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CHALLENGES IN THE MANAGEMENT OF AGRICULTURAL LAND RESOURCES DURING UKRAINE'S POST-WAR RECOVERY

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Abstract. The strategic importance of land governance in Ukraine's post-war recovery has grown amid severe disruptions to the agricultural sector. With rural livelihoods threatened and economic capacities diminished, this study explores institutional, legal, economic, and logistical challenges to restoring land functionality across various ownership forms. The primary aim is to identify pathways for reorganizing land systems to stabilize agricultural output, reintegrate displaced communities, and strengthen food security. The research examines land management under post-conflict conditions, assessing both damage and opportunities for reform. Methodologically, it applies comparative analysis, economic evaluation, remote sensing to estimate damage, and post-conflict recovery models from other countries. Findings indicate substantial degradation of agricultural capacity. Farmland has become inaccessible or unusable due to contamination, abandonment, or infrastructure collapse, causing estimated annual losses exceeding $11 billion. The disruption of trade corridors has heightened global food price volatility and exposed vulnerabilities in international supply chains, increasing demand for alternatives to Ukrainian grain. Drawing from global cases, the study emphasizes the role of secure tenure, transparent restitution, and decentralized governance in successful recovery. To address these challenges, the paper introduces a recovery index tailored to Ukraine's agrarian context and proposes practical policy guidelines. Rebuilding credible land institutions emerges as urgent, not only for national stability but also for broader regional food security and investment attractiveness.

Keywords: post-conflict recovery, land governance, agricultural reform, digital cadastre, property restitution, institutional capacity, environmental rehabilitation, international cooperation.

JEL Classification: O13, Q15, Q10, Q12, Q56

1. Introduction

Agricultural land resources refer to the aggregate of land used by agribusiness entities of all forms of ownership to conduct agricultural activities. These lands serve as the foundation for agribusiness, enabling crop cultivation, livestock management, infrastructure placement, and overall support of the agricultural production cycle.

For agribusiness entities, regardless of their legal structure or ownership form, land is not merely a physical space, but a strategic asset. The efficiency of land resource management directly affects production volumes, profitability, and operational stability. On the national level, efficient management of agricultural land, which comprises the largest share of cultivated land in the country, is of strategic importance. Agribusiness not only ensures national food security, but also plays a vital socio-economic, environmental, and external economic role. Therefore, creating conditions for unhindered and effective land resource management must be a state-level priority.

Ukraine is one of the countries with decisive importance for the global agricultural market. Despite declining production due to the war and shrinking sowing areas, Ukraine has maintained its position as a major exporter of wheat, barley, corn, and sunflower oil, owing to its export orientation, adaptability, and development of processing capacity. Before the full-scale invasion,

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Ukraine accounted for approximately 10% of global wheat exports and 50% of sunflower oil, supplying food to countries experiencing food insecurity, such as Egypt, Lebanon, and Somalia. According to the European Council, prior to the war, Ukraine provided half the world's sunflower oil and about 12% of wheat exports (Global wheat shipments withstood the shock of Russia's invasion of Ukraine, n.d.).

From 2016 to 2020, the now-occupied regions of Donetsk, Luhansk, Kherson, and Zaporizhzhia contributed 21% of Ukraine's wheat production, 17% of barley, and 19% of sunflower seeds (Glauber, 2024). However, as of 2023, 7.5% of Ukraine's agricultural land was abandoned due to the war (Becker-Reshef & Mitkish, 2024). By 2024, U kraine had become the most heavily mined country in the world: 139,000 km² were contaminated with landmines, and 2.5% of arable land was rendered unusable, resulting in annual GDP losses exceeding $11 billion (Harmash, 2024). The collapse of the Black Sea Grain Initiative triggered a 17% increase in global wheat prices, exposing vulnerabilities in the global food logistics system (FAO food price index | food and agriculture organization of the united nations, n.d.). In the long run, there is a growing risk of contamination of Ukraine's fertile black soils, which account for 25% of the world's black soil reserves (Didenko, 2024).

