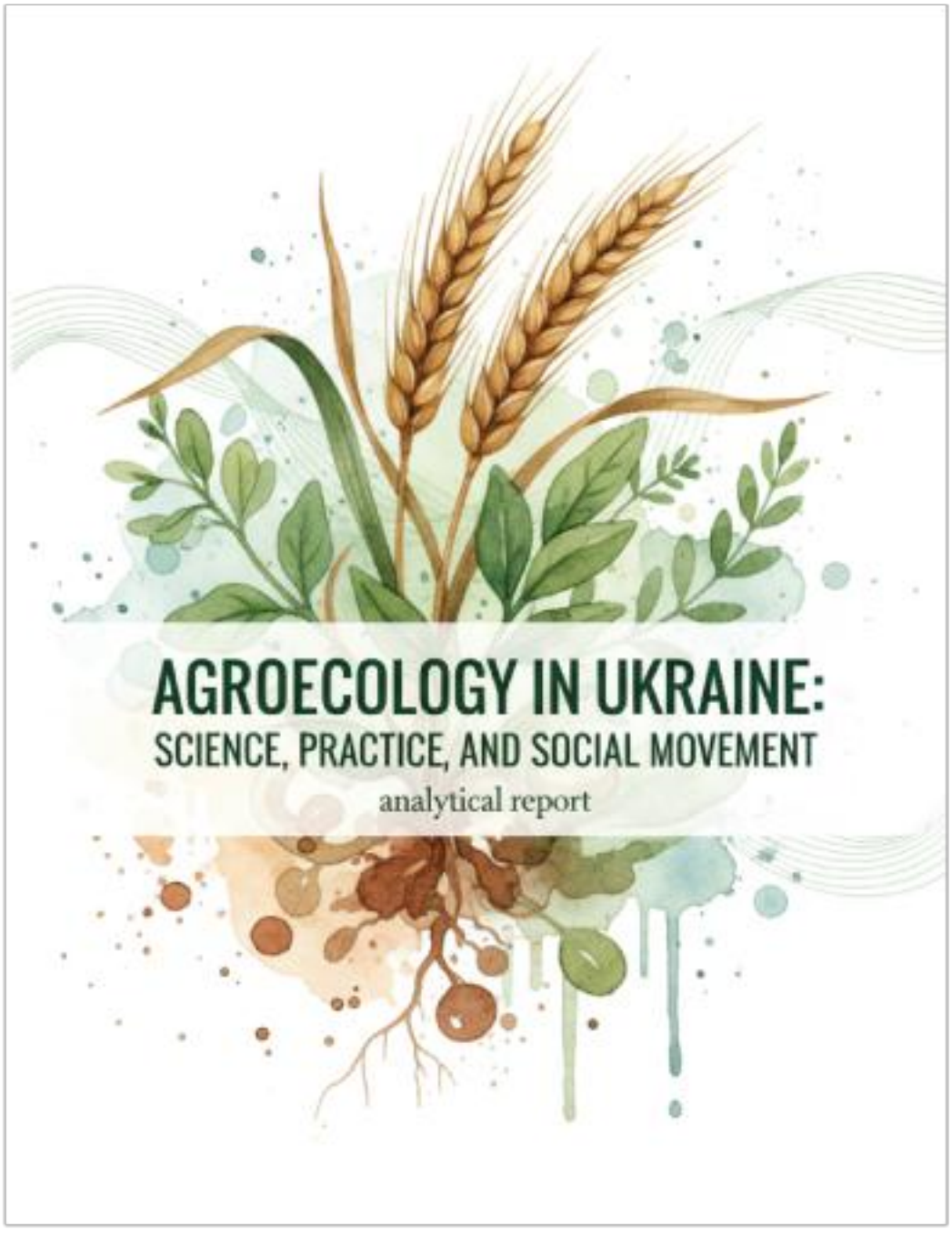
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The Analytical Report "Agroecology in Ukraine: Science, Practice, and Social Movement" has been developed with the aim of disseminating new knowledge about the socio-economic potential of agroecology in Ukraine. The report highlights the stages of transformation of the agroecological concept, the evolution of scientific views on agroecology, and the fundamental principles underlying its identification as both a system of agricultural production and a framework for shaping sustainable, fair, and inclusive agri-food systems, grounded in a human rights framework. It provides an analytical assessment of agroecologically oriented practices across different economic entities, offers a typology and mapping of production practices, scientific and educational initiatives, and social movements, and presents the Agroecological Map of Ukraine developed on this basis. The report proposes a system of strategic measures to facilitate the agroecological transition, including the development of a National Roadmap as a coordination document that defines the pathways and actions to scale up agroecology, improve the institutional environment, and establish mechanisms for monitoring and evaluating the implementation of the agroecological transition.

The report is intended for a wide audience of professionals in agricultural economics, sociology, food security, public administration, and local governance, as well as researchers, educators, and the international community.

State Organization "Institute for Economics and Forecasting of National Academy of Sciences of Ukraine"

Institute of Rural and Agricultural Development of the Polish Academy of Sciences

Project "Substantiation and measures for implementation of a human rights-based integrated approach to rural development, food security and land policy in post-war rebuilding of Ukraine (rUAr: Rebuild Rural Ukraine)"

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I. Agroecological vision

The authors of this analytical report conceptualize agroecology as a transformative approach rooted in traditions and knowledge of local communities in dialogue with scientific knowledge and grounded in a human rights framework.

