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# ECONOMIC ANALYSIS OF GREENHOUSE TOMATO PRODUCTION UNDER AGROECOLOGICAL AND CONVENTIONAL CONDITIONS: THE CASE OF ANTALYA PROVINCE, TÜRKIYE

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***Abstract***

*This study aimed to compare the economic aspects of greenhouse tomato production under agroecological and conventional conditions in Antalya province, which ranks first in tomato production in Türkiye. The main material of this study was collected from questionnaires compiled by face-to-face interviews with 80 producers following either agroecological or conventional management for tomato production under greenhouse conditions. According to the results of the research, the average farm size was 3.97 ha, with 2.68 ha devoted to tomato production area on 5.8 parcels in agroecological farms and 1.55 ha, 1.11 ha and 4.49 parcels in conventional farms, respectively. Total production costs per hectare resulted 68,840.80€ in agroecological farms and 59,744.67€ in conventional ones. Gross production value per hectare was 139,625.34€ in agroecological production and 87,707.84€ in conventional one. Net profit was 70,784.55 €/ha and 27,963.17 €/ha for agroecological and conventional production, respectively. Profit margin resulted 0.34 and 0.18 €/kg in agroecological and conventional production, respectively. The ratio of profit margin to sales price was 50% in agroecological production and 31.83% in conventional one. In terms of profitability indicators, agroecological production was found to be more advantageous than conventional one due to a higher production value resulting from higher yield and tomato selling price.*

***Key words***: *tomato, agroecological practices, factors that motivate for agroecological production, production cost, profit margin*

## INTRODUCTION

Tomatoes are among the most important vegetables at the world level being cultivated on 4.98 million ha and registering a production of 182 million tons, representing 16.28% of the global production of vegetables in the period 2016-2021 [10].
Türkiye has a good potential for producing tomatoes looking for more efficient growing systems like in geothermal houses [14].
During the last decade there has been a growing sensibility in the consumers about the undesired effects that the conventional management of agricultural production has on the environment and on human health. This is partly due to the increasing quantities of synthetic inputs (fertilizers, pesticides) required to achieve satisfactory levels of yield to cope with the depletion of the soil and with invasive and native pests, the latter made more aggressive by climatic change. Hence, in economically important crops, including tomato, there has been a demand for alternative management approaches more respectful for the environment and human health. In this context, the agroecological approach seemed to be a valid alternative to conventional one being based on the exploitation of functional biodiversity (above and belowground) regulating the ecosystem services (plant nutrition, protection and pollination).
The exploitation of plant diversity and biocontrol agents aboveground together with soil symbionts belowground leads to a progressive reduction of synthetic inputs needed to feed and protect the agricultural production. However, before proposing this

approach to conventional farmers, a scrupolous analysis of costs and benefits of the agroecological management must be carried out. Due to the increase of population in Türkiye and in the world and the division of agricultural land, it is advisable to exploit all available small agricultural areas. Protected agriculture is one of the leading methods to obtain higher yields from unit area. It also guarantees a constant availability of vegetables, which are a basic element of human health and nutrition [19]. According to 2022 data, world tomato production is approximately 186 million tons and Türkiye ranks third after China and India with a production of 13 million tons [6]. In Türkiye, according to 2023 data, a total of 70,000 hectares are cultivated in greenhouses of which 57.95% is represented by plastic greenhouses, 18.89% by low tunnels, 13.45% by high tunnels and 9.71% by glass greenhouses. Tomato ranks first among the vegetable species produced under greenhouses and 4.71 million tons of tomatoes were produced under greenhouses in 2023 of which 62% come from Antalya province [17].

The aim of this study was to compare the economic aspects of greenhouse tomato production following an agroecological or conventional management in Antalya province, which ranks first in tomato production in Türkiye. The agroecological and conventional production systems were compared in terms of general characteristics of farmers (age, education, experience, cooperative membership, record keeping and credit utilization), land assets of the farms, crops grown, tomato varieties grown, planting periods, production costs and profitability indicators including gross profit, net profit and relative return. In addition, we recorded which agroecological practices were adopted by the farmers, the reasons to follow the agroecological management, the institutions and organizations encouraging agroecological practice and the possible problems experienced. We expect that the results of this study will provide useful information to researchers and investors who are considering to move to an agroecological approach for tomato production and to other relevant institutions and organizations.

