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INPUT USE AND FACTORS AFFECTING IN POTATO FARMING IN TÜRKİYE

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Abstract

The study aimed to analyse the technical applications of the farmers in the production of potatoes in Türkiye and to reveal the information sources that were affected. In this framework, the provinces of Niğde, Nevşehir, İzmir, Afyonkarahisar, Konya, Adana, Aksaray and Kayseri, which constitute more than half of Türkiye's potato production, were included in the scope of the research. Data were obtained from 533 farmers by face-to-face survey technique. The average of the interviewed farms was 14.07 hectares of potato cultivation area, 62.07% of which was for rent, 35.96% was property and 2.77% was lands held in partnership. As the scale of the farms' increases, the rate of rental land for potato cultivation increases. In the region average, almost half of the potato cultivation area was grown on rented land. In addition, the average parcel size of 2.72 hectares and the number of pieces of potato planted land cause an increase in pre- and post-production costs. 71.63% of the potatoes produced on the farms were table, 23.57% industrial type and 4.80% seed. Although 44 different kinds of potatoes were grown in the region, it was determined that the farmers gave weight to Melody, Madeleine, Jelly, Marabel, and Agria varieties. Seed diversity varies according to the characteristics of the regions. Seed use per hectare in the research area was determined as 4,076.6 kg in the average of the enterprises and 3,950.0 kg in the weighted average of the region. In the average of the farms interviewed, the labour force used per hectare was 1,419.4 hours, and the average of the region was 1,940.4 hours. In potato production, machinery was used for 37.7 hours on average and 56.5 hours on average for the region. The amount of nitrogen given per hectare in the potato cultivation areas was 416.6 kg, the weighted average of the region was 497.2 kg, the phosphorus 89.7 kg, the regional weighted average 108.2 kg, the potassium 75.2 kg, the regional weighted average 86.1 kg. The irrigation system was mainly in the form of sprinkler irrigation. Farmers in the selection of seeds; expressed the factors of yield level, price, ease of sale, germination power, and resistance to diseases and pests as very important criteria. The farmers were using traditional information sources in the selection of seeds. It was determined that modern information sources and traditional information sources were equally effective in agricultural control. The farms interviewed received high scores on the level of cultural practices in an agricultural struggle. It was determined that producers were more affected by modern information sources in potato cultivation in the region. The potato was a product that uses a high level of input. In this respect, more conscious use of inputs and policies that guide farmers to modern information sources were considered important in terms of sustainability.

Key words**:** *input use, potato farming, technical applications, information sources, Türkiye*

INTRODUCTION

The potato is a plant whose homeland is South America and belongs to the genus *Solanum* [28]. It is stated that potato farming was brought to Türkiye via Russia and the Caucasus, and it was first produced in the Eastern Anatolia Region and the Black Sea Region in areas where the highland climate is dominant [15].

Potato production in the world ranks sixth after sugarcane, corn, wheat, rice and oil palm

fruit. It is in sixteenth place in terms of agricultural cultivation areas. The most important potato-producing country in the world in terms of production is China with a production of 91,818,950 tons and a share of 24.79%. China is followed by India with a share of 13.55 percent and Russia with a share of 5.96%.

Potato production in Türkiye ranks sixth after wheat, sugar beet, tomato, barley and corn production. Türkiye takes a 1.34% share of the world's total potato production. The share of Türkiye in world potato production generally shows an increasing trend between 1961 and 2019, and it is in the 1.10-1.50% band in the 2005-2019 period.

When the potato yield per hectare in the world and Türkiye between 1961-2019 was examined; Potato yield in Türkiye increased to more than 15,000 kg per hectare in 1980, 20,410 kg in 1986, 25,889 kg in 1998, and over 30,000 kg in 2009 and later. Especially in yield, an upward trend has been experienced after the above-mentioned dates. When the annual increase rate of potato per hectare yield in Türkiye was calculated for the 1961-2019 period, it can be stated that there was a positive development of 2.22%. The annual increase rate of potato per hectare yield was 2.70% in the 1961-1980 period, 2.37% in the 1980-1999 period and 1.47% in the 2000-2019 period. In the world, while the potato yield per hectare was 12,216 kg in 1961, it was around 15,000 kg in the 1980s, followed a stable course until the 2000s, exceeded 16,000 kg in the 2000s and increased to 20,000 kg in 2014 and after watched over. Potato yield per hectare in Türkiye in 2019 was 35,377 kg. Potato yield per hectare in Türkiye increased 3.7 times in 2019 compared to 1961. In 2019, the potato yield per hectare in the world was 21,362 kg. When the annual increase rate of potato per hectare yield was calculated for the 1961-2019 period in the world, it has been determined that there was a positive development in the form of an increase of 0.95%. It has been determined that the annual rate of increase in the yield of potato per hectare in the world in the 1961-1980 period was at a very low level, such as 0.23%. It was determined that there was an increase of 0.83% in the period 1980-1999, and an increase of 1.38%, which was close to the average growth rate of Türkiye, in the period 2000-2019.

According to the data obtained, potato yield per unit area showed a great increase in Türkiye, it caught the world yield in 1975 and remained above it after this year. Despite the decrease in the total potato production area in Türkiye, the increase in the amount of production resulted from the increase in yield.

The potato cultivation area in Türkiye followed a fluctuating course in the 1961-2019 period. In 2019, Türkiye's potato cultivation area was 140,776 ha. Compared to 1961, the potato cultivation area in Türkiye decreased by 4.24%. When the annual increase rate of potato cultivation area in Türkiye was calculated for the 1961-2019 period, it can be stated that it exhibits a decrease of seven per ten thousand. The annual rate of increase in potato cultivation areas increased by 1.10% in the 1961-1980 period, increased by 1.31% in the 1980-1999 period and decreased by 1.85% in the 2000-2019 period. In the world, potato cultivation areas decreased by 0.69% annually in the 2000-2019 period.

