According to 2012 FAO statistics, grape production in the world was realized in 6.97 million ha area. In the same year, the grape production in the world was 67.07 million tonnes. The most important grape-growing countries are China (14%), USA (10%), Italy (9%), France (8%), Spain (8%), Turkey (6%) and Chile (5%) (FAO, 2015).

The most of grapes in Turkey are produced by conventional agricultural practice in the Aegean region. Conventional farming poses a negative impact on the environment, agriculture, and human health. The largest negative impact of conventional farming is its contamination of our freshwater supply (Turgut, 2007). Farmers use chemicals on the crops, which then soak into the soil and migrate into water supplies or enter to

the air and can also transported to other areas where no pesticides are used (Turgut, 2003). In grape cultivation, more than 30 pesticides of different chemical families are being used annually to combat weeds, insects or fungi (Hildebrandt et al., 2008).

A grape pest is anything destructive to grapes or grapevines. Pests include insects, diseases, birds and deer. Pest control information for small vineyards is a difficult topic because of the limited choice of materials available to non-commercial growers. Moreover, the cost of several products is prohibitively high for small vineyards, and frequent changes occur in pesticide registration of materials approved for use on grapevines. Good pest control in grapevines involves more than the use of pesticides. Several cultural practices should be used in conjunction with pesticides to control insect and disease problems on grapevines. Grape diseases are often promoted by high humidity or water sitting on vine tissues. Therefore, vine management that promotes faster drying will decrease disease incidence. Sloping ground promotes airflow through the vineyard; trees or other structures inhibit airflow, block sunlight, slow drying conditions and promote disease. Use canopy management practices including shoot positioning, leaf removal and summer pruning to keep vines open to sunlight and airflow (Zabadal, 1999).

Turkey have been trying to decrease pesticide residues in vegetables and fruits. There is a growing social desire to reduce pesticide usage in vineyards to decrease the risk of pesticide residues. Today, many countries are moving away from an unsustainable agriculture system. Integrated Pest Management (IPM) and GLOBALGAP applications were developed as an effective and environmentally sensitive alternative approach to pest management. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment (Turgut et al., 2011).

Many studies have been made on economic analysis of pesticide applications for grape growing in different country of the world (Cornejo, 1998; Wheeler and Crisp, 2009; Sholefield and Morison, 2010; Lescot et al., 2011). In recent years, many studies have been made on economic analysis of pesticide applications for grape growing in Turkey (Akgungor, 1995; Turgut et al., 2011; Kızılaslan and Somak, 2013). Though, there is still need for study, especially at farmers' level.

The purposes of this study was to determine the amount and types of pesticides used on grape grown in Manisa, Turkey and to analyse the farm-level economics of pesticide use. However, farmers' attidues toward their use of pesticides, their pesticide use problems were also determined.

MATERIAL and METHOD

Material

This study was conducted in Manisa province of Turkey. Manisa is situated in the western part of Turkey between 38° 36'N and 27° 26'E. Manisa is an important province in grape production of Turkey and it's share in Turkey's total grape production is 42% (TurkStat, 2015). Alasehir and Sarigol are the most important counties related to grape production in Manisa; hence two counties were selected for this study. Nine villages were choosen for this study from Alasehir and Sarigol counties. In this study, farmers who record data in a registering system were selected for obtaining correct and reliable data. For this aim, 72 farmers were selected and their records examined. Furthermore, a survey was also carried out on these selected farmers to collect socio-economic data. All data were collected for the 2009 growing season.

There are 9,780 farmers in two counties according to data of Turkish Ministry of Food, Agriculture and Livestock, Directorate of Manisa. Therefore, sample size was calculated for this study. The sample size was calculated as 72 farmers using the following proportional sampling formula (Newbold, 1995). At 90% confidence level and 10% error level with p= 0.5 and q= 0.5 is used for getting the maximum sample size.

$$n = \frac{Np(1-p)}{(N-1)\sigma_{\hat{p}x}{}^2 + p(1-p)} \qquad (1)$$

In this formula;

n = Sample size

N = Total number of farmers

p = Proportion for the grape farmers

$\sigma^2_{\hat{p}x}$: Variance

Method

In this study, yield data and observations were recorded throughout the production period. Thus, income and expense data were collected on time. The cost items of grape production was classified into variable costs and fixed costs.

