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Analysis of agricultural pesticide usage habits of farmers in cotton planting areas of Kahramanmaraş province

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Abstract
This research was conducted to determine the chemical pesticide usage habits of cotton growers, the socioeconomic factors influencing this process, and their environmental risk perception in Kahramanmaraş province, one of Turkey's prominent cotton production basins. The primary material consists of surveys conducted with 80 randomly selected cotton producers in the central, Türkoğlu, and Pazarcık districts of Kahramanmaraş. Findings indicate that the average age of the producers is quite high (56.3% over 50 years old), and the education level is predominantly primary school (55%). It was determined that agricultural pesticide dealers, rather than technical personnel, significantly influence pesticide application decisions at a rate of 91.25%. Furthermore, it was found that 100% of the producers apply pesticides immediately upon seeing pests or diseases without waiting for the economic threshold, and a large portion of the empty containers (63.75%) is disposed of by burning. Based on these data, it is concluded that Integrated Pest Management (IPM) principles are not fully implemented in the region, leading to excessive and unconscious pesticide use that poses potential environmental risks

Keywords: Cotton, pesticide, integrated pest management, producer behavior

Introduction

Cotton is a strategically important industrial crop with a wide range of uses worldwide, such as in the textile, food (oil industry), feed, and paper industries (Wakelyn *et al.*, 2010; Saxena *et al.*, 2011; Akın, 2024; Akışcan, 2025) [5, 6, 25, 27]. Eighty percent of the world's cotton production is carried out by a limited number of countries, including ICAC (2010). In Turkey, the cotton plant forms the basis of agriculture-industry integration, providing substantial employment and added value to the national economy, and is the most important crop for rotation with wheat in irrigated agricultural areas (Mert and Çopur, 2009) [11]. However, the intensification of pest pressure has increased cotton producers' reliance on chemical control, thereby heightening the risks associated with pesticide residues, applicator exposure, and contamination of soil and water resources. Research conducted in the East Mediterranean region indicates that pesticide use remains an important component of cotton production in Kahramanmaraş and emphasizes the need for improved farmer training and broader dissemination of information regarding the health and environmental effects of pesticides (Budak and Budak, 2006) [10]. These concerns are particularly significant when applications are based on commercial advice or visual observation alone rather than on pest monitoring and economic-threshold principles, since such practices may encourage unnecessary treatments and undermine the effectiveness of Integrated Pest Management. Recent evidence from Turkey likewise shows that pesticide-use behavior and the sources of technical information received by farmers are closely associated with perceptions of environmental risk, underscoring the importance of strengthening extension services, producer training, and oversight of pesticide dealers (Gürbüz, 2024) [16].

However, the increasing demand for industrial raw materials, along with the growing global population, has made it mandatory to obtain the highest yield per unit area. The biggest biological threats to achieving high yields in cotton production are pests, weeds, and diseases

(Doğan *et al.*, 2014; Bange *et al.*, 2016, Kamburova *et al.*, 2018 Tarazi *et al.*, 2020; Hussain *et al.*, 2023) [8, 15, 17, 19, 23]. To combat these threats, "chemical control," namely intensive pesticide use-which is often the most direct method with relatively low costs but high environmental and ecological risks-is generally preferred (Akbaba, 2010) [3]. Despite this preference, studies indicate that excessive reliance on synthetic inputs often leads to the development of pesticide-resistant species, thereby disturbing the natural biological equilibrium and inadvertently escalating long-term production costs (Deguine *et al.*, 2007; Trapero *et al.*, 2016) [14, 24]. Repeated applications can also eliminate beneficial arthropods, trigger secondary pest outbreaks, and create a cycle in which declining pesticide efficacy encourages farmers to increase application frequency or dosage (Deguine *et al.*, 2007) [14]. For this reason, sustainable cotton protection should prioritize regular field monitoring, economic-threshold-based decisions, conservation of natural enemies, crop resistance, and the selective use of chemical products only when necessary (Trapero *et al.*, 2016; Wilson *et al.*, 2018) [24, 28].

A significant percentage of all agricultural pesticides used in Turkey is consumed in corn and cotton cultivation (Akbay and Yurdakul, 1993) [4]. Chemical-based control methods in modern agriculture have over time led to serious consequences, such as residue problems, the loss of beneficial insect species, mutations in plants and animals, and the contamination of drinking water (Yücel, 2007; Dağlıoğlu *et al.*, 2010; Alengebawy *et al.*, 2021; Tudi *et al.*, 2021; Ahmad *et al.*, 2024; Muñoz-Bautista *et al.*, 2025) [2, 7, 13, 21, 26, 29]. The problem is further aggravated by the fact that many producers practice applications without knowledge of scientific methods such as pesticide calibration, application dosage, and timing (like the economic threshold). Moreover, socioeconomic constraints, including low levels of education and limited access to professional extension services, frequently force growers to rely on dealer recommendations rather than evidence-based agronomic practices. Studies from Turkey show that education, contact with extension services, and access to contemporary information sources significantly influence farmers' selection of crop-protection practices (Boz and Özçatalbaş, 2010) [9]. Evidence from cotton production in the East Mediterranean region likewise emphasizes the need for expanded farmer training and improved dissemination of information on the health and environmental consequences of pesticide use (Budak and Budak, 2006) [10]. Therefore, strengthening public extension services, improving the technical supervision of pesticide dealers, and providing practical training on calibration, dosage, application timing, and economic thresholds are essential for promoting safer and more rational pest-management practices (Gürbüz, 2024) [16].

In this study, the levels of chemical fertilizer and agricultural pesticide use by farmers in existing cotton planting areas in Kahramanmaraş province-a strategic agricultural region for Turkey-the factors affecting their decisions, and their environmental awareness levels were analyzed in detail, and regional strategies to solve these problems were discussed.

