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FIFTY-FIVE YEARS OF EXPERIENCE WITH LAND CONSOLIDATION IN CYPRUS: LESSONS LEARNED AND FUTURE DIRECTIONS

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Abstract

Over the past 55 years, land consolidation in Cyprus has significantly supported agricultural and rural development. This paper reviews the land consolidation process from 1969 to the present, highlighting major achievements, persistent challenges, and strategic recommendations for the future. Land consolidation has effectively addressed severe land fragmentation and inadequate infrastructure, hindering agricultural productivity. However, the continuous decline in the agricultural sector, criticism of favouring land speculation, and the 2013 financial crisis have raised doubts about its necessity, leading to a decline in land consolidation efforts.

The study synthesizes lessons learned from 15 critical aspects, such as the legal framework, stakeholder engagement, policy alignment, environmental protection, transparency, justice, and technology. It also discusses five future directions: climate change, leveraging innovative technologies, developing new business models and integrating with smart agriculture. These insights not only provide a roadmap for revitalising land consolidation in Cyprus but also serve as a valuable guide for other countries facing similar challenges.

1. Introduction

Land consolidation (Thomas, 2023; Louwsma *et al.*, 2022) involves land tenure restructuring and the provision of appropriate infrastructure such as roads, irrigation networks and drainage facilities to create more economically viable farms. The land consolidation planning process reduces land fragmentation (Hartvigsen, 2014; Demetriou, 2013a), thereby enhancing efficiency and promoting sustainable agricultural and rural development. This is important, considering that having small, fragmented and irregularly shaped land parcels in agriculture impedes farming practices, increases production costs and limits access to infrastructure and markets. Thus, through land consolidation, these parcels are reorganised both in terms of boundaries and ownership rights. The objectives of land consolidation (agricultural or multi-purpose) vary based on requirements and needs in each country where it is applied, and furthermore it is supported by international organizations, such as the Food and Agriculture Organization (FAO) (Veršinskas *et al.*, 2020). In Europe, land consolidation supports the implementation of most of the measures provided by the European Union's Common Agricultural Policy (CAP) and other rural development initiatives.

Cyprus enacted its land consolidation legislation in 1969 (Demetriou, 2013b), following a period of approximately 30 years of research and debate (Land Consolidation Department, 1993). Subsequently, the Land Consolidation Authority, a semi-governmental body, which was an entity that operated with both public and private sector characteristics, was established to manage, coordinate, and execute land consolidation initiatives and projects. The first project began in December 1970 in Kissonerga village, Paphos, and was completed in 1974. In 1985, the Land Consolidation Authority was replaced by the Land Consolidation Department (LCD) within the Ministry of Agriculture, Natural Resources and Environment (M.A.N.R.E) indicating an improvement in the status and powers of the land consolidation institution.

For over 30 years until 2014, the Land Consolidation Department oversaw the implementation of land consolidation projects aimed at addressing land fragmentation and focusing on agricultural development. However, after Cyprus faced a severe financial crisis in 2013, the country required financial assistance from the European Union (EU) and the International Monetary Fund (IMF) to prevent the collapse of its banking system and stabilize the economy. This financial rescue package, known as a bailout, came with strict austerity measures. Consequently, to reduce public sector spending, the government decided to dissolve the Land Consolidation Department. Originally operating as an independent Service under the Ministry of Interior, itwas later transformed into a new Branch of the Department in Land and Surveys. This restructuring inevitably led to a decline of land consolidation activities and in the meantime, the Land Consolidation Department employees either retired or were transferred through secondments to other departments. Although there are still some land consolidation projects under finalization, there are not any new land consolidation projects on the horizon, and the future of land consolidation in Cyprus is uncertain.

From the beginning of land consolidation in Cyprus in 1969 and until the end of 2023, a total of 83 land consolidation projects have been successfully completed, covering a total area of 19 222 hectares (ha). It is important to note that the review of the 83 completed projects (internally carried out by the land consolidation authorities) showed good results with significant improvements in land ownership systems and infrastructure leading to outcomes for agriculture and benefiting both farmers and landowners.

Currently, there are no prospects for applying land consolidation as a multi-purpose approach. This includes contributing to development beyond agriculture, such as nature restoration, environmental protection, and climate change adaptation and mitigation. As a result of circumstances and the different priorities of the Ministry of Interior and the Land and Surveys Department, which differ from agricultural development tasks (which are under the jurisdiction of the Ministry of Agriculture, Rural Development and Environment), there has been a significant decrease in efforts towards land consolidation over the years. Moreover, the agricultural sector's share of the GDP has significantly dropped from 20 to 30 percent in the 1960s to as low as 2 to 3 percent in 2024. This has also raised doubts about the relevance and urgency of further land consolidation measures. In addition, the practice of land speculation where investors purchase land with the expectation that its value will increase, since Cypriot planning regulations permit building a house on agricultural land when a land parcel is larger than 4 000 m2 and has access to a road, which was provided by land consolidation projects. This has led to scattered housing development, which contradicts the overall goal of consolidation efforts aimed at promoting organized and sustainable land use. In this regard, a report by the Audit Office of the Republic of Cyprus (2018) pointed out negative aspects of some specific land consolidation projects that seem to deviate from their original objectives.

Currently, one land consolidation project is at its final phase (after the road network construction), two projects in an advanced stage and six projects in an early phase of implementation, all of which have been on hold for more than ten years due to the dissolution of the Land Consolidation Department and the inevitable subgrading (on an administrative and personnel level) of the land consolidation instrument in Cyprus.

Despite these setbacks in the process of land consolidation, the government of Cyprus is pushing for legislation on urban land readjustment as part of its initiatives and obligations to the European Union outlined in the 2021 Recovery and Resilience Plan (RRP). The aim of the Recovery and Resilience Plan is to address the economic, social, and environmental challenges and to set the European Union on a path toward a more sustainable, resilient, and inclusive future. Land consolidation, which is strongly supporting the agricultural sector, can contribute to some aspects of the Recovery and Resilience Plan.

In this context, the main aim of this paper is to examine the 55 years of implementing land consolidation in Cyprus, extract the lessons learned and define potential future directions. The specific objectives include: (i) analysing the land consolidation process in Cyprus, including its objectives, available measures, legal framework, procedures, project results and obstacles; (ii) drawing insights, lessons and recommendations from the experience in Cyprus; and (iii) bringing forward suggestions for land consolidation projects, considering current global challenges related to the United Nations Agenda 2030 (United Nations General Assembly, 2015) for sustainable development and climate change and new trends such as utilising innovative technologies and business models.

The research presented here draws from the author's own background, in Cyprus, where he has been engaged in land consolidation implementation for more than two decades and closely engaged with stakeholders such as landowners, farmers, government officials across sectors and policymakers. Such experience offers insights into the factors contributing to success and the practical hurdles faced in land consolidation efforts. Furthermore, the study includes an analysis of government reports and statistical data spanning 55 years on land consolidation in Cyprus. This analysis sheds light on trends like changes in land ownership agricultural productivity levels and advancements in infrastructure. However, it is noted that a comprehensive exploration of the socio-economic and environmental impacts of these initiatives would require more dedicated research, beyond the scope of this current paper.

