Journal of Environmental Biology **April 2006,** 27(2) 299-303 (2006)

Farm level analysis of pesticide use in cotton production in East Mediterranean region of Turkey

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(Received: 27 August, 2004 ; Accepted: 21 March, 2005)

Abstract: *Various kinds of pesticides have been used in cotton production to increase yield and farm income in Turkey. Using a standardized questionnaire, farm management and pest management practices were analyzed on the basis of information gathered from 100 farmers in two provinces, Adana and Kahramanmaraş of East Mediterranean region of Turkey. Insecticide use varied considerably between two provinces. The average level of herbicides and fungicides use was slightly higher in Kahramanmaraş than in Adana. The mean level of pesticide use, as a total active ingredient, in Adana (2.69 kg/ha) was more than twice of Kahramanmaraş (1.20 kg/ha). The share of pesticides in the variable cost was 13.47% and1.14% in Adana and Kahramanmaraş, respectively. Shifting from conventional cotton production to organic production was considered to increase the producers' income and reduce the possible environmental and health hazards. Also, the need for further training and dissemination of information about pesticide use and health effects throughout the Mediterranean Region is stressed.*

Key words: *Pesticide, Cotton production, Farm management, Extension, Turkey.*

Introduction

Cotton is the most widely grown crop in the East Mediterranean region of Turkey, especially in Adana, accounting for about 77,712 hectares of Turkey's total cotton production area (764,645 ha) in 2000. Production of cotton has been intensified in Adana since 1950s, to meet the National demand. Also, cotton has been economically cultivated in Kahramanmaraş in 18,000 ha during year 2000 (SIS, 2001). In recent years, all cotton farmers have started using chemical inputs especially pesticides to increase yields and farm income. Of the total insecticides used worldwide, around 23% was applied to cotton (Krattiger, 1997).

Excessive use of pesticides has shown negative effects on the environment and human health (Lichtenberg and Zimmerman, 1999). The environmental effects include damage to agricultural land, fisheries and fauna and flora. Increased mortality and morbidity of humans due to exposure to pesticides are also recorded especially in several developing countries (Wilson and Tisdell, 2001).

Many of the immediate environmental impacts of agriculture occur at a local level initially, so it is important to focus on the details of farming systems to reduce the environmental consequences of pesticide usage (Falconer and Hodge, 2001). Researches on economics of pesticide use in agriculture have received attention since 1990s in Turkey. Studies conducted in Turkey implied that production costs have increased with overuse of pesticides without any effective monitoring procedure (Tanrıvermiş, 2000).

This paper reports a survey of pest and farm management practices in cotton production at the farm level in two different agro-ecological provinces, but with similar production techniques, in the East Mediterranean region of Turkey. Two provinces were evaluated by comparing basic characteristics of farms, input use per hectare, type of pesticide used, share of inputs in variable cost, target insects, type of equipment, experienced health problems, information sources, prevention measures and containers' disposal.

Materials and Methods

The study was based on farm-level data for crop year 2000 collected from two leading cotton producing agro-ecological provinces situated in the East Mediterranean of Turkey. Since one of our main objectives was to compare the differences in pest management and farm profitability, two provinces Adana and Kahramanmaraş were selected carefully (Fig. 1). We choose Adana because it is the most important province in commercial cotton production and farmers here apply more chemical pesticides on their crops than other crops in Turkey. Contrarily, farmers' low input use was the most important reason for selection of Kahramanmaraş. The mean temperature was 18.8ºC in Adana and 16.5ºC in Kahramanmaraş. The mean annual rainfalls were 647.1mm (Adana) and 709.8mm (Kahramanmaraş). The mean annual humidity was 66.0% (Adana) and 57.8% (Kahramanmaraş)

Two administrative districts were selected from each province with the criteria of area under cotton crop and its yield. Ecological characteristics of both the province has also played an important role in selection the administrative districts. Five villages were selected from each province. A total of 100 farmers (50 from Adana and 50 from Kahramanmaraş), from twenty villages (ten from each province), were randomly selected for the study. The survey was conducted at the end of the harvest season in year 2000. Data were collected through personal interviews with farmers at their farms. A standardized