Prior to the conflict, Ukraine was a digital leader in land management, having introduced reforms such as an electronic cadastre, land auctions via the ProZorro system, and transparency initiatives (Savishchenko, 2024). However, the war has jeopardized these achievements. Rebuilding efforts must go beyond infrastructure and include legal and digital system restoration. Peace disruption and instability in Ukraine's agribusiness sector have global implications, worsening humanitarian crises in North Africa, the Middle East, and South Asia. In 2022, the Food and Agriculture Organization (FAO) of the United Nations reported that price shocks from the war pushed up to 258 million people into food insecurity, highlighting Ukraine's recovery as critical to global food security (Brief: The impact of russian war on the Ukrainian agricultural sector and global food security 2022-2024, 2024).

Effective land management is essential for reconstruction, as land underpins property rights, tax revenues, and rural employment. Before the war, agriculture contributed over 10% of Ukraine's GDP and accounted for 14% of employment (Agriculture, forestry, and fishing, value added (% of GDP) – Ukraine, n.d.). Transparent land systems will be vital for attracting investment, supporting displaced persons, and accelerating recovery. In their absence, corruption, delays, and social tensions may undermine progress.

Historical examples underscore the importance of robust land management systems in post-war recovery. Following World War II, countries such as France and Germany restored agricultural productivity through effective land restitution and consolidation. In contrast, the absence of reliable restitution mechanisms in Syria, Iraq, and the former Yugoslav republics resulted in informal land practices, corruption, and destabilizing patterns of displacement. These contrasting outcomes emphasize the need for Ukraine to implement transparent and efficient land governance systems to ensure economic revival, support agribusiness, and foster a resilient, equitable post-war society.

This article analyzes the structural and institutional barriers to land restitution and management across all forms of ownership in post-war Ukraine, while outlining recovery strategies based on international experience. The analysis employs a comparative-analytical approach, combining legal, economic, and institutional review with satellite-based damage assessment and secondary data sources. While grounded in cross-sectoral evidence, the research remains constrained by the dynamic nature of ongoing hostilities and limited access to complete field data, which restricts the real-time evaluation of institutional capacity and implementation feasibility. In the second part of the study, case studies from France, Iraq, the former Yugoslavia, and other countries provide broader context for Ukraine's post-war land restitution. A tailored recovery index is developed to highlight concrete and relevant legal, economic, and policy recommendations. The discussion is organized thematically, with each section addressing legal, economic, institutional, and infrastructural challenges alongside recovery pathways adapted to Ukraine's conditions and agricultural sector.

2. Post-war Challenges in the Management of Agricultural Land Resources in Ukraine

The legal and political framework governing land use in Ukraine has historically been fragmented,

a condition further aggravated by the full-scale war. Since independence, Ukraine initiated a land reform aimed at privatizing agricultural land; however, the land sale moratorium imposed in 2001 to protect smallholders effectively stalled the development of a functioning land market for nearly two decades. This moratorium encompassed approximately 41 million hectares, including 31.5 million hectares under private ownership and an additional 10.5 million hectares managed by state or local communities (Bilous et al., n.d.) (Kravchuk & Bilous, n.d.).

Despite its intention to prevent speculation, the moratorium became an obstacle to establishing a transparent land market. As a result, landowners, especially small and medium-sized farmers, were unable to legally sell their plots or use them as collateral, which restricted their access to capital for investment and productivity improvements (Matvieiev, n.d.). Consequently, agricultural business entities in Ukraine faced serious difficulties in acquiring land ownership through legal means due to the lack of legal mechanisms for concluding purchase-sale agreements for agricultural plots. This significantly hindered the expansion of their land banks with newly acquired private farmland.

By 2020, over 6.9 million Ukrainians collectively owned roughly 31 million hectares–approximately 75% of the nation's agricultural land. However, only 29% of this land was cultivated by its owners, with the majority leased to third parties, underscoring a highly fragmented and inefficient land market (Postwar Ukraine: Planning for a successful and secure recovery, 2024). This fragmentation has obstructed land consolidation efforts, restricted economies of scale, and hampered sectoral modernization–challenges that persist amid the ongoing conflict and will remain critical barriers to effective post-war agricultural recovery.