In light of the above, this paper comprises five main sections. Section 2 examines the land consolidation process in Cyprus, focusing on its objectives, the available measures included in the land consolidation process, the legal framework, project outputs/results, and associated problems. Then Section 3 provides a summary of the lessons learned across fifteen critical aspects and draws upon insights and provides recommendations. In Section 4 the potential future directions are discussed, addressing global challenges, climate change, and new needs regarding business models and technology. Finally, the concluding Section 5 summarises the key findings and recommendations which can be valuable for other regions and countries facing similar challenges. It also outlines some final considerations on the future of land consolidation in Cyprus.

2. The process of land consolidation in Cyprus

2.1 Aims and available measures

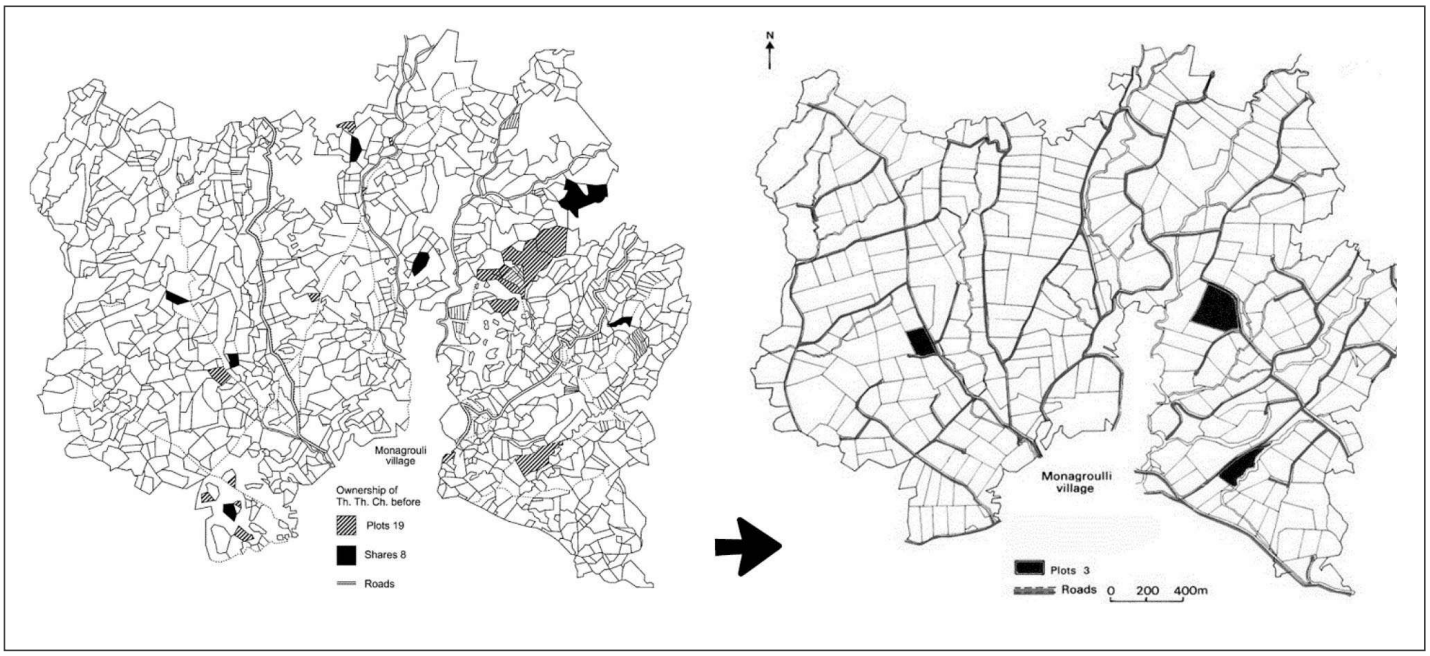
Land consolidation aims to create economically sustainable farm holdings and address inadequate land tenure systems that include ineffective farm structures (Demetriou, 2013b; Land Consolidation Department, 1993). An economically sustainable holding is annually defined by the Director of the Land and Surveys Department as the minimum income needed for a farm to support a family's living standards in Cyprus. To meet these goals, land consolidation has employed five key strategies (Land Consolidation Department, 1993): (i) merging fragmented parcels to make them larger, (ii) building the necessary new rural roads for providing access to the parcels, (iii) acquiring and redistributing private or state land to enlarge small holdings, (iv) creating regular, geometrically shaped parcels, and (v) resolving dual or multiple ownership/undivided shares. Part of the state land included in the land consolidation area is reallocated to private landowners who pay compensation for the state land they receive. Dual ownership involves different individuals owning land, trees, or water rights, while multiple ownership involves co-ownership by more than one individual. Co-ownership is often a problem in terms of achieving good cooperation for the utilization of the land. It should also be noted that in most land consolidation areas, only a few land parcels have access to a registered road.

The land consolidation instrument provides the following six key advantages linked to agricultural development: (i) enhancing the organization and operation of agricultural holdings by reducing land fragmentation; (ii) reducing the cost of measures for soil improvement, irrigation, and other infrastructural works by reorganising space and constructing a new rural road network; (iii) utilising abandoned agricultural land by clarifying ownership rights or redistributing it to other farmers (the level of land abandonment varies between different regions in the country); (iv) restructuring cultivation through a complete spatial rearrangement of ownership boundaries, soil classes, and parcel orientation; (v) mechanising agricultural activities by increasing parcel size and improving parcel shape; and (vi) increasing production while simultaneously reducing costs and improving productivity as a result of the entire land consolidation scheme.

The benefits of the land consolidation instrument are clearly visible on the cadastral maps before and after land consolidation in the area concerned in Monagroulli village (shown in Figure 1), which was completed in 1985. Prior to land consolidation (see the map on the left), the area suffered from excessive land fragmentation, characterized by a multitude of small parcels with irregular shapes and a lack of access to roads.

Furthermore, landowners owned parcels and shares in multiple locations. For instance, one landowner owned 19 parcels before the project, marked in black shading, and eight shares in other parcels, shown in hatched black as presented in the map on the left side of Figure 1. However, following land consolidation, as demonstrated in the map on the right, the situation improved significantly. The cadastral plan was prepared spatially with larger, regular-shaped parcels that had access to roads.

Figure 1. *The cadastral plan in Monagroulli village before and after implementing land consolidation.*



Source: *Demetriou, D. 2013b. "Land Consolidation", in The Development of an Integrated Planning and Decision Support System (IPDSS) for Land Consolidation, pp. 39–66. Springer Cham.*

The owner of the original 19 parcels and eight shares received only three parcels after the land consolidation, which had an approximate land value similar to the value of the initial land parcels. It is obvious that land consolidation measures successfully addressed the cadastral and land tenure issues in the aforementioned area.