Potato production in Türkiye was close to 5 million tons according to 2019 data. Between 1961 and 1999, a continuous increase trend was dominant in potato production in Türkiye, after the 2000s, it entered a decreasing trend and remained in the band of 4-5 million. Compared to 1961, potato production in Türkiye increased by 254.44%. It has been calculated that the annual rate of increase in potato production in Türkiye has increased by 2.14% for the 1961-2019 period. The annual rate of increase in potato production was 3.79% in the 1961-1980 period, and 3.69% in the 1980-1999 period. On the other hand, it was calculated that there was a decrease of thirty-eight per ten thousand in the 2000-2019 period. In the world, there was an annual increase of 0.69% in potato production in the 2000-2019 period.

Although the potato cultivation area in Türkiye followed a fluctuating course during the 1961-2019 period, it showed an increasing

trend until 1999, and after this year, it showed a fluctuating but decreasing trend. In the same period, an increase was observed in potato production. Until 1999, the increase in cultivation area and the unit area was effective. After this year, the increase in yield has been effective. Especially since 2005, it has been following a fluctuating course in the band of 4.00-4.95 million tons.

The provinces of Niğde, Nevşehir, İzmir, Afyonkarahisar, Konya, Adana, Aksaray and Kayseri, which constitute more than half of Türkiye's production, were included in the scope of the research.

This study aimed to analyse the affecting factors and input use of potato producers in the Türkiye.

MATERIALS AND METHODS

The main material was obtained by the survey method from the producers in the villages producing potatoes in the provinces of Adana, Afyonkarahisar, Aksaray, Kayseri, Konya, İzmir, Nevşehir, and Niğde. The data belonged to the 2019 production period.

The sample size was calculated as 533 potato producers according to the Stratified Sampling Method [27]. The distribution of sample enterprises according to groups was made using the "Neyman Method" [6]. The farms were divided into three groups, considering the frequency distribution of the potatoes land they owned. Accordingly, farms with less than 5 hectares of potatoes cultivation area was I. group (248 farms), farms with 5.01-10.00 hectares of potatoes cultivation area were II. group (91 farms), and farms with a potatoes cultivation area of more than 10.01 hectares were also included in III. group (194 farms) formed. The "Neyman Method" we used for sampling takes more samples from the layer with high variance. For this reason, we determined the regional weighted average using the method specified by [11] and [12]. In the study, the technical applications of potato producers in potato farming in the provinces in the research area were determined and their judgment, attitude and current knowledge levels about potato farming practices, and information channel selection were measured. According to the Likert scale, the statements in the attitude scale were evaluated according to a 5-point scale. The severity of the attitude increases or decreases towards the extremes [3].The research area was given in Map 1.



Map 1. Location map of the study areas
Source: Own calculation.

RESULTS AND DISCUSSIONS

When the soil characteristics of the potato production areas were examined, the average of the farms was sandy-loamy soil with a rate of 55.72%, sandy soil with a rate of 26.83%, sandy-stony soil with a rate of 4.69%, clay soil with a rate of 4.50%, and humus soil with a rate of 3.56%. It was stated that stony soil with a rate of 2.81% and a calcareous soil type with a rate of 1.88%. Sandy-loam soil, in particular, potato cultivation was dominant on the farms. The potato planting area was 14.07 hectares on the average of the enterprises interviewed in the research area. The number of pieces of potato planted land was 6.17 and the average parcel width was 2.28 hectares. The potato area, which was 5.52 hectares in the region on average, was grown in 3.58 parcels and an average parcel size of 1.33 hectares. The potato area of the first group of enterprises was 2.95 hectares, the average parcel size was 0.99 hectares and the number of potato planted land was 2.98. The potato area of the second group enterprises was 7.97 hectares, the average parcel size was 2.22 hectares and the number of potato planted land was 3.59. The potato area of the third group enterprises was 31.15 hectares, the average parcel size was 2.72 hectares, and the number of potatoes planted plots was 11.46 (Table 1). The increase in the number of land

plots in potato farming causes an increase in pre- and post-production costs. When the ownership, tenant and shareholder status of the total potato lands of the farms in the research area were examined, the property land amount of the first group of farms was 1.97 hectares and the ratio of this figure to the total land amount was 66.92%. The amount of land leased for potatoes in the first group of farms was 0.95 hectares and constitutes 32.15% of the total area. The potato property land amount of the second group of farms was 4.25 hectares and the ratio of this figure to the total potato land amount was 53.32%. The amount of land leased by the second group of farms for potatoes was 3.72 hectares and constitutes 46.68% of the total area. The amount of land owned by the third group of farms for potato cultivation was 9.39 hectares and the ratio of this figure to the total potato land was 30.13%. The amount of land leased for potato cultivation in the third group farms was 21.04 hectares, and the ratio of this figure to the total potato land amount was determined to be 67.54%. On the average of the farms interviewed, 62.07% of the 14.07 hectares of potato planting area was for rent, 35.96% was property and 2.77% was lands held in partnership. As the scale of the farms' increases, the rate of rental land for potato cultivation increases. On average in the region, 51.34% of the potato planting was grown on the property and 47.54% on leased land. It was determined that 44 different kinds of potatoes were grown in the farms considered within the scope of the research.

The varieties that were mainly grown on the farms' were Melody with 17.19%, Madeleine with 16.07%, Jelly with 14.99%, Marabel with 11.71%, Agria with 10.34%, Florice with 4.06%, Arizona with 3.91%, Lady Amarilla with 3.10%, 2.57 of them were Universal potato variety. The rate of other potato varieties was around 2%. Melody type was mostly in the first and second group enterprises proportionally. In the first group of enterprises, Melody in 31.58%, Marabel in 21.71%, Madeleine in 15.03%, Agria in 8.77% and Jelly in 3.19% of the total area.