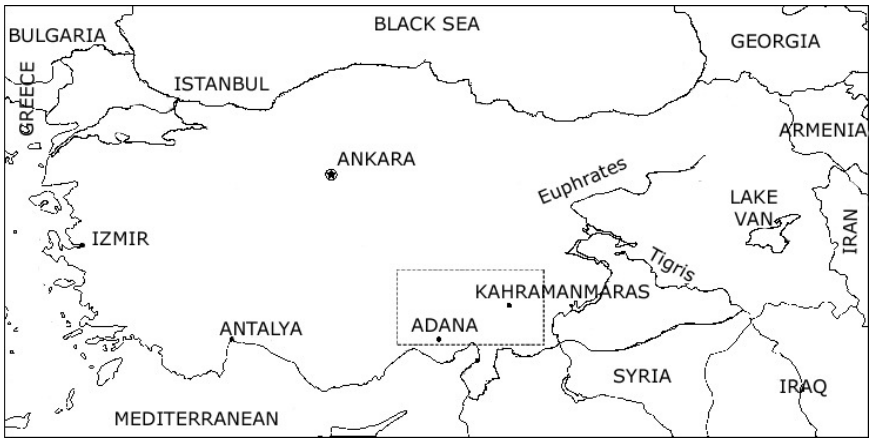

Fig. 1: Research area.

questionnaire was used in order to obtain farm level technical and economic data.

Results

Basic characteristics of farms: The average farm sizes in Adana and Kahramanmaraş were 35.40 and 11.55 ha, respectively. Many of these farms are family enterprises. The average household size was 5.4 in Adana and 5.3 in Kahramanmaraş, which are close to Turkey's average of 4.8. The average cotton production area was 4.74 ha in Kahramanmaraş, which is lower than Adana's 6.48 ha. In Kahramanmaraş, roughly three-fourths (73.24%) of the farmers owned their agricultural land while this ratio was 51.54% in Adana. Almost one fifth (20%) of the farmers were illiterate in Kahramanmaraş while illiteracy rate was 8% in Adana. Other than cotton, wheat, barley, watermelon, melon and citrus are also cultivated in this area. The general characteristics of farms are presented in Table 1.

Input use: There was a difference in pesticide use in cotton production between the sites in the study area because of difference in climatic condition and pest intensification levels in the two provinces. A common way of summarizing pesticide use is by summing the pounds of active ingredient for all pesticides used. This allows for some aggregation of the numerous pesticide products used in agriculture. Using conversion factors it is quite simple to summarize pesticides with common active ingredients in terms of kilograms of that active ingredient (Agnew and Baker, 2000). In the study area, the most commonly used active ingredients with WHO (2003) hazard classification are listed in Table 2.

Input use and input cost as a percentage of variable costs in cotton production in sampled farms are given in Table 3. The mean level of pesticide use, as a total active ingredient, in Adana (2.69 kg/ha) was more than twice of Kahramanmaraş (1.20 kg/ha). The average level of herbicides and fungicides use was slightly higher in Kahramanmaraş than in Adana. Insecticide use varies considerably between two provinces. As mentioned above the average temperature and humidity level in Adana is higher than Kahramanmaraş. Chen and McCarl (2001) pointed out that warm areas often suffer more intense pest problems. The average amount of insecticides used in the

Table – 1: General characteristics of surveyed farms.

	Adana		Kahramanmaraş	
	Mean	**St. d.**	**Mean**	**St. d.**
Farm size (ha)	35.40	46.35	11.55	11.19
Cotton production area (ha)	6.48	5.68	4.74	4.41
Number of plot	5.54	2.92	3.14	2.06
Household size (people)	5.42	1.80	5.30	2.59
Farmers age (years)	47.58	13.52	54.32	12.50

Table – 2: The common pesticides used by cotton farmers in Adana and Kahramanmaraş provinces.

Active ingredient	**WHO classes***	**% use by farms**	
		Adana	**Kahramanmaraş**
Insecticides			
Chlorpyrifos-ethyl	II	20	74
Carbosulfan	II	56	-
Cypermethrin	II	64	-
Diafenthiuron	U	58	-
Acetamiprid	O	48	-
Thiodicarb	II	36	-
Lambda-Cyalothrin	II	16	-
Lufenuron	O	46	-
Chlorfenapyr	II	38	-
Furathiocarb	Ib	12	-
Monocrotophos	Ib	10	-
Alpha-Cypermethrin	II	22	-
Teflubenzuron	U	18	-
Fungicides			
Carboxin	U	52	-
Quintozene	U	-	76
Herbicide			
Trifuralin	U	52	82

Ib=Highly hazardous, II=Moderately hazardous, hazardous, U=Unlikely to present acute hazard in normal use, O=Obsolete as pesticide or not classified.

Table – 3: Input use and input cost as a percentage of variable costs in cotton production in sampled farms.