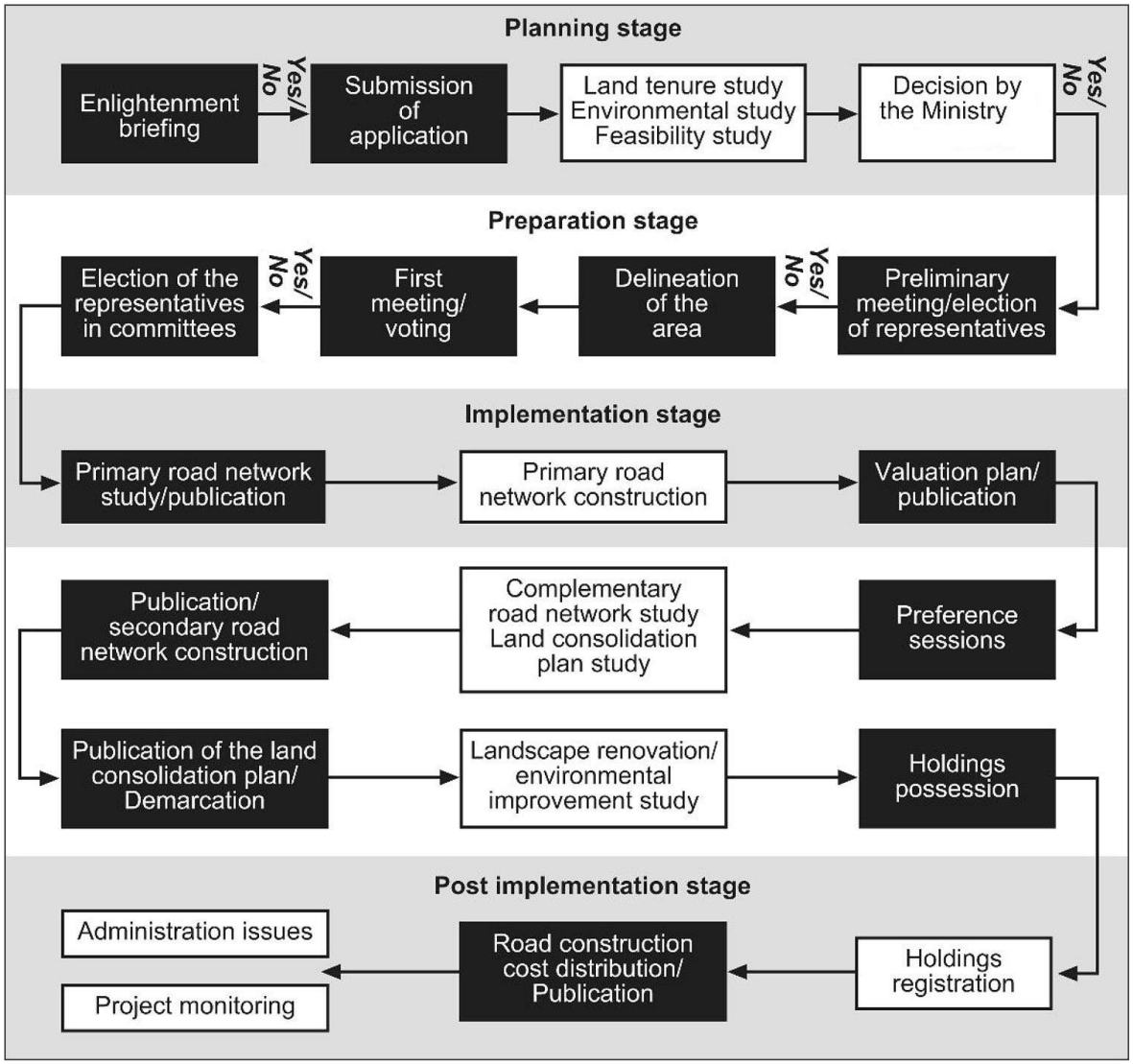
2.2 Legal framework and the land consolidation procedure

The legal framework for land consolidation in Cyprus encompasses the Land Consolidation Law of 1969 (Law 24/1969), the pertinent Regulations (K.G.P 182/2018), instructions and circulars of the Land Consolidation Department, and legal opinions from the Attorney General (Demetriou, 2013b). The primary organizations responsible for implementing land consolidation projects comprise the Land and Surveys Department (post–2018) (previously the Land Consolidation Department), the Land Consolidation Committee (LCC), and the Land Valuation Committee (LVC). The Department of Land and Surveys, more specifically the Land Consolidation Branch, oversees, manages, and executes all land consolidation activities, including all the field work. The Land and Surveys Department has the authority to acquire, dispose of, exchange, and mortgage properties. It can also advance funds and make loans (i.e. borrow money provided by the Government's budget) to achieve its goals.

The Land Consolidation Committee is established for each consolidation area/project and is pivotal in project implementation, making and approving major decisions. Composed of seven members: three elected by the landowners and four government officers from the Land and Surveys Department, the District Administration, the Department of Agriculture, and the Water Development Department. The Land Consolidation Committee is chaired by the Director of the Land and Surveys Department or their representative. It oversees the organization, monitoring, and administration of the Land Consolidation Association, with key decisions on approving plans (including both the land consolidation and road network plans), addressing landowners' objections to the consolidation plan, road network plan, and distributing road network construction costs. Landowners contribute to the funding of the infrastructure construction through a deduction of approximately 5–7 percent of the value of their land, which is estimated to be about 10–20 percent of the total construction costs. Similarly, a committee called the Land Valuation Committee is set up for each land consolidation project. It consists of six members, including two landowners elected from the project area and four government officials from departments such as the Land and Surveys Department, the District Administration, the Department of Agriculture, and the Water Development Department. The Land Valuation Committee, which is led by the Department of Land and Surveys officer, assesses the market value of properties like agricultural land, buildings, trees and wells in the project area. Moreover, the Committee deals with any objections (at a first level) raised by the landowners concerning the Land Valuation Plan.

According to the relevant legislation in European countries, land consolidation can be implemented using three approaches: voluntary, majority-based, and mandatory (Veršinskas *et al.*, 2020). In Cyprus, a semi-compulsory approach to land consolidation has been used, requiring majority consent to initiate a project. Approval rates from landowners (agreeing to apply land consolidation to their land in the various projects) range between 60 and 92 percent. It is important to note that starting a project requires both that the majority of landowners agree, and that these landowners also possess holdings with a value of over 50 percent of the total land value in the project area. Landowners who are absent or unable to sign, such as those living abroad, are seen as opposing the Plan. In addition, during the process, landowners have the right to inspect various plans and documents, each published for 21 days. These include the list

Figure 2. *The land consolidation procedure in Cyprus.*



Source: *Demetriou, D. 2013b. "Land Consolidation", in The Development of an Integrated Planning and Decision Support System (IPDSS) for Land Consolidation, pp. 39–66. Springer Cham.*

of landowners, the land valuation list, the land consolidation plan, and the road network plan. Landowners may submit specific objections related to their affected properties against any of the aforementioned plans, which is then examined by a relevant Committee. The land consolidation process usually takes around 7 to 10 years, and it involves four stages: planning, preparation, implementation and post-implementation follow-up. These stages consist of 21 tasks which are depicted in Figure 2 (Demetriou *et al.*, 2013b).

As indicated in Figure 2, stakeholders participate in 13 of the 21 steps of the process, which are signified by black-shaded rectangles. The process can be halted at four critical decision points marked "Yes/No". The primary stakeholders in the land consolidation process are the landowners in the project area, and they are the only ones with the right to object to the land consolidation plan, the road network plan, the land valuation, and the distribution of costs. Other stakeholders include farmers or tenants, governmental departments associated with the project, local community leaders, and so forth.