Accurate documentation of land ownership is a critically important legal foundation that provides guarantees, particularly for agribusinesses, to manage land effectively. However, Ukraine faces significant deficiencies in this area. The State Land Cadastre currently covers 71% of the national territory, or approximately 42.7 million hectares, while the Property Rights Register, which confirms ownership, is only 40% complete. This figure is even lower in territories that have been temporarily occupied since 2014 (Ukraine special focus note: Land market for agricultural growth, 2019/n.d.). Discrepancies between cadastral data and ownership registers affect a significant portion of land parcels, frequently attributable to boundary inaccuracies or documentation errors. Such inconsistencies generate delays and legal uncertainties, impeding reliable land governance (Rapid needs assessment: Protecting property rights during and after the war in Ukraine – global land alliance, n.d.).

Under decentralization reforms, land management responsibilities were delegated to territorial communities. Yet, many of these communities, particularly smaller ones, suffer from inadequate funding, insufficient qualified personnel, and underdeveloped institutional infrastructure. This situation has produced uneven application of land legislation and weakened regulatory oversight.

The ongoing conflict has further complicated the verification of land rights and the delineation of physical boundaries. Numerous paper archives have been destroyed, especially in rural areas where local councils often serve as the main custodians of land documentation. The loss of these records or resistance from local authorities poses serious obstacles for both individual landowners and agribusinesses in confirming land rights and implementing restitution procedures.

Additionally, the war has weakened institutional capacity due to the destruction of offices, displacement of personnel, and the administrative burden related to compensation obligations, collectively resulting in a 20% decline in the efficiency of land resource management (COMMISSION STAFF WORKING DOCUMENT | Ukraine 2023 Report, 2023/2023).

Although Ukraine introduced the electronic State Land Cadastre in 2013 to modernize its registration system, the ongoing conflict has significantly compromised its accuracy, data integrity, and public accessibility. Digital platforms such as Prozorro and Prozorro.Sale, designed to enhance transparency in procurement and land auctions, have also experienced operational disruptions attributable to damage to administrative infrastructure and displacement of personnel (Nizalov, 2022).

It is important to note that even prior to the war, the land management system in Ukraine's agribusiness sector suffered from the effects of a prolonged moratorium and incomplete registries.

The ongoing conflict has only intensified these issues, leading to the loss of documentation, institutional fatigue, mass displacement of populations, and relocation of agribusiness offices and administrative staff. It is evident that post-war land governance will face a crisis of institutions, resource shortages, disruptions in local self-government, and a likely increase in corruption risks – factors that will significantly hinder effective restitution, reconstruction, and the functioning of agribusiness.

Moreover, land institutions – including the State Service of Ukraine for Geodesy, Cartography, and Cadastre (Derzhheocadastre), local land commissions, and the judiciary – are under immense strain. Infrastructure destruction and personnel displacement have significantly diminished their operational capacities, while the loss of critical documentation further complicates the provision of impartial and effective land management services.

The shortage of qualified professionals, particularly land surveyors, certified notaries, and GIS experts, is another critical factor that further undermines the effectiveness of land administration (World bank marks positive impact of prozorro.sale – transparency international ukraine, 2022). The lack of skilled personnel significantly complicates the legal processing of land documentation, land valuation, and the updating of digital registries, both for private individuals and for agribusiness entities.

Thus, while effective legal frameworks require stable and capable institutions, the vulnerability of Ukrainian institutions caused by the war considerably complicates the processes of restitution and land resource governance. Moreover, Ukraine's post-war recovery is further challenged by large-scale physical and environmental destruction. Approximately 40% of the country's fertile black soil has undergone erosion, largely due to the movement of heavy military equipment and the construction of defense structures. The use of explosives and the destruction of industrial facilities have introduced toxic substances – lead, mercury, arsenic – into the soil, posing a serious public health threat (Solomon, n.d.). The catastrophic destruction of the Kakhovka Dam in June 2023 led to the release of over 90,000 tons of heavy metals (arsenic, nickel, zinc) into the Dnipro River and surrounding agricultural land, endangering water supply security and food production (War worsens climate and environmental challenges in Ukraine, 2025).