In the second group of businesses, 27.17% of the total area was Melody, 18.76% Madeleine, 17.52% Marabel, 13.42% Agria, 3.45% Belmondo, 3.32% Lady Amarilla, 2.96% Jelly, Hermes variety was planted in 2.48.

In the third group of businesses, 17.86% of the total area was Jelly, 17.86% Madeleine, 14.25% Melody, 10.16% Agria, 9.80% Marabel, 4.69% Arizona, 4.66% Florice, 3.24%, Lady Amarilla in 2.95%, Universal in 2.95%, Hermes in 1.80% and Lady Olympia in 1.38%. According to the statements of the business owners, it has been determined that the businesses take into account factors such as yield, durability and earliness in the selection of varieties. The change in potato cultivation areas of the examined enterprises in the period of 2010-2020 was examined.

Accordingly, based on 2019, it was estimated that there will be a 15.30% decrease in the potato cultivation areas of the examined enterprises in 2020. It has been estimated that there will be a contraction in the cultivation area, especially in large-scale enterprises.

It was determined that small-scale enterprises planted 7.83-55.73% more potatoes in 2010-2018 compared to the potato planting area in 2019. On the other hand, it was determined that large-scale enterprises planted 12.33-34.72% fewer potatoes from 2010-2018 compared to the 2019 planting area (Table 2).

On the other hand, potato cultivation areas increased by 4.94% in the research region in 2020. The reason for this can be explained by the perception that fewer producers will turn to potato planting with the decrease in prices at the end of 2019.

Table 1. Potato average parcel width and number of pieces in farms

Farm groups	Number of potato pieces	Average parcel size (ha)	Potato planting area (ha)
I	2.98	0.99	2.95
II	3.59	2.22	7.97
III	11.46	2.72	31.15
FA*	6.17	2.28	14.07
WA**	3.58	1.33	5.52

*FA: Farms Average; **WA: Research Region Weighted Average
Source: Own calculation.

Table 2. Change in potato cultivation areas of farms

Years	Farm groups			FA	WA
	I	II	III		
	Index (2019=100)				
2010	155.73	101.01	65.28	81.83	118.17
2015	128.90	100.23	68.99	80.78	106.01
2016	115.19	83.90	80.24	85.32	97.99
2017	108.12	84.44	84.31	87.79	95.78
2018	107.83	94.45	87.67	91.37	99.15
2019	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
2020	101.56	83.29	81.80	84.70	91.68

Source: Own calculation.

Farmers' potato production period (planting to harvest, days) in the study area averaged 137.82 days on farms and 137.36 days on the regional average. The second group farms had the highest number of days with 138.80 days, and the first group farms had the lowest number of days with 136.90 days. The third group farms were 138.46 days.

When the potato production process (sowing-harvest months) in the research area was examined, it was determined that the potato producers of Adana province carried out potato sowing in November-December-January, and the potato harvest was in April-May-June (Table 3 and Table 4).

It was determined that potato producers in İzmir province planted early potatoes in January-February, harvested potatoes in May-June, planted potatoes as the second or third product in August and harvested in November-December (Table 3 and Table 4).

It was determined that the potato planting period of the producers in Konya was from March-April-May, and the harvesting period was from July-August-September (Table 3 and Table 4).

It was determined that the producers interviewed in Nevşehir and Aksaray provinces planted potatoes in April-May, and harvested their products in August-September-October (Table 3 and Table 4).

In Niğde, the province where the most potatoes are grown in Türkiye, it was determined that the interviewed producers planted potatoes in April-May-June and harvested their products in September-October-November (Table 3 and Table 4).

In the province of Kayseri, the period in which potato producers plant their crops was March-April-May. The producers were also harvested in the months of August-September-October-November (Table 3 and Table 4).

In Afyonkarahisar, on the other hand, the periods in which the potato producers interviewed carried out planting were determined as March-April-May. It was determined that the harvest periods were in the months of August-September-October-November (Table 3 and Table 4).

The ratio of the enterprises in the research area that had soil analysis was 43.15%. This rate was the highest in the third group of enterprises with 55.67%. 34.68% of the first group enterprises and 39.56% of the second group enterprises had soil analysis. With the increase in the scale of the enterprise, the level of soil analysis was increased. The rate of farms that had leaf analysis was 14.63%. In the third group of enterprises, the rate of leaf analysis was the highest at 20.10%. 9.68% of the first group enterprises and 16.48% of the second group enterprises had leaf analysis. With the increase in business scale, the level of leaf analysis was increasing.

It was stated that 74.30% of the enterprises in the research area did not use consultants in potato production, 23.64% received firm support and 2.06% received paid consultant support. The ratio of paid consultants and firms was higher in the third group of enterprises.

When the importance levels of the information sources used by the enterprises in potato cultivation are examined; It was determined that the most important source was other growers (neighbours) (4.03), fertiliser dealers (3.91), drug dealers (3.90), seed dealers (3.72), product buyers (industry) (3.72), product buyers (trader) (3.70) (Table 5). Therefore, it was determined that farms preferred modern information sources more than traditional information sources.

Table 3. Potato planting period in the research area

Provinces	January	February	March	April	May	June	July	August	September	October	November	December
Adana												
Konya												
Aksaray												
Nevşehir												
Niğde												
Kayseri												
Afyon												
İzmir												

Source: Own calculation.

Table 4. Potato harvest period in the research area

Provinces	January	February	March	April	May	June	July	August	September	October	November	December
Adana												
Konya												
Aksaray												
Nevşehir												
Niğde												
Kayseri												
Afyon												
İzmir												

Source: Own calculation.