## MATERIALS AND METHODS

Data were collected by face-to-face interviews to tomato farmers following either agroecological or conventional production in greenhouses in Antalya province to fill in a questionnaire elaborated after a preliminary survey/test. We also used data collected by previous study in the same province. The survey data referred to the production of 2022. The list of producers following an agroecological approach for tomato cultivation was obtained by contacting the officials of Antalya Provincial Directorate of Agriculture and Forestry. According to this list, Aksu, Kumluca, Serik, Demre, Kas and Manavgat districts were selected for the study. A total of 80 producers, 35 producers agroecological and 45 conventional, were interviewed. The data collected from the producers by questionnaire method were elaborated by Microsoft Excel and SPSS programs. General Linear Model (GLM) approach was used to determine the significance levels of variables between agroecological and conventional production systems. Significance levels of $p<0.01$ and $p<0.05$ were selected.

The questionnaire included questions on general information such as age, education, experience, population, cooperative membership, credit use, general information about the farm such as total land assets, crops grown, agroecological and conventional greenhouses and tools and machinery, inputs used in agroecological and conventional tomato production (seedlings, labor, fertilizer, pesticides, electricity, water, bumblebees, etc.), tomato yield, and economic activities such as sales price. The questionnaire also included questions on which agroecological practices the producers who adopted the agroecological production system adopted, the factors motivating agroecological practice, institutions and organizations encouraging agroecological practice, and the problems encountered in cultivation.

In order to calculate the total production costs, we considered both variable and fixed costs.

Variable costs change depending on the scale of production and occur as production is carried out. Fixed costs, on the other hand, are costs that do not depend on the scale of production and always occur regardless of production [9, 16]. Variable costs include: seedlings, fertilizers, chemical pesticides, bumblebees (if used), heating, water, electricity, temporary labor, rope, cocopeat, shade dust, insects, insurance, certificates, packaging, oil and fuel, repair and maintenance of tools and machinery, and interest on revolving funds. Fixed costs include: general administrative expenses, permanent labor, land rent, greenhouse repair and maintenance, greenhouse capital depreciation, greenhouse capital interest, greenhouse capital interest, tool-machine depreciation, and tool-machine capital interest.

Of the total variable costs 3% are considered general administrative expenses. Interest on revolving capital is a variable cost and constitutes the opportunity cost of capital invested in the production activity. Interest on revolving capital was calculated by applying half of the interest rate (1.70% for agroecological production and 2.125% for conventional production) applied by the Turkish Republic Agricultural Bank to the changing costs.

Land rent was calculated by taking 5% of the bare land value.

Interest on greenhouse and tool-machine capital was calculated by applying 5% real interest to the total greenhouse and tool-machine half-value [11]. For the depreciation share of greenhouse and machinery capital, the depreciation rate was 5% [15].

Gross production value, gross profit, net profit and relative return indicators were calculated to find the profitability levels of agroecological and conventional tomato production. Gross production value was calculated by including subsidies in the tomato sales income resulting from multiplying tomato yield by sales price. Gross profit was calculated by subtracting variable costs from the gross production value, net profit by subtracting total production costs, and relative return by the ratio of gross production value to total production costs [16].

## RESULTS AND DISCUSSIONS

The information about agroecological and conventional farmers is given in Table 1. All agroecological producers were male, their average age was 46 years, education level was 11 years, experience was about 9 years and family composition was 3.31 people. It was determined that 5.71% of the agroecological producers were members of an agricultural cooperative, 60% of them received training on tomato cultivation, 97.14% of them were included in the farmer registration system and 71.43% of them kept records. It resulted that 17.14% of agroecological producers used agricultural credit and 22.86% of them were engaged in a non-agricultural business. The proportions of producers who watched agricultural programs, read agricultural magazines, newspapers and brochures and used the internet were 22.86%, 17.14% and 91.43%, respectively. When the conventional producers were analyzed, it was determined that their gender, age, education level and population were similar to the producers engaged in agroecological production. However, the duration of experience in tomato cultivation resulted higher in conventional production. This was expected because agroecological approach is a relatively recent management system compared to conventional production. The proportion of producers who received training on tomato cultivation and kept records was found to be higher in agroecological production. This shows that producers engaged in agroecological production are more conscious and professional. The rate of agricultural credit utilization was found to be higher in conventional producers than in agroecological producers due to their smaller farm sizes that render them economically weaker. The rate of following agricultural programs was found to be higher in conventional producers. The rate of producers who read agricultural magazines, newspapers and brochures was low in both production systems. Conversely, the rate of internet use was found to be high regardless the type of management.