Moreover, Ukraine currently stands as the most heavily mined country globally. The widespread presence of landmines and unexploded ordnance severely endangers civilian safety and critically disrupts agricultural operations essential for both domestic and global food security. World Bank estimates indicate that demining efforts may require investments exceeding $37 billion and span up to a decade, underscoring the immense scale and urgency of this issue (Destruction of Ukraine dam triggered toxic 'time bomb,' researchers say, 2025).

Landmines have inflicted severe damage on Ukraine's agricultural sector, which prior to the full-scale invasion contributed approximately 11% to the national GDP. Due to landmine contamination, this contribution declined to 7.4% by the end of 2023, with annual economic losses estimated at $11.2 billion (From economic recovery to global food security: The urgent need to demine Ukraine, 2024). The conflict has also caused extensive environmental degradation: roughly 1.7 million hectares of forest, equivalent to 15% of Ukraine's total forested area, have been affected by hostilities, predominantly through wildfires and artillery strikes (Chaika, 2024). The Sviati Hory National Park alone has lost nearly 80% of its 12,000-hectare territory (War worsens climate and environmental challenges in Ukraine, 2025). Following the destruction of the Kakhovka Dam, approximately 55,000 hectares of protected land were flooded, including 6,400 hectares of nature reserves and 1,000 hectares of wetlands, resulting in irreversible biodiversity loss and threatening numerous rare species (Hunder & Peter, 2024). The devastation of water infrastructure has deprived about 1.8 million people of access to safe drinking water. Concurrently, contamination of the Dnipro River and other water bodies by heavy metals and toxic substances poses long-term risks to aquatic ecosystems and human health.

It is therefore unequivocal that both the Ukrainian state and representatives of the agribusiness sector will be compelled to allocate considerable financial resources to mitigate these environmental consequences, conduct extensive demining operations, and, in certain cases, re-establish land ownership through legal procedures.

The war has gravely disrupted the functioning of Ukraine's agribusiness sector and, consequently, national agricultural productivity. The collapse of the Kakhovka Dam eliminated irrigation on approximately 584,000 hectares of arable land, transforming previously fertile areas into arid zones. These lands had supported the annual production of nearly 4 million tonnes of grain and oilseed crops, accounting for about 4% of Ukraine's total agricultural output (Economic consequences of the dam destruction at the Kakhovka HPP, 2023). Furthermore, the widespread presence of heavy metals in the soil and extensive landmine contamination have rendered vast territories unsuitable for cultivation. In total, the agricultural sector has incurred losses of approximately $41 billion due to military operations and the temporary occupation of territories (Khan & MacDonald, 2023).

Post-war land governance in Ukraine's agribusiness sector will face a complex set of interrelated challenges that demand a comprehensive strategic response. One of the principal issues is the absence of a complete and reliable land cadastre, which hinders the verification of land ownership rights and limits landowners' access to recovery programs. This deficiency may lead to widespread land abandonment. Such neglected areas become increasingly vulnerable to erosion as well as contamination by landmines and unexploded ordnance, thereby compromising their safety and future usability.

The shortage of qualified personnel, particularly land surveyors and specialists in digital cartography, will present additional obstacles to restoring accurate land records and improving governance quality. Physical destruction caused by the war, including damage to infrastructure and environmental degradation, further compounds the situation. The collapse of key systems, notably the electronic land cadastre, could derail land administration processes, while soil contamination and landmine hazards will continue to diminish both the agricultural and broader economic potential of affected areas.

Addressing this complex web of interrelated issues requires legal reforms and economic measures aimed at restoring institutional capacity and implementing large-scale ecological rehabilitation to recover land resources that are safe and fit for use. International financial and technical assistance will be critically important to ensure that Ukraine and its agribusiness sector can navigate this difficult post-war landscape as efficiently as possible.

For agribusinesses whose land resources have been affected by the consequences of military operations, post-war recovery will depend heavily on support for demining and soil fertility restoration. This support could be provided by the state in the form of temporary tax incentives or direct financial compensation for the implementation of such measures, along with targeted international financial aid.