Table 5. The importance level of some information sources in potato cultivation

Information source	Farm groups			FA	WA
	I	II	III		
Other farmers (neighbours)	4.00	4.14	4.03	4.04	4.03
Fertiliser dealer	3.93	3.79	4.09	3.97	3.91
Agrochemical dealer	3.91	3.82	4.06	3.95	3.90
Seed dealer	3.72	3.73	3.76	3.73	3.72
Product buyers (industry)	3.69	3.87	3.64	3.70	3.72
Product buyers (trader/merchant)	3.68	3.82	3.58	3.67	3.70
Producer association-Cooperative	3.49	3.49	3.80	3.60	3.51
Mukhtar (village mayor) etc. notables of the village	3.25	3.49	3.13	3.25	3.29
Technical personnel of the Provincial/District Directorate of Agriculture and Forestry	2.82	2.89	2.89	2.86	2.84
Fairs	2.69	2.60	2.62	2.65	2.67
Internet	2.47	2.74	2.80	2.63	2.54
University	2.50	2.46	2.50	2.49	2.49
TV	2.29	2.69	2.31	2.37	2.37

(1=Not at all important 2=Not important 3=Partly 4=Important 5=Very important)
Source: Own calculation.

Farmers interviewed in the research area were evaluated according to the 5-point Likert scale for the factors affecting the selection of seeds. In the farm general average, while yield level, price factor, ease of sale, germination power, resistance to diseases and pests were considered very important by the farmer, earliness, physical characteristics of the product (size, shape, etc.), flesh-shell colour, ease of payment, firm, period, cold resistance and variety factor were considered important (Table 6).

It was determined that potato planting distance was 70.09 cm between rows and 21.57 cm in-row planting distance on farms' average.

Farmers interviewed in the research area were evaluated according to a 5-point Likert scale, which was effective in choosing seeds. In the farms' general average, their own knowledge and experience, suggestions from other producers, product buyers (trader), and product buyers (industry) were important resources by the operator (Table 7). Therefore, although the effect of modern information sources was important in the selection of seeds, it was determined that the producers attach more importance to the traditional sources of information.

When the people-institutions-organizations that were effective in the agricultural struggle in farmers' potato farming were examined, it was determined that the most important factor was their own experience (4.49), agrochemical dealers (4.20), and suggestions of other producers (4.02). The explanations on the packaging and the technical staff of the Ministry of Agriculture and Forestry

Provincial/District Directorate were also close to significant levels (Table 8). At this point, it was determined that the producers preferred modern information sources and traditional information sources together equally.

Table 6. The importance level of some factors in the selection of seed potatoes

Factors	Farm groups			FA	WA
	I	II	III		
Yield ability (level)	4.70	4.75	4.79	4.74	4.71
Price	4.59	4.56	4.60	4.59	4.58
Ease of sale	4.60	4.55	4.57	4.58	4.59
Germination power	4.52	4.60	4.50	4.53	4.53
Disease and pest resistance	4.49	4.60	4.53	4.53	4.51
Earliness	4.49	4.37	4.49	4.47	4.47
Physical characteristics of the product (size, shape, etc.)	4.49	4.43	4.46	4.47	4.48
Flesh colour	4.46	4.41	4.45	4.45	4.45
Shell colour	4.44	4.42	4.38	4.41	4.43
Ease of payment	4.42	4.41	4.39	4.41	4.42
Manufacturer	4.33	4.41	4.37	4.36	4.35
Production period	4.38	4.37	4.33	4.36	4.38
Cold resistance	4.34	4.40	4.25	4.32	4.35
Sort	4.25	4.29	4.18	4.23	4.25

(1=Not at all important 2=Not important 3=Partly 4=Important 5=Very important)
Source: Own calculation.

Table 7. The significance level of some information sources about seeds

Information source	Farm groups			FA	WA
	I	II	III		
Own knowledge and experience	4.34	4.44	4.41	4.38	4.36
Recommendations from other farmers	4.00	4.20	3.89	3.99	4.03
Product buyers (merchant)	3.87	3.73	4.05	3.91	3.85
Product buyers (industry)	3.68	3.65	3.87	3.74	3.68
Producer organisation (Coop. or Union)	3.43	3.35	3.52	3.45	3.42
Research Institute	3.29	3.53	3.32	3.34	3.34
Suggestions for the staff of the Provincial/District Directorate of Agriculture	3.21	3.22	3.18	3.20	3.21
Fair	2.83	2.90	2.80	2.83	2.84
Counsellor	2.61	2.85	2.44	2.59	2.65
Written tariffs (books, brochures, etc.)	2.40	2.52	2.37	2.41	2.42
TV	1.96	2.14	2.24	2.09	2.01

(1=Not at all important 2=Not important 3=Partly 4=Important 5=Very important)
Source: Own calculation.

Table 8. The significance level of some information sources related to agricultural protection

Information source	Farm groups			FA	WA
	I	II	III		
Own knowledge and experience	4.46	4.59	4.52	4.51	4.49
Agrochemical dealer's recommendations	4.18	4.25	4.37	4.26	4.20
Recommendations from other farmers	4.02	4.03	3.97	4.01	4.02
Descriptions on the packaging	3.71	3.85	3.68	3.72	3.74
Suggestions of the staff of the Provincial/District Directorate of Agriculture	3.65	3.45	3.78	3.66	3.62
Producer organisation (Coop. or Union)	3.42	3.09	3.47	3.38	3.36
Counsellor	2.84	2.97	2.74	2.82	2.86
Written tariffs (books, brochures, etc.)	2.52	2.64	2.58	2.56	2.55
TV	2.19	2.21	2.53	2.32	2.21

(1=Not at all important 2=Not important 3=Partly 4=Important 5=Very important)
Source: Own calculation.