The variable costs associated with grape growing were all inputs that directly related to the production

of grape and covered labour, fertilizer, pesticide, electricity, transport cost, etc.. Variable costs were calculated by using current input prices and labour costs. Variable costs included also interest on variable costs. In this study, interest on total variable costs was calculated by charging a simple interest rate of 6% (annual saving deposits interest rates on US $). But, interest on total variable costs was calculated for six months and interest rate was taken to be 3%, since grape production and marketing period were approximately six months.

In this study, fixed costs included; interest on variable costs, administrative costs, annual depreciation costs, and rent equivalent of land. Administrative costs can estimated to be 2–7% of total gross production value or 3–7% of total costs (Kiral et al., 1999; Mulayim, 2001). In this study, administrative costs were estimated to be 3% of total costs (labour, machinery and input costs). This method was applied in most of the previous studies (Koc et al., 2001; Engindeniz and Engindeniz, 2006; Engindeniz, 2006; 2008; Engindeniz and Cosar, 2013).

Fixed costs plus variable costs equal total production costs. Total costs were subtracted from total gross rereturn to calculate the net return.

Breakeven yield was also estimated for grape production in this study. Breakeven analysis is a useful farm manegement tool because it allows calculation of various combinations of price and yield that will cover anticipated costs. Breakeven analysis can also be used to calculate the breakeven price or yield required to cover variable costs (short-term production decisions). If anticipated receipts are greater than anticipated variable costs, you should continue the enterprise. Any loss would be equal to some amount between the difference in total costs (variable costs plus fixed costs) and variable costs. If anticipated receipts are less than variable costs, losses would be minimized by not continuing the enterprise. In this situation, losses would be limited to the amount of fixed costs that would have to be absorbed. The breakeven yield is the minimum yield required to cover all costs at the anticipated price per unit. The breakeven yield is computed as follows (Greaser and Harper, 1994; Engindeniz and Engindeniz, 2006);

Breakeven yield = anticipated total costs / anticipated price.

RESULTS and DISCUSSION

Socio-Economic Characteristics of Farmers

Socio-economic characteristics of farmers are presented in Table 1. Average age and education level of farmers were determined to be 44.92 and 6.70, respectively. The average experience of farmers was 22.56 years. The average houshold size of farmers was 4.29. Average farm size was 3.95 ha. The share of agricultural income in farmer's total income was 79.77%.

In a conducted study in Kemalpaşa, Izmir, average age and education level of grape farmers were determined to be 59.00 and 3.50, respectively (Artukoglu, 1990).

Table 1. Socio-economic background of farmers

Socio-economic characteristics	Average
Age (years)	44.92
Education level (years)	6.70
Houshold size (Person)	4.29
Farm size (ha)	3.95
Family labour usage (%)	82.25
The share of agricultural incomes in total incomes (%)	79.77

Pesticide Applications of Farmers

The most important insects are very similar throughout the grape production regions of Turkey. Farmers maintain predatory mite populations by the careful selection of safe pesticides. *Lobesia botrana* and *Strophomorphus ctenotus* Desbr are the two significant pests of grapes in Turkey and require regular control to prevent serious damage. Diseases are of far greater concern and impact on grape production throughout Turkey. Downy mildew (*Plasmopara viticola*), Botrytis (*Botrytis cinerea*) and anthracnose (*Elsinoe ampelina*) are the most damaging diseases of grapes in all regions (Kara, 2007).

Copper oxychloride and mancozeb are the major fungicides used for downy mildew control. Powdery mildew (*Uncinula necator*) is very important in the wet and humid climate throughout in seaside regions, although it is less effective in dry climates especially inland regions. Wettable sulphur is commonly used early in the season, and then as the daytime temperatures exceed 30 °C the demethylation inhibitor fungicides are used. Control of anthracnose is possible only with regular applications of the pre-infection dithiocarbomate fungicides or dithianon for woolly bud and whenever new growth is present during wet weather (Anonymous, 1998).

The number of pesticide applications for insects and fungicides vary according to climatic conditons in the research area. According to the results of this research, farmers applicated the pesticides beetween 12-16 times. These applications were performed

according to the rules of Turkish Ministry of Food, Agriculture and Livestock. Especially, farmers who produced with contract for the exporter firms produced their products with the rules of GLOBALGAP. Pesticides that farmers used for grape production are presented in Table 2.