Re-allotment planning (Cay *et al.*, 2010) is considered the most complex and time-consuming process of land consolidation and is, when integrated with the road network plan, the process that forms the final land consolidation plan. This multi-objective spatial allocation process seeks to optimally restructure existing land tenure, based on the land consolidation legislation, regulations, directives, circulars, and best practices. It aims to balance factors like efficient agricultural development planning, the landowners' preferences, environmental impact reduction and enhancement. In Cyprus, land re-allotment is based on the market value of holdings and each landowner should approximately receive property of equivalent value (after deducting their contribution in land, for the construction of roads or other infrastructure) to their pre-consolidation holdings.

The enlargement of farms is facilitated in the land consolidation process through the reallocation of land from those landowners who will not receive land (they receive compensation based on the land valuation) in the new plan, if they have land under a defined land value and/or size. Those limits are defined by the Land Consolidation Committee for the specific project. Sales/purchase transactions are fully permitted during the whole period of the project (apart from a couple of months before the approval of the Land Consolidation Plan).

Table 1. *Overall statistics of land consolidation implementation during 1969–2020*

	BEFORE	AFTER	CHANGE (%)
Number of owners	25 874	19 486	-29.69
Number of parcels/shares	59 200	26 674	-54.94
Average number of parcels and shares per owner	2.55	1.80	-29.32
Average size of parcel and share (ha)	0.41	0.65	+56.81
Average size of ownership (ha)	0.73	0.85	+16.57
% area in undivided form	35.57	2.62	-93.02
% of parcels in undivided form	24.03	2.38	-90.08
% of parcels served by farm roads	33.31	99.70	+199.32
Road length (kilometres)	439	1330	+203.21

Source: *Department of Land and Surveys. 2020. Annual Report. Ministry of Agriculture, Natural Resources and Environment of Cyprus. Nicosia.*

2.3 Project results

A comparison of the land ownership structure before and after land consolidation, based on the findings from the 80 completed projects completed in 2020 (Department of Land and Surveys, 2020), is presented in Table 1.

The outcomes show a significant improvement in farm structures through the implementation of land consolidation (Murken and Gornott, 2022) in these areas of Cyprus, representing a crucial structural transformation. Specifically, the number of landowners declined by 24.69 percent, the number of parcels/shares experienced a substantial decrease of 54.94 percent, and the average number of parcels/shares per landowner decreased by 29.32 percent. Conversely, the average size of parcels/shares witnessed a notable increase of 56.81 percent, while the average size of ownership saw a smaller increase of 16.57 percent. It should be noted that a "share" means that a parcel belongs to more than one landowner, i.e. there is co-ownership. So, the decrease in the number of parcels/shares is a positive outcome because land parcels become larger and shares, i.e. co-ownership, are reduced. On the other hand, the increase in the average size of land parcels and shares is also a positive change because landowners have more land to farm. Furthermore, the percentage of the area and number of parcels held in undivided shares significantly decreased by 90.08 percent. In addition to the land tenure indicators, the length of the road network increased by 203.21 percent, providing access to almost all (99.70 percent) of the new parcels. These figures indicate the efficiency of land consolidation measures in reducing land fragmentation (Liu *et al.*, 2019; Demetriou, *et al.*, 2012), thereby creating conditions for rational agricultural development and enhancing rural development.

Regarding the impacts of the aforementioned land ownership changes, based on older sample surveys and analysis conducted by the Land Consolidation Department (2010), there was an improvement in agriculture and, ultimately, in farmers' income. Specifically, capital productivity rose by 45 percent, while both labour productivity and production increased by 100 percent. Agricultural income rose by up to 300 percent, the number of economically viable holdings increased by 16 percent, and the internal rate of return in the 15 completed schemes ranged between 10 and 22 percent.

2.4 Problems faced during implementation

The implementation of land consolidation in Cyprus has encountered obstacles over the last 20 years. Some sceptics suggest that the ongoing decline in the agricultural sector, with its contribution to GDP dropping from 20 to 30 percent in the 1960s to only 2–3 percent by 2024, calls into question the government's decision to invest in land consolidation. Additionally, urban planning and environmental authorities have raised concerns about land consolidation leading to unplanned "isolated" housing development that harms the environment, despite its benefits for the protection of ecosystems, through specific actions.

The main reason for this was the lack of appropriate spatial planning regulations for development in rural regions, along with the insufficient enforcement of these rules. This situation has led to speculation in some land consolidation areas. Individuals who were not farmers or residents of the areas bought land in regions undergoing consolidation. When these areas received road access, they acquired the right to develop housing, such as for dwellings or vacation homes, if the land size exceeded 4 000 square meters. Consequently, the parcel values significantly increased after consolidation. Additionally, in some instances, large areas were chosen for land consolidation, including parts of regions with limited agricultural activity, instead of selecting smaller and more productive areas. Furthermore, certain areas were close to urban development zones or had a sea view,

prompting landowners to prioritize building isolated homes over farming, due to regulations allowing this under specific circumstances. Clearly, the phenomenon of isolated housing development is not a result of land consolidation itself, but due to the rules outlined in the planning and development documents for rural areas. Moreover, the negative image of land consolidation was worsened by a report from the Auditor General (2018), which highlighted potential irregularities in some land consolidation projects, in which rules of legislation and best practices were relaxed in favour of the landowners. The report suggested that the objectives of land consolidation may have been compromised and that they were inefficient.

This is due to the fact that land reallocation rules and practices were relaxed (by staff and Land Consolidation Committee members) so as to favour certain landowners, hence creating a positive reaction towards land consolidation. These discoveries, along with Cyprus facing a serious financial crisis in 2013, played a significant role in the decision to dissolve the Land Consolidation Department in 2014 and merge it with the Department of Land and Surveys in 2018. Unfortunately, this development resulted in ongoing projects being put on hold and the implementation of land consolidation coming to a halt in Cyprus, without addressing the underlying issues.

In terms of the process itself, land consolidation faces three significant challenges (Demetriou, 2013b): the time it takes to complete a project (Janus and Markaszewska, 2019), high operational costs (Wojewodzic *et al.*, 2021), and conflicts among stakeholders (de Vries, 2022). In Cyprus, projects have typically lasted seven to ten years, although some projects from the 1970s were completed in four to five years. However, the duration of a project depends on several factors such as the size of the project area, the number of landowners involved, the level of activity of the relevant authorities, the availability of resources, the absence of a cadastral inventory, and the need for consensus in decision-making.

The length of a project significantly influences the success of land consolidation in meeting its goals. Specifically, if a project continues for more than five to six years, then the anticipated benefits like improved productivity, cost efficiency and higher future income of farmers may not be fully realized. This is because of the challenges faced by the agricultural sector and the ageing population of farmers nearing retirement. Moreover, prolonged project duration can lead to outdated land valuation that does not reflect the actual market prices, resulting in lower compensation for landowners and more complicated land redistributions. Updating land valuation may cause delays and escalate project costs. However, the main repercussion of project durations is a spike in costs, which can be significant due to the extended timeframe. This leads to increased construction costs along with interest payments, on project loans made by the Department of Land and Surveys. These costs increase the impact on landowners who bear part of the construction expenses, as noted earlier.