When the integrated control knowledge status of the enterprises in potato farming was examined, 37.15% of the farms have no knowledge at all, 33.21% have low integrated knowledge levels, 16.14% have medium levels of integrated knowledge, 8.82% have high integrated knowledge levels and They stated that 4.69% of them had a very high level of integrated knowledge. There was a direct relationship between the scale of the enterprise and the level of integrated combat knowledge.

When the status of integrated pest control in potato farming was investigated, 80.11% of the farms did not apply, 5.44% of them applied integrated control less, 3.19% of them were medium, 8.26% of them were more and 3% of them were at the integrated farming application level was found to be excessive. In general, the level of implementation of IPM methods by the enterprises was low. There was a direct relationship between the scale of the enterprise and the level of IPM.

When the good agricultural practice knowledge levels of the enterprises in the research area were examined, 24.95% of the farms stated that they did not know at all. On the other hand, 32.27% of them reported that they had little knowledge, 22.70% of them had moderate knowledge, 14.82% of them had a lot of knowledge of good agricultural practices, and 5.25% of them had a very high level of knowledge of good agricultural practices. In general, the knowledge level of good agricultural practices of enterprises was low. There was a direct relationship between the scale of the enterprise and the knowledge level of good agricultural practices.

When the good agricultural practice levels of the interviewed enterprises were examined, 70.36% of the farms reported that they did not apply at all and 7.88% of them applied less. It was determined that 19.14% of them applied moderately, 1.50% of them applied good agricultural practices at a high level, and 1.13% of them applied good agricultural practices at a very high level. The level of application of good agricultural practices in the surveyed enterprises was low. As the scale of the enterprise increased, the level of application of good agricultural practices increased.

In the average organic agriculture knowledge level in the research area, 28.71% of the producers have no organic farming knowledge, 27.95% have little knowledge, 31.33% have medium organic farming knowledge, and 7.32% have organic farming knowledge. It was determined that 4.69% of them had too much organic farming knowledge. The organic farming knowledge level of the surveyed enterprises was low. However, as the scale of farms increased, the knowledge level of organic farming was increasing.

It was determined that 87.66% of the enterprises examined did not practice organic agriculture at all, 5.07% of them had little organic farming practices, and 6.94% of them had moderate organic farming practices. The level of organic farming practices of the enterprises studied was low.

It was stated that the knowledge levels of biological control in potato production of the enterprises in the research area, with a ratio of 54.22% on the farm average, did not know at all, and 24.58% of them had little knowledge. It was determined that 16.14% of the enterprises had a medium level of knowledge, 2.44% had a high level of knowledge and 2.63% had a very high level of knowledge. The level of biological control knowledge and biological control application level of the enterprises interviewed were low. However, biological control knowledge levels were increasing with the farms' scale.

In potato production, it was of great importance to combat diseases, pests and weeds to obtain more quality products from the unit area. The emergence of the side effects of the intensive use of chemical drugs in the fight against these factors brought the issues of human health, the protection of the environment and biological diversity to the fore. Therefore, in addition to reducing the consumption of chemical drugs, to combat the agroecosystem and sustainability criteria was needed. Emphasis was placed on methods that are alternatives to chemical control and integrated control. To make an economical and ecological struggle against potato diseases, pests and weeds in Türkiye, the "Potato Integrated Control Research, Application and Training Project" was put into practice in 1995 [10].

IPM is a sustainable struggle system that takes into account human health, environment and natural balance. In Türkiye, basic research on integrated combat began in 1970. Research-integrated projects were carried out in important crops such as cotton, apples, hazelnuts, wheat, citrus fruits, corn, potatoes, vegetables grown under cover, olives, cherries, pistachios and vineyards until 1994. "Integrated Combat Research, Implementation, Education and Promotion Policy, Strategy and Priorities" were revised and "Integrated Struggle Research, Application and Education Projects" were put into practice in potato, which is one of the 16 important products [10].

In Türkiye, the Ministry of Agriculture and Forestry issued the potato integrated technical manual in 1998, where potato definition, diseases and pests, control methods and

periods of pests were specified. At this point, the cultural, biological and biotechnical control methods specified in the technical instructions were also included in the questionnaire of potato growers and the producer was evaluated.

The level of cultural practice in the enterprises interviewed received high scores. In general, their cultural practices were close to my "practices". Within cultural practices; "I clean the weeds of *Solanum* species at the edge of the field, I prevent weeds from developing and giving seeds", "I clear the soil as much as possible while the tuber is stored", "I do hoeing, throat filling and maintenance carefully and regularly", "The tubers obtained from the dished field are definitely seed-proof. , I do not use it as table and animal feed", "I do seed checks after harvest or before planting, I make weeding", "I use clean-resistant potato varieties", "I avoid deep planting - I adjust the planting depth well", "potatoes in the fields determined to be contaminated" production and all kinds of production materials and sugar beet, onion, etc.

Table 9. The level of application of some methods against diseases and pests in potato cultivation

