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CONTAMINATED AND POTENTIALLY HAZARDOUS AGRICULTURAL LAND IN THE SYSTEM OF UKRAINE'S FOOD SECURITY FACTORS

The article develops a model that distinguishes the procedural status of a land area from the verifiability of reported data when estimating the agricultural potential of land affected by mine action. The model prevents operationally surveyed, formally released and actually cultivated areas from being treated as one measure of restored productive capacity. Only land with a reported production status enters the physical-output scenarios; certified land without evidence of cultivation remains outside them. The model also specifies the site-level data needed for NPV and benefit-cost analysis: release and restoration costs, time to first harvest, crop, yield and product use, without deriving those indicators from disconnected aggregates. Contaminated land is interpreted as a constraint on absorptive capacity, agronomic recovery as an adaptive function, and registry integration as a transformative function.

Keywords: Ukraine's food security, agricultural land, explosive-ordnance contamination, humanitarian demining, land release, procedural status of a land area, data verifiability, strategic management, agri-food system.

JEL Classification: Q18, Q15, Q12, H56, C81.

ЗАБРУДНЕНІ ТА ПОТЕНЦІЙНО НЕБЕЗПЕЧНІ СІЛЬСЬКОГОСПОДАРСЬКІ ЗЕМЛІ В СИСТЕМІ ЧИННИКІВ ПРОДОВОЛЬЧОЇ БЕЗПЕКИ УКРАЇНИ

У статті розроблено модель, яка дає змогу розмежувати процедурний статус земельної ділянки та верифікованість повідомлених даних під час оцінювання сільськогосподарського потенціалу земель, що зазнали впливу мінної небезпеки. Запропонована модель запобігає ототожненню земельних площ, обстежених в оперативному порядку, формально вивільнених та фактично введених у сільськогосподарське використання, з єдиним показником відновленої продуктивної спроможності.

Обсяги виробництва оцінено за комбінованим сценарним орієнтиром: структуру посівів наближено до довоєнної структури південних регіонів України, а врожайність задано на рівні середніх загальнонаціональних показників. Такий орієнтир не відтворює продуктивність конкретного регіону і не враховує повною мірою деградацію ґрунтів та особливості неполивного землеробства. Грошові оцінки наведено в єдиній ціновій базі; вони не є прогнозом поточної інвестиційної дохідності. Зіставлення з актуальними публічними повідомленнями використано лише для перевірки порядку величини оцінок.

Науковий внесок дослідження полягає у формуванні двовимірної класифікації повідомлених земельних площ за процедурним статусом та рівнем верифікованості джерел даних, доповненої моделлю управлінського циклу, заснованою на реєстрових даних і такою, що поєднує вивільнення земель, агрономічне відновлення, їх сільськогосподарське використання, економічне оцінювання та результати у сфері продовольчої безпеки. Концептуальна модель може застосовуватися для моніторингу та визначення пріоритетів відповідних програм без ототожнення неоднорідних показників земельних площ з імовірностями переходу між різними статусами. Забруднені землі інтерпретуються як обмеження абсорбційної спроможності, агрономічне відновлення – як адаптивна функція, а інтеграція реєстрів – як трансформаційна функція.

Ключові слова: продовольча безпека України, сільськогосподарські землі, забруднення вибухонебезпечними предметами, гуманітарне розмінування, вивільнення земель, процедурний статус земельної ділянки, верифікованість даних, стратегічне управління, агропродовольча система.

Problem statement. Wartime contamination of agricultural land has substantially reduced the resource base of Ukraine's agricultural sector and weakened the absorptive

capacity of the national food system. Eliminating explosive hazards alone is insufficient to restore agricultural production. Productive land use also requires agronomic

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assessment, land rehabilitation, and the recovery of irrigation systems, agricultural machinery, logistics infrastructure, and working capital. At the same time, integrating mine action, cadastral, agricultural, and production datasets performs a broader transformative function by enabling evidence-based recovery planning.

According to the Accounting Chamber of Ukraine, 9.85 million hectares of agricultural land across ten regions remain unavailable for safe use. The audit also reports 7.75 thousand hectares officially returned through certified land release and 402.7 thousand hectares released following operational survey activities. The nearly 52-fold difference between these estimates reflects differences in operational procedures, documentary verification, and residual risk management rather than inconsistencies in reporting [1, pp. 3–4]. Publicly available official statistics further report 286 thousand hectares of returned land, 225 thousand hectares with documented cultivation and harvesting, 12,287.5 hectares partially reimbursed under the 2025 State Demining Compensation Programme, and 16 thousand hectares announced in July 2026 [2–4]. Since these figures originate from different programmes, reporting periods, and verification frameworks, combining them into a single statistical series would substantially overestimate the recovered agricultural production base.

From an economic perspective, assessment should trace the sequential transition from the spatial footprint of potential contamination to measurable agricultural and food-system outcomes. Land release does not necessarily imply agricultural cultivation; harvested output is not equivalent to domestic food availability; gross agricultural output cannot be equated with gross value added (GVA) or net social benefit; and production potential alone, without comparison against recovery costs, is insufficient to demonstrate economic viability.

Analysis of Recent Research and Publications.

Armed conflict alters the morphology, density, chemical composition, and biological properties of soils, while many forms of environmental degradation persist even after explosive hazards have been removed [5, pp. 1–15; 6]. In Ukraine, documented consequences include mechanical soil degradation, contamination by fuel residues and heavy metals, structural disturbance, and risks associated with explosive remnants of war [7]. Although geospatial mapping effectively identifies potentially contaminated areas, it cannot substitute for formal land release procedures or subsequent agronomic verification of land suitability for agricultural use [8].

Studies by the Geneva International Centre for Humanitarian Demining (GICHD) and the United Nations Development Programme (UNDP) demonstrate that mine action contributes not only to public safety but also to the restoration of productive assets, household incomes, mobility, and market access [9–11]. At the operational level, IMAS 07.11 (Edition 2) establishes the international framework governing land release, including requirements for national land release systems, institutional responsibilities, and evidence-based decision-making [12]. In Ukraine, these principles are incorporated into the National Mine Action Strategy and its updated implementation plan [13–14].

The audit conducted by the Accounting Chamber of Ukraine clearly distinguishes between different land release procedures. During 2022–2024, accredited mine action operators cleared 21 thousand hectares, of which 5.3 thousand hectares were officially released through certification, whereas the security and defence sector surveyed 598.2 thousand hectares and returned 402.7 thousand hectares to productive use [1, pp. 33–36]. Consequently, the generic term "returned land" provides little analytical value unless accompanied by information on the release procedure, certification status, and subsequent agricultural utilisation.