Table 1. General characteristics of producers.

| Characteristics | Production system | |
|---|---|---|
| | Agroecological | Conventional |
| Male (%) | 100.00 | 100.00 |
| Age (year) | 46.00 | 44.87 |
| Education (year) | 11.09 | 9.80 |
| Experience in tomato production (year) | 8.66 | 18.33 |
| Population (person / family) | 3.31 | 3.67 |
| Membership of cooperative (%) | 5.71 | 33.33 |
| Tomato cultivation training (%) | 60.00 | 26.67 |
| Involvement in farmer registration system (%) | 97.14 | 97.78 |
| Proportion of producers keeping records (%) | 71.43 | 51.11 |
| Proportion of producers using agricultural credit (%) | 17.14 | 48.89 |
| Proportion of producers engaged in a non-agricultural business (%) | 22.86 | 15.56 |
| Proportion of producers following agricultural programs (%) | 22.86 | 42.22 |
| Proportion of producers reading agricultural magazines, newspapers and brochures (%) | 17.14 | 11.11 |
| Proportion of producers using the Internet (%) | 91.43 | 86.67 |

Source: Own calculation.

Table 2. Land presence of farms.

| | Production system | | P value |
|---|---|---|---|
| | Agroecological | Conventional | |
| Total land size (ha/farm) | 3.97 | 1.55 | 0.011* |
| Tomato land size (ha/farm) | 2.68 | 1.11 | 0.024** |
| Property land (ha/farm) | 3.88 | 1.51 | 0.019** |
| Rent land (ha/farm)) | 0.09 | 0.04 | 0.152 |
| Irrigated land (ha/farm)) | 3.97 | 1.55 | 0.011* |
| Number of parcel (parcel/farm) | 5.8 | 4.49 | 0.918 |

Source: Own calculation. *: $p<0.01$, **: $p<0.05$

Table 3. Plants grown in farms.

| Plants | Production system | | | |
|---|---|---|---|---|
| | Agroecological | | Conventional | |
| | ha/farm | %* | ha/farm | %* |
| Tomato | 2.68 | 67.48 | 1.11 | 71.57 |
| Pepper | 0.78 | 19.72 | 0.07 | 4.58 |
| Aubergine | 0.05 | 1.15 | 0.01 | 0.43 |
| Cucumber | 0.10 | 2.58 | - | 0.00 |
| Citrus | 0.07 | 1.87 | 0.20 | 12.89 |
| Olive | - | - | 0.02 | 1.43 |
| Other | 0.29 | 7.19 | 0.14 | 9.09 |
| Total | 3.97 | 100.00 | 1.55 | 100.00 |

Source: Own calculation. *percentages are higher than 100 because of multiple choice

The land features of the farms are given in Table 2. It was calculated that the total amount of land per farm, tomato production area and number of parcels were higher in agroecological farms than in conventional ones.

In detail, the total extension of farm was 3.97 ha, of which tomato production area was 2.68 ha over 5.8 parcel units in agroecological farms, and 1.55 ha, 1.11 ha and 4.49 parcel units in conventional farms, respectively. In both production systems, tomato was irrigated and most farmers were also owners of the land. The production features in the farms are given in Table 3. Vegetables constitute the majority of plants in the farms with tomato ranking first among vegetables. The share of tomato cultivation land in total cultivated land was 67.48% in agroecological farms and 71.57% in conventional ones. The other vegetables grown in the farms were aubergine, pepper and cucumber.