The third issue that arises in the implementation of land consolidation is the possibility of disagreements between the parties involved, specifically between the Department and/or the Land Consolidation Committee and the landowners whose land is being consolidated. These disputes, which may vary in number from a few to several hundred cases depending on the number of landowners involved, can be expressed informally or formally through the submission of objections. These disputes frequently occur due to the rigid nature of the legislation and the emphasis on maximizing the efficiency of the plan, which often neglects the human element. Drawing on two decades of experience with land consolidation across Cyprus, the subsequent section mainly presents relevant lessons learned, insights, and recommendations, primarily based on Cyprus and also based on a broader literature review so as to provide a more comprehensive and richer framework, when necessary.

3. Lessons learned from the implementation of land consolidation projects

The insights derived from the implementation of the various land consolidation projects in Cyprus offer valuable perspectives on 15 critical factors that contribute to their success, as detailed in Table 2 below. This table summarises each factor by outlining the lesson learned, insight, and basic recommendations. Further discussion on the topic follows, aiming to provide a more generic framework that could be useful beyond to Cyprus and to the countries that apply or intend to apply land consolidation.

Although some of the lessons learned may seem obvious to countries with extensive experience and high levels of organization, they are still valuable as a comprehensive record for countries that are in the process of implementing or planning to implement land consolidation, and there is always room for improvement, even for advanced countries.

Up-to-date land ownership records and cadastral maps

They are essential for implementing land consolidation projects as they offer the foundation for precise and reliable land re-allotment. Thus, a reliable cadastral system that accurately links land ownership with cadastral plans supports land governance (Enemark, 2010) and provides a clear basis for reallocating land parcels.

To apply these insights effectively, consider these recommendations: i) Develop and maintain cadastral systems (Krigsholm *et al.*, 2020) ii) Document land parcels in the absence of formal systems: In areas without formal cadastral systems (not in the case of Cyprus), conduct a thorough inventory of land ownership and usage within the target area. The concept of a "fit-for-purpose" land administration system is relevant (Bennet *et al.*, 2021).

Legal and regulatory framework

A structured, transparent legal framework is essential for successful land consolidation (Veršinskas *et al.*, 2020). It should include laws, regulations, expert guidance, and best practices to ensure a clear,

Table 2. *Lessons learned, insights and recommendations.*

ASPECT	LESSON LEARNED	INSIGHT	RECOMMENDATIONS
1. Up-to-date records and cadastral plans	Essential for precise and reliable land reallocation.	A robust cadastral system provides the necessary foundation for land consolidation.	(i) Develop and maintain comprehensive cadastral systems. (ii) Document land parcels in the absence of formal systems.
2. Legal and Regulatory Framework	A clear, robust framework is vital for successful implementation.	A strong legal framework ensures clarity, structure, transparency and stakeholder trust.	(i) Develop and regularly update a comprehensive legal framework. (ii) Provide training and resources for effective application.
3. Landowners (and other stakeholders) Engagement	Early and continuous engagement is crucial for acceptance and cooperation.	Proactive engagement reduces resistance and conflict.	(i) Implement a comprehensive stakeholder engagement plan. (ii) Tailor communication strategies for various stakeholders.
4. Project Planning and Management	Detailed planning and efficient management are key to staying on schedule and budget.	Poor planning can extend timelines and inflate costs.	(i) Develop comprehensive project plans. (ii) Allocate resources effectively and conduct risk assessments. (iii) Include contingency plans and regular reviews.
5. Financial Considerations	Accurate cost estimation and financial management are essential for project viability.	Robust financial management prevents budget overruns and project failure.	(i) Conduct thorough feasibility studies. (ii) Develop financial projections and manage risks. (iii) Establish robust financial management practices.
6. Land Valuation	Fair and transparent valuation is critical for equitable land reallocation.	Fair valuation fosters trust and cooperation among landowners.	(i) Standardize the valuation process. (ii) Use modern technology for accuracy. (iii) Communicate clearly with stakeholders and provide an appeal mechanism. (iv) Update valuations when needed.
7. Policy Alignment	Alignment with national, regional, and local plans is essential for project success.	Misalignment can lead to conflicts and inefficiencies in the various sectoral objectives.	(i) Conduct comprehensive policy analysis. (ii) Perform gap analysis and adapt the project design. (iii) Engage with sectoral representatives for coordination.
8. Environmental Protection	Environmental protection must be integrated into all project stages.	Without careful planning, land consolidation can affect ecosystems.	(i) Conduct Environmental Impact Assessments (EIAs). (ii) Integrate environmental enhancement projects. (iii) Use sustainable construction practices.
9. Transparency and Publication	Full transparency ensures trust and fairness in land consolidation.	Transparency helps prevent disputes and ensures widely accepted decisions.	(i) Establish clear publication protocols. (ii) Set reasonable periods for public review. (iii) Create a fair and transparent review mechanism. (iv) Maintain transparency and accountability throughout the project.
10. Comprehensive Justice Mechanism	A multi-tier justice mechanism ensures fairness, but delays need addressing.	Delays in appeals can undermine effectiveness and trust in the process.	(i) Implement a multi-tiered justice mechanism. (ii) Streamline the appeal process to expedite resolutions.
11. Social Equity	Ensuring social equity in land redistribution is vital for long-term success.	Failure to address equity can lead to conflicts and dissatisfaction.	(i) Conduct social equity assessments. (ii) Design equitable land redistribution mechanisms, considering marginalized groups.
12. Technology Use	Leveraging technology improves efficiency and accuracy.	Modern technology is essential for precise and transparent outcomes.	(i) Adopt specialized software for land reallocation. (ii) Integrate general technologies like Geographic Information Systems (GIS) and remote sensing.
13. Monitoring and Evaluation	Continuous monitoring ensures alignment with goals and adaptability.	Ex ante and ex post evaluations are critical for assessing impacts and guiding future projects.	(i) Implement comprehensive ex ante evaluations. (ii) Conduct detailed ex post evaluations.
14. Institutional Capacity	Strong institutional capacity is essential for effective execution.	Weak capacity can lead to delays and inefficiencies.	(i) Invest in institutional capacity building through training. (ii) Enhance inter-institutional coordination. (iii) Foster collaboration with the private sector.
15. Public Awareness and Education	Raising public awareness is crucial for gaining support and reducing conflicts.	Misinformation can lead to resistance and delays.	(i) Develop a comprehensive public awareness strategy. (ii) Utilize multiple communication channels. (iii) Implement education programs and workshops. (iv) Engage local leaders and influencers.

Source: *FAO. 2025. Special issue on Land Consolidation. Land Tenure Journal No. 1–2025. Rome.*

step-by-step process that builds trust among landowners. Without it, projects may face uncertainties, conflicts, and delays. The legal framework must also remain adaptable by addressing challenges and learning from experience. To strengthen legal support: i) Develop and enforce a country-specific legal framework outlining procedures, rights, and responsibilities. ii) Regularly review and update provisions to address emerging issues and align with broader land management strategies. iii) Provide training and resources to ensure stakeholders understand and apply regulations effectively, preventing conflicts and minimizing delays.