Agroecology is an emergent social phenomenon integrating scientific inquiry, specialized practice methodologies, and social movement dynamics, collectively influencing holistic agri-food system formation in human-nature harmony. As a scientific discipline, agroecology prioritizes applied research, holistic and participatory methodological approaches, and transdisciplinary frameworks incorporating diverse knowledge systems. As practice, agroecology is predicated on sustainable local renewable resource utilization, local farmer knowledge and priority integration, strategic biodiversity employment for ecosystem service provision and sustainability enhancement, and solution implementation yielding multiple ecological, economic, and social benefits across local-to-global scales. As a movement, agroecology advocates for small farmers and family farm protection, rural community empowerment and traditional consumption culture preservation, food sovereignty advancement, local and short food supply chain development, local seed and breed diversity maintenance, and healthy, quality domestic food production promotion.

Agroecology transcends simple agricultural practice collection, emphasizing social relation transformation, peasant and farmer empowerment, local value addition, and short agri-food chain utilization. This framework enables farmers and peasants to adapt to climate change, utilize and conserve natural resources and biodiversity rationally, and secure decent rural livelihoods. Agroecology receives recognition as a development pathway maximizing ecological and economic sustainability, small and medium producer autonomy, and social security enhancement. The comprehensive agroecological concept demonstrates considerable breadth, with national, European, and global applications characterized by diverse approaches, as distinct researcher constituencies emphasize varying elements and thematic orientations.

Comprehensively, agroecology constitutes a relatively new scientific knowledge domain, having crystallized as a scientific discipline during the 1930s. Initially, agroecological methodologies were implemented across individual plots or small-scale farming operations, focusing on biological interaction dynamics between ecosystem and agricultural components. This farm-as-ecosystem conceptualization, wherein vital functions are sustained through ecological forces, facilitated novel agricultural production management approach development in nature-harmony frameworks. Ecological understanding advancement influenced ecological principle application expansion within agroecology and scaling initiatives in agroecosystem design and management, transcending field and farm limitations to encompass landscape and community dimensions. The evolved agroecological concept incorporates, beyond the aforementioned components, human community social organization, recognized as a fundamental agroecological pillar.

Over the past two decades, various countries worldwide have witnessed an "agroecological boom" initiated from the grassroots level, which has been largely scaled through farmer-to-farmer knowledge sharing, with research institutions and scientists supporting such farmer innovations. As a scientific discipline, agroecology is not prescriptive and does not provide specific instructions, technological maps, or technical packages. It is based on the local application of fundamental agroecological components/principles of management. The modernized concept of agroecology unequivocally supports the value of participatory "bottom-up" research and knowledge, encourages the combination of formal and informal processes for implementing agroecological innovations, integrates local experience with traditional scientific developments, and is founded on recognizing farmers as knowledge holders, researchers, and innovators.

The authors of this report support the view that the internationally recognized need for transition to sustainable agri-food systems that ensure net positive impacts on nutrition, environment, and livelihoods has necessitated the modernization of the agroecology concept as a theoretical and methodological approach underpinned by socioeconomic principles. The outcomes of agroecological management extend beyond production changes such as the elimination of chemical plant protection products, zero tillage, precision agriculture, or organic production. Concurrently, socioeconomic (social, related to reproductive processes), sociocultural (mentality, values, practices, etc.), and political-economic (equitable distribution of benefits) potentials of agroecological management are being developed. The practical socioeconomic outcomes include local food sovereignty, guaranteed rural livelihoods in place of residence, clean environment and safe nutrition, human, soil, and animal health, and enhanced social cohesion and ecological security of human communities.

The research team from the National Academy of Sciences of Ukraine, led by Professor O. Borodina, in this analytical report focused their attention on examining the contemporary conceptual and applied foundations of agroecology in Ukraine during the pre-war and wartime periods, encompassing the integration of production practices, science, and social movements for equity and sustainable development, aimed at fundamental transformation of agriculture and rural areas in the interests of society, rural poverty alleviation, climate change adaptation, employing agricultural methods that reduce emissions, recirculate resources, and prioritize local products and supply chains.



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II. Executive summary

Agroecological research examining science, practice, and social movement interactions during Ukraine's pre-war and wartime periods reveals predominant narrow agroecological conceptualizations among scientific communities, oriented toward ecological harm mitigation associated with industrial agricultural irrational management systems. Under prevailing conditions, this perspective demonstrates inadequacy, addressing only partial ecological damage dimensions. This approach additionally fails to consider inequality deepening, exploitation intensification, and economic power imbalance potentials underlying Ukraine's contemporary industrial, export-oriented, monoculture agricultural framework. The constrained sectoral methodology precludes conscious socioeconomic agroecological effect comprehension, including social justice and human rights principle implementation, food sovereignty advancement, socially significant solidarity-based management system establishment promotion, and family-type producer autonomy and welfare support, among other considerations.