A key policy benchmark is SDG Indicator 2.5.1, defined as the share of agricultural land returned to cultivation relative to the area that remained inaccessible as of June 2024 [15]. However, meaningful economic interpretation of this indicator requires metadata describing the numerator, the procedure used to verify agricultural cultivation, and the spatial correspondence between contamination and release boundaries.

The FAO Food Balance Sheet framework distinguishes agricultural production from trade, stock variation, feed use, seed use, industrial utilisation, food consumption, and post-harvest losses [16]. Accordingly, restored production volume represents only primary agricultural output, whereas assessing food availability and food access requires information on the subsequent allocation of that output throughout the food system.

From the perspective of economic appraisal, project evaluation should compare with-project and without-project scenarios while accounting for full economic costs, discounting, and alternative intervention strategies. Both the Economic Appraisal Vademecum 2021–2027 and the World Bank appraisal framework recommend selecting the most appropriate evaluation method according to project characteristics, including cost–benefit analysis (CBA), cost-effectiveness analysis (CEA), least-cost analysis (LCA), or multi-criteria analysis (MCA) [17–18].

Sitnicki et al. [19] examine coordination in agricultural market clusters, Pimenowa et al. [20] analyse sustainable business models under uncertainty, and Sitnicki and Kurinskyi [21] discuss managerial development of Ukraine's agricultural sector under EU integration. Pereguda [22] focuses on digitalisation of circular business models in the agro-industrial complex, while Pereguda and Biloshkurska [23] analyse digital transformation and international cooperation. Sitnicki and Kurinskyi [24] examine organisational constraints on agricultural exports; Sitnicka and Serhiienko [25] analyse adaptation to wartime shocks; Sitnicki et al. [26] assess the commercial potential of new product ideas; and Sitnicki [27] links innovation potential with strategic flexibility. For mine-contaminated agricultural land, these studies inform the managerial and information dimensions of recovery; procedural verification of land release and confirmation of actual cultivation remain separate requirements.

The unresolved methodological issues are the classification of indicators by data source and verification status, the distinction between operational survey activities and land release under national mine action standards, the use

of unrelated administrative aggregates as if they represented transition probabilities for individual land parcels, and the specification of data required for net present value (NPV), benefit–cost ratio (BCR), and food balance analyses.

Research Objective. The objective of this study is to develop an evaluation framework for agricultural recovery potential that explicitly distinguishes between the procedural status of land and the verification status of supporting data. The research comprises five interrelated tasks: (i) auditing available data sources; (ii) developing a status–procedure framework; (iii) classifying the key analytical parameters; (iv) conducting scenario-based estimates of agricultural output under alternative land areas and relative yield coefficients; and (v) verifying the order of magnitude of the results while identifying the information required for both food balance analysis and investment appraisal.

Research Methods. Methods of analysis and synthesis were used to examine regulatory documents, audit materials, official statistics, and programme reports. Comparison method was used for distinguishing survey, clearance, formal land release, and actual cultivation. Classification method allowed to group indicators by information source, procedural status, and verification level. The scenario method was used for estimating the potential agricultural output under alternative land-area and relative-yield

assumptions. The calculation method allowed to determine the physical output and indicative gross value on a common price basis. Scenario outputs are estimates of production potential, not statistical forecast intervals.

Presentation of the main results of the study. The basic analytical unit is defined as the combination of spatial boundary – procedure – status – reference date – land use – crop – scenario. For land classified as either a Suspected Hazardous Area (SHA) or a Confirmed Hazardous Area (CHA), the area eligible for current production calculations is assumed to be zero until the appropriate sequence of Non-Technical Survey (NTS), Technical Survey (TS), and/or clearance has been completed. The cancellation of suspicion, area reduction, or clearance may provide the basis for documented land release; however, none of these procedures confirms agronomic suitability, actual cultivation, or crop production.

Data sources were classified according to their functional role and the verification level of the reported indicators (Table 1). Regulatory and methodological documents, audit reports, official statistics, programme reporting, official communications, and author-generated estimates each serve distinct analytical purposes. Audit reports and official statistical datasets developed under clearly defined methodological frameworks were classified as high-verification sources (Figure 1).

