Turkish Journal of Agriculture - Food Science and Technology, 13(3): 594-600, 2025
DOI: https://doi.org/10.24925/turjaf.v13i3.594-600.7622

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

Development of Land Consolidation Studies in Türkiye (1961-2004)

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ARTICLE INFO

Research Article

Received : 28.02.2025
Accepted : 05.03.2025

Keywords:
Land consolidation
Regional analysis
Statistical evaluation
Temporal analysis
Türkiye

ABSTRACT

This study aims to comprehensively evaluate land consolidation studies carried out in Türkiye between 1961 and 2004. Data from 509 land consolidation and on-farm development services projects carried out in 33 provinces of Türkiye were examined using statistical analysis methods. It was determined that land consolidation projects significantly contributed to more efficient use of agricultural lands, reducing the number of parcels and reaching more suitable sizes of agricultural enterprises. The results show that the average consolidation rate of the examined projects was 35.76% and an average increase of 81.45% occurred in parcel sizes. In the regional evaluations, it was determined that the Black Sea Region had the highest consolidation rate. In contrast, relatively lower success rates were obtained in the Eastern Anatolia and Southeastern Anatolia regions. These differences are related to land structure, property relations and agricultural enterprise sizes. It has been observed that technological developments, especially computer-aided mapping techniques and tools such as Geographic Information Systems, have increased the success of consolidation projects. As a result, it has been determined that land consolidation studies play a critical role in the sustainability of agricultural production. Still, more strategic planning should be made by considering regional characteristics. This study is essential for evaluating the historical development and impacts of land consolidation studies in Türkiye. It is also considered a guide for institutions carrying out consolidation studies.

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Introduction

Land consolidation is a mechanism to eliminate economic, social, and environmental imbalances in rural areas (Acar, 2024). It means arranging fragmented, scattered, or degraded parcels of land where agricultural activities cannot be economically sustained and making them suitable for agriculture. These arrangements, made in accordance with modern agricultural methods, aim to increase agricultural land productivity and the number of arable lands (Arıcı & Akkaya Aslan, 2014; Kirmikil & Akkaya Aslan, 2024).

Land consolidation projects worldwide can provide different positive benefits both within the land consolidation project area and on a larger scale. The numerical ratio of such benefits varies mainly depending on the country where the projects are carried out and the content of the projects. By improving the structure of the parcels and farms within the land consolidation project area, agricultural enterprises can be made more efficient and adapted to rural development, environment and other relevant needs. Legal uncertainties regarding land ownership rights within the project area are eliminated to reallocate the parcels, which also brings legal benefits that increase the functionality of official agricultural land markets. With consolidation projects, in addition to reallocation planning depending on regional needs, other infrastructure works such as agricultural roads, irrigation and drainage, recreation areas and studies for the protection of the ecosystem, social areas and ecotourism can contribute to the improvement of agricultural infrastructure. In addition, improvements in landownership, farm structures, and rural infrastructure in the project area will benefit farmers and society in general. Land consolidation can also provide social benefits such as integrated community development, new social spaces, better opportunities for young farmers, reduced emigration, improved public infrastructure, and strengthened gender equality (Veršinkas et al., 2021).

Land consolidation studies in the world and Türkiye have social and economic importance in agricultural activities. Many factors should be considered for these studies to yield successful results. These studies, which require intensive effort and significant investments, are challenging to implement. It is not always possible for each project area to have the same standards due to its demands and conditions. The success rate in projects varies depending on how much technical requirements are taken into account and how much regional demands are met (Kirmikil & Akkaya Aslan, 2024).