Thus, the challenges of post-war land governance in Ukraine are deeply interwoven. Successful recovery demands an integrated approach that combines technical-legal, economic, institutional, and environmental solutions aimed at breaking the vicious cycle currently obstructing progress and laying the foundation for sustainable development.

To systematize the key post-war challenges faced by the state in establishing the foundations necessary for effective land resource governance in agribusiness, and to propose potential interventions, Table 1 has been compiled.

Table 1

Key post-war challenges faced by the state in establishing the necessary foundations for effective land resource management in agribusiness and proposed potential measures

Challenge	Possible measure	Required support
Lack of cadastral data	Digitization	International grants
Landmine hazard	Demining	Financial assistance
Soil contamination	Remediation	Environmental funds
Shortage of qualified experts	Educational programs	Financial and technical assistance

Note. Table created by authors

3. Case Studies and Historical Practices

Ukraine and its agricultural sector face numerous post-war challenges in land resource management, including legal uncertainty, institutional weaknesses, economic losses, and environmental degradation. These challenges are common; many countries emerging from conflict have experienced similar issues and adopted innovative solutions that Ukraine can learn from. One urgent need is restoring land ownership records lost or destroyed during the war. This gap hinders reconstruction, agricultural development,

agribusiness activities, and the return of internally displaced persons. After the conflict in Bosnia and Herzegovina (1992–1995), the Commission for Real Property Claims of Displaced Persons and Refugees (CRPC) was established. By 1999, it processed over 175,000 claims and issued nearly 50,000 certificates of ownership rights (Martyn & Bavrovska, 2024). However, enforcement was limited by the commission's authority and local resistance. Destruction of farmland and infrastructure complicated farming and resettlement. Additional problems included landmine contamination and unclear land titles. This experience highlights the need to link land reforms with broader economic recovery efforts.

Similarly, Syria and Iraq faced extensive land governance issues after prolonged violence and displacement. In Syria, damage to property records and shifts in territorial control made verifying ownership rights difficult. In Iraq, after 2003, instability caused widespread land grabs and disputes over abandoned properties. Despite legal reforms and compensation efforts, weak institutions and ongoing unrest limited success. Community dispute resolution and international aid made some progress, but enforcing formal property rights remains challenging (Williams, 2006). Agriculture also suffered due to destroyed irrigation systems, neglected arable land, and landmine threats, further worsening food insecurity and rural poverty.

Like Bosnia and Herzegovina, Ukraine must secure property rights for internally displaced persons returning to destroyed, occupied, or undocumented land and housing. As in Syria and Iraq, illegal land occupation, legal document issues, destruction of records, and instability threaten recovery. Past experiences with long legal processes and institutional weakness emphasize Ukraine's urgent need to establish an efficient restitution system.

Clear laws and quick property return processes are vital to prevent conflicts and meet basic needs. Restoring trust in land governance is especially important in rural and conflict-affected areas, where records may be lost. Ukraine should create specialized restitution agencies with legal authority and technical skills, especially in mapping and document reconstruction, and provide sufficient funding. Mobile units, similar to those in Syria and Iraq, could improve access to justice in remote or dangerous regions and help rebuild confidence in government institutions.

Using digital tech for land registry recovery improves transparency and trust. For example, Georgia's National Agency of Public Registry used satellite images and community input after the conflict to digitize land data, improving accuracy, dispute resolution, and public trust (Spencer, 2024). Satellite data is also key for agricultural planning and mapping, aiding recovery. Still, challenges remain, such as accessing isolated areas and securing digital platforms from cyber threats. Georgia's experience underscores the importance of combining tech solutions with local input.

Colombia, after years of conflict, also used innovative methods for managing land rights. In a pilot project with Peersyst and Ripple Labs, blockchain was used to register property rights, creating transparent, tamper-proof records. This helped reduce informal land occupation and attracted more investment in agriculture. However, political changes halted the project, showing that digital reforms need stable institutions and long-term political support (Colombia puts its land registry on Ripple blockchain, 2022).