Landowner (and other stakeholder) engagement

Engaging all stakeholders throughout a land consolidation project fosters collaboration and reduces conflicts (Gorgan and Bavorova, 2022). Involving landowners in decision-making – from inception to land valuation, reallocation, road network design, and cost allocation – builds trust and ensures smoother implementation. Effective communication, combining face-to-face meetings with media platforms, is key. Recommendations include: i) Develop a stakeholder engagement plan that integrates both traditional and modern communication channels. ii) Use tailored communication strategies to address the specific needs and concerns of different stakeholder groups.

Project planning and management

Thorough planning and effective management are crucial for keeping land consolidation projects on track, within budget, and ensuring their success (Pašakarnis *et al*., 2012). Poor planning can cause delays, hindering agricultural development, especially given an ageing farming population and the need for timely solutions. Cost overruns may also raise doubts about a project's feasibility, jeopardizing its support. To address these challenges: i) Develop comprehensive plans covering all project stages, with clear timelines and milestones to detect potential setbacks early. ii) Allocate resources efficiently, ensuring the availability of personnel and funding while conducting risk assessments to mitigate potential threats. iii) Implement adaptive management strategies, conducting periodic evaluations to monitor progress and make necessary adjustments.

Financial considerations

Accurate cost estimation and financial management are essential for the success of land consolidation projects, helping identify risks and opportunities. A feasibility study at the project's outset is crucial for informed decision-making and economic sustainability (Wojewodzic *et al*., 2021). Without proper financial planning, projects risk budget overruns, resource shortages, and failure. Key recommendations: i) Conduct a feasibility study with detailed cost estimates for land acquisition, infrastructure, stakeholder compensation, environmental assessments, and operations. ii) Develop financial projections covering best-case, worst-case, and likely scenarios, identifying risks and mitigation strategies. iii) Implement financial monitoring with regular updates for stakeholders and contingency planning to address potential financial challenges.

Land valuation

Fair and transparent land valuation is essential for equitable land redistribution and compensation, fostering trust among landowners (Demetriou, 2016). Since land value determines parcel re-allotment, inconsistencies can lead to disputes. Key recommendations: i) Establish clear valuation criteria based on location, land use, soil quality, and infrastructure access. ii) Utilize Geographic Information Systems (GIS), remote sensing, and Computer-assisted mass appraisal (CAMA) software for accurate, data-driven valuations (Demetriou, 2018). iii) Ensure transparency by clearly communicating valuation methods and providing a process for landowner feedback. iv) Regularly update valuation to reflect market trends and maintain fairness.

Alignment with regional and local spatial development planning

Aligning land consolidation projects with regional and local plans – as well as with agriculture, forestry, water, soil, biodiversity, ecosystem conservation, and climate policies – is essential for success and sustainability (Vigar, 2009). Such integration enhances project effectiveness and contributes to sustainable development. In contrast, misalignment can cause conflicting goals, regulatory hurdles, and inefficiencies. Key actions include: (i) Assess existing plans and policies at national, regional, and local levels to spot potential conflicts. (ii) Analyze gaps between project goals and policies and adjust the project design accordingly. (iii) Engage with sector representatives to resolve conflicts and integrate specific priorities through dialogue.

Environmental protection

Integrating environmental protection throughout all phases of land consolidation is crucial to minimizing impacts and enhancing local ecosystems. The process can alter landscapes, change parcel boundaries, and reduce fragmentation, potentially leading to soil degradation, biodiversity loss, and water system disruptions (Shan et al., 2019). Key recommendations: i) Conduct Environmental Impact Assessments (EIAs) before starting to identify risks and guide planning (Thomas, 2023). ii) Incorporate environmental initiatives such as reforestation and wetland restoration. iii) Use sustainable construction methods, including locally sourced permeable materials and infrastructure designs that protect sensitive habitats.

Transparency and publication of plans

Effective communication and transparency are key to building trust and ensuring successful land consolidation (de Vries, 2022). Landowners must have access to key documents, such as valuation maps,

land reallocation plans, and road alignment plans, with a structured process for review and objections before final decisions. Transparency directly impacts stakeholder satisfaction and project credibility (Polívka and Reicher, 2019). Key recommendations: i) Ensure access to project documents at each phase, both online and in physical locations like a Village Hall. ii) Set a legally defined review period allowing stakeholders sufficient time to examine materials and submit objections.

Comprehensive justice mechanism

A strong justice system is essential for fairness and transparency in land consolidation. Cyprus demonstrates this by allowing objections and appeals at three levels, ensuring equity. However, delays at the ministerial level and the Administrative Court undermine effectiveness, prolong uncertainty, and erode trust. Key recommendations: i) Maintain a tiered justice framework that upholds landowners' rights to challenge decisions. ii) Implement measures to expedite appeals within a reasonable timeframe to enhance system credibility.

Social equity

Prioritizing social fairness is essential for successful and sustainable land consolidation (de Vries, 2022). Addressing the needs of marginalized groups – such as small-scale farmers, young farmers, women, and rural residents – helps prevent widening inequalities and reduces conflicts and opposition. Key recommendations: (i) Conduct a pre-project assessment to identify marginalized groups and their challenges in land ownership and access. (ii) Implement fair land redistribution guidelines, prioritizing disadvantaged groups or providing resources to support them.

Technology use

Modern technology enhances efficiency, accuracy, and transparency in land consolidation projects. Tools like GIS, remote sensing, Planning Support Systems (PSS) (Demetriou, 2013c), and specialized land management software facilitate spatial data management, land characteristic analysis, and informed decision-making. Proposed solutions include: i) Adopting specialized software such as for land reallocation and cost distribution to landowners to meet the country's specific needs, and ii) Integrating general technologies like GIS and remote sensing into project workflows for improved decision-making in land reallocation. Investigate the new horizons opened by the Artificial Intelligence (AI) capabilities for community planning (Hollander *et al.*, 2020).

Monitoring and evaluation

Ongoing monitoring and assessment play a role in maintaining project alignment and overcoming obstacles. It is suggested to carry out pre-project assessment of land reallocation (Demetriou, 2024), which is actually part of the feasibility study and the environmental impact study, as noted earlier and also wherever necessary a broader *ex ante* evaluation (Colombo and Perujo Villanueva, 2019) to assess the economic, environmental and social impacts of land consolidation (Jin *et al.*, 2017). These evaluations ensure that the project stays on track towards its objectives while minimizing any effects. Therefore, it is advised to: i) Before commencing the project, conduct a comprehensive assessment to gather baseline data on social, economic, land use and environmental aspects for impact evaluation purposes. ii) Upon project completion, conduct in-depth assessments to analyze the actual social, economic and environmental impacts by comparing them with baseline data to measure the project's efficiency and achievements.

Institutional capacity

The gradual strengthening of the capabilities of institutions is crucial for the success of land consolidation initiatives (Zhang *et al.*, 2021) within a feasible timeframe. Building expertise, allocating resources effectively, and improving institutional efficiency are key to successful land consolidation. Collaboration with relevant entities enhances project outcomes by leveraging knowledge, technology, and innovation. Weak institutional capacity can cause delays and inefficiencies. Key recommendations: i) Provide training for public sector staff in project management, legal matters, GIS, and stakeholder engagement. ii) Establish collaboration mechanisms among land registries, local authorities, planning, agricultural, and environmental agencies, with some directly involved in project oversight.