Materials and Methods

The primary material of the research consists of primary (original) data collected at the enterprise level in the 2011 production season in Kahramanmaraş province. While determining the research sample, a proportional (random) sampling method was used, taking into account the records of the Kahramanmaraş Provincial Directorate of Agriculture (Farmer Registration System). The agricultural areas where cotton farming is most intense and representativeness is highest were selected. In this context, a field survey based on face-to-face interview techniques was conducted with a total of 80 producers: 50% (40 producers) from the central district of Kahramanmaraş, 32.5% (26 producers) from Türkoğlu district, and 17.5% (14 producers) from Pazarcık district.

Two main dimensions of the enterprises were analyzed through the developed questionnaire: The first group included questions aimed at measuring the sociodemographic profiles of the producers (age, education, family size) and the agricultural structural size of the enterprise; the second group asked questions investigating pesticide brand/type selection (herbicide, insecticide, fungicide, etc.), calibration, number of applications, storage habits, and waste (empty packaging) disposal methods directly in field practice. The raw data obtained as a result of the interviews were classified, and proportional statistical analyses were made using percentages (%) or frequencies (n), and interpreted by supporting them with similar regional or market trend-oriented studies in the current literature (e.g., Özer and Özçelik, 2010) [22].

Results and Discussion

Demographic Characteristics of Producers and Enterprise Structure

The age and education status of the 80 enterprise owners examined are critical data in terms of technology adoption and openness to agricultural innovations (such as integrated pest management). It was determined that 56.3% (more than half) of the producers were 50 years of age or older. Examining the education level in parallel, it was observed that the rate of primary school graduates was dominant at 55%, while university graduates remained at only 8.8%. As is known in the theoretical literature, there is usually an inverse proportion between low levels of education/advancing age and the desire (adaptation) to turn to new agricultural techniques (e.g., precision agriculture, dose adjustment, reading and understanding technical instructions). Looking at the enterprise topographies, the vast majority of producers (71.3%) operate on relatively large lands of 51 da. and above. Unfortunately, the use of new technologies is quite slow; almost all of the producers (98.8%) apply the flood irrigation method, which causes high water waste in the field, while drip irrigation rates (1.3%) are almost non-existent.

Agricultural Pest Control and Decision-Making Dynamics

The decision about which method and chemical to use to combat agricultural diseases and pests has economic dimensions for the farmer-given the burden of spraying costs on the general budget-and environmental dimensions for ecology. A striking result was reached when examining the role models of enterprise owners in choosing the pesticide brand and dosage: While only 2.5% of the producers stated that they received advice from an "expert agricultural engineer" or ministry official, an overwhelming majority of 91.25% stated that they took the statements and recommendations of agricultural pesticide dealers as a reference. The pesticide market's commercial (sales) mentality can push cultural and biological measures into the background and prioritize chemical solutions (and higher product sales).

Similarly, scientific data do not form the basis of the decision to start spraying. All of the producers (100%) start spraying pesticides (especially insecticides and herbicides) immediately when they see the pest in the field (without waiting for the Economic Threshold (ET) criterion that controls the economic crop loss limit). As emphasized in studies conducted in the region by Kasap (2005) [20], these unnecessary chemical applications made without waiting for the threshold value both increase the toxicity risk in the plant and cause the death of beneficial insects (natural predators), leading to an increase in parasite/pest density against the plant in the long run. In fact, 78.75% of the cotton farmers in the study apply pesticides for an average of two periods throughout the season.

Environmental Risk Approaches, Safety, and Packaging Waste

By the nature of pesticides, both the preparation and application stages pose a danger. All cotton farmers who participated in the surveys verbally confirmed that pesticides could mix with groundwater and cause fish poisonings or bird/bee deaths, acknowledging this risk. However, when protective measures were questioned, a serious risk group was identified consisting of 12.5% of producers who do not comply with measures such as wearing gloves, protective filtered masks, or special clothing, and instead apply pesticides "without taking any precautions," merely filling the mixture into the tank.

Furthermore, the most dangerous stage for the surrounding soil structure is what happens to the empty chemical cans/bottles after pesticide application. A large portion of the producers in the research area (63.75%) randomly dispose of these containers by burning them in open areas. The burning of empty containers increases the emission of CO_2 and toxic chlorine into the air, paving the way for serious poisoning cases. The rate of producers who said they threw the waste into the trash can/empty field was 31.25%. Both results prove that toxic waste (pesticide packaging) disposal protocols are not in effect in rural Kahramanmaraş, essentially inviting environmental disasters.

Conclusion

In this comprehensive research conducted in the Kahramanmaraş province, it has been observed that producers in regions where cotton crop production is intense continue their activities in an ecosystem that is still conventional, detached from technological information transfer, and directed by commercial concerns (dealers). Both the socioeconomic level of the producers (experience-based, older than average age, and predominantly primary education) and the weakness of the link between the agricultural engineering institution (consulting/extension organization) and the farmer prevent the concept of Integrated Pest Management (IPM) from taking root in cotton fields.

Interventions made solely "upon seeing the disease/insect" before reaching the economic threshold (ET) escalate economic waste (increase in input costs) and ecological destruction. Furthermore, the burning of pesticide packaging in the open air without regard to any standard rules puts human physiology under acute and chronic threat, as well as soil and air health (Dağlıoğlu, 2009) [12]. In light of these data, it is imperative to promptly encourage an independent and field-active Agricultural Consultancy system in the Kahramanmaraş region (Ağca, 2009) [1] and to implement structural reforms that ensure pesticide application doses and packaging waste are systematically collected by official authorities or cooperatives

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