Implemented activity	Farm groups			FA	WA
	I	II	III		
I clean the weeds of the *Solanum* species on the edge of the field, I prevent the weeds from developing and giving seeds on the edge of the field	4.64	4.63	4.72	4.67	4.64
I remove as much soil as possible while the tuber is being stored	4.58	4.65	4.62	4.61	4.60
I do hoeing, throat filling and maintenance operations carefully and regularly	4.56	4.52	4.56	4.55	4.55
I definitely do not use the tubers obtained from the contaminated field as seed, table and animal feed	4.50	4.56	4.61	4.55	4.52
I check the seeds after harvest or before planting, I make weeding	4.54	4.51	4.57	4.54	4.54
I use disease-resistant potato varieties	4.49	4.48	4.57	4.52	4.49
I avoid deep planting - I adjust planting depth well	4.48	4.41	4.53	4.49	4.47
I do not produce potatoes in the fields determined to be contaminated, and I do not grow crops such as sugar beet, onions, etc., whose soil can carry all kinds of production materials	4.42	4.43	4.48	4.44	4.43
I fight weeds	4.37	4.43	4.40	4.39	4.38
I collect and destroy potatoes in the field before planting potatoes, I do not leave any tubers in the field after the potato harvest	4.38	4.37	4.36	4.37	4.38
I take care not to injure the tuber during harvest	4.39	4.37	4.30	4.36	4.38
I do not harvest in humid and rainy weather	4.26	4.46	4.41	4.35	4.31
I clean soil tillage tools used in dishes	4.35	4.20	4.35	4.32	4.32
I do not fertilise excessive nitrogen	4.14	4.05	4.07	4.10	4.12
In the hot and dry months of the year, I make deep tillage in the soil with an interval of 15 days	4.04	3.96	4.14	4.06	4.03
I grow potatoes in the dew-free, south-facing fields morning and evening	3.98	3.73	4.11	3.98	3.94
I practice rotation	3.87	4.19	3.85	3.91	3.93
I provide good soil drainage	3.92	3.67	3.83	3.84	3.87
I do not plant the seed tubers by cutting, as it facilitates the entry of the disease agent	3.79	3.81	3.89	3.83	3.80
I keep it in storage below 10°C	3.76	4.02	3.65	3.77	3.80
I do seed spraying	3.83	3.76	3.68	3.76	3.81
I provide ventilation and air circulation in warehouses	3.73	3.95	3.61	3.72	3.77
I weed out sick tubers, with their storage checked frequently	3.71	3.88	3.63	3.71	3.74
I do warehouse spraying	3.35	3.68	3.34	3.40	3.41
I apply sulphur according to soil analysis	3.17	3.38	3.36	3.28	3.22
I use certified seeds	2.92	3.09	3.65	3.22	2.99
I use burnt farm manure	2.67	2.88	2.74	2.73	2.71
Using a predator (beneficial insect)	1.36	1.40	1.39	1.38	1.37
Using parasitoids	1.34	1.38	1.38	1.36	1.35

(1=I definitely do not apply 2=I do not apply 3=Sometimes 4=I do 5=I definitely do)
Source: Own calculation.

I do not grow plants that can carry contaminated soil, such as "I do not collect and destroy potatoes in the field before planting potatoes", "I do not leave a tuber in the field after the potato harvest", "I pay attention not to injure the tuber during harvest", "I do not harvest in humid and rainy weather" "Tillage used in dishwashing areas" It can be stated that practices such as "I clean their tools" are made consciously by the farmers (Table 9).

Seed is the most important input item in potato cultivation. In some countries, seed production started with real seed production. However, tubers, which are vegetative organs, are used as seeds in many countries [18].

In plants whose vegetative organs such as potatoes are used as seeds, the effect of seeds on yield is very high. If a good seed is not used in production, there will be problems in the yield and quality of potatoes, even if the best cultivation techniques are applied [2]. In general, if potato growers use the potato tuber

they produce as seeds, there may be serious yield losses. If the yield obtained from potatoes is 100% under the condition of using 0 seeds (free from viruses and diseases), if their seeds are used in the second year, the yield decreases to 80%, and 50% in the third year. However, there may be serious losses in the marketable properties of potato tubers [18].

In addition to the low number of varieties that have been bred and registered in Türkiye, the scarcity of commercial production of these varieties, the supply of potato varieties in production from countries such as the Netherlands, Germany, France and the USA [23] and as a result, the seed is the most important cost factor in potato production [5].

Seed used in the research area was determined as 4,076.6 kg per hectare on farms average and 3,950.0 kg on the regional weighted average. While the amount of seed usage per hectare in the first group enterprises was 3,903.0 kg, it was 4,022.0 kg in the second group enterprises and 4,076.6 kg in the third group enterprises.

Kızıloğlu [18] determined the use of seeds per hectare in the province of Erzurum as 2000 kg in potato production. Engiz [8] calculated the use of seeds per hectare in farms groups in the production of seed potatoes in Nevşehir province as 3,262.5-3,722.5 kg, and enterprises producing edible-industrial potatoes as 3,989.6-3,990.9 kg per hectare. Kadakoğlu [16] determined the use of seeds per hectare in potato production as 3,377.8 kg in Afyonkarahisar province.

Although it is the best way to determine the amount of fertiliser to be applied in potato planting areas by soil and leaf analysis, reasons such as lack of technical facilities and lack of producer information especially in the region prevent this.

Potato comes first among the plants that make the best use of farm manure. With the application of 20-40 tons of farm manure per hectare in the cultivation area, significant increases in tuber yield and quality can be achieved. It is known that the use ratio of nitrogen, phosphorus and potassium, which are the basic nutrients in potatoes, is 1:0.5:2. However, in Türkiye, composite fertilisers such as 20-20-0, 15-15-15, 18-46-0 are widely used [1]. Half of the nitrogen needed by the plant is recommended to be given with potato planting, and the remaining half in two parts during the period of throat filling and tuber swelling [18].

The amount of nitrogen given per hectare was 416.6 kg in the farm averages considered in the potato cultivation areas, and 497.2 kg in the regional weighted average. The lowest amount was in the third group farms with 402.0 kg application per hectare and the highest amount was in the first group farms with 521.0 kg application. In the interviewed farms average application amount of phosphorus, one of the plant nutrients, was 89.7 kg per hectare, and the weighted average of the region was 108.2 kg. While the first group farms had the highest use of phosphorus with 113.7 kg per hectare, the third group farms had the lowest application amount with 86.3 kg. Potassium, one of the other main nutrients, was 75.2 kg per hectare in the farms interviewed, and the regional weighted average was 86.1 kg. The farms' group that applied the least potassium per hectare was the second group farms with 71.4 kg, while the farms in the first group with the most 90.8 kg.