Therefore, Ukraine must align technological advances with lasting political dedication to promote agricultural growth. Building a transparent, reliable cadastral system is key to Ukraine's recovery. Learning from Georgia and Colombia, Ukraine should develop digital platforms using satellite imagery and blockchain to protect and update land records. This will improve data accuracy, security, and trust among the public and businesses – crucial for resettlement, rebuilding, and farming. The plan should include an open, tamper-proof cadastral system that incorporates data on demining and environmental factors. Engaging local communities in mapping, as Georgia did, will be critical for ensuring the system's effectiveness and inclusivity.

Ukraine should also seek international support, especially from countries with experience restoring land governance after conflicts. For instance, after extensive record destruction and population displacement in Kosovo, international aid through the United Nations Interim Administration Mission (UNMIK) helped reestablish land administration. The Kosovo Cadastral Agency reformed land laws, created a centralized system, and built local capacity (Shang & Price, 2019). These steps helped restore

agricultural productivity disrupted by land disputes and showed the importance of strong institutions and international backing.

A comparable approach was carried out in Timor-Leste, where the United Nations Transitional Administration set up the Directorate of Land, Property, and Cadastral Services. International experts helped with training and capacity-building efforts, which were crucial for clarifying land rights and restoring agriculture as a way to stabilize the economy. This experience highlights the importance of coordinated international effort and developing local capacities for effective land governance after conflicts.

Post-war recovery in Ukraine requires rebuilding land administration institutions to ensure good governance, support reconstruction, and promote agricultural development. Building on the experiences from Kosovo and Timor-Leste, Ukraine should proactively establish international partnerships to secure technical assistance, training, and support for institutional growth. Twinning initiatives with land governance agencies from the EU and Canada could foster system updates, legislative reforms, digital cadastral platforms, and coordination of demining efforts. Such cooperation would help create a transparent, efficient, and resilient land administration system in Ukraine. Equally important is integrating environmental restoration into spatial planning to ensure safe and sustainable conditions for population return, reconstruction, and agricultural business growth (Todorovski et al., 2015).

For example, in Croatia, demining efforts led by the Croatian Mine Action Centre played a key role in restoring land usability and reviving agriculture, which had been devastated by landmines and unexploded ordnance. Systematic clearing of affected areas allowed displaced populations to safely return to economic activities. By 2024, the contaminated land area had decreased to 91.2 square kilometers, reflecting a sustained government focus on combining demining with ecological restoration and rural development. Croatia's experience shows the importance of aligning clearance efforts with community support – a vital lesson for regions in Ukraine affected by landmines (Croatia's demining experts hope to clear country of landmines by 2026, 2024).

After World War II, Germany faced widespread land contamination from unexploded ordnance and industrial pollution. The Federal Soil Protection Act created the legal framework for identifying, assessing, and cleaning up contaminated sites, while also holding polluters responsible. Notably, the cleanup of the Kesslergrube landfill involved participation from companies like Roche and BASF, which used excavation, thermal treatment, and containment barriers to prevent further pollution. Additionally, the Research Institute of Post-Mining (FZN) at Georg Agricola University of Applied Sciences has developed approaches for sustainable use of post-mining land and groundwater monitoring. Germany's strategy demonstrates how coordinated legal, industrial, and scientific efforts are effective in accomplishing environmental recovery and land rehabilitation.

In France, post-war reconstruction also incorporated ecological restoration into spatial planning through the adoption of the Loi d'Orientation sur l'Aménagement et le Développement du Territoire (LOADT). This law made sure environmental considerations were part of the recovery process in affected regions. Moreover, the government started soil reclamation programs in former industrial zones to remove contamination and restore land for farming and residential use, fueling sustainable regional growth.

The challenges Ukraine may face are similar to those experienced by Croatia, Germany, and France after conflicts. Croatia's efforts to combine demining with ecological restoration and spatial planning enabled safe return and recovery of farmland. Post-war strategies in Germany and France emphasize the importance of integrating restoration with soil remediation and land zoning, considering both environmental and economic factors. For Ukraine, this means coordinating clearance, environmental recovery, and spatial planning efforts. Priority should be given to integrated demining and support for displaced persons and agriculture, working closely with international partners. This approach would promote safe return, sustainable growth, and better land governance.