Table 4. Varieties of tomato grown in farms

| Tomato varieties | Production system | | | |
|---|---|---|---|---|
| | Agroecological | | Conventional | |
| | (n) | %* | (n) | %* |
| Truss tomato | 14 | 40.00 | 11 | 24.44 |
| Big red tomato | 14 | 40.00 | 30 | 66.67 |
| Big pink tomato | 6 | 17.14 | 6 | 13.33 |
| Cherry tomato | 3 | 8.57 | 10 | 22.22 |
| Cocktail tomato | 3 | 8.57 | - | - |
| Single tomato | 3 | 8.57 | 5 | 11.11 |
| Elips | 1 | 2.86 | - | - |

Source: Own calculation. *percentages are higher than 100 because of multiple choice

Table 5. Tomato planting periods in farms

| | Production system | | | |
|---|---|---|---|---|
| | Agroecological | | Conventional | |
| Production periods | (n) | % | (n) | % |
| Single planting per year | 24 | 68.57 | 32 | 71.11 |
| Two plantings per year | 11 | 31.43 | 13 | 28.89 |
| Total | 35 | 100.00 | 45 | 100.00 |
| **Single planting periods** | | | | |
| September -June | 22 | 91.67 | 32 | 100.00 |
| April-November | 2 | 8.33 | - | - |
| **Two planting periods** | | | | |
| **Autumn period** | | | | |
| August-January | 11 | 100.00 | 13 | 100.00 |
| **Spring period** | | | | |
| February-June | 11 | 100.00 | 13 | 100.00 |

Source: Own calculation.

The tomato varieties grown in the farms are reported in Table 4. The most common tomato varieties grown in agroecological farms were Truss (40%) and Big Red (40%), while Big Red (66.67%), Truss (24.44%) and Cherry (22.22%) were grown in conventional farms.

Tomato planting periods are given in Table 5. It was determined that the majority of the agroecological and conventional farms planted run only one tomato crop per year. The proportion of the farms practicing single planting in a year was found to be 68.57% in agroecological production and 71.11% in conventional production. It was determined that the single planting period mainly occurs during September-June period.

The proportion of farms planting tomato twice/year was found to be 31.43% in agroecological production and 28.89% in conventional one. The two planting periods were August-January (autumn cycle) and February-June (spring cycle).

The production costs elements are given in Table 6. The average production costs were higher in agroecological farms than in conventional farms ($p<0.01$). Total production costs per hectare were 68 840.80€ in agroecological farms and 59 744.67€ in conventional ones. In agroecological and conventional farms, fixed costs constituted a large portion of total production costs. The share of fixed costs in total production costs was 64.92% in agroecological production and 63.85% in conventional one. The share of variable costs was 35.08% and 36.15% in agroecological and conventional production, respectively. The most important fixed cost items were permanent labor, land rent and depreciation. Seedling, fertilizer, pesticide and heating costs constituted the highest share among the variable cost items.

Profitability indicators in the analyzed farms are given in Table 7. The gross production value per hectare was higher in agroecological farms than in conventional farms ($p<0.01$). The gross production value per hectare was found to be 139,625.34€ in agroecological production and 87,707.84€ in conventional one. The higher gross production value in agroecological production was due to the

higher yield per hectare and the higher sale price of tomatoes. Gross profit is an important criterion that measures the success of the production branches in the farm and is used in the short-term planning of agricultural farms. It was determined that gross profit was higher in agroecological production (115,478.41 €/ha) than in conventional one (66,112.85 €/ha) ($p<0.01$). However, net profit represents a more precise value. While fixed costs are included in gross profit, both variable and fixed costs are subtracted from net profit. In terms of net profit, agroecological farms resulted more advantageous than conventional farms with values of 70,784.55 €/ha and 27,963.17 €/ha respectively ($p<0.01$).