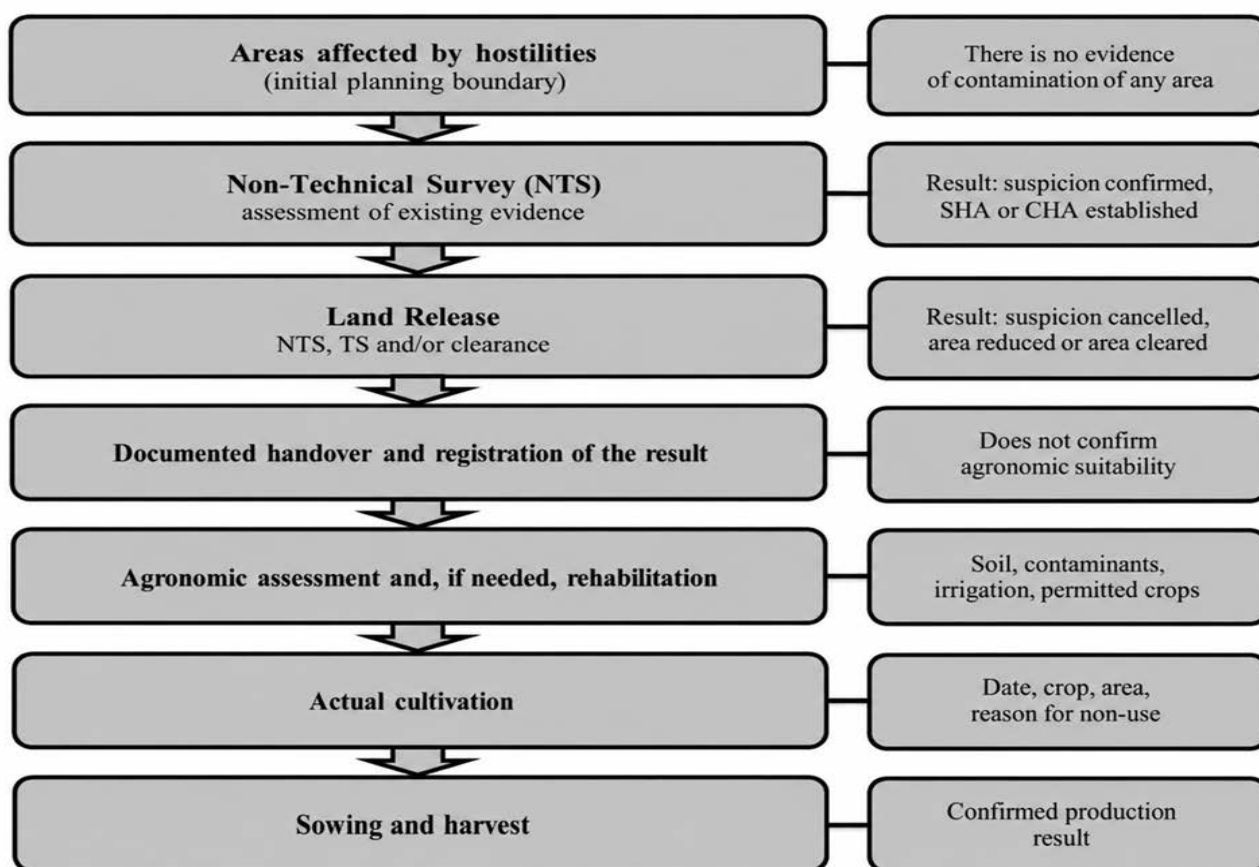


Figure 1. Status–Procedural Sequence for Returning Agricultural Land to Productive Use

Source: systematised by the author based on [1; 12–13; 28].

Table 1

Categories of the Procedural Status of a Land Area and Permissible Analytical Use

Procedural Status of the Land Area	Economic Interpretation	Production Calculation	Required Verification
Area affected by hostilities	Planning boundary; does not constitute evidence of contamination at the individual site level	Excluded	Data source, spatial geometry, date
Suspected Hazardous Area (SHA)	Indirect evidence of a hazard	Asc = 0	NTS/TS; cancellation, reduction, or clearance
Confirmed Hazardous Area (CHA)	Direct evidence of a hazard	Asc = 0	TS, clearance, quality control
Surveyed / returned by the security and defence sector	Operational activities; not equivalent to land release under national standards	Excluded unless cultivation is confirmed	Method, result, residual risk, handover document
Cancelled, reduced, or cleared in accordance with applicable standards	The relevant land release method has been completed	Not yet classified as cultivated land	Documented handover; agronomic assessment
Actually brought into cultivation	Agricultural use has been confirmed	Basis for scenario-based production estimates	Date, crop, area, agronomic condition
Sown and harvested area	Production outcome has been confirmed	Highest verification status for physical output estimation	Yield, product quality, intended use

Source: systematised by the author based on [1; 12–13; 28].

Programme reporting was assigned a moderate verification level because its indicators are defined within individual programme frameworks. Author-generated assumptions, scenario parameters, and transferred coefficients

were treated as scenario-based evidence (Table 2). Publication on an official government website alone does not make a press communication an official reporting instrument.

Table 2

Land Area Estimates Reported in Public Sources, Their Verification Level, and Permissible Analytical Use

Area	Description of the Indicator	Source Type	Verification Level	Permissible Analytical Use
9,850.0 thousand ha	Agricultural land unavailable for safe use across ten regions	Accounting Chamber Audit, 2025	High	Indicates the overall scale of the problem; does not constitute evidence of contamination at the individual parcel level
598.2 thousand ha	Surveyed by the security and defence sector during 2023–2024	Accounting Chamber Audit, 2025	High	Measure of operational survey activity
402.7 thousand ha	Returned following operational survey	Accounting Chamber Audit, 2025	High	Not equivalent to land release under national standards
21.0 thousand ha	Cleared by mine action operators during 2022–2024	Accounting Chamber Audit, 2025	High	Clearance output; documented handover is confirmed separately
7.75 thousand ha	Returned through issued land release certificates	Accounting Chamber Audit, 2025	High	Documented land transfer following certification
12,287.5 ha	Demined after 15 April 2024; costs partially reimbursed under the 2025 budget programme	Budget Programme Implementation Report, 2026	Moderate	Programme performance indicator; does not confirm actual agricultural cultivation
286.0 thousand ha	Reported as returned during 2024	Official press communication, 2025	Limited	Scenario representing administratively reported land area
225.0 thousand ha	Reported as sown and harvested during 2024	Same press communication, 2025	Limited	Scenario representing land with confirmed production status; the relationship to the reported 286.0 thousand ha has not been demonstrated
16.0 thousand ha	Announced on 3 July 2026 as demined agricultural land	Statement by Minister Oleksii Sobolev, reported by the media, 2026	Limited	Updated figure used for an order-of-magnitude verification

Note: The ratio $402.7 / 7.75 = 51.96$ compares different procedural categories and should not be interpreted as a measure of operational performance or effectiveness.

Source: compiled based on [1, pp. 3–4, 33–36; 2–4].

The audit clearly distinguishes between 402.7 thousand hectares returned following operational survey activities

and 7.75 thousand hectares officially transferred through land release certification. The reported figure of 286

thousand hectares may partially overlap with areas covered by operational activities, but the publicly available data do not quantify this overlap. The indicator is therefore used only as an upper-bound scenario for the administratively reported land area.

The 286- and 225-thousand-hectare figures are retained

because the same publicly available 2024 source reports both the administratively recorded land area and the area with documented cultivation and harvesting. The ratio $225/286 = 78.7\%$ is used only as a descriptive statistic and is not extrapolated to individual regions or land parcels (Table 3).

Table 3

Classification of Model Parameters

Parameter	Value	Parameter Status	Source / Verification Level	Role in the Model
Aprod	225 thousand ha	Reported area with documented cultivation and harvesting	Official press communication / Limited	Scenario representing land with confirmed production status
Aadm	286 thousand ha	Administratively reported land area	Official press communication / Limited	Upper-bound scenario; agricultural cultivation not confirmed
Crop structure	2019–2021 crop shares	Scenario-based transfer of crop shares	Official statistics / High; transfer is scenario-based	Crop shares approximating the pre-war production structure of southern Ukraine
Yield	National average, 2019–2021	Scenario-based parameter transfer	Official statistics / High; transfer is scenario-based	National benchmark; not intended to represent regional yields
f_y	0.90 or 1.00	Relative yield coefficient	Author's assumption / Scenario-based	0.90 represents a 10% yield reduction; not a confidence limit
Prices	Average prices, 2021	Statistical parameter	Official statistics / High	Indicative values expressed in constant prices
7.75 thousand ha	Land transferred through certification	Documented land transfer	Audit / High	Excluded from output estimates unless actual agricultural cultivation is confirmed

Source: developed by the author based on [1–2; 29].

The scenario-based physical output was estimated for the land area that the underlying data source identifies as having production status, together with a separate scenario based on the administratively reported land area. The proposed model does not assume that either the actual crop structure or the pre-war productivity of individual land parcels has been restored.