Engiz [8] determined that 402.9-456.6 kg nitrogen (N), 132.1-230.5 kg phosphorus (P_2O_5) and 44.3-50.7 kg potassium (K) per hectare were used as plant nutrients in farm groups in seed potato production in Nevşehir province. The author calculated that 678.1-739.1 kg nitrogen (N), 206.8-402.7 kg phosphorus (P_2O_5) and 69.3-88.2 kg potassium (K) are used per hectare in enterprises producing edible-industrial potatoes. Kadakoğlu [16] determined that 488.5 kg nitrogen (N), 146.4 kg phosphorus (P_2O_5) and 172.9 kg potassium (K) per hectare are used as plant nutrients in the farm average in potato production in Afyonkarahisar province. Er et al. [9] found that irrigation was done 10-15 times in potato farming in the Nevşehir-Niğde region and the use of nitrogen fertiliser increased up to 700-900 kg per hectare. They report that this amount is excessive and 500 kg of nitrogen per hectare will be sufficient. Gunel et al. [13] reported

that excessive washing in the region inevitably increases the use of nitrogen in the region.

In the farms considered within the scope of the research, the farms' average labour force usage per hectare in potato production was 22.0 hours in tillage plough, 4.57 hours in sowing, 5.97 hours in cover, 10.98 hours in irrigation, 90.8 hours in fertiliser and pesticides, 37.9 hours in hoeing, and harvesting. It was calculated that 445.1 hours, 151.1 hours in the classification packaging process, 421.6 hours in the transport process, 11.7 hours in the storage process, and 24.0 hours in the marketing process. In total, the workforce used per hectare was 1,419.4 hours. It was calculated that the most labour use per hectare in the average of the examined farms was in the harvesting process with 445.1 hours. The use of labour per hectare in potato farming was the highest in the first group with 2,093.0 hours. In the second group of farms, 1,531.8 hours of labour per hectare and 1,324.4 hours in the third group of farms were used. It was determined that the use of labour per hectare decreased as the scale of the enterprise increased.

When the proportional distribution of labour use, which was used as 1,419.4 hours per hectare, was examined; 1.55% in tillage-ploughing, 3.22% in sowing, 4.21% in cover, 7.74% in irrigation, 6.40% in fertilisation-spraying, 2.67% in hoeing, 31.36% in harvesting. 10.64% in the sorting-packaging process, 29.70% in the transport process, 0.83% in the warehouse process and 1.69% in the marketing process (Table 10).

Yalçın [26], in the Central Sakarya Basin, calculated 552.0 hours of labour and 21.7 hours of machine power per hectare of potato production. Dernek [7], in Ankara, determined that there were 626.0 hours of labour and 42.3 hours of machine drawing power in one hectare of potato production. Güney [14], and Yalçın [26], in the province of Tokat, calculated 718.4 hours of labour and 12.6 hours of machine drawing power per hectare of potato production. Kolçak [21], in Erzurum, determined the use of 913.4 hours of labour and 14.6 hours of the machine drawing power in one hectare of potato production. Kızıloğlu [19] calculated the labour demand as 705.8 hours and the machine drawing power requirement as 48.7 hours in potato production in Erzurum province. Ozcelik et al. [25] found that the labour demand of agricultural enterprises producing contracted potatoes in Nevşehir province was 978.1 hours and the demand for machine drawing power was 55.5 hours. In the same study, they calculated the share of field rent as 11.42%, machine wages as 32.56%, labour force as 24.83% and material costs as 31.19% in total cost elements. Koral and Altun [22] calculated the labour demand per hectare as 723.6 hours, machine draft power demand as 55.6 hours in the enterprises producing potatoes in irrigated conditions in the Aegean region, and as 668.3 hours and 42.3 hours in the Ankara region, respectively. Birinci and Küçük [4] calculated the labour demand of potato enterprises as 782.0 hours and the demand for machine drawing power as 44.0 hours in the province of Erzurum for the 2003 production season. Engiz [8], in Nevşehir province for the 2002-2003 production season, found the farm labour force to be 768.0 hours and the machine drawing power to be 78.8 hours in the production of seed potatoes. He reported that labour demand was mostly used in maintenance works. It has been determined that 796.2 hours of labour and 77.8 hours of machine drawing power are used per hectare for the production of edible and industrial potatoes.

When the farmers within the scope of the research had a spraying schedule for potato production, it was determined that 87.05% of the farms had a spraying schedule. In general, it was determined that there was a spraying schedule for potato cultivation in all farm groups.

The rate of those who mechanically struggle with weeds in potato farming was 94.93%. In general, all farm groups preferred mechanical methods for weed control in potato farming.

In the farm potato production in the research area, it was determined that 85.74% of the chemical drug dose application amount applications were applied as specified, 12.38% applied by increasing the chemical

drug dose amount, and 1.88% reduced the chemical drug dose.

It was determined that 74.30% of them took protection measures in chemical drug dose application in farm potato production within the scope of the research. With the increase in the scale of the enterprise, the situation of taking protective measures in the application of chemical pesticides was increasing.

Potato, which is an important industrial plant, has many diseases, harmful and weed species that cause product loss. The most important of these are potato beetle, potato moth, potato downy mildew, potato wart disease, weeds, nematodes, and bacterial and viral diseases [9].

The alteration, or rotation, refers to planting different plants in the same field sequentially. Alternation is important in potato production. 79.5% of the interviewed farmers were in alternation. The producers of the second farms' group drew attention as the group that alternated the most. This was followed by the third farms' group and the first farms' group, respectively.

The use of machinery in potato production was 104.01 hours in tillage-ploughing, 77.07 hours in sowing works, 0.10 hours in cover operations, 125.59 hours in irrigation works, 39.20 hours in fertilisation, 60.71 hours in pesticide works, 13.62 hours in hoeing operations, and 95.73 hours in harvesting works, 5.37 hours were used in transport operations.