Table 6. Production costs in farms

| Cost items | Production system | | | | P value |
|---|---|---|---|---|---|
| | Agroecological | | Conventional | | |
| | (€/ha) | % | (€/ha) | % | |
| Seedling | 4,634.73 | 6.73 | 4,435.05 | 7.42 | 0.341 |
| Fertilizer | 7,627.00 | 11.08 | 6,188.38 | 10.36 | 0.124 |
| Pesticide | 3,156.64 | 4.59 | 3,301.05 | 5.53 | 0.043** |
| Bumble bee | 235.72 | 0.34 | 228.53 | 0.38 | 0.573 |
| Heating | 3,715.14 | 5.40 | 1,665.05 | 2.79 | 0.000* |
| Water | 8.86 | 0.01 | 109.31 | 0.18 | 0.046** |
| Electricity | 857.06 | 1.24 | 547.33 | 0.92 | 0.139 |
| Temporary labour | 113.63 | 0.17 | 2,413.05 | 4.04 | 0.000* |
| Rope | 403.09 | 0.59 | 167.99 | 0.28 | 0.388 |
| Cocopeat | 42.36 | 0.06 | 0.00 | 0.00 | 0.002* |
| Shadow powder | 184.85 | 0.27 | 105.59 | 0.18 | 0.184 |
| Beneficial insects (natural enemies) | 49.26 | 0.07 | - | - | 0.250 |
| Insurance | 774.12 | 1.12 | 540.87 | 0.91 | 0.546 |
| Certification | 162.10 | 0.24 | - | - | - |
| Packaging | 933.32 | 1.36 | - | - | - |
| Fuel | 654.72 | 0.95 | 1,078.56 | 1.81 | 0.001* |
| Machinery repair and maintenance | 190.70 | 0.28 | 364.90 | 0.61 | 0.010* |
| Revolving fund interest | 403.64 | 0.59 | 449.35 | 0.75 | 0.004* |
| Total variable costs (A) | 24,146.93 | 35.08 | 21,594.99 | 36.15 | 0.950 |
| Administrative costs (A*0.03) | 724.41 | 1.05 | 647.85 | 1.08 | 0.950 |
| Permanent labour | 13,603.20 | 19.76 | 7,003.12 | 11.72 | 0.001* |
| Land rent | 11,592.78 | 16.84 | 14,335.89 | 24.00 | 0.013* |
| Greenhouse repair maintenance | 1,257.31 | 1.83 | 1,779.87 | 2.98 | 0.010* |
| Greenhouse depreciation | 8,891.63 | 12.92 | 5,162.84 | 8.64 | 0.139 |
| Greenhouse interest | 4,445.81 | 6.46 | 2,868.77 | 4.80 | 0.895 |
| Machinery depreciation | 3,561.26 | 5.17 | 4,697.78 | 7.86 | 0.049** |
| Machinery interest | 617.47 | 0.90 | 1 653.56 | 2.77 | 0.000* |
| Total fixed costs (B) | 44,693.86 | 64.92 | 38,149.68 | 63.85 | 0.048** |
| Total production costs (A+B) | 68,840.80 | 100.00 | 59,744.67 | 100.00 | 0.009* |

Source: Own calculation. *: $p<0.01$, **: $p<0.05$

Relative return shows the income obtained for one unit of cost. It helps producers to choose the production branches in which they will utilize their resources in the best way. When the interviewed farms were compared in terms of relative return, it resulted that agroecological farms were more profitable. Relative return was calculated as 2.03 in agroecological production and 1.47 in conventional one due to higher gross production value obtained with higher yield and tomato sales price.

The profit margin of 1 kg of tomato produced and the ratio of profit margin to sales price in farms are given in Table 8. The profit margin per kilogram was found by subtracting the production costs of 1 kg tomato from the price of 1 kg tomato. The ratio of the profit margin to the selling price was used to determine how much of 1 kg of tomato did cost and how much produced as profit. By comparing the profit margin referred to 1 kg tomato, the value resulted significantly higher in agroecological

production (0.34 €/kg) than in conventional one (0.18 €/kg) ($p<0.01$).

The ratio of profit margin to sales price was higher in agroecological production (50%) that in conventional one (31.83%).

Table 7. Gross profit, net profit and relative return in farms

| | Production system | | P value |
|---|---|---|---|
| | Agroecological | Conventional | |
| Yield (ton/ha) | 203.86 | 154.56 | 0.000* |
| Sale price (€/ton) | 683.91 | 567.05 | 0.021** |
| Tomato sales revenue (€/ha) | 139,419.54 | 87,640.70 | 0.000* |
| Agricultural supports (€/ha) | 205.80 | 67.14 | 0.000* |
| Gross product value (€/ha) | 139,625.34 | 87,707.84 | 0.000* |
| Variable costs (€/ha) | 24,146.93 | 21,594.99 | 0.950 |
| Production costs (€/ha) | 68,840.80 | 59,744.67 | 0.009* |
| Gross profit (€/ha) | 115,478.41 | 66,112.85 | 0.000* |
| Net profit (€/ha) | 70,784.55 | 27,963.17 | 0.009* |
| Relative return | 2.03 | 1.47 | 0.182 |