The applied crop–yield profile is a composite scenario.

Crop shares were approximated using the pre-war production structure of southern Ukraine, whereas crop yields were represented by the national average values for 2019–2021. This profile serves as a standardised scenario benchmark for the national aggregates of 225 thousand hectares and 286 thousand hectares and is not intended to reproduce the productivity of rain-fed agriculture in any specific southern region.

$$Q_{sc} = A_{sc} \times \sum_c (a_c \times \bar{y}_{c,2019-2021}) \times f_y \quad (1)$$

where:

A_{sc} denotes the land area under the respective scenario;

a_c is the assumed crop share;

$\bar{y}_{c,2019-2021}$ is the average pre-war crop yield;

f_y is the relative yield coefficient.

A value of $f_y = 0.90$ represents a 10% reduction in yield under the scenario assumptions, whereas $f_y = 1.00$

represents the baseline scenario. The indicative gross output value was estimated using the average agricultural producer prices recorded in 2021:

$$V_{ind} = \sum_c Q_{sc,c} \times \bar{p}_{c,2021} \quad (2)$$

The indicator V_{ind} represents the indicative gross value of primary agricultural output. It should not be interpreted

as gross value added (GVA), net income, fiscal impact, or net social benefit (Figure 2). The use of 2021 producer

prices ensures a consistent valuation framework across scenarios while deliberately excluding the effects of current

netback prices, logistics-related price differentials, and product quality adjustments.

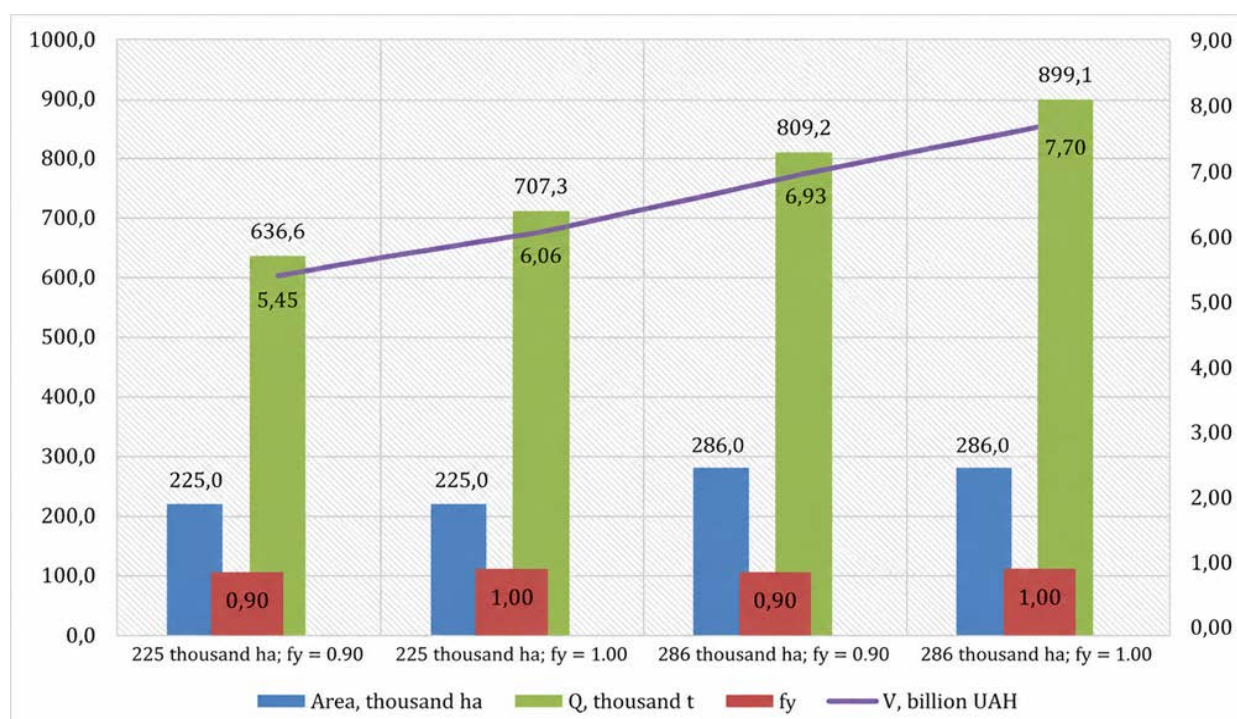


Figure 2. Scenario Matrix of Land Area and Relative Yield Coefficient

Source: calculated by the author based on [2; 29].

Because the underlying land cohorts, indicator definitions, and price years differ, the comparison is used only as

an order-of-magnitude check; it is not a formal validation (Table 4).

Table 4

Assumed Crop Structure under the Composite Baseline Scenario for the 225 Thousand ha Area

Crop	Area (thousand ha)	Output (thousand t)	Main End Use	Data Required for Food System Assessment
Wheat	92.7	330.6	Milling, feed, seed, export	Domestic availability, flour milling, losses, stocks
Barley	38.6	132.7	Feed, food processing, export	Feed and food use, losses
Sunflower	66.6	119.1	Oil processing, seed and oil exports	Processing share, oil extraction rate, domestic utilisation
Maize	10.0	85.5	Feed, starch processing, export	Feed and industrial use, stocks
Rape-seed	17.0	39.4	Oil processing, predominantly export	Domestic processing and food use
Total	225.0	707.3	Primary agricultural output	Complete commodity balance by crop

Source: calculated by the author based on [2; 29]; utilisation pathways systematised based on [16].

The implied crop yields are 3.57 t/ha for wheat, 3.44 t/ha for barley, 1.79 t/ha for sunflower, 8.55 t/ha for maize, and 2.32 t/ha for rapeseed. For maize, the analysis applies the national average yield for 2019–2021; no estimate of rain-fed yields in southern Ukraine was used [29].

Cereal and oilseed crops contribute to food security

through different pathways. Sunflower and rapeseed primarily support farm income, processing activities, and exports, whereas wheat, barley, and maize are allocated among food, feed, seed, industrial, and export uses.

The transition from primary agricultural output to the domestic food supply is expressed as:

$$Q_{food,c} = Q_{sc,c} \times d_c \times (1 - l_c) \times k_{food,c} \quad (3)$$

where:

d_c denotes the share of domestic availability after accounting for trade and stock changes;

l_c represents losses;

$k_{food,c}$ is the proportion allocated to food use after excluding feed, seed, and industrial processing.

Equation (3) is not evaluated numerically, as publicly available data do not link the scenario-based production estimates with these commodity flows at the crop level.