Table 1. Land consolidation projects carried out in Türkiye by year

Year	Institution	Consolidated Area (ha)
1961-2002	General Directorate of Soil and Water – General Directorate of Rural Services	450,000
2003-2007	Special Provincial Administrations	132,000
2008-2018	General Directorate of Agricultural Reform – Provincial Directorates of Food, Agriculture and Livestock	3,018,021
2019-2023	General Directorate of State Hydraulic Works	3,673,566
Total		7,273,587

Land consolidation studies started in Türkiye in 1961 and were carried out entirely by state institutions until 1987. In 1987, land consolidation projects were opened to the private sector for the first time. With the closure of the General Directorate of Rural Services, the duties and authorities of the General Directorate were given to the Provincial Special Administrations. The workload and understanding of the Provincial Special Administrations, their financial situation and the need for expertise in land consolidation caused the studies to end throughout the country. With the closure of the General Directorate of Rural Services, the General Directorate of Agricultural Reform began to focus on land consolidation studies (Arıcı & Akkaya Aslan, 2014). With the Presidential Decree No. 30479 published in the Official Gazette dated July 15, 2018, the responsibility and authority of land consolidation and on-farm development services were transferred to the State Hydraulic Works (DSI, 2024; Tunalı, 2024) (Table 1).

Sustainable rural land management is critical for the correct and efficient use of land, protection of the environment and support of socio-economic development (Ayhan et al., 2024). Land consolidation projects, one of the most important elements contributing to sustainable agriculture, have significant social and economic importance in agriculture in Türkiye and worldwide. These projects require large-scale investments and intensive effort, and have local conditions and demands. Success rates are affected in different ways depending on the extent to which the demands in the regions where the projects are carried out are met, and how much the technical needs are taken into account (Kirmikil & Akkaya Aslan, 2024). In addition, the conditions during the implementation of the projects should also be examined well. It is possible to say that such studies will make significant contributions to the studies of the consolidation projects to be carried out later. This study aims to evaluate the land consolidation studies by the General Directorate of Rural Services in Türkiye in the first 40 years. In this way, the development status of the land consolidation projects carried out in Türkiye in the first period was examined, and the impact of the projects carried out on the present day was evaluated.

Materials and Methods

This study examined 509 land consolidation and on-farm development services projects completed in 33 provinces in Türkiye between 1961 and 2004. For this purpose, land consolidation project data belonging to the repealed Ministry of Agriculture and Rural Affairs, General Directorate of Rural Services, were evaluated in the study. These data were entered into the Microsoft Excel program, and a single-variable statistical report was created with the help of the descriptive statistics analysis tool. Thus, the central tendency and diversity of the data belonging to land consolidation projects were examined in general. In addition, the total number of parcels, average parcel area, and the change in the average number of parcels per enterprise for the projects carried out in different regions were also evaluated. The changes in the Consolidation Rate (CR, %), Parcel Area Increase Rate (PAIR, %), Parcel Reduction Index (PRI) and Consolidation Coefficient (CC) values, which are important success criteria in land consolidation projects, were also examined regionally and depending on the years. Equations 1, 2, 3 and 4 were used regarding the success indicators of land consolidation projects (Arıcı, 1994; Crecente et al., 2002):

$$CR = \frac{PreCPN - PostPCN}{PreCPN} \times 100 \quad (1)$$

PreCPN : Pre consolidation parcel numbers
PostCPN: Post consolidation parcel numbers

$$PAIR = \left(\frac{PostCPA}{PreCPA} \times 100\right) - 100 \quad (2)$$

PostCPA: Post consolidation parcel area
PreCPA : Pre consolidation parcel area

$$PRI = \frac{PreCPN}{PostCPN} \quad (3)$$

$$CC = \frac{PreCPN}{PostCPN} \times \frac{100}{\frac{PreCPN}{Number\ of\ landowners}} \quad (4)$$

Results

Descriptive statistics of land consolidation project data are given in Table 2.

The study evaluated 509 consolidation projects completed in 33 provinces in different regions of Türkiye between 1961 and 2004. The total project area is 405,869 ha, which is given to farmers after the deduction rate.