Source: Own calculation. *: $p<0.01$, **: $p<0.05$

Table 8. Profit margin for 1 kg tomato in farms

| | Production system | | P value |
|---|---|---|---|
| | Agroecological | Conventional | |
| Production costs (€/ha) | 68 840.80 | 59 744.67 | 0.009* |
| Yield (kg/ha) | 203 857.14 | 154 555.56 | 0.000* |
| Production costs (€/kg) | 0.34 | 0.39 | 0.746 |
| Sale price (€/kg) | 0.68 | 0.57 | 0.021** |
| Profit margin (€/kg) | 0.34 | 0.18 | 0.018** |
| Share of profit margin in sales price (%) | 50.00 | 31.83 | 0.168 |

Source: Own calculation. *: $p<0.01$, **: $p<0.05$

There have been many studies on the socio-economic impact of agroecology. Altieri suggested that natural resource management strategies should target poor farmers not only to increase production and conserve natural resources, but also to create employment and provide access to local inputs and output markets. Their study emphasized that researchers and rural development practitioners should apply general ecological principles and natural resource management strategies to the conditions and needs of smallholder farmers and they noted that governments and public international organizations should encourage and support effective collaboration between civil society organizations, local universities and farmers' organizations to empower and help poor farmers achieve food security, income generation and conservation of natural resources [1].

Research showed that agroecology enhances financial, human and social capital that contribute to sustainable livelihoods at the farmer level and adopting agroecological practices increased yield and profitability compared to traditional practices [2, 3, 4].

Our results are in accordance with what reported by Muhammed et al., who conducted a study on Mediterranean organic greenhouse production and reported that rational combination of agroecological practices (short-cycle agroecological service products, farmyard manure or compost-based fertilization regimes, crop residue recycling) within a crop rotation program resulted in agronomic benefits while maintaining profitability [12].

Agroecology could be the basis for the future transformation of European agricultural policies, as it not only enables healthier food to be produced in a more sustainable way, but also significantly increases farmers' incomes.

Likewise, agroecology holds the promise of re-expanding productive agricultural employment and increasing the total income generated by the agricultural sector at both regional and national levels [18].

The report published by Grémillet and Fosse, reviewed the scientific literature and analyzed the framework of twenty-three references on agroecology. In particular, the study emphasized that organic agriculture is the best economically and environmentally option for today [8].

Agroecological approaches can be also a suitable solution for resource-poor farmers, especially on marginal lands that are less profitable for agricultural activities. The farmers who adopt this system have better social relations at the community level, which can expand farmers' influence on institutions and contribute to better solutions to complex problems such as poverty and food security [5].

When considering the effect of agro-ecology, environmental impact of it should also be considered. Fiore et al. reviewed studies on the socio-economic impacts of agroecology. They highlighted a significant gap in addressing climate change issues, methodologically, the prevalence of qualitative approaches and the need for a shift towards bottom-up, participatory research methods. Studies on food security and food sovereignty reveal the potential of agroecology, but more research is needed in socio-economic contexts [7].

In agreement with our results, a recent research showed that the socio-economic impacts of agroecological practices are mostly positive (51% positive, 30% negative, 10% neutral and 9% uncertain outcomes) [13].

Tomato sales places of the farms are given in Table 9. It was determined that the majority of agroecological and conventional production farms sell to wholesales market. In addition to the wholesale markets, agroecological farms also sell to exporters and organic markets.

Table 9. Tomato sale places of farms

| Sale Places | Production system | | | |
|---|---|---|---|---|
| | Agroecological | | Conventional | |
| | (n) | %* | (n) | %* |
| Merchant | - | - | 2 | 4.44 |
| Wholesales market | 24 | 68.57 | 45 | 100.00 |
| Exporter | 10 | 28.57 | - | - |
| Organic market | 4 | 11.43 | - | - |

Source: Own calculation. *percentages are higher than 100 because of multiple choice

Table 10. Agricultural supports for tomato production

| Agricultural supports | Support amount |
|---|---|
| Organic agriculture support (€/ha) | 57.47 |
| Diesel support (€/ha) | 9.77 |
| Chemical fertilizer support (€/ha) | 0.56 |
| Soil analysis support (€/ha) | 3.33 |
| Good agricultural practices support (€/ha) | 2.78 |
| Agricultural products insurance support (%) | 50.00 |
| Bumble bee (€/colony) | 0.16 |
| Biological control support (€/ha) | 7.41 |
| Biotechnical control support (€/ha) | 2.22 |
| Small family farm support (€/ha) | 3.71 |

Source: Own calculation.