Physical output (tonnes) or gross output value per hectare characterises production potential, but not cost efficiency. Investment appraisal requires information on the

costs of survey, clearance, quality assurance, land handover, land rehabilitation, irrigation and drainage restoration, logistics, insurance, and working capital. Economic benefits should be assessed on an incremental basis relative to the without-project scenario [17–18].

$$NPV_r = -C_{0,r} + \sum_t \frac{B_{t,r} - C_{t,r}}{(1+i)^t}; BCR_r = \frac{PV(B_r)}{PV(C_r)} \quad (4)$$

Equation (4) establishes the parcel-level criterion for cost–benefit evaluation. Its application requires linked information on land status, date of handover, total project costs, actual crop cultivated, crop yield, time to first harvest, and end use of production. No integrated dataset currently links these variables, so NPV and BCR were not estimated. The empirical analysis is limited to scenario-based physical output and its indicative gross value [1; 16–18].

The allocation of institutional responsibilities should correspond to the successive stages of the process. The national mine action authority and mine action operators are responsible for land release decisions and handover; agronomic institutions assess soil condition and crop-related constraints; agricultural producers are responsible for actual cultivation; the registry administrator links production data with land status and cost information; the programme authority conducts the economic appraisal; and statistical and market institutions evaluate food system outcomes. A single land-area indicator cannot simultaneously measure land safety, agricultural production, and economic efficiency. The integrated registry should include the polygon identifier, procedural status, land release method, date and handover documentation, residual risk, agronomic

assessment results, date of cultivation, crop, harvested area, yield, end use of production, costs, and the reason for non-use. Such a registry would enable the calculation of the land returned to cultivation indicator while distinguishing among absorptive, adaptive, and transformative outcomes.

The estimated range of UAH 5.45–7.70 billion should not be added to the RDNA5 estimates of damage, losses, or recovery needs, because the assessments differ in object, time horizon, price framework, and double-counting rules [30]. The proposed model also excludes mine-clearance and agricultural-recovery costs and therefore does not estimate net social benefits. The main limitations are the absence of cadastral linkages among aggregated datasets, the unknown actual crop structure, the combination of crop shares approximating the pre-war structure of southern Ukraine with national average yields, the potential decline in soil productivity, the use of 2021 prices, and the scenario assumption of $fy = 0.90$ (Figure 3). Without parcel-level data, time to first harvest cannot be estimated reliably, NPV and BCR cannot be calculated, and the estimated parameters cannot be transferred reliably to the regional level.

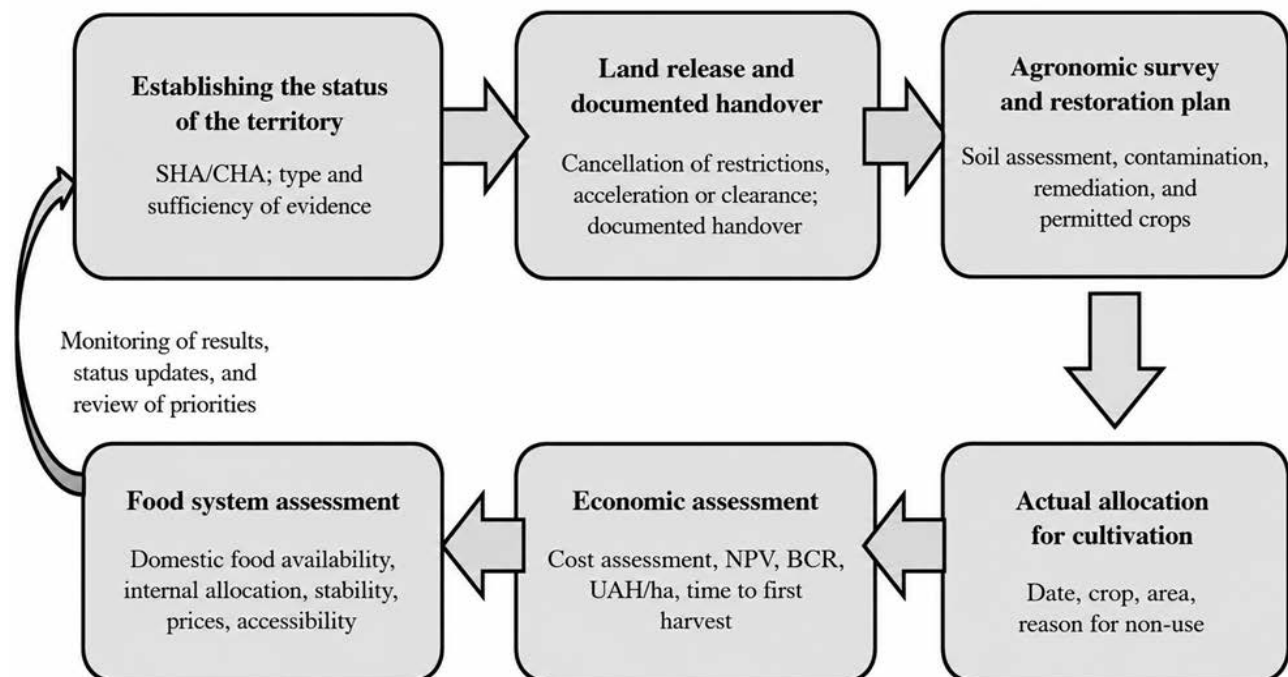


Figure 3. Management Cycle for Returning Agricultural Land to Productive Use
Source: developed by the author.

Conclusions. The model separates the procedural status of a land area from the verification level of the data source and prevents heterogeneous administrative aggregates from being reduced to a single indicator of restored agricultural potential. Its managerial value lies in establishing a comparable basis for monitoring, prioritising land parcels and budget programmes, and moving from the formal fact of land release to a verified production outcome.

Official mine action area figures do not constitute a single indicator. A total of 402.7 thousand ha was returned following operational survey, whereas 7.75 thousand ha was transferred through issued certificates; the 51.96-fold difference reflects distinct procedures and documentary standards. The figures of 286 thousand ha reported as returned and 225 thousand ha reported as sown and harvested originate from a press communication, while the ratio of 78.7% has no parcel-level reference. For the 225 thousand ha scenario, estimated output ranges from 636.6 to 707.3 thousand tonnes, with an indicative value of UAH 5.45–6.06 billion. Under the conditional cultivation of the entire administratively reported area of 286 thousand ha, the corresponding estimates are 809.2–899.1 thousand tonnes and UAH 6.93–7.70 billion. The applied profile combines crop shares approximating the pre-war structure of southern

Ukraine with national average yields for 2019–2021 and should therefore be interpreted as a scenario benchmark rather than a regional forecast.