When the table data is examined, it is seen that the average project area is 797.39 ha. The lowest project area is recorded as 14 ha in Sinop – Boyabat – Osman village, the consolidation of which was completed in 2000. The largest project area is the 14,394-ha in Aksaray – Eskil – Eşmekaya village, which was completed in 2002. In addition, the mode value (132 ha) given among the descriptive statistics shows that most projects are small-scale. When the descriptive statistics of the number of enterprises in the project areas are examined, it is seen that the average enterprise number is 326 and the maximum enterprise number is 2,869. The standard deviation value is high since some projects have high enterprise numbers.

Table 2. Descriptive Statistics

	PA	NE	NP	TPN		APA	
				Before	After	Before	After
Mean	797.39	325.52	415.77	848.23	472.24	1.49	2.26
Standard Error	46.79	15.87	19.21	59.65	40.44	0.06	0.08
Median	534.00	217.00	294.00	461.00	275.00	1.09	1.78
Mode	132.00	115.00	192.00	236.00	181.00	0.60	2.02
Standard Deviation	1,055.68	358.06	433.39	1,345.65	912.42	1.41	1.76
Sample Variance	1,114,459.91	128,208.66	187,829.83	1,810,786.88	832,509.22	1.98	3.11
Kurtosis	59.70	13.88	15.13	43.59	90.58	11.86	18.40
Skewness	6.00	3.19	3.27	5.60	8.56	2.95	3.22
Range	14,380.00	2,865.00	3,741.00	15,404.00	11,824.00	10.81	18.39
Minimum	14.00	4.00	4.00	11.00	10.00	0.01	0.01
Maximum	14,394.00	2,869.00	3,745.00	15,415.00	11,834.00	10.82	18.40
Sum	405,869.00	165,690.00	211,629.00	431,748.00	240,369.00	758.71	1,148.22
Count	509.00	509.00	509.00	509.00	509.00	509.00	509.00
Largest (1)	14,394.00	2,869.00	3,745.00	15,415.00	11,834.00	10.82	18.40
Smallest (1)	14.00	4.00	4.00	11.00	10.00	0.01	0.01
Confidence Level (95%)	91.93	31.18	37.74	117.18	79.45	0.12	0.15

	AAP	ANE		CR	PRI	PAIR	CC
		Before	After				
Mean	2.31	3.05	1.78	35.76	1.81	81.45	90.14
Standard Error	0.09	0.23	0.18	0.96	0.04	4.32	2.09
Median	1.73	1.97	1.18	36.60	1.58	57.73	84.47
Mode	1.80	1.00	1.00	33.33	1.50	24.52	100.00
Standard Deviation	2.11	5.11	3.95	21.56	0.97	97.37	47.17
Sample Variance	4.45	26.16	15.60	464.94	0.95	9,481.30	2,225.43
Kurtosis	12.24	88.38	179.02	0.47	45.23	45.23	8.41
Skewness	2.96	8.45	12.38	-0.19	4.83	4.83	1.80
Range	18.06	67.71	67.26	159.32	13.02	1,301.85	458.08
Minimum	0.19	0.34	0.22	-66.67	0.60	-40.00	1.48
Maximum	18.25	68.05	67.47	92.66	13.62	1,261.85	459.56
Sum	1,177.76	1,553.27	904.02	18,203.63	923.56	41,455.94	45,881.71
Count	509.00	509.00	509.00	509.00	509.00	509.00	509.00
Largest (1)	18.25	68.05	67.47	92.66	13.62	1,261.85	459.56
Smallest (1)	0.19	0.34	0.22	-66.67	0.60	-40.00	1.48
Confidence Level (95%)	0.18	0.45	0.34	1.88	0.08	8.48	4.11

PA: Project Area (ha); NE: Number of Enterprises (pcs); NP: Number of Person (pcs); TPN: Total Parcel Number (pcs); APA: Average Parcel Area (ha); AAE: Average Parcel Area per Enterprise (ha); AAP: Average Parcel Area per Person (ha); ANE: Average Parcel Number per Enterprise (pcs); CR: Consolidation Rate (%); PRI: Parcel Reduction Index; PAIR: Parcel Area Increase Rate (%); CC: Consolidation Coefficient

The average of the consolidation rate values in the evaluated project areas was found to be 35.76%. The negative consolidation ratio values in some projects decreased this rate. However, the maximum value was seen in Isparta – Atabey – Harmanören Village (92.66%) in 1976. Out of 509 projects, only 12 had a negative consolidation rate.