Throughout agroecological practice and initiative identification and synthesis processes, the report's authors conducted agroecological aspect analysis across more than seven hundred organic and ecologically sound agricultural product and food producers, over two hundred scientific institutions and higher and professional educational establishments, and approximately one hundred public movements and initiatives. The application of diverse methodological approaches to classify Ukrainian agroecological cases improved comprehension of agroecological practices, their essential characteristics, and their environmental, economic, and social impacts. Particularly

valuable was the socioeconomic approach application for research purposes, conceptualizing agroecology not merely as technological assemblages, but as complex systems incorporating diverse social effect interactions.

Organic production represents one of the most widespread forms of agroecological activity in Ukraine, but it is often limited to technological aspects only, without adequate consideration of social and economic factors. Civil agroecological initiatives, such as permaculture centers and ecovillages, play an important role in disseminating agroecological knowledge and practices, but they require greater support and promotion from the state and society. Scientific-educational practices are also an important element of agroecology development, but they remain insufficiently focused on socioeconomic aspects.

Within Ukraine's agricultural structure, specific producer segments demonstrate agroecological requirement adherence, particularly through agroecological practice implementation. During the pre-war 2020s, agroecologically-oriented producer segments comprised four hundred certified organic producers (representing 1% of total producer populations), encompassing approximately 6,000 small-scale operations producing environmentally sound products for personal consumption and commercial purposes, plus approximately 600,000 rural and urban households engaged in such production exclusively for self-consumption. Land area utilization by these entities, according to authorial estimates, potentially exceeded 500,000 hectares—constituting 1.3% of total agricultural land area. Approximately 70% of this area consisted of certified agricultural land maintaining organic status.

Ukraine's experience demonstrates that the target orientation and production specialization in households applying agroecological approaches decisively influence the socioeconomic content of their activities. Although the use of agroecological practices is typically associated with increased labor intensity of production, cultivation of organic cereals and oilseeds for export ensures the creation of fewer additional employment opportunities. Accordingly, the socioeconomic effects of agroecology are more fully manifested and disseminated within the environment of family farms and agricultural producers oriented toward national and local agri-food markets.

Populations engaged in agroecologically-based agricultural production encompass: owners and employees of operations producing certified organic products; owners and members of non-certified peasant farms and farming households implementing agroecological approaches in commercial agricultural production; proprietors and household members conducting agricultural activities for subsistence food requirements utilizing agroecological practice elements. The estimated population is approximately 250,000, of which approximately 19,000 individuals belong to the first category mentioned above and 19,000 to the second.

The national system for generation and dissemination of agroecological knowledge includes formalized and non-formalized components: official educational programs and non-formal education through civil society initiatives:

(i) Formal (official) agroecological educational programs in Ukraine are fragmented and insufficiently comprehensive. They cover only individual elements of agroecology as a scientific discipline, focusing predominantly on specific technological aspects. This limits opportunities for training specialists capable of addressing the broad spectrum of agroecological challenges. The causes, manifestations, and consequences of this include: lag of educational practices behind the contemporary agroecological paradigm and international theoretical and practical developments; insufficient integration of socioeconomic aspects of agroecology into formal education; narrow program specialization and low attention to

socio-economic aspects of agroecology; disconnect between theory and practice due to lack of practical components in curricula; insufficient attention from the state, relevant sectoral executive and regulatory bodies, to educational program content and disciplines resulting from absence of comprehensive vision of agroecological issues; limited state support for scientific research and formal educational initiatives in the field of agroecology, lack of adequate integration of contemporary scientific results into educational practices; deceleration of transition to sustainable agriculture and deepening of social, economic, and environmental problems in rural areas.

(ii) Non-formalized civil agroecological educational initiatives in Ukraine constitute an important element of sustainable agriculture development and agroecological transition, through the dissemination of agroecological ideas, knowledge, and practices that are often ignored in formal education. Such initiatives play a key role in updating the agroecological agenda, strengthening attention to the need for establishing the socioeconomic vector of agroecological transformations, and raising societal awareness of its importance. Civil agroecological initiatives contribute to human capital development, strengthening the resilience of agricultural systems and rural territories under crisis conditions. Many of these initiatives transform into coordinated networks, formalize as civil society organizations, and actively interact with international networks.

Important characteristics of the current stage of civil agroecological initiative development in Ukraine include: key role in disseminating and establishing the socioeconomic orientation of agroecological ideas, knowledge, and practices; human capital development through dissemination of agroecological ideas and knowledge about the socioeconomic nature of agroecology; contribution to strengthening agricultural system resilience under crisis conditions and global challenges; insufficient comprehensive support for this vector and non-formalized educational element of agroecological transformations, both at the level of state policies and at the level of local development strategies and programs; permanence of civil initiative development linked to donor funding, their transformation into networks of like-minded individuals, formalization as civil society organizations, and active interaction with international structures.

The information system currently operating in Ukraine regarding agricultural producer functioning is practically incapable of serving as a quality foundation for monitoring and evaluating agroecological practice implementation. In this regard, harmonization of Ukrainian statistics with European Union requirements appears advisable, introducing agrarian enterprise surveys in accordance with Regulation (EU) 2018/1091 of 18 July 2018 on integrated statistics on agricultural holdings; implementing contemporary approaches to obtaining objective information in agriculture, for example, through establishing a network of information sources oriented toward forming comparable economic, social, and environmental data packages. This would enable comparison of agricultural producer development trends across space and time, monitoring and analysis of agricultural policy implementation effectiveness, targeting policy measures, and evaluating progress toward achieving established objectives.