The comparison between UAH 24.2 thousand per hectare in 2021 prices and the figure of more than UAH 62.5 thousand per hectare reported in 2026 shows only that the estimates do not differ by an order of magnitude. Moving from primary agricultural output to a food security outcome requires commodity balance data, while establishing economic priority requires full cost information and the calculation of NPV and BCR. Contaminated land constrains the absorptive capacity of the food system, agromomic recovery strengthens its adaptive capacity, and an integrated registry supports transformative capacity.

Declaration on the Use of Artificial Intelligence Tools. During the preparation of this article, generative artificial intelligence tools (ChatGPT-4, OpenAI, 2025) were used to support the search for and synthesis of relevant literature, as well as to improve the structure and logical coherence of the article. No AI-generated text was used without critical review and editorial revision. The author assumes full responsibility for the scholarly quality, accuracy, and integrity of the content.

References:

1. Accounting Chamber of Ukraine. (2025). Humanitarian demining of agricultural land in Ukraine: Restoring safety and agricultural production. Performance audit report approved by Decision No. 21-2 of 26 August 2025. https://rp.gov.ua/upload-files/Activity/Collegium/2025/21-2_2025/Zvit_21-2_2025.pdf [in Ukrainian].
2. Demine Ukraine. (2025, January 22). Innovative financing of humanitarian mine action discussed in Davos. <https://demine.gov.ua/news/u-davosi-hovoryly-pro-innovatsiine-finansuvannia-humanitarnoho-rozminuvannia> [in Ukrainian].
3. Ministry of Economy of Ukraine. (2026). Information on the achievement of planned objectives, tasks and performance indicators of budget programmes, as well as public policy objectives, based on 2025 results. <https://me.gov.ua/download/a07ed116-0288-4a66-9d2c-9417d93d24c1/file.pdf> [in Ukrainian].
4. LB.ua. (2026, July 3). Sixteen thousand hectares of agricultural land demined in Ukraine. https://lb.ua/economics/2026/07/03/749270_ukrayini_rozminovano_16_tisyach.html [in Ukrainian].
5. Certini, G., Scalenghe, R., & Woods, W. I. (2013). The impact of warfare on the soil environment. *Earth-Science Reviews*, (127), 1–15. <https://doi.org/10.1016/j.earscirev.2013.08.009>
6. Certini, G., & Scalenghe, R. (2024). War is undermining soil health and availability more than urbanisation. *Science of the Total Environment*, (908), Art. 168124. <https://doi.org/10.1016/j.scitotenv.2023.168124>
7. Solokha, M., Demyanyuk, O., Symochko, L., Mazur, S., Vynokurova, N., Sementsova, K., & Mariychuk, R. (2024). Soil degradation and contamination due to armed conflict in Ukraine. *Land*, 13(10), 1614. <https://doi.org/10.3390/land13101614>
8. Food and Agriculture Organization of the United Nations. (2025). Mapping impacted soils of war-affected farmers in Kharkiv oblast, Ukraine. FAO. <https://openknowledge.fao.org/items/77039d7f-40ea-48fb-9eeb-349d8043cf73>
9. Geneva International Centre for Humanitarian Demining, & United Nations Development Programme. (2017). Leaving no one behind: Mine action and the Sustainable Development Goals. <https://www.gichd.org/publications-resources/publications-and-reports/leaving-no-one-behind-mine-action-and-the-sustainable-development-goals/>
10. United Nations Development Programme, & Geneva International Centre for Humanitarian Demining. (2001). A study of socio-economic approaches to mine action. UNDP; GICHD. <https://digitallibrary.un.org/record/449304>
11. Jensen, S., Clarke, E., Meryon, R., Kirk, H., & Giugovaz, M. (2024). From economic recovery to global food security: The urgent need to demine Ukraine. Tony Blair Institute for Global Change. <https://institute.global/insights/geopolitics-and-security/the-urgent-need-to-demine-ukraine>
12. United Nations Mine Action Service. (2026). International Mine Action Standards: IMAS 07.11 Land release (2nd ed.). <https://www.mineactionstandards.org/standards/07-11/>
13. Cabinet of Ministers of Ukraine. (2024, June 28). Pro skhvalennia Natsionalnoi stratehii protyminnoi diialnosti na period do 2033 roku ta zatverdzhennia operatsiinoho planu zakhodiv z yii realizatsii u 2024–2026 rokakh [On approval of the National Mine Action Strategy until 2033 and the operational action plan for its implementation in 2024–2026] (Order No. 616-r). <https://zakon.rada.gov.ua/go/616-2024-%D1%80> [in Ukrainian].