The average parcel size increase rate was 81.45%, and the highest increase rate was observed in the largest project area, Isparta – Atabey – Harmanören village, with 1,261%. In addition, the increase rate in the parcel area was negative, as in the 12 villages with a negative project area consolidation rate. The average parcel size per person in the projects is 2.31 ha. The highest average parcel area was seen in the consolidation project in Aydın – Karacasu – Tepecik Village in 1990 with 18.25 ha.

The average parcel reduction index value was found to be 1.81. The smallest parcel reduction rate value (0.60) occurred in Konya – Ereğli – Taşağıl Village, while the largest parcel reduction rate occurred in Isparta – Atabey – Harmanören Village, just like the consolidation rate and average parcel size increase rate. The fact that the difference between the minimum and maximum values is so high shows that the differences between the projects are also very high. When the consolidation coefficient values, which should be examined together with the parcel reduction index, are examined, it is seen that the average consolidation coefficient value is 90.14. As the parcel reduction rate increases, the consolidation coefficient increases somewhat.

In addition to the statistical evaluation made nationwide in the study, the characteristics of the parcels at the geographical region level were also evaluated. For this purpose, the total number of parcels, the average parcel area and the average number of parcels per enterprise were calculated separately for each region (Table 3). When Table 3 is examined, it is seen that the region with the most projects is the Aegean Region, while the region with the fewest projects is the Southeastern Anatolia Region. The number of projects has changed proportionally with the regional land size values. While the region with the highest average parcel area before and after consolidation is the Southeastern Anatolia Region, the regions with the lowest are the Marmara Region with 1.00 ha before consolidation and the Black Sea Region with 1.28 ha after consolidation.

Table 3. Changes in some parcel characteristics in different geographical regions

Row Labels	NP	Project Area	Total Parcel Number		Average Parcel Area (ha)		Average Parcel Number per Enterprise	
			Before	After	Before	After	Before	After
Mediterranean	16	16,247	1,826	839	1.07	1.61	3.07	1.34
Eastern Anatolia	13	15,794	703	525	2.04	2.94	3.47	2.02
Aegean	225	148,662	683	434	1.50	2.12	2.16	1.43
Southeast Anatolia	3	2,680	270	172	3.33	5.46	2.54	1.63
Central Anatolia	116	135,123	881	399	2.10	3.18	3.51	1.60
Black Sea	40	17,136	851	375	0.71	1.28	2.92	1.42
Marmara	96	70,227	1,070	632	1.00	1.78	4.59	3.00
Total	509	405,869	848	472	1.49	2.26	3.05	1.78

NP: Number of Project

Table 4. Changes in different geographical regions according to some consolidation evaluation criteria

Row Labels	Consolidation Rate (%)	Parcel Area Increase Rate (%)	Parcel Reduction Index	Consolidation Coefficient
Mediterranean	41.20	159.89	2.60	94.45
Eastern Anatolia	29.04	57.43	1.57	80.62
Aegean	29.72	52.12	1.52	90.04
Southeast Anatolia	34.91	66.44	1.66	69.60
Central Anatolia	38.30	96.41	1.96	86.40
Black Sea	47.33	126.11	2.26	113.80
Marmara	42.08	104.14	2.04	86.25
Total	35.76	81.45	1.81	90.14

The highest values for the average number of parcels per enterprise are in the Marmara Region, and the lowest values are in the Aegean Region before consolidation and in the Black Sea Region after consolidation. However, after consolidation, the average number of parcels per enterprise in the Aegean region is very close to the Black Sea region.

The study evaluates some important success indicators of consolidation projects at the regional level. Table 4 provides the consolidation rate, parcel area reduction rate, parcel reduction index, and consolidation coefficient values.