Public awareness and education

Raising public awareness and educating stakeholders is crucial for gaining support and minimizing resistance to land consolidation (Podhrászká *et al.*, 2015). Clear communication of project objectives, benefits, and procedures reduces opposition and delays, increasing the likelihood of success. Key recommendations: i) Develop a targeted awareness strategy with clear messaging for landowners, communities, environmental groups, and officials. ii) Use diverse communication channels, including media, social platforms, community meetings, and brochures, to reach all audiences. iii) Conduct workshops and training, informing landowners about property impacts and equipping community leaders with engagement skills. iv) Engage trusted influencers and leaders to build trust, address concerns, and support project acceptance.

4. Future potential for land consolidation to contribute to non-agricultural objectives

This section explores emerging short-term directions for land consolidation, focusing on Cyprus and beyond. It highlights the roles of land consolidation in addressing climate change, leveraging technology, developing new agricultural business models, and integrating advanced technologies. Some countries with a long-standing experience in land consolidation have already adapted to several of these challenges.

4.1 Adapting to and mitigating climate change effects

Land consolidation can help adapt to and mitigate climate change effects (Stańczuk-Galwiaczek, *et al*., 2018; Hartvigsen, 2022). In Cyprus, where rising temperatures and altered precipitation patterns are reshaping the agricultural landscape, land consolidation should in the future prioritize reorganizing parcels to support climate-resilient practices and has great potential to contribute to climate change adaptation and mitigation. Key aspects include: i) Climate-resilient agriculture: consolidating fragmented parcels into larger units can enable advanced irrigation systems, such as drip irrigation, which are crucial for water conservation in drought-prone areas. ii) Soil conservation (Kadlec *et al*., 2014): redistribution should encourage contour farming and terracing to prevent soil erosion and promote land restoration through reforestation or afforestation, based on topography and soil quality. iii) Ecosystem preservation: land consolidation (Lisec and Pintar, 2005) can convert private land to state land and vice versa, protecting sensitive ecosystems. This process safeguards private land by converting it to state land, preventing both legal and illegal human intervention. In this context, the implementation of climate change adaptation and mitigation projects can be supported.

Mitigation efforts can focus on the following aspects: (a) Carbon sequestration (Yang and Cao, 2023): aggregating land into larger parcels for agroforestry improves carbon sequestration, biodiversity, and soil fertility. EU programs require a minimum ownership size for farming or livestock to qualify for subsidies and support. (b) Reducing emissions (Janus and Ertunç, 2023): land reallocation optimizes sustainable farming, cutting greenhouse gas emissions by reducing the travel distances between consolidated parcels. Consolidating livestock operations in resource-rich areas can reduce methane emissions through improved feeding strategies and manure management. (c) Enhancing landscape elements (Bonadonna *et al*., 2020): land consolidation involves creating new environmentally friendly areas like parks or woodlands and restoring existing green and cultural heritage sites. (d) Communities' resilience planning (Hay *et al*., 2017): reorganizing land with community needs in mind supports diversified and resilient livelihoods, such as solar farms or agrotourism, alongside traditional agriculture.

4.2 Leveraging innovative technologiess

Remote sensing and GIS advancements are revolutionizing land consolidation and re-allotment by providing comprehensive spatial data analysis and decision-making tools on land tenure, land value, land use, soil quality, and environmental factors, enabling informed and efficient land management. These technologies are specifically applied in land consolidation through: i) Creating detailed maps using high-resolution satellite imagery, unmanned aerial vehicles (UAVs)/drones (Cienciała, 2022), to provide data and information on the existing situation, which is a necessary background for carrying out land reallocation. Also, GIS data analysis tools identify priority areas for agriculture, conservation, and infrastructure, optimizing land use for productivity and sustainability. The Department of Land and Surveys is currently enabled to use these data, i.e. satellite images, UAVs and advanced GIS tools, to support land consolidation. In addition, Planning Support Systems (Geertman and Stillwell, 2012) aid decision-making and the use of extensive AI applications, introducing new possibilities. ii) Facilitating continuous monitoring of post-consolidation land use changes, evaluating the impacts of land reallocation in achieving objectives such as enhanced crop yields or decreased environmental degradation, and providing data for necessary adjustments.

Digital platforms and blockchain technology can enhance stakeholder engagement and land administration as follows: (a) Digital platforms facilitate stakeholder involvement in land consolidation. Tools like social media and Public Participation GIS (Bąkowska-Waldmann and Kaczmarek, 2021) enable landowners and stakeholders to view maps, provide feedback, and partake in decision-making, promoting transparent and inclusive land reallocation. (b) Blockchain technology (Ameyaw and de Vries, 2021) for land registration, although currently of very limited application in land administration, can secure and streamline post-consolidation land registration. Blockchain-recorded transactions improve transparency, integrity, and ownership clarity, reducing disputes. Wider implementation necessitates further research and legal frameworks.

4.3 Proposing new business models for agricultural land development

Land consolidation supports the development of new farming methods and economic stability (Cotula and Leonard, 2010). By organizing land into manageable parcels, it promotes the adoption of modern farming practices and diversification of income sources. This process is vital in two aspects: i) Combining lands into agricultural units promotes and supports the development of more sustainable agricultural production, including agroecology, organic farming and regenerative agriculture, focusing on environmental wellbeing, biodiversity conservation and soil fertility. These approaches address challenges posed by climate change and meet market requirements. ii) Land consolidation enables agrotourism activities (Chen *et al*., 2024) and value-added agriculture by reallocating land for various

purposes. Consolidated plots can support both farming operations and tourism-related ventures, like farm stays or educational tours that offer farmers sources of income.

Various cooperative and collaborative approaches are utilized in these ways (e.g. in some cases in Cyprus): (a) Through land consolidation farmers come together to share resources, equipment and market opportunities which helps improve the sustainability of smallholder farmers by boosting their bargaining power and access to new technologies. (b) In areas with land holdings cooperation in land management allows neighbouring farmers to collectively oversee parcels of land and share the benefits and risks associated with modern farming practices. (c) Public Private Partnerships (PPPs) involved in land consolidation initiatives (Wang *et al.*, 2022) attract investments for rural infrastructure development such as irrigation systems and processing facilities. In these partnerships the governments provide land and water resources while private entities focus on constructing the necessary infrastructure. These collaborations promote an economy and environmentally friendly investments enhancing land redistribution by equipping consolidated regions with necessary infrastructure, for contemporary agricultural practices.

4.4 Integrating technological innovations into land consolidation

Integrating smart agriculture technologies and Internet of Things (IoT) (Singh *et al.*, 2022), i.e. a network of interconnected physical devices that collect, exchange, and process data via the internet. These devices, embedded with sensors, software, and communication technologies, enable automation, remote monitoring, and real-time decision-making without human intervention. With land consolidation, this significantly enhances agricultural efficiency and sustainability when farms have adequate size after land consolidation. IoT provides real-time data on environmental and operational factors, which can be useful for making land reallocation decisions in terms of optimizing land use, improving productivity, and reducing environmental impact. Land consolidation supports the implementation of precision farming (Addicott, 2020) that needs larger and regularly shaped land parcels. In this context, the data collected related to precision farming can also be used to improve land reallocation decisions and practices for new projects. Also, land consolidation creates larger, uniform plots suitable for automated machinery and IoT devices. These devices provide real-time data on various conditions, supporting informed land reallocation to optimize new parcels for modern farming. Similarly, post-reallocation, the IoT data collected can create guidelines to improve land reallocation.