	Adana			Kahramanmaraş		
	Input use		Input cost (% in variable cost)	Input use		Input cost (% in variable cost)
	Mean	St. d.		Mean	St. d.	
Pesticides (kg /ha)[1]	2.69	1.16	13.47	1.20	0.49	1.14
Insecticides	1.80	0.98		0.15	0.01	
Fungicides	0.62	0.59		0.76	0.40	
Herbicides	0.24	0.46		0.29	0.18	
Others	0.04	0.07		-		
Fertilizers (kg /ha)[2]	385.10	63.09	9.84	355.99	79.46	9.51
Nitrate	289.58	60.34		269.53	70.28	
Phosphorus	88.26	13.06		86.46	45.97	
Potassium	7.27	2.20		-		
Seed (kg /ha)	54.57	20.13	1.45	79.17	16.39	1.83
Labor (hr/ha)	596.53	125.64	29.56	642.32	96.85	39.42
Machinery (hr/ha)	19.24	3.49	21.29	19.91	3.69	24.15
Others			24.39			23.95
Yield (kg/ha)	3,712	647.05		3,265	686.07	
Gross margin (% of total revenue)			28.40			27.73

[1]Active ingredient [2] Plant nutrients

Table – 4: Information sources on pesticide management (%).

	Adana	Kahramanmaraş
Information sources		
By experience	61.7	15.6
Pesticide dealers	14.9	33.4
Extension workers	21.3	42.2
Others	2.1	8.8
Decision on application dosage		
By experience	19.2	13.3
Pesticide dealers	17.0	35.6
Extension workers	8.5	35.6
Others	55,3	15,5
Compliance recommended		
Absolutely	25.5	66.7
Sometimes below	8.5	6.7
Sometimes over	36.2	22.2
Generally below	6.4	2.2
Generally over	23.4	2.2

cotton production was much higher in Adana (1.80 kg/ha) than in Kahramanmaraş (0.15 kg/ha). A very large range of insecticides were applied for white fly, cotton bollworm, red spiders mite, aphids, pink bollworm and spodoptera etc. The most common fungal disease was *Phytium debaryum*. Not only pesticides but fertilizer use was also higher in Adana.

The share of pesticides in the variable cost was much higher (13.47%) in Adana than that in Kahramanmaraş (1.14%). Even though higher amount of pesticides were used in Adana, the gross margin per hectare as a percentage of total revenue did not significantly differ from Kahramanmaraş (Table 3).

Information sources: The public extension service has been the major provider of information in Turkey. However, farmers use different sources of information to solve their problems and adopt new techniques. Different sources provide different information (Just e*t al.,* 2003) on the health and environmental effects of pesticides and it was expected that trust on certain information sources would influence the decision not only to purchase the new pesticides but also the application dosage.

Data presented in Table 4 indicated that farmers' information sources for pesticide management were mainly depended on public extension agencies. Farmers who received more information from extension agents were more likely to adopt the recommended dosage.

Prevention measures: In the study area, the pesticides were mainly prepared, mixed, loaded and applied by farmers themselves. The majority of farmers were ignorant about the use of any protective clothing or breathing apparatus while applying pesticides. These protective measures were too expensive for small farmers. In Kahramanmaraş 68.9% of farmers were using face masks and gloves during application while it was quite low (21.3%) in Adana. Preventive measures after application increased to 70.2% (Adana) and to 97.8% (Kahramanmaraş) with changing clothes, taking a shower after work and eating yoghurt. In both provinces, all farmers were aware of the danger of the smoking during pesticide application so none of them were smoking or eating while pesticide application.

Pesticide storage and container disposal: Pesticides are very important for farmers because of its price. Majority of them (94% in Adana and 93% in Kahramanmaraş) stored the pesticide in the special places. The remaining farmers (6-7%) indicated that they buy just needed amount of pesticide so they do not need store them.

Disposal of empty containers was also an important issue of environmental and health concern (Salameh *et al*.,

2004). Only 42.0 and 32.6% of farmers reported digging special holes or burning the containers in Adana and in Kahramanmaraş respectively. Almost half of them (46.0% in Adana and 46.5% in Kahramanmaraş) discarded pesticide containers by throwing them near their farm and 12.0% (Adana) and 20.9% (Kahramanmaraş) farmers disposed the containers in irrigation ditches. Some farmers were reluctant to indicate any technique of disposal of containers, probably they used for other purposes such as the storage of grain or oil. This has also been reported by Matthews *et al*. (2003).

Farmers were also asked whether they sell pesticide containers to the cooperatives or pesticide dealers. Majority of farmers (76.6%) in Adana and almost all farmers (95.6%) in Kahramanmaraş were willing to sell the pesticide containers to cooperatives or pesticide dealers instead of disposing them to earn extra income.