The region with the highest consolidation rate and consolidation coefficient values, which are accepted as success indicators, is the Black Sea Region. The Mediterranean Region has the highest parcel area reduction rate and parcel reduction index. When the lowest values are examined, the Eastern and Southeastern Anatolia Regions stand out regarding consolidation rate and consolidation coefficient, respectively. In contrast, the region with the lowest parcel area reduction rate and parcel reduction index values is the Aegean Region. When the average values of Türkiye are considered, it is seen that the consolidation rate values of the Black Sea, Marmara and Central Anatolia Regions are above the average ones of Türkiye. Again, while the parcel area reduction rate is above the average of Türkiye in the Black Sea and Marmara Regions, the parcel reduction rate values of the Aegean, Eastern Anatolia and Southeastern Anatolia Regions are above average. The regions with a consolidation coefficient higher than the average are the Black Sea and Aegean Regions. In general, it is seen that the Black Sea Region, especially the parcel area reduction rate and consolidation coefficient values, are much higher than other regions. It can be said that the merging of parcels, which are much smaller in size compared to other regions, increases the success rates of the projects even more compared to other regions. It is also expected that the Southeastern Anatolia region, which has much larger parcels compared to other regions of Türkiye, has lower values compared to other regions. It would be correct to say that these data are due to parcel sizes based on regional characteristics of agricultural areas rather than project performance (Table 4).

The change values according to the years in which land consolidation projects were carried out in Türkiye are given in Figures 1-6. In 1961-2004, 509 projects were completed on a total area of 405,869 hectares, and an increase was observed in the projects according to the years. Just as in the number of projects and project area values, an increase was observed in the consolidation rate, the parcel reduction index, the parcel area increase rate, and the consolidation coefficient values according to the years. The reason for this is the increasing specialization of the technical team carrying out the project in the field and the use of computer technologies over time. The fluctuations in the graphs are due to the periods when the number of completed projects was lower compared to other years. However, these values do not mean a decrease in consolidation projects in those years. Since consolidation projects are projects completed in the long term, it is normal for there to be decreases in the graphs in these years. Therefore, it would be more accurate to consider the trend lines instead of the results in the graphs.

When Figure 1 is examined, it is seen that the highest number of completed projects was in 1997 (50 projects). Although there was a specific decrease in the number of projects after this year, an increase was observed again after 2000. However, no land consolidation projects were completed in 1963, 1965, 1980, and 1981. This situation is not due to the complete cessation of work on land consolidation projects. Since these projects are long-term, the emergence of such a situation should be considered normal.