Effective implementation of agroecological transition in Ukraine necessarily requires quality integration of bottom-up and top-down initiatives, engaging state authorities, science, education, and civil society. At the same time, the country's agroecological policy must contain "soft" regulatory instruments that create a conceptual framework for coordinating actions among involved actors, since implementation of agroecology principles substantially depends on biophysical environment characteristics and socioeconomic relations specific to each particular region. Simultaneously, civil society requires

substantial support, as it is capable of forming relationships based on cooperation, mutual respect, solidarity, and trust, which will contribute to improving implementation quality and scaling agroecology.

To ensure the greening of Ukraine's agri-food policy and strengthening sustainability, equity, and inclusiveness of its local, regional, and national agri-food systems, it is necessary to develop an Agroecological Transition Roadmap as one of the implementation instruments of the Strategy for Agriculture and Rural Areas Development for the long-term perspective. It should appropriately include measures for: strengthening regulatory-legal foundations for agroecology dissemination; assessing sustainability, resilience, and socioeconomic performance of existing agricultural production and food consumption systems; promoting agroecological practice dissemination and scaling agroecological transition; expanding scientific research, improving utilization methods for their results, and enhancing knowledge dissemination systems about agroecology and its application for improving quality of life; forming institutional environment to support agroecological transition.

The scale of potential losses to Ukraine's agricultural sector from war is unprecedented. The longer military actions continue, the greater damage is inflicted on land resources, the environment, and rural communities, and food security for Ukrainians with quality and accessible products. Agroecology, with its broad implementation, could substantially help address all these problems. However, under conditions of the dominant agricultural model in Ukraine based on large-scale export-oriented agricultural production, implementing "less toxic" industrial production practices in this agricultural production segment would not create conditions for reformatting deep power relations in Ukraine's agri-food complex. This would also not change the economic behavior mechanisms of large-scale, export-oriented, monocultural corporations that undermine the existence of smallholder farms operating on agroecological principles. Without appropriate state policy, as family farmer efforts are directed toward expanding agroecological transition, they will be blocked by the political and economic system formed by agricultural corporations that perceive this as a threat to their power and profit-generating capacity.

Global practice demonstrates that major corporate actors in the agri-food system protect their profits by promoting their own interpretation of agroecology that includes broad opportunities for benefit extraction while excluding its transformational component. Such approaches are compatible with preserving industrial agriculture and corporate control over farming. Particularly, industrial agribusiness readily supports "nature-based solutions" as a potentially new revenue stream that allows them to appear green while continuing to promote conventional, destructive agricultural business models. Support for nature-based solutions enables them to demonstrate a certain type of regenerative agriculture, focusing on promoting the application of several conservation farming methods – no-till farming, fertilizer management, cover crops with application of corporate digital technologies – rather than systemic changes.



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III. Agroecology in Ukraine during the Pre-war and Wartime Period



Photo by Swastik Arora on Pexels

1. Scientific and Regulatory Framework for Agroecological Development

1.1. Ukrainian Agroecological Science

Scientific development actualization in Ukraine, intensifying during the 1990s, resulted from the necessity for practice-oriented solution development addressing agricultural and rural territorial development in regions affected by the Chernobyl Nuclear Power Plant (ChNPP) accident consequences in 1986. The catastrophe generated substantial agricultural sector impacts, rendering numerous areas unsuitable for agricultural operations and rural territories uninhabitable for human populations due to radiation's detrimental effects. Accident consequences encompassed contamination exceeding 5 million hectares of productive land supporting approximately 3 million residents, alongside significant cattle livestock losses. Initial post-accident years witnessed the practical cessation of sheep farming, hop cultivation, and flax production in affected regions, with exclusion zone territories withdrawn from land utilization. Radioactively contaminated agricultural land restoration directions for recultivation and gradual

economic reintegration included unique agroecological soil treatment technique development, specialized agricultural crop utilization with regenerative potential and scientifically-justified rotation systems, biological plant protection method application, and biodiversity enhancement initiatives, among other approaches.

The first component of agroecology – science-gained substantial and unique methodological and empirical foundations for restoring production after the technological catastrophe. During this period, the deepening of scientific research in agroecology was accompanied by institutional changes in the Academy of Agricultural Sciences system and the establishment of the Institute of Agroecology and Biotechnology, where scientific schools of agroecologists subsequently formed, including such renowned national scientists as O. Sozinov, O. Tarariko, M. Masyuk, M. Gorodniy, V. Pisarenko, A. Babych, O. Zinchenko, O. Furdychko, and others. Higher education personnel training was carried out by the specially reprofiled Zhytomyr Agroecological University, while agroecological science and education units were created at regional-level institutions. Subsequently, scientific and practical interest in agroecological knowledge and practices was lost, as export orientation and commercialization of agriculture based on monoculturization made achievements of national agricultural science undemanded. Today, Ukrainian scientists engaged in agroecology study the ecological aspects of agronomic processes and substantiation of ecologically-oriented technological solutions in agricultural production. It is considered that "the subject of agroecology comprises crops and plantings of agricultural cultures, animal husbandry, agrolandscapes in interconnection with the environment... The main task of agroecology is optimizing land use and crop production systems; developing theoretical and practical foundations for ecologically waste-free and harmless production of crop and livestock products, forming agrolandscapes that maintain harmonious balance with the biosphere; orienting technologies for cultivating crops and animals toward creating balance of natural resources; assessing ecological substantiation of measures and ecological solutions in large-scale agroindustrial production systems" [1].