In Türkiye, some supports are provided by the Ministry of Agriculture and Forestry to tomato production. These supports are for organic farming, diesel oil, chemical fertilizer, soil

analysis, good agricultural practices, agricultural insurance pool (TARSİM), bumblebee, biological control, biotechnical control and small family farm supports (Table 10). It was determined that agroecological production farms benefited more from the supports (Table 11), and that producers engaged in agroecological production follow the supports better and meet the criteria for receiving support better.

Table 11. Agricultural supports received by producers for tomato production

| | Production system | | | |
|---|---|---|---|---|
| | Agroecological | | Conventional | |
| Agricultural supports | (n) | %* | (n) | %* |
| Organic agriculture support | 4 | 11.43 | - | - |
| Diesel support | 28 | 80.00 | 13 | 28.89 |
| Chemical fertilizer support | 26 | 74.29 | 8 | 17.78 |
| Soil analysis support | 3 | 8.57 | - | - |
| Good agricultural practices support | 27 | 77.14 | - | - |
| Agricultural products insurance support | 35 | 100.00 | 26 | 57.78 |
| Bumble bee | 35 | 100.00 | 40 | 88.89 |
| Biological control support | 4 | 11.43 | - | - |
| Biotechnical control support | 3 | 8.57 | - | - |
| Small family farm support | 1 | 2.86 | - | - |

Source: Own calculation. *percentages are higher than 100 because of multiple choice

Table 12. Agroecological practices of farms

| Agroecological practices | (n) | %* |
|---|---|---|
| Reducing pesticide use | 18 | 51.43 |
| Biological and biotechnical control | 5 | 14.29 |
| Bumble bee use | 35 | 100.00 |
| Good agricultural practices | 27 | 77.14 |
| Organic agriculture | 4 | 11.43 |
| Organic and green fertilizers use | 3 | 8.57 |
| Remote monitoring and management system | 1 | 2.86 |
| Drip irrigation application | 35 | 100.00 |

Source: Own calculation. *percentages are higher than 100 because of multiple choice

The different agroecological practices followed in the agroecological management by farms are given in Table 12. The most common were the use of bumblebees (100%), the drip irrigation (100%), the good agricultural practices (44.14%) and the reduction of pesticide use (51.43%). On the other hand, it was found that the proportion of farms implementing agroecological practices such as biological and biotechnological control, organic farming, organic and green fertilizer use, and remote monitoring and management system was lower.

The factors motivating the agroecological production in farms are given in Table 13. The main factor motivating the choice is the easier marketing (77.14%) followed by agroecological products being healthier (40%), sensitivity to the environment (40%), higher profitable plants (40%), higher demand for agroecological products (37.14%), support received (5.71%) and being an effective method in combating pests (2.86%).

The institutions, organizations or individuals who were helpful in the producers' initiation of tomato cultivation are given in Table 14. In starting tomato cultivation, agroecological farmers stated they were effectively helped by the Provincial Directorate of Agriculture and Forestry (31.43%), their own family (28.57%), agricultural fertilizer, pesticide and seed dealers (20%), and other producers (20%). As for conventional farming the family played a key role (66.67%) followed by other producers (48.89%).

The main problems encountered by the producers in tomato cultivation are given in Table 15. For Agoecological producers they were: insufficient support (42.86%), diseases and pests (40%) and high costs (25.71%). Conversely, diseases and pests (82.22%), high costs (37.78%), instability in prices (31.11%) and insufficient support (20%) were the most important problems encountered by conventional producers.

The institutions, organizations or individuals to whom the producers applied for the solution of the problems encountered in tomato cultivation are given in Table 16. Producers engaged in agroecological production mostly applied to pesticide, fertilizer and seed dealers and Provincial Directorate of Agriculture and Forestry for the solution of the problems encountered in cultivation.