Effective post-conflict recovery depends on strong cooperation among government agencies, donors, NGOs, and local communities. For example, in Mozambique, the Program Aid Partners initiative in the 2000s improved coordination between the government and donors, making aid more efficient and reducing

duplication. Similarly, the Integrated Landscape Management portfolio aligned projects focused on sustainable resource use and rural livelihoods. In Sri Lanka, the Post-Disaster Recovery Plan (2016–2017), led by key ministries with support from the United Nations and the World Bank, used a comprehensive recovery approach. Through the AGORA method, government agencies, local authorities, and civil society worked together in planning processes that built long-term resilience (Mozambique's integrated landscape management portfolio (ILM), n.d.).

Ukraine's post-war rebuilding needs a centralized coordination system to prevent fragmented efforts and inefficient use of resources. Learning from Mozambique and Sri Lanka, Ukraine should set up a National Land Recovery Coordination Council (NLRCC) to connect national and regional authorities, donors, NGOs, and local governments. A shared digital platform would allow real-time progress tracking, identifying gaps, and managing aid more effectively, improving transparency and accountability.

Approaches to land recovery vary based on a country's income level and capacity. Low-income countries typically rely on donor support and rebuilding institutions; middle-income countries like Ukraine focus on digitalization and capacity-building; while high-income countries use advanced technologies backed by strong institutions. As a middle-income country, Ukraine is well-placed to adopt a hybrid approach that combines international aid, digital innovation, and institutional strengthening. Innovative solutions tested worldwide hold promising prospects for Ukraine and its farming sector. Satellite imagery provides quick assessments of land degradation and helps plan recovery efforts. Blockchain technology, used in Colombia and Georgia, improves transparency and security in land registries. Public-private partnerships contribute investment, expertise, and local knowledge, reinforcing sustainable land governance systems.

Although Ukraine faces major challenges, these are not unprecedented. Successfully applying strategies like accelerated restitution, blockchain-based digital cadastres, ecological zoning, and coordinated donor efforts could lay a strong foundation for rebuilding and managing land resources effectively in farming. Ultimately, success depends on how quickly, precisely, and decisively Ukraine can adopt and implement these global best practices.

4. Conclusion

The restoration of land governance systems in Ukraine's agricultural sector following the war presents urgent and multifaceted challenges – from the destruction of registries to widespread environmental contamination – that demand coordinated, multidimensional state reforms and sustained external support. Comparative experiences from Bosnia, Rwanda, Georgia, and Croatia underscore that successful recovery hinges on the rapid yet lawful restitution of land rights, the establishment of secure digital cadastre systems, and the rebuilding of institutional capacity and public trust.

In Ukraine, restoring land governance is not merely a technical process of reestablishing property rights; it is a fundamental driver of livelihood restoration, state legitimacy, and inclusive, sustainable development. Addressing this challenge requires an integrated and adequately resourced strategy that links land reform with ecological rehabilitation, merges domestic policy innovation with international expertise, and promotes digital transformation alongside community-level engagement.

With coherent international assistance and firm political commitment, Ukraine has the potential to turn its land governance crisis into a blueprint for institutional modernization and spatial revitalization. Conversely, delayed action risks deepening economic fragility, aggravating social fragmentation, and weakening the long-term foundations for peace and resilience.

Given Ukraine's position as a middle-income country, future land policy efforts should prioritize the digitalization of land registries and the securing of property and user rights as core levers of economic recovery. These efforts must incorporate insights from both low- and high-income recovery models, while remaining attuned to Ukraine's specific institutional and socio-political realities.

At this critical juncture, mobilizing collective political will is imperative for ensuring the inclusive and timely implementation of these measures – measures that will anchor Ukraine's long-term recovery and provide durable support to its agricultural sector.

Finally, future research should explore the effectiveness of digital cadastral technologies in

post-conflict settings and the design of participatory land governance frameworks that promote equitable access and sustainable agricultural redevelopment. Evaluating the socio-economic outcomes of land restitution policies will be key to shaping adaptive, context-specific strategies. These research avenues will reinforce the empirical basis for evidence-driven policymaking and support the resilient reconstruction of Ukraine's agrarian landscape.

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