The current focus of Ukrainian agroecological research is confirmed by an analysis of scientific research directions and their ranking by prospects, conducted at the Institute of Agroecology and Nature Management of NAAS of Ukraine during 2014–2022 [2], [3], [4]. Through analysis of extensive national publications using agroecological keywords and phrases, eleven thematic clusters emerged: ecological state of agrosphere resources; optimization of agrolandscape structure, agricultural lands, agrophytocenoses; ecological assessment of farming systems; assessment and regulation of anthropogenic load on natural resources of agrosphere; ecological principles of agro-industrial waste management; patterns of pollutant migration in agroecosystems; ecological state of rural residential territories; foundations of ecological safety in agro-industrial complex; adaptation of agricultural production to predicted climate changes; agroecological monitoring; scientific foundations of ecological forecasting of agrosphere development. This analysis determined the relative prominence of each research direction in agroecological publications, creating a ranking of research themes in Ukrainian agroecology. The reliability of such clustering was verified by expert survey results. Based on expert comments and proposals, some clusters were combined, and the optimal structure of contemporary agroecological research themes by ranks was determined (see Fig. 1) [5].

Ultimately, five main agroecological directions were identified:

1. Ecological assessment and regulation of anthropogenic and technogenic load of farming systems, soil cultivation, plant protection, fertilization, and agrotechnologies on natural resources of the agrosphere.
2. Ecological state and optimization of agrolandscape structure, agricultural lands, agrobiocenoses.
3. Foundations of ecological safety in the agro-industrial complex (pollutants, GMOs, production waste, biological preparations).
4. Agroecological monitoring and scientific foundations of ecological forecasting of agrosphere development (agricultural lands, forestry lands, water fund lands, and rural residential territories).
5. Adaptation of agricultural production to predicted climate changes.

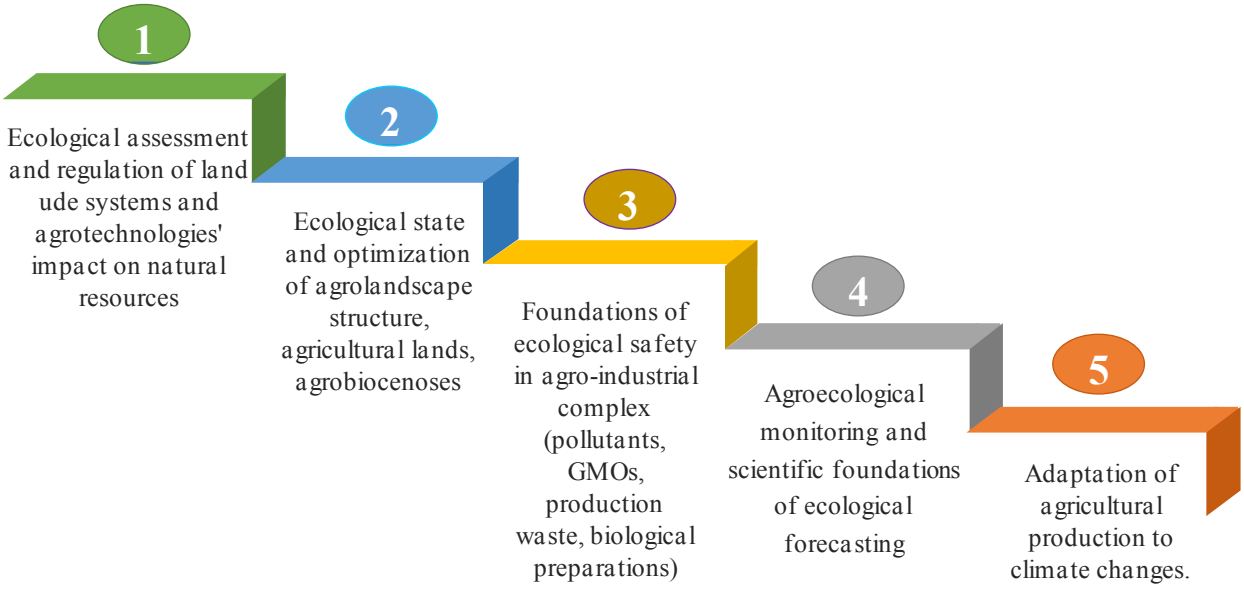


Fig. 1. Ranking of Ukrainian agroecological research directions

Source: based on [2], [3], [4]

As evident from the aforementioned list of priority research directions, Ukrainian scientific discourse in the field of agroecological knowledge is based on sectoral aspects of environmental research.