Table 13. Factors that motivate producers for agroecological production

| Motivation factors | (n) | %* |
|---|---|---|
| Having healthy products | 14 | 40.00 |
| Environmental awareness | 14 | 40.00 |
| High demand for products | 13 | 37.14 |
| Having profitable products | 14 | 40.00 |
| Marketing is easy | 27 | 77.14 |
| To get support | 2 | 5.71 |
| Being the most effective method in control pests | 1 | 2.86 |

Source: Own calculation. *percentages are higher than 100 because of multiple choice

Table 14. Institutions/organizations or individuals that are helpful to start tomato cultivation

| | Production system | | | |
|---|---|---|---|---|
| | Agroecological | | Conventional | |
| | (n) | %* | (n) | %* |
| Provincial Directorate of Agriculture and Forestry | 11 | 31.43 | 1 | 2.22 |
| Agricultural pesticide, fertilizer and seed dealer | 7 | 20.00 | 2 | 4.44 |
| Other farmer | 7 | 20.00 | 22 | 48.89 |
| Internet | 1 | 2.86 | 1 | 2.22 |
| Agricultural fairs | 3 | 8.57 | - | - |
| Family | 10 | 28.57 | 30 | 66.67 |
| Itself | 1 | 2.86 | 3 | 6.67 |

Source: Own calculation. *percentages are higher than 100 because of multiple choice

Table 15. Problems of producers regarding tomato cultivation

| | Production system | | | |
|---|---|---|---|---|
| | Agroecological | | Conventional | |
| | (n) | %* | (n) | %* |
| Diseases and pests | 14 | 40.00 | 37 | 82.22 |
| High costs | 9 | 25.71 | 17 | 37.78 |
| Low yield | - | - | 2 | 4.44 |
| Difficulties in labour supply | 1 | 2.86 | 3 | 6.67 |
| Price instability | 5 | 14.29 | 14 | 31.11 |
| Marketing difficulties | 3 | 8.57 | 2 | 4.44 |
| Low demand | 1 | 2.86 | - | - |
| Embargoes on exports | 2 | 5.71 | - | - |
| Insufficiency of supports | 15 | 42.86 | 9 | 20.00 |
| No problem | 5 | 14.29 | 1 | 2.22 |

Source: Own calculation. *percentages are higher than 100 because of multiple choice

Table 16. People or institutions that producers turn to solve problems

| | Production system | | | |
|---|---|---|---|---|
| | Agroecological | | Conventional | |
| | | %* | (n) | %* |
| Provincial Directorate of Agriculture and Forestry | 14 | 40.00 | 12 | 26.67 |
| Agricultural pesticide, fertilizer and seed dealer | 23 | 65.71 | 43 | 95.56 |
| Other farmer | 3 | 8.57 | 10 | 22.22 |
| Agricultural cooperatives or producer associations | - | - | 1 | 2.22 |
| Certification firm | 1 | 2.86 | - | - |

Source: Own calculation. *percentages are higher than 100 because of multiple choice

The shares of pesticide, fertilizer and seed dealers and Provincial Directorate of Agriculture and Forestry were found to be 65.71% and 40 7%. In conventional production, the institutions, organizations or individuals that producers applied for the solution of problems related to cultivation were determined as pesticide, fertilizer and seed dealers (95.56%), Provincial Directorate of Agriculture and Forestry (26.67%) and other producers (22.22%), respectively.

## CONCLUSIONS

Our results, which are in line with previous ones, demonstrated the profitability of the agroecological approach in respect to the conventional one for the management of tomato crop under greenhouse conditions. The economic parameters were analyzed are all in favour of the agroecological production due to higher yield and higher selling price. To this, add the benefits for the environment and the human health. The reduced application of synthetic inputs characterizing the agroecological approach results in a fruitful protection of biodiversity above and belowground whose exploitation leads to better plant protection, nutrition and pollination. Nonetheless, if not supported by economic benefits, the agroecological approach would be rarely followed by farmers. In this context, we believe that our study contributed to demonstrate the feasibility of this modern concept of agriculture, more respectful of the environment and less dependent by synthetic inputs.

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