Discussion

There has been growing concern in the general public in Turkey about the adverse effects of pesticide on human health and the environment. Therefore, in this study, farmers were asked about their experience of any health problems from pesticides. None of the farmers in Kahramanmaraş have experienced illnesses probably because of the low level of pesticide use. In Adana, 12.8% of farmers reported sickness, headaches, nausea and eye or skin irritation while mixing, loading or applying pesticides. These results are similar with the findings of Huang *et al*. (2003). Consumers may also get affected from pesticides through their residue in food and water. As Pimentel *et al*. (1991) pointed out that low level of pesticide use in crops not only has an important impact on reducing poisoning accidents but also contribute to human health.

As pointed out earlier, farmers in Adana, who had long experience of pesticide application, took fewer preventive measures than those of Kahramanmaraş. In the present study we noted that regular contact with agricultural extension workers had a positive effect on pesticide use as was observed by Maumbe and Swinton (2003). Agricultural extension services in past have often failed to meet the specific needs of farmers (Bernet *et al*. (2001), however, there is urgent need for more extension training so that farmers are able to use less pesticides and more effective protective measures. Tambi *et al*. (1999) stated that in developing countries it has always been felt that it is the responsibility of the state to provide these services regardless of whether they are provided efficiently or not. That is also true for Turkey because the public extension services provide information free of charge. Majority of farmers in Turkey are also willing to pay for these government services. In short, public extension service can play a major role in the adoption of prevention measures and the reduction of pesticide use.

The present findings were in agreement with Huang *et al*. (2003) that the government must give incentives to the extension personnel to push integrated pest management (IPM) and other eco-friendly techniques of pest control. The concepts of sustainable agriculture and IPM provide the background in which pesticides are no doubt recognized as a valuable tool, but it should be used as a last resort after all other control tactics have been tried (Matthews, 2003). Berg (2001) and Heong *et al*. (1998) reported that farmers in Vietnam have adopted IPM approach which provides saving in production costs followed by reducing in health risks and less pollution to the environment due to reduced pesticide usage. As seen from the Table 3, the share of pesticide in variable costs in Adana is very high as compared to Kahramanmaraş.

Pimentel *et al*. (1991) suggested two major practices to reduce pesticide use. They argue that pest control can be achieved with enhanced pest monitoring and by improving the efficiency of application equipment. Woods *et al*. (2001) stated that agricultural aircrafts are very important in the application of pesticides, especially in cotton growing areas. Farmers when asked to indicate type of equipment used for pesticide application, 74% of the farmers in Adana indicated use of agricultural aircrafts while no farmers used it in Kahramanmaraş. When pesticides are applied through aircrafts possibility of negative environmental effects are increased. As Pimentel *et al*. (1991) declared that pesticides not only cause health problems but also damage to environment by poisoning beneficial biota including the honeybees and killing the fishes with other wild habitats. When pesticides are applied by aircrafts close to the sensitive areas, spray drift management strategies are employed that can significantly reduce negative effects of pesticide on environment (Woods *et al*., 2001). Spray drift management can be applied in the study area however we do not recommend aircraft use in pesticide application in cotton production in Adana.

The organic cotton production has been developed in the early 1990s in Turkey. Organic cotton production reached to 23,091 tones with 4,974 hectares in 2000. Turkey and the United States are the largest organic cotton producers (Kenanoğlu and Karahan, 2002). With low pesticide use, family farms and microclimatic conditions, Kahramanmaraş has a considerable potential for the production of organic cotton. Shifting from conventional cotton production to organic production will increase the producers' income because of the high returns and minimum possible impact on environmental and health effects. However, the strategies for organic production such as support prices, encouragement activities or subsidies etc. need to be improved in Turkey (Kenanoğlu and Karahan, 2002).

Importance of agricultural biotechnology in reducing pesticide use in crop protection is being increasingly felt in recent years. Huang *et al*. (2003) found out that farmers who adapted genetically engineered (GE) cotton significantly reduced the number of pesticide sprayings, the quantity of pesticides used and the level of pesticides costs without effecting the net returns. GE cotton varieties can therefore be used to reduce pesticide use in cotton production in Adana. However, more research should be conducted to establish GE

varieties not only to reduce pesticide use but also to ensure health and environmental safety.

Moreover, like in Europe, with new environmental policy, reduction of pesticide use can be targeted in more vulnerable areas and substitute the pesticides from more environmentally harmful to more environmentally beneficial ones (CEC, 1992). Finally, instead of relying too heavily on regulatory instruments, a wide range of theoretical economic policy options such as input taxes, subsidies, insurance, credit instruments etc. (Falconer and Hodge, 2000) can be used to reduce pesticide usage.

Acknowledgments

We would like to thank the Agricultural Economics Research Institute, Turkey, for the financial support.

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