Meanwhile, the methodological foundation of agroecology in international and European debates is increasingly aligned with political economy principles and socioeconomic narratives concerning the future of global food security. This is directly related to the fact that the existing industrial agricultural model, in addition to creating significant environmental problems, exacerbates the negative consequences of climate change and anthropogenic pressure on ecosystems, fails to resolve existential problems of guaranteeing the basic human right to food and increasing economic and social inequality.

Modern international agroecological studies build upon the concept of multifunctional agriculture, equitable and sustainable food security, adherence to the right to food through local production, establishment of healthy food systems, environmental safety, and ecological justice.

The environmental justice theme is considered to emerge from agroecological principles, particularly the limited use of agrochemicals on any agroecological farm. In this context, humans are viewed as part of nature, dependent upon it for their existence; commercialization of ecosystem services on farms is rejected. Fair trade includes all four benefit dimensions: social, economic, environmental, and political. Environmental justice establishes the evidence base demonstrating the adverse effects of the productionist agriculture model[1].

The drastic reduction of external inputs in agroecological practices is considered equally important for the environment and for promoting the *financial independence* of family farms from industrial agriculture. *The market access and autonomy* theme focuses on promoting transparent trade, equitable participation in global markets, and favoring self-governance by small-scale family producers. Financial independence also emphasizes the importance of diversifying agroecological farms to ensure autonomy from market fluctuations. Diversification is also viewed as improving the *resilience and adaptability* of agricultural systems facing socioeconomic shocks and climate change. Themes encompassing financial independence, market access and autonomy, resilience, and adaptability characterize fundamental differences between agroecology and other alternative agricultural models, particularly organic agriculture.

Diversity and knowledge exchange in agroecology are studied differently in the literature. The most influential agroecology researchers emphasize expanding local knowledge, the importance of horizontal farmer-to-farmer knowledge exchange, as well as intergenerational knowledge sharing. Other authors focus more on the importance of mobilizing and creating synergy between traditional and modern knowledge potential, including digital technologies.

Social justice is addressed through concepts of quality of life and livelihoods in rural areas; health of producers and consumers; animals and soils; equity in land control; economic power and benefit sharing; quality of employment opportunities, etc. It is argued that since agroecology requires higher levels of knowledge and skills, provides access to viable income and greater power, and facilitates self-determination, it leads to better human livelihoods and work quality than in industrial agriculture.

Historically, the importance of social justice has been viewed differently across three aspects of agroecology: agroecology as a science, as practice, and as a social movement. The science component of agroecology examines social justice in the context of approaches to agricultural and rural development based on sustainable agri-food systems. Given the importance of social justice in scientific research, this approach is proposed to be studied from the perspective of humans' central place in society, nature, and agri-food systems.

Social justice stands at the core of agroecological practices and movements. As a practice, it highlights the advantages that agroecology provides to smallholders and family farms in adopting local agricultural methods as alternatives to high-input agriculture advocated by large industrial producers and multinational corporations. Likewise, agroecology as a movement concentrates on resource-constrained small-scale family farms, regarded as the primary target group for agroecological transformation.

The theme of partnerships between producers and consumers in agri-food systems is central to the agroecological approach and emphasizes the

[1] This model is conceptualized as adherence to intensive, industrially managed, and expansionist agriculture with state support, which is based primarily on increasing production, export, and improving productivity.

importance of developing transparent relationships between these two key stakeholders. Restoring connections between family farms and consumers in alternative food systems ensures the implementation of such agroecological principles as social and ecological justice, preservation of rural livelihoods, and localization of agri-food production.

Geographic proximity between different stakeholders from production to consumption, as well as *rural development and preservation of rural livelihoods*, contributes to the establishment of local food systems with producer–consumer linkages to support communities and social cohesion. Rural development based on social justice and autonomy forms the foundation of local food security, which aims to strengthen rural families and their small-scale agriculture to enhance their viability, while contributing to rural development, poverty eradication, and household food self-sufficiency.

Contemporary agroecological literature addresses issues of equitable power distribution in agri-food chains, themes of *collective organization (collective action)* between farmers and participants in processing stages, as well as *the problem of fair profit distribution in value chains and democratic governance.*

International agroecological research examining scaling processes of agroecological principles relies on its conceptual approaches in studies of global and regional processes that include agroecosystems and the people who depend on them. In this context, the Belgian Interdisciplinary Agroecological Research Group (GIRAF) proposed the following five socioeconomic effects of scaling agroecology [6]:

- agroecology as social organization generates collective knowledge and local adaptability through producer networks (e.g., grassroots organizations and community seed banks);
- agroecology as a system for accumulating and preserving traditional knowledge and agricultural culture. Knowledge plays an important role in agroecology, recognizing the diversity of skills and abilities (e.g., indigenous knowledge);
- agroecology as a catalyst for autonomy, enabling farmers to become less dependent on market fluctuations (e.g., crop diversification);
- agroecology as a foundation for social justice in food systems through solidarity mechanisms (e.g., pricing systems along the food chain and multinational farmer cooperatives);
- agroecology as a guarantor of strengthening democracy at multiple levels: member power in organizations is not based on their assets, and decisions are made through democratic processes.