14. Cabinet of Ministers of Ukraine. (2026, February 25). Pro vnesennia zmin do operatsiinoho planu zakhodiv z realizatsii u 2024–2026 rokakh Natsionalnoi stratehii protymynnoi diialnosti na period do 2033 roku ta vyznannia takymy, shcho vtratyly chynnist, deiakykh rozporiadzhen Kabinetu Ministriv Ukrainy [On amendments to the operational action plan for the implementation in 2024–2026 of the National Mine Action Strategy until 2033 and recognition of certain orders of the Cabinet of Ministers of Ukraine as no longer in force] (Order No. 191-r). <https://zakon.rada.gov.ua/go/191-2026-%D1%80> [in Ukrainian].
15. Cabinet of Ministers of Ukraine. (2024, November 29). Deiaki pytannia dosiahnennia Tsilei staloho rozvytku v Ukraini [Certain issues concerning the achievement of the Sustainable Development Goals in Ukraine] (Order No. 1190-r). <https://zakon.rada.gov.ua/go/1190-2024-%D1%80> [in Ukrainian].
16. Food and Agriculture Organization of the United Nations. (2001). Food balance sheets: A handbook. FAO. <https://www.fao.org/4/x9892e/x9892e00.htm>
17. European Commission. (2022). Economic Appraisal Vademecum 2021–2027: General principles and sector applications. Publications Office of the European Union. <https://doi.org/10.2776/182302>
18. World Bank. (2023). Bank policy: Investment project financing. <https://the-docs.worldbank.org/en/doc/6da2e812c0b8e84a1a614bb3c0507e5a-0290012023/original/Bank-Policy-Investment-project-financing.pdf>
19. Sitnicki, M. W., Kurinskyi, D., Pimenowa, O., Wasilewski, M., & Wasilewska, N. (2024). Strategic formation of agricultural market clusters in Ukraine: Emerging as a global player. *Sustainability*, 16(21), Art. 9430. <https://doi.org/10.3390/su16219430>
20. Pimenowa, O., Pimenov, S., Fyliuk, H., Sitnicki, M. W., Kolosha, V., & Kurinskyi, D. (2023). Sustainable business model of modern enterprises in conditions of uncertainty and turbulence. *Sustainability*, 15(3), 2654. <https://doi.org/10.3390/su15032654>
21. Sitnicki, M. W., & Kurinskyi, D. O. (2022). Upravliniski perspektyvy rozvytku vitchyznianoï aharnoi haluzi v umovakh statusu Ukrainy yak kandydata u chleny Yevropeiskoho Soiuzu [Managerial prospects for the development of the domestic agricultural sector in the context of Ukraine's status as a candidate for membership in the European Union]. *Efektivna ekonomika*, (8). <https://doi.org/10.32702/2307-2105.2022.8.14> [in Ukrainian].
22. Pereguda, Y. A. (2026). Tsyfrovizatsiia yak draiver vprovadzhennia tsyrkuliarnykh biznes-modelei v ahro-promyslovomu kompleksi [Digitalisation as a driver for the implementation of circular business models in the agro-industrial complex]. *Visnyk Sumskoho natsionalnoho aharnoho universytetu. Seriia «Ekonomika i menedzhment»*, 2(106), 161–169. <https://doi.org/10.32782/bsnau.D2026.2.24> [in Ukrainian].
23. Pereguda, Y., & Biloshkurska, N. (2026). Digital transformation as a strategic imperative for the development of innovative entrepreneurship in Ukraine in the context of international economic cooperation. *Social Development: Economic and Legal Issues*, (15). <https://doi.org/10.70651/3083-6018/2026.3.19>
24. Sitnicki, M. W., & Kurinskyi, D. O. (2022). Pidpysannia trystoronnoi zernovoi uhody yak rozviazannia orhanyzatsiino-upravlinyskykh problem ahropidpryemstv Ukrainy [Signing of the tripartite grain agreement as a solution to the organizational and management problems of the Ukrainian agricultural enterprises]. *Visnyk Kyivskoho natsionalnoho universytetu imeni Tarasa Shevchenka. Ekonomika*, 4(221), 58–63. <https://doi.org/10.17721/1728-2667.2022/221-4/8> [in Ukrainian].
25. Sitnicka, K., & Serhiienko, R. (2025). Business adaptation to extreme conditions: Analysis of business shocks in the context of the war in Ukraine. *SocioEconomic Challenges*, 9(4), 216–255. [https://doi.org/10.61093/sec.9\(4\).216-255.2025](https://doi.org/10.61093/sec.9(4).216-255.2025)
26. Sitnicki, M. W., Balan, V., Tymchenko, I., Sviatnenko, V., & Sychova, A. (2021). Measuring the commercial potential of new product ideas using fuzzy set theory. *Innovative Marketing*, 17(2), 149–163. [https://doi.org/10.21511/im.17\(2\).2021.14](https://doi.org/10.21511/im.17(2).2021.14)
27. Sitnicki, M. W. (2007). Vplyv innovatsiinoho potentsialu na stratehichnu hnuchkist pidpryemstva [The impact of innovation potential on the strategic flexibility of an enterprise]. *Statystyka Ukrainy*, (1), 43–47. https://www.researchgate.net/publication/340581608_Vplyv_innovacijnogo_potencialu_na_strategicnu_gnuchkist_pidpryemstva_Influence_of_Innovative_Potential_on_Strategic_Flexibility_of_Enterprise
28. Geneva International Centre for Humanitarian Demining. (2011). A guide to land release: Technical methods. <https://www.gichd.org/publications-resources/publications-and-reports/a-guide-to-land-release-technical-methods/>
29. State Statistics Service of Ukraine. (2022). Agriculture of Ukraine 2021: Statistical yearbook. Kyiv. https://www.ukrstat.gov.ua/druk/publicat/kat_u/2022/zb/09/sg_21.pdf.zip
30. World Bank, Government of Ukraine, European Commission, & United Nations. (2026). Ukraine Fifth Rapid Damage and Needs Assessment (RDNA5): February 2022 – December 2025. World Bank. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099022026094036395>

Список використаних джерел:

1. Accounting Chamber of Ukraine. Humanitarian demining of agricultural land in Ukraine: Restoring safety and agricultural production. Performance audit report approved by Decision No. 21-2 of 26 August 2025. URL: https://rp.gov.ua/upload-files/Activity/Collegium/2025/21-2_2025/Zvit_21-2_2025.pdf (дата звернення: 01.05.2026).