The use of machinery in potato production of the examined enterprises was 37.7 hours per hectare. This value was the highest with 59.1 hours in the first group enterprises. While the use of machine power was 53.0 hours per hectare in the second group enterprises, it was 33.3 hours in the third group enterprises. When the proportional distribution of machine usage was examined, it was 19.58% in tillage-ploughing, 14.51 in sowing, 0.02% in cover, 23.65% in irrigation, 7.38% in fertilisation, 11.43% in spraying, 2.56% in hoeing, 18.03% were at harvest and 1.01% were at the transport (Table 11).

Table 10. Use of labour in potato production

Implemented activity	Farm groups			FA	WA
	I	II	III		
	Ratio (%)				
Tillage	2.36	2.26	1.30	1.55	2.31
Sowing	2.82	3.55	3.25	3.22	2.95
Covering	15.79	5.18	1.86	4.21	13.62
Irrigation	6.33	7.58	8.03	7.74	6.59
Fertilisation-Spraying	8.64	9.40	5.55	6.40	8.63
Hoeing	6.60	4.69	1.64	2.67	6.12
Harvest	23.45	28.44	33.28	31.36	24.59
Classification packaging	7.72	9.33	11.38	10.64	8.11
Transport	22.95	26.14	31.49	29.70	23.77
Warehouse	2.08	0.75	0.60	0.83	1.82
Marketing	1.25	2.66	1.64	1.69	1.49
Total	100.00	100.00	100.00	100.00	100.00

Source: Own calculation

When the production types were examined according to the farms' potato cultivation area in the research area, 71.63% were a table, 23.57% were industrial type and 4.80% were a seed. It was determined that 66.52% of the potatoes planted on large-scale farms were table, 27.77% industrial type and 5.71% seed (Table 12).

When the production types of the interviewed enterprises were examined according to potato production, 70.64% were a table, 24.41% were industrial and 4.95% were a seed. Considering the calculations as the research region average, it was determined that 84.05% of the potatoes were used for table production, 13.33% for industrial production and 2.62% for seed production. It was calculated that 65.49% of the potatoes produced in large-scale farms were a table, 28.63% industrial and 5.88% seed. Therefore, small-scale farms were more concentrated on table production.

When the irrigation system used in the farms' potato production in the research area was examined, it was determined that 99.67% of

them used the sprinkler irrigation system on average. Since the potato plant growth period was 120-150 days, the water requirement of the plant is between 500-700 mm depending on the climatic conditions. In general, it is reported that there is no need for irrigation to ensure good development of the roots until the budding period. The most sensitive period for irrigation is expressed as the beginning of tuber growth with the beginning of stolon formation (between budding and 75% flowering). Especially for this period, the useful moisture in the soil should not be reduced below 75%. Between the end of flowering and the harvest, 50% of the useful moisture should be kept in the soil, and it is recommended to stop irrigation 20 days before the harvest starts [24].

Potatoes with a root depth of around 30 cm are usually grown in coarse-textured, permeable soils. Due to the highly permeable nature of the soils in Niğde-Nevşehir and similar provinces where potato cultivation was intense in Türkiye, the irrigation interval in potato cultivation narrows. The number of irrigation was also increasing [20]. It was reported that the best irrigation system was a sprinkler, as the plant surface was partially cooled by sprinkling during the development period [17] [18]. Almost all of the farms in the region were using the sprinkler system.

While the number of irrigation was 11.87 on the farms' average, it was 12.15 on the weighted regional average.

The third group was determined as the farm width group with the lowest number of irrigations with 11.34 farms. While the first group farms were irrigated 12.29, the second group farms had 11.85 irrigations.

Table 11. Use of machine power in potato production

Implemented activity	Farm groups (da)			FA	WA
	I	II	III		
	Ratio (%)				
Tillage	22.88	19.93	18.81	19.58	22.19
Sowing	16.21	12.86	14.47	14.51	15.56
Covering	0.02	0.00	0.02	0.02	0.00
Irrigation	15.97	24.53	25.13	23.65	17.79
Fertlisiation	5.40	5.49	8.17	7.38	5.52
Spraying	11.30	8.97	11.93	11.43	10.94
Hoeing	2.15	2.06	2.75	2.56	2.19
Harvest	22.79	18.31	16.95	18.03	21.81
Transport	0.96	3.56	0.54	1.01	1.47
Total	100.00	100.00	100.00	100.00	100.00

Source: Own calculation.

Table 12. Potato production type

Farm groups	Seed potato	Table potato	Industrial potato	Total
	Ratio (%)			
I	1.97	92.99	5.04	100.00
II	0.06	92.70	7.25	100.00
III	5.71	66.52	27.77	100.00
FA	4.80	71.63	23.57	100.00
WA	2.63	84.44	12.92	100.00

Source: Own calculation.

CONCLUSIONS

In the study, the technical practices of farmers in “Türkiye” potato production and the information sources they are affected by were analysed. In the region average, almost half of the potato cultivation area was grown on rented land. With the increase in the scale of the enterprise, the rate of rental land for potato cultivation was also increasing. In potato farming, the average parcel size was small, and the number of pieces of potato planted land was high. Therefore, this situation creates an increasing situation in the use of technical inputs and causes an increase in costs. It was determined that 44 different potato cultivars were grown in the region and the variety of seeds varied according to the characteristics of the regions. Farmers used traditional information sources in the selection of seeds and preferred modern information sources and traditional sources of information equally in

the agricultural struggle. In the agricultural struggle, the level of making cultural practices was high. Although producers were more affected by modern information sources in potato cultivation, traditional information sources were still important. Since potato farming uses a high level of inputs, it is important for sustainability to ensure that farmers use more conscious inputs with policies that guide them to modern information sources.

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