Table 2. Pesticides that farmers used for grape production

Pesticides	Active ingredient	Using aim of pesticide	Number of pesticide user farmers	Pesticide quantity per ha	Number of pesticide application
Insecticides					
Avaunt	Indoxacarb 150 g/L	Lobosio botrono	61	750 ml/ha	3
Laser	Spinozad 10 cc/100 L.	Lobosio botrono	56	400 ml/ha	3
Dursban	Chlorpyrifos Ethyl 200 g/L	Lobosio botrono	25	500 ml/ha	3
Prodigy	Methoxyfenozide 240 g/L	Lobosio botrono	55	300 ml/ha	3
Coragen	Chlorantraniliprole 200 g/L	Lobosio botrono	45	150 ml/ha	3
Proclaim	Emamectin benzoate % 5	Lobosio botrono	28	250 ml/ha	3
Hekvidor	Imidacloprid 350 g/L	Anophothris	59	1000 ml/ha	3
Karate	Lambda Cyhalothrin 50 g/L	Anophothris	53	250 ml/ha	3
Fungicides					
Topos	Penconazole 100 g/L	Unicilo Necator	57	500 ml/ha	4
Collis	Kresoxim methyl 100 g/L	Unicilo Necator	52	500 ml/ha	4
Vivondo	Metrafenone 500 g/L	Unicilo Necator	45	200 ml/ha	3
Luna	Fluopyram 200 g/L	Unicilo Necator	24	600 ml/ha	4
Ritreap	Cyflufenamid % 5	Unicilo Necator	34	400 ml/ha	6
Miclothane	Myclobutanil 125 g/L	Unicilo Necator	46	600 ml/ha	4
Baymenol	Triadimenol 250 g/L	Unicilo Necator	54	400 ml/ha	4
Domark	Tetraconazole 100 g/L	Unicilo Necator	48	1,000 ml/ha	5
Milis	Pyrimethanil 300 g/l	Botrytis cinero	49	2,500 ml/ha	3
Switch	CYPRODINIL +FLUDIOXONIL	Botrytis cinero	62	1,200 ml/ha	4
Teldor	Fenhexamid 500 g/L	Botrytis cinero	58	2,000 gr/ha	6
Antrocol	Propineb 200/L	Plasmoporo viticolo	52	4,000 gr/ha	4
M-45	Mancozeb % 30	Plasmoporo viticolo	63	5,000 gr/ha	4
Heliosarfre	Kükürt % Sc	Plasmoporo viticolo	61	7,000 gr/ha	5
Acaricides					
Zoom	Etoxazole 110 g/L SC 25 ml	Tetranychus urticae	57	700 ml/ha	2
Voliam Targo	Chlorentroniliprde+184 G/L		40	1,400 ml/ha	3
Herbicides					
Raundup	Glyphosate 441 g/L		42	10,000 ml/ha	1

Farmer's practices for pests in grape growing included selecting agrochemicals that are registered for the specific pests; strictly following agrochemical label instructions including personal safety and environmental precautions; preventing spills while mixing and loading; avoiding backsiphoning while filling sprayers; calibrating agrochemical application equipment before use; mixing only that amount of agrochemical needed; never rinsing agrochemical application equipment near wellheads, ditches, streams or other water sources; and triple rinsing or pressure rinsing agrochemical containers before disposal or recycling. Almost all farmers used waterproof gloves. Further, farmers indicated that they used additional safety equipment such as enclosed cabs, protective glasses or goggles, and facemasks.

The biggest complaints of farmers regarding pesticides may be specified as the high level of pesticide prices and failure to obtain the expected results of the pesticides. The other points of complaints of farmers are the low grape prices and the insufficient subsidies of pesticide uses.

Production Area and Yield

Grape production area of farmers varied between 0.30 and 9.00 ha. Average production area was 3.95 ha. Yield of grapes varied beetween 22,000 and 41,000 kg/ha, and average yield was determined to be 25,800 kg/ha. In a similar studies done in Antalya and Manisa (Sarigol), Turkey, yield of grapes was estimated to be 10,220 kg/ha (Ozkan et al., 2007) and 42,000 kg/ha (Cebeci and Yener, 2013), respectively. In a conducted study in Manisa (Alasehir), Turkey, average fresh

sultana yield was determined to be 27,450 kg/ha (Kocturk and Engindeniz, 2009). In Berrisso Region, Argentina, the yield was differed between 10,880 and 51,000 kg/ha (Abbona et al., 2007).

Costs

The variable and fixed costs of grape production is given in Table 3. The results reveal that the variable and total costs per hectare for grape production is 3,497.85 $/ha and 4,923.35 $/ha, respectively. The biggest share for total costs are pesticide (19.88%), land rent (19.66%), fertilizer (11.56%) and irrigation (11.31%). However, these figures can change depending on the climatic conditions and variation in input prices each year.