2. Demine Ukraine. Innovative financing of humanitarian mine action discussed in Davos. 22 January 2025. URL: <https://demine.gov.ua/news/u-davosi-hovoryly-pro-innovatsiine-finansuvannia-humanitarnoho-rozminuvannia> (дата звернення: 01.05.2026).
3. Міністерство економіки України. Інформація про досягнення запланованої мети, завдань та результативних показників бюджетних програм, а також цілей державної політики за результатами 2025 року. 2026. URL: <https://me.gov.ua/download/a07ed116-0288-4a66-9d2c-9417d93d24c1/file.pdf> (дата звернення: 01.05.2026).
4. LB.ua. Sixteen thousand hectares of agricultural land demined in Ukraine. 3 July 2026. URL: https://lb.ua/economics/2026/07/03/749270_ukrayini_rozminovano_16_tisyach.html (дата звернення: 25.05.2026).
5. Certini G., Scalenghe R., Woods W. I. The impact of warfare on the soil environment. *Earth-Science Reviews*. 2013. Vol. 127. Pp. 1–15. DOI: <https://doi.org/10.1016/j.earscirev.2013.08.009>
6. Certini G., Scalenghe R. War is undermining soil health and availability more than urbanisation. *Science of the Total Environment*. 2024. Vol. 908. Art. 168124. DOI: <https://doi.org/10.1016/j.scitotenv.2023.168124>
7. Solokha M., Demyanyuk O., Symochko L., Mazur S., Vynokurova N., Sementsova K., Mariychuk R. Soil degradation and contamination due to armed conflict in Ukraine. *Land*. 2024. Vol. 13(10). Art. 1614. DOI: <https://doi.org/10.3390/land13101614>
8. FAO. Mapping impacted soils of war-affected farmers in Kharkiv oblast, Ukraine. 2025. URL: <https://openknowledge.fao.org/items/77039d7f-40ea-48fb-9eeb-349d8043cf73> (дата звернення: 01.05.2026).
9. GICHD & UNDP. Leaving no one behind: Mine action and the Sustainable Development Goals. 2017. URL: <https://www.gichd.org/publications-resources/publications-and-reports/leaving-no-one-behind-mine-action-and-the-sustainable-development-goals/> (дата звернення: 11.05.2026).
10. UNDP & Geneva International Centre for Humanitarian Demining. A study of socio-economic approaches to mine action. UNDP; GICHD, 2001. URL: <https://digitallibrary.un.org/record/449304> (дата звернення: 01.05.2026).
11. Jensen S., Clarke E., Meryon R., Kirk H., Giugovaz M. From economic recovery to global food security: The urgent need to demine Ukraine. Tony Blair Institute for Global Change, 2024. URL: <https://institute.global/insights/geopolitics-and-security/the-urgent-need-to-demine-ukraine> (дата звернення: 11.05.2026).
12. United Nations Mine Action Service. International Mine Action Standards: IMAS 07.11 Land release (2nd ed.). 2026. URL: <https://www.mineactionstandards.org/standards/07-11/> (дата звернення: 01.05.2026).
13. Про схвалення Національної стратегії протимінної діяльності на період до 2033 року та затвердження операційного плану заходів з її реалізації у 2024–2026 роках : Розпорядження Кабінету Міністрів України від 28.06.2024 № 616-р. URL: <https://zakon.rada.gov.ua/go/616-2024-%D1%80> (дата звернення: 11.05.2026).
14. Про внесення змін до операційного плану заходів з реалізації у 2024–2026 роках Національної стратегії протимінної діяльності на період до 2033 року та визнання такими, що втратили чинність, деяких розпоряджень Кабінету Міністрів України : Розпорядження Кабінету Міністрів України від 25.02.2026 № 191-р. URL: <https://zakon.rada.gov.ua/go/191-2026-%D1%80> (дата звернення: 13.05.2026).
15. Деякі питання досягнення Цілей сталого розвитку в Україні : Розпорядження Кабінету Міністрів України від 29.11.2024 № 1190-р. URL: <https://zakon.rada.gov.ua/go/1190-2024-%D1%80> (дата звернення: 01.05.2026).
16. FAO. Food balance sheets: A handbook. Rome: FAO, 2001. URL: <https://www.fao.org/4/x9892e/x9892e00.htm> (дата звернення: 01.05.2026).
17. European Commission. Economic Appraisal Vademecum 2021–2027: General principles and sector applications. Publications Office of the European Union, 2022. DOI: <https://doi.org/10.2776/182302>
18. World Bank. Bank policy: Investment project financing. 2023. URL: <https://the-docs.worldbank.org/en/doc/6da2e812c0b8e84a1a614bb3c0507e5a-0290012023/original/Bank-Policy-Investment-project-financing.pdf> (дата звернення: 01.05.2026).
19. Sitnicki M. W., Kurinskyi D., Pimenowa O., Wasilewski M., Wasilewska N. Strategic formation of agricultural market clusters in Ukraine: Emerging as a global player. *Sustainability*. 2024. Vol. 16(21). Art. 9430. DOI: <https://doi.org/10.3390/su16219430>
20. Pimenowa O., Pimenov S., Fylyuk H., Sitnicki M. W., Kolosha V., Kurinskyi D. Sustainable business model of modern enterprises in conditions of uncertainty and turbulence. *Sustainability*. 2023. Vol. 15(3). Art. 2654. DOI: <https://doi.org/10.3390/su15032654>
21. Ситницький М. В., Курінський Д. О. Управлінські перспективи розвитку вітчизняної аграрної галузі в умовах статусу України як кандидата у члени Європейського Союзу. *Ефективна економіка*. 2022. № 8. DOI: <https://doi.org/10.32702/2307-2105.2022.8.14>
22. Перегуда Ю. А. Цифровізація як драйвер впровадження циркулярних бізнес-моделей в агропромисловому комплексі. *Вісник Сумського національного аграрного університету. Серія «Економіка і менеджмент»*. 2026. № 2(106). С. 161–169. DOI: <https://doi.org/10.32782/bsnau.D2026.2.24>
23. Pereguda Y., Biloshkurska N. Digital transformation as a strategic imperative for the development of innovative entrepreneurship in Ukraine in the context of international economic cooperation. *Social Development: Economic and Legal Issues*. 2026. № 15. DOI: <https://doi.org/10.70651/3083-6018/2026.3.19>

24. Ситницький М. В., Курінський Д. Підписання тристоронньої зернової угоди як розв'язання організаційно-управлінських проблем агропідприємств України. Вісник Київського національного університету імені Тараса Шевченка. Економіка. 2022. № 4(221). С. 58–63. DOI: <https://doi.org/10.17721/1728-2667.2022/221-4/8>
25. Sitnicka K., Serhiienko R. Business Adaptation to Extreme Conditions: Analysis of Business Shocks in the Context of the War in Ukraine. SocioEconomic Challenges. 2025. Vol. 9(4). Pp. 216–255. DOI: [https://doi.org/10.61093/sec.9\(4\).216-255.2025](https://doi.org/10.61093/sec.9(4).216-255.2025)
26. Sitnicki M. W., Balan V., Tymchenko I., Sviatnenko V., Sychova A. Measuring the commercial potential of new product ideas using fuzzy set theory. Innovative Marketing. 2021. Vol. 17(2). Pp. 149–163. DOI: [https://doi.org/10.21511/im.17\(2\).2021.14](https://doi.org/10.21511/im.17(2).2021.14)
27. Ситницький М. В. Вплив інноваційного потенціалу на стратегічну гнучкість підприємства. Статистика України. 2007. № 1. С. 43–47. URL: https://www.researchgate.net/publication/340581608_Vpliv_innovacijnogo_potencialu_na_strategicnu_gnuckist_pidpriemstva Influence_of_Innovative_Potential_on_Strategic_Flexibility_of_Enterprise (дата звернення: 08.05.2026).
28. Geneva International Centre for Humanitarian Demining. A guide to land release: Technical methods. 2011. URL: <https://www.gichd.org/publications-resources/publications-and-reports/a-guide-to-land-release-technical-methods/> (дата звернення: 08.05.2026).
29. State Statistics Service of Ukraine. Agriculture of Ukraine 2021: Statistical yearbook. Kyiv, 2022. URL: https://www.ukrstat.gov.ua/druk/publicat/kat_u/2022/zb/09/sg_21_pdf.zip (дата звернення: 08.05.2026).
30. World Bank, Government of Ukraine, European Commission, United Nations. Ukraine Fifth Rapid Damage and Needs Assessment (RDNA5): February 2022 – December 2025. Washington, DC: World Bank, 2026. URL: <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099022026094036395> (дата звернення: 01.05.2026).

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