This data-driven decision-making scenario involves (a) Using big data analytics (Weersink *et al.*, 2018) to improve the redistribution of land, in consolidation projects by examining satellite images, soil samples and climate information. This process determines the crops for each land parcel based on factors like soil quality, past crop performance and local climate conditions. The goal is to increase productivity and sustainability while supporting land management and adaptation post-redistribution. (b) The integration of Planning and Decision Support Systems (PDSS) (Demetriou, 2013c) in land consolidation projects facilitates data-informed decisions regarding land reallocation by considering environmental and social aspects to suggest optimal land utilization strategies that benefit both farmers and the environment.

5. Conclusions and perspective

The implementation of 55 years of land consolidation in Cyprus has yielded significant results and impacts on sustainable agricultural and rural development. However, over the past decade, activities have declined due to the several challenges outlined in this paper. The author's two decades of involvement in land consolidation projects have provided valuable opportunities to document the lessons learned, propose recommendations, and envision new directions for the instrument. Despite the notable benefits that land consolidation offers to the agricultural sector, a persistent problem in Cyprus is the delay in project completion and prolonged implementation time.

These delays hinder the timely realization of anticipated benefits, particularly considering the ageing population of farmers. New farmers are also affected as they are unable to invest in or expand their businesses while waiting for project outcomes. Addressing this issue is crucial and can be achieved through better project planning, prioritising areas with high agricultural activity, and aligning with EU measures under the Common Agricultural Policy (CAP), which provides direct payments and rural development funding to enhance farm competitiveness and sustainability.

The land consolidation instrument in Cyprus has the potential to meet emerging EU rural policy priorities, especially in response to climate change, nature conservation, and environmental protection. In particular, land consolidation can play a pivotal role in Cyprus's climate adaptation and mitigation strategies. It can support optimised agricultural systems, enhance biodiversity, and conserve ecosystems. Collaboration with key authorities, such as the Departments of Agriculture, Environment, Spatial Planning, and Forests, is essential for integrating specific procedures and policies into the instrument. In this context, harmonising land consolidation with national, regional, and local spatial planning frameworks helps to prevent conflicts between the different views of departments, reduce inefficiencies, and ensure that environmental considerations are embedded throughout the process. Moreover, the use of modern technologies such as GIS, remote sensing, and AI can enhance the efficiency and fairness of land reallocation while also supporting data-driven scenario planning. The outcomes must be continuously assessed against predefined goals to guide future improvements. Implementing these measures requires political support, strong institutional capacity, public awareness, and investment in educating local communities, as land consolidation remains a vital tool for rural development, agriculture, and environmental sustainability. Furthermore, new farming models, livestock systems, and agrotourism ventures supported by land consolidation can provide alternative income streams and bolster rural communities' economic resilience.

Land consolidation in Cyprus is at a critical turning point. Without immediate and strategic intervention, the instrument is at risk of disappearing from the national land policy toolbox. If this decline continues, Cyprus could lose a key planning tool for rural development, spatial reorganization, and environmental stewardship. Lessons from past challenges suggest the need to redefine land consolidation with a focus on smaller, intensively farmed areas and to reposition it as a multi-purpose and fit-for-purpose land management tool.

Such a tool should address emerging needs related to climate change, biodiversity, and the wider rural population, and not just farmers. In practice, a modern multi-purpose land consolidation approach can distinguish between the different objectives within a single project. In one part of the project area, traditional agricultural goals such as parcel enlargement, irrigation improvement, and road access could be emphasised. Non-agricultural objectives can be prioritised in other areas, including the development of biodiversity corridors, recreational spaces, renewable energy zones, and nature conservation areas. Such flexible place-based zoning would allow the instrument to serve a wider range of goals aligned also with local needs. This approach supports the integration of agricultural modernization with environmental restoration, eco-recreation, and agrotourism, achieving both production and protection objectives. These synergies can strengthen local rural development strategies, attract younger generations, and foster climate-smart agricultural entrepreneurship.

Revitalising the land consolidation instrument in Cyprus requires a strong political will and a shift in approach to emphasise its role in sustainability, resilience, and integrated land management. This transformation is feasible but demands effective interdepartmental coordination among relevant departments and the involvement of local authorities, stakeholders, and academic institutions. Success also depends on administrative efficiency and incentive schemes that ensure fairness and foster participation. To support this transformation, the following actions will be essential:

- Redefine the project scope by focusing on smaller, high-value agricultural areas and adopting a fit-for-purpose, multi-purpose approach.
- Enable spatial differentiation within projects, allowing agricultural and non-agricultural objectives (e.g. biodiversity, recreation, and agrotourism) to coexist in different zones of the same project area.
- Strengthen institutional coordination among state departments (Agriculture, Environment, Planning, Forests, Land and Surveys) and local authorities to align land consolidation with broader spatial and climatic strategies.
- Establish monitoring and evaluation frameworks to track progress, assess outcomes, and adapt strategies based on predefined goals.
- Enhance stakeholder engagement and education through inclusive participation and targeted capacity-building programmes.
- Develop financial and regulatory incentives, including targeted subsidies, EU rural development funding, and tax relief schemes, to support participation and ensure long-term project viability.
- Promote digital transformation through advanced geospatial tools and data-driven methods to improve planning, transparency, and performance monitoring.

The insights and future pathways presented in this paper form the basis of a roadmap for revitalising land consolidation in Cyprus and can also offer guidance to other countries facing similar challenges. Relevant departments must collaboratively revise their strategic vision to reflect evolving socio-environmental and economic realities. With accelerating climate impacts and the growing need for ecosystem protection and innovation in agriculture, a forward-thinking and adaptive model for land consolidation is now essential. Rather than being regarded solely as a technical restructuring mechanism, land consolidation should evolve into the cornerstone of resilient and integrated land management. A significant and timely development in this direction is the recent promotion of legislation in the Cyprus Parliament to implement urban land consolidation (land readjustment). This legislative initiative represents a crucial step in revitalising the instrument by extending its application to urban areas. Urban land consolidation can play a key role in addressing spatial fragmentation, the problem of limited access to land parcels with registered roads, promoting sustainable urban growth, enhancing infrastructure and increasing spatial efficiency. This expansion confirms the relevance of land consolidation as a versatile modern policy tool for integrated land governance in rural and urban settings.

Successful revitalization also requires inclusive participation from landowners, farmers, private sector actors, and civil society. Universities and research institutions can contribute by introducing innovative methods and supporting robust analysis and planning. Cyprus faces the threat of further agricultural decline and the weakening of rural communities unless the scope and goals of land consolidation are clearly redefined so as to continue to support both agriculture and rural communities. By positioning land consolidation within a broader framework for sustainable land management and climate resilience, Cyprus could transform this tool into a pillar of efficient, inclusive, and forward-looking land governance.

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