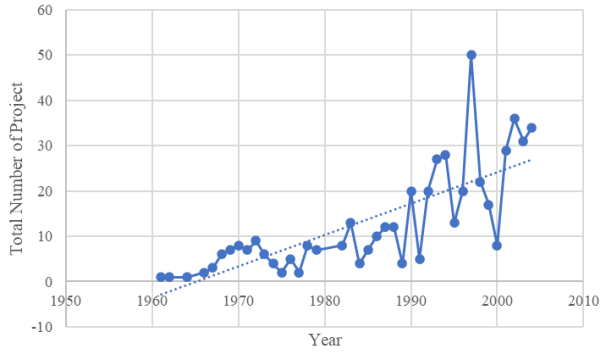

Figure 1. Change in the total number of land consolidation projects by year

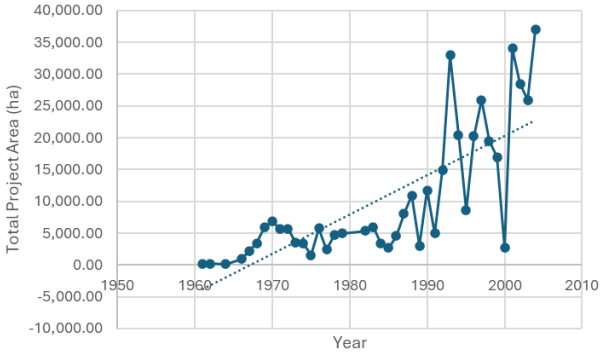

Figure 2. Change in total project area by year

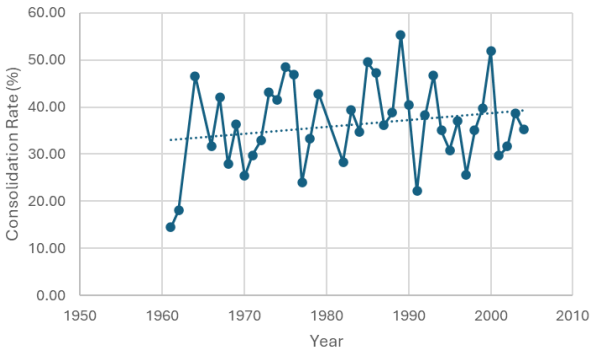

Figure 3. Change in consolidation rates by year

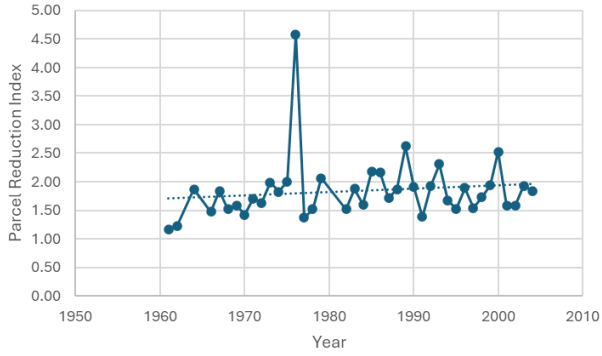

Figure 4. Changes in parcel reduction index by year

Just like the total number of projects whose consolidation has been completed, there has also been an increase in area values over the years. When we look at the trend lines of the increase in project areas, it is seen that it is more than the total number of projects. This situation also shows that project engineers have started to work on projects in larger areas, which can indicate that they have started to specialize in their fields (Figure 2).

Although it is lower compared to the total number of projects and project areas, it has been observed that there has been a slight increase in the consolidation rates over the years. The lowest consolidation rate average obtained from land consolidation projects was observed in 1961, while the highest average occurred in 1989. Although the consolidation rate values were low in specific years after 1989, this situation did not change the upward trend. In this context, it is thought that evaluating each project on its own would be more accurate. For example, the consolidation rate value of 78.39%, the land consolidation project completed in Gökdere Village of Eskişehir Central District in 1989, provided a significant increase in the 1989 average compared to other years. Since the consolidation rate values of the other three projects completed in 1989 were above the national average, they ensured the annual average was high (Figure 3).

When the parcel reduction index values, which reflect the technical quality of the consolidation project, belonging to the land consolidation projects completed by year, are examined in Figure 4, it is seen that there has been a low increase, just like the consolidation rate averages. The most significant increase in parcel reduction index averages occurred in 1976. The parcel reduction index value that affected this increase the most was the reduction index value 13.62, which was carried out on a 569-ha area in the Harmanören village of the Atabey district of Isparta province. The highest consolidation rate, parcel reduction index, and parcel area increase rate values in the projects evaluated were obtained from this project. As expected, the lowest parcel reduction index value was obtained from the project completed in 1961. Based on this, it is possible to say that the technical quality and efficiency of the projects have increased over the years.

When Figure 5, which shows parcel area increase rate values, is examined, a similar change occurs in parcel reduction index values. Based on this, it is possible to say that an evaluation using only one of the parcel reduction index and parcel area increase rate values will be sufficient.

When Figure 6, which shows the change in the consolidation coefficient values depending on the years, is examined, a higher increase is observed in the consolidation coefficient values compared to the consolidation rate, parcel reduction index and parcel area increase rate values. The highest consolidation coefficient averages were obtained from the eight projects completed in 2000. Although these values do not include maximum values, they are above the general average. The lowest consolidation coefficient averages were obtained from the two projects completed in the Central Anatolia Region in 1975.