Political recognition of the renewed understanding of agroecology occurred at the international level. During the International Symposium on Scaling-up Agroecology for Food Security and Nutrition, held at FAO headquarters in Rome on 18–19 September 2014, government officials from many countries, representatives of civil society, academia, the private sector, and the United Nations system discussed agroecology's contribution to building sustainable food systems [7]. The symposium provided an opportunity to exchange experiences and create an evidence base on agroecology, presented in the scientific–practical publication "Agroecology for food security and nutrition: Proceedings of the FAO International Symposium" [7]. The symposium materials combine scientific research, lessons, and examples of agroecology from around the world. Currently, experience with agroecological transition is present in all regions

of the world; public policies supporting it operate in many countries in Europe and the Americas.

In the context of the current global food crisis, exacerbated by pandemic consequences and military conflicts, it is internationally recognized that agroecology, as a management system based on sustainability principles for eradicating hunger and extreme poverty, serves as a means of promoting transition to more productive, resilient, and inclusive food systems. FAO continues to work with United Nations Member Countries to harness the benefits of agroecology by strengthening the evidence base of its systemic effectiveness. To this end, both traditional economic indicator analysis for evaluating agroecological practices and a broader socioeconomic approach that provides a more robust foundation for assessing agroecology's contribution to social welfare are applied.

The application of socioeconomic efficiency methodology in agroecology has not yet found wide dissemination and recognition in Ukrainian science and practice. More prevalent are traditional concepts limited to sectoral approaches of ecological improvement in production processes. Given the intensification of problems regarding the existential meaning of farming in harmony with nature, perceiving agroecology merely as a toolkit whose individual practices can be selectively incorporated into current technologies of large-scale industrial agricultural enterprises oriented towards active external resource utilization is unlikely to significantly reduce their ecological impact and ensure safe human existence in medium- and long-term perspectives.

Under current national agrarian model conditions, based on large-scale export-oriented agricultural production, research on "less toxic" production practices does not create conditions for reformatting deep power relations in industrial agrarian systems, nor does it change mechanisms through which large-scale, export-oriented, monocultural structures undermine the existence of small farms operating on agroecological principles and contributing to strengthening ecosystem viability, preserving soil, animal and human health. Without appropriate state policy, as family farms' efforts are directed towards expanding agroecological transition, they will be undermined by the political and economic system in which they are embedded, particularly by corporations that see this as a threat to their power and ability to generate profits. "…for successful implementation of European integration processes, it is necessary to form an institutional architecture adequate to the nationally rooted type of economic development, based on Ukrainian identity" [8].

1.2 Legal and Regulatory Framework

Agricultural and food production based on agroecological principles is realized in Ukraine within a certain legal framework that defines the basic rules of conduct in the areas of natural resource use and food production. Among these, a prominent place belongs to the Laws of Ukraine "On Environmental Protection" and "On Basic Principles and Requirements for Food Safety and Quality".

Environmental protection legislation is aimed at regulating relations in the sphere of protection, use and reproduction of natural resources, ensuring environmental security, preventing and eliminating negative impacts of economic and other activities on the environment, preserving the genetic fund of wildlife, landscapes, and other natural complexes. Besides the above-mentioned law, these relations are also regulated by special legislation: land, water, forest, subsoil, atmospheric air protection, flora and fauna protection, etc. The formation and implementation of state policy in this area is currently ensured by the Ministry of Environmental Protection and Natural Resources of Ukraine, while the policy for state supervision

(control) is implemented by the State Environmental Inspection of Ukraine. Executive bodies of village, settlement and city councils must coordinate the activities of enterprises, institutions, and organizations located in their territory on environmental protection and natural resource use; organize the development of local ecological programmes, education and awareness of citizens; perform other powers in the field of environmental protection.

Legislation on food safety and quality includes the above-mentioned basic law, the Laws of Ukraine "On State Control over Compliance with Legislation on Food Products, Feed, Animal By-Products, Animal Health and Welfare", "On Feed Safety and Hygiene", "On Consumer Information on Food Products", "On Materials and Articles Intended for Contact with Food Products", "On Basic Principles and Requirements for Organic Production, Circulation and Labelling of Organic Products", as well as regulatory legal acts issued in accordance with them. The main body in the system of central executive authorities that ensures the formation and implementation of state policy in the field of food safety and certain quality indicators, quarantine and plant protection was the Ministry of Agrarian Policy and Food, which now functions as part of the Ministry of Economy of Ukraine. The central executive authority that implements state policy in this area (as well as in the field of veterinary medicine, animal identification and registration, etc.) is the State Service of Ukraine for Food Safety and Consumer Protection.

The above-mentioned Law of Ukraine "On Basic Principles and Requirements for Food Safety and Quality" regulates relations between executive authorities, food market operators and food consumers and defines the procedure for ensuring safety and certain quality indicators of food products that are produced, in circulation, imported, and/or exported to the customs territory of Ukraine. It is important to note that here: a) market operators include *business entities* that produce agricultural products, manufacture, sell and/or handle food products, and are responsible for compliance with the requirements of legislation on food safety and certain quality indicators of food products; *individuals* engaged in the production and/or handling of food products; *agro-food markets*; b) the aforementioned law does not apply to food products intended (produced) for personal consumption [9].