Costs of grape production and gross production values were put forward with a number of preceding studies. For example, a study done in Antalya, Turkey, showed that the total cost for grape production was 3,368.60 $/ha. Variable costs make up 41.82% of the total cost. In the same survey, gross production value from grape production was found out to be 7,460.60 $/ha (Özkan et al., 2007). In another survey in Izmir and Manisa, Turkey, total cost for grape production was 879.30 $/ha (Bayramoglu and Gundogmus, 2008).

Table 3. Total costs of grape production ($/ha)

Cost items	Costs ($/ha)	%
1. Machinery costs	532.25	10.81
2. Labor costs	543.22	11.03
3. Other input costs	2,104.39	42.75
Fertilizer	569.03	11.56
Pesticide	978.70	19.88
Irrigation (electricity, oil etc.)	556.66	11.31
4. Harvest and transport	317.99	6.46
A. Total Variable Costs (1+2+3+4)	**3,497.85**	**71.05**
5. Interest on variable costs (%3)	104.94	2.13
6. Administrative costs (%3)	104.94	2.13
7. Annual depreciation costs (*)	247.88	5.03
8. Rent equivalent of land	967.74	19.66
B. Fixed costs (5+6+7+8)	**1,425.50**	**28.95**
Total Costs (A+B)	**4,923.35**	**100.00**

(*) The economic life of plantations was estimated as 40 years.

Gross and Net Return

Most grapes (80%) are marketed to exporter firms and commission agents. On the other hand, smaller farmers marketed their products to retailers and sellers in a markets. The grape prices received by the farmers varied between $0.21 and 0.44/kg. Average grape price was calculated to be $0.32/kg. The total gross revenue per hectare was estimated to be $8,256. Total costs per hectare of grape production were determined to be $4,923.35. Therefore, the net revenue per hectare was calculated to be $3332.65 (Table 4).

Table 4. Gross and net return obtained from grapes

Item	Total ($/ha)	Proportion of Revenue (%)
Yield (kg/ha)	25,800.00	-
Averaga grape price ($/kg)	0.32	-
Total gross revenue (1)	8,256.00	100.0
Variable costs	3,497.85	42.37
Fixed costs	1,425.50	17.26
Total costs (2)	4,923.35	59.63
Net return (1-2)	3,332.65	40.37

In a previous study in Manisa, Turkey, gross production value obtained from grape production was 6,039.00 $/ha. Gross margin obtained from grape production was determined to be 3,191.77 $/ha (Kocturk and Engindeniz, 2009).

Break-Even Yield

The break-even yield was also estimated for grape production. The break-even yield is calculated by dividing the total pesticide and pesticide aplications costs by the grape price. According to the results of this study, average costs for pests and average grape price were $978.70/ha and $0.32/kg, respectively. Therefore, break-even yield was calculated to be 3,058.44 kg/ha. This means that the increase in yield has to be 3,058.44 kg/ha for pesticide use to be economic.

CONCLUSION

Turkey is one of the most important countries in grape production of the world. Recently, China, Iran and Afghanistan inScreased their grape production.

Therefore, Turkey must increase their grape productivity and decrease their grape production costs for international competition. According to the results of study, the most important variable costs items of grape production in Turkey are pesticide, fertilizer, and irrigation costs. On the other hand, the land rent is very importants item as the fixed cost item.

Turkey produce some pesticides. But, Turkey import some pesticides from other countries. Farmers use the imported pesticides for grape production. The Ministry of Food, Agriculture and Livestock suggest to farmers some pesticides for their production. Indeed in Turkey in a study examining the pesticide residues in fruit vegetables including grape, to solve pesticide remains problem training of farmers, the development of organic farming and implementation of IPM system has been proposed (Bakirci et al., 2014). Further, grape exporter firms controll pesticide use of farmers with contract and the rules of GLOBALGAP. Recently, pesticide residue problem is eliminated in grape export of Turkey.

In Turkey, consumers have indicated increasing concern regarding the use of pesticides in food production. As a result of public concern, the government mandated that all cropland should be farmed using IPM practices. To reach this end, IPM must be clearly defined and the current level of IPM use in the region determined. Applicable research and technology can then be identified and educational needs and appropriate distribution methods determined to promote IPM to target farmers.

As a conclusion, if grape diversity and productivity of Turkey are increased and pesticide and other production costs in grape production of Turkey are decreased, the share of grape production and export of Turkey in the world will increase. For this aim, farmers should be trained by The Ministry of Food, Agriculture and Livestock and universities.

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