Discussion

Many studies have been conducted in Türkiye to evaluate land consolidation projects. However, these studies generally include project-based studies covering only one or a few villages. In addition, limited studies evaluated land consolidation projects from before 2005.

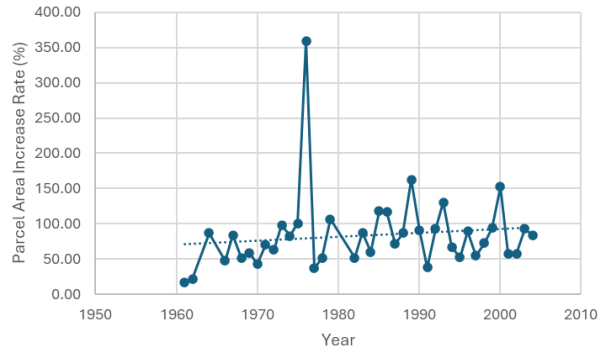

Figure 5. Change in parcel area increase rates by the year

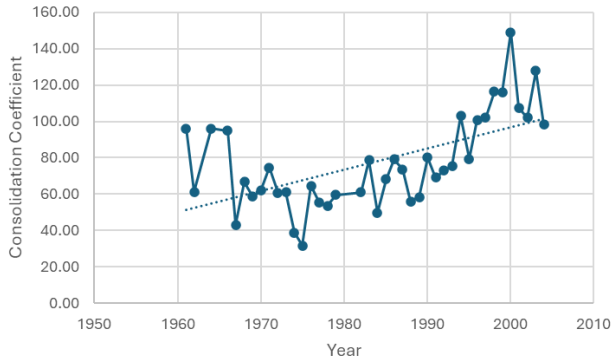

Figure 6. Changes in consolidation coefficient by year

In a study examining land consolidation projects in Karkın village of Konya province by Çevik (1974), it was reported that there was a 44% decrease in the total number of parcels and a 72% increase in the average parcel size (Gündoğdu, 1993). Takka (1993) reported that in the land consolidation studies carried out in Türkiye between 1961 and 1992, the average parcel size increased by 84%, the average number of parcels per farm decreased by 62%, and an average agricultural land size of 3.14 ha per farm emerged.

In the study conducted by Tulukcu & Çağla (2005), in which land consolidation projects were examined in Çumra district, it was determined that many social, economic and natural factors affected the implementation of the applications for the first time in Çumra. In their study in Galicia - Spain, Crecente et al. (2002) determined the reduction index value as 6.1 and the consolidation coefficient value as 90. Akkaya Aslan et al. (2007) determined the parcel reduction index value as 4.28 for Serem (Thrace District) and 1.51 for Beyköy (Marmara Region) in the consolidation projects they evaluated. The consolidation coefficient values for the same projects were 100.00 (Serem) and 76.45 (Beyköy), respectively. Arıcı & Akkaya Aslan (2014) reported that although the land consolidation studies carried out within the General Directorate of Soil, Water and Rural Services were distributed to various irrigation areas of the country, many of them consisted of projects implemented in Manisa, Aydın, Denizli, İzmir, Aksaray, Tokat, Konya, Eskişehir and Bursa. The results obtained from the studies conducted in general are parallel to those obtained from this study. However, it was observed that changes in parcel size distribution and consolidation rate values were generally considered in Türkiye's studies. When the consolidation rate values, one of the most important outputs of land consolidation studies, are examined, it is seen that even today, examples from the world have not yet been reached. For example, in Germany, which has made significant progress in rural area planning, the consolidation rate is 80%, and in Spain, it is 82.14% (Arıcı & Akkaya Aslan, 2014). However, this situation should not be accepted as an indication that the consolidation studies conducted in Türkiye have failed. In the studies conducted today, instead of aiming for a high consolidation rate, the aim is to prevent the hidden fragmentation that occurs due to shareholding, one of rural areas' most important problems. Therefore, this study is considered an important source regarding the historical development of consolidation projects in Türkiye in terms of periodic evaluation.

It has been observed that technological developments play an important role in land consolidation processes. Since the 1980s, computer-aided mapping techniques, geographical information systems, and remote sensing methods have enabled projects to be completed more successfully and quickly. When the increasing trend over the years is examined, it is observed that technological developments increase project success. However, it has been observed that some difficulties such as the participation of farmers in the consolidation processes, legal regulations, financing and infrastructure deficiencies limit the success of the projects. Informing the local people and ensuring their active participation in the projects is important for the more efficient implementation of future projects. In addition, integrating other rural development elements such as irrigation infrastructure and transportation facilities with consolidation projects will increase long-term success.

As a result, to implement land consolidation projects more effectively in Türkiye, projects should be planned and implemented taking regional differences into account. In future studies, detailed research on the socio-economic effects of consolidation projects and farmers' perspectives on the project is recommended.

Conclusion

In this study, 509 land consolidation and on-farm development services projects carried out in 33 provinces of Türkiye between 1961-2004 were statistically evaluated. It was determined that land consolidation projects provided significant gains in more effective and efficient use of agricultural lands. The data obtained show that due to the projects, there was an increase in average parcel sizes, a decrease in the number of parcels, and a significant improvement in consolidation coefficient values.

When the study results are evaluated in general, the average consolidation rate is calculated as 35.76% and it is observed that this rate reaches relatively high levels in some projects. The average parcel area increase rate is 81.45%, and higher rates are reached especially in regions where small-scale agricultural lands are located. However, the average value of the parcel decrease index is determined as 1.81.

When regional differences are examined, it is determined that the Black Sea Region is the most prosperous in consolidation rate and parcel area increase rate. In contrast, relatively lower success is achieved in the Eastern Anatolia and Southeastern Anatolia regions. This situation is due to differences in land structure and agricultural enterprise sizes between the regions.

This study's results are important in providing a broader assessment compared to previous project-based studies. Considering that many previous studies were related to a limited number of projects or regions, this research more comprehensively reveals the success of consolidation projects throughout Türkiye.

To increase the success of land consolidation projects, it is recommended that more detailed analyses be conducted before the project, farmers should be more involved in the processes, and modern technologies should be used effectively. In addition, consolidation processes should focus on parcel size and have an integrated structure with irrigation infrastructure, transportation facilities, and rural development goals.

To increase the effectiveness and sustainability of land consolidation projects, it is recommended to use Geographic Information Systems and remote sensing technologies, implement artificial intelligence-based decision support systems, and create digital cadastral and blockchain-based property records. In addition, long-term monitoring systems that evaluate the socio-economic impacts of consolidation projects should be established, irrigation infrastructure and consolidation processes should be integrated, and farmers' participation in the process should be increased. A model that includes local governments and stakeholders should be adopted with a participatory planning approach, and digital platforms and mobile applications should be developed to ensure that consolidation processes are carried out transparently. In addition, some legal and structural regulations need to be implemented. Legislative changes should make consolidation mandatory throughout the country in irrigation areas outside agricultural reform regions. In addition, necessary legal measures should be taken to prevent land fragmentation again and relevant regulations should be implemented. For consolidation projects to be carried out more efficiently, the number of technical personnel to work in the field should be increased. These personnel should be trained in Turkey and abroad and their expertise should be ensured. Communication channels such as written, visual, and social media should be used more effectively to explain the consolidation process's benefits to wider audiences and raise awareness among farmers.

In conclusion, land consolidation projects are critical for the sustainability of agricultural production in Türkiye. However, more regional strategies should be developed, considering each region's specific conditions, and consolidation projects should be supported by longer-term planning. The results of this study are believed to shed light on future projects and guide policy makers.

Declarations

Ethical Approval Certificate

This study does not require an Ethical Approval Certificate.

Author Contribution Statement

Safiye Pınar Tunalı: Data collection, investigation, formal analysis, and writing the original draft, project administration, supervision, conceptualization, methodology, review and editing.

Fund Statement

This study has not been funded.

Conflict of Interest

The authors declare no conflict of interest.

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