Producers of commercial agricultural products, producers and/or sellers of food products intended for sale who apply agroecological practices, like all other market operators, are obliged to comply with requirements and rules established by regulatory legal acts in the fields of environmental protection and food safety, and quality. Beyond this, they also follow other formal and informal norms and rules provided by their agroecological practices. The same also applies to producers of goods intended for their own consumption who operate on the agroecological principles, even though they are not formally subject to legislation on the safety and quality of food products. However, all producers of agricultural products intended for their own consumption are obliged to comply with environmental protection requirements.

Compared to other agroecological practices, the regulatory and legal regulation of organic production is currently the most detailed. It is represented by the Law of Ukraine "On Basic Principles and Requirements for Organic Production, Circulation and Labelling of Organic Products", Cabinet of Ministers resolutions, orders of relevant ministries and departments aimed at implementing the provisions of this law, and other regulatory and methodological materials. The list of relevant documents exceeds a dozen and a half positions [10]. Ukraine also has at least five public associations of organic producers that express interests and coordinate their actions.

General requirements for organic production include, among others: use by its participants of predominantly renewable and own resources; compliance with technologies that do not harm human health, plants, animal welfare, prevent environmental pollution or minimize it; use of food additives, microelements and additives for technological purposes in maximum permissible quantities determined by legislation in the field of organic production. Organic seeds and planting material must be used when sowing and planting crops, and animals that were bred and kept in accordance with organic livestock requirements must be forwarded to livestock production. The following are prohibited: use of genetically modified organisms and products; agrochemicals, pesticides, antibiotics for preventive purposes, hormonal preparations, growth stimulants and animal feed supplements, other synthetic substances; tranquillizers; ionizing radiation; hydroponic methods, etc [11].

To bring the Law of Ukraine "On Basic Principles and Requirements for Organic Production, Circulation and Labelling of Organic Products" into compliance with the provisions of Regulation of the European Parliament and Council (EU) No. 2018/848 of 30 May 2018 on organic production and labelling of organic products, the Cabinet of Ministers of Ukraine submitted a draft law in April 2025 [12], which essentially provides for presenting the Law in a new version. Compared to the current Law, it provides for: expanding the list of types of products that can be certified as organic; extending mandatory certification requirements to business entities that sell organic products directly to end consumers; increasing the number of state registers in the field of production, circulation, and labelling of organic products, etc. Adoption of the draft law will allow the start of implementation of more than 10 Commission (EU) regulations that constitute the general system of legislation in the field of organic production in the EU, and introduce in Ukraine a production and control system in the relevant field that corresponds to the European system.

A key condition for organic production and/or circulation of organic products is their certification. Certification and the bodies that conduct it are dedicated to a separate section of the above-mentioned Law of Ukraine, Cabinet of Ministers resolutions, which approve: the Procedure for Certification of Organic Production and/or Circulation of Organic Products, the Procedure (detailed rules) for Organic Production and Circulation of Organic Products, and the Procedure for Maintaining the State Register of Operators Carrying Out Production of Products in Accordance with Legislation Requirements in the Field of Organic Production, Circulation and Labelling of Organic Products, the State Register of Certification Bodies in the Field of Organic Production and Circulation of Organic Products, the State Register of Organic Seeds and Planting Material.

Certification is quite extensive and costly process. It is conducted by institutions accredited in the field of organic production and included in the State Register of Certification Bodies. A legal or individual person (operator) who intends to switch to organic farming chooses an acceptable certification body and concludes a relevant contract with it. Then the first inspection is conducted – an on-site verification of the operator for compliance of their activities with organic production standards requirements. The operator submits to the certification body a description of their activities, provides inspectors with access to their facilities, sampling, documents, etc., provides materials necessary to determine compliance of all stages of production and/or circulation of organic products with legislation requirements. In particular, soil samples are taken for analysis for harmful residues, information is recorded on plant varieties used, seeds, own and purchased permitted fertilizers used in the farm, etc. Based

on the results of verification at all stages of production and circulation of organic products, the certification body makes a reasoned decision to issue or refuse to issue a certificate. The issued certificate must be confirmed annually.

A certified operator, according to the Procedure (detailed rules) for Organic Production and Circulation of Organic Products, is obliged to maintain a general and sectoral description of their activities. The general description includes information about all operator facilities, product range produced and/or in circulation, production methods (technological processes), measures taken to comply with legislation in the field of organic production, etc. The sectoral description reflects the same information for each type of product. In addition, the operator must keep in electronic or paper form accounting journals in the relevant field of organic production and/or product circulation, where all operations regarding production, procurement, reception and storage of products, transport and payment documents for delivered goods/provided services should be reflected, and fulfil other requirements set out in the above-mentioned Procedure (detailed rules).

While for large farms with a sufficient number of specialists in various sectors, compliance with established requirements, conditions and detailed rules of organic production and its certification is not an overly complex process, for small producers it is often burdensome. A restraining factor for undergoing certification is also its cost. According to the Organic Movement of Ukraine, certification fees for farms in Europe range from EUR 250 to EUR 750, depending on the type of activity, enterprise size, etc., but in Ukraine, considering the significantly larger size of agricultural enterprises, when engaging a foreign certification body, it can be ten times higher than European indicators [13].



Photo by Akil Mazumder on Pexels

2. Analytical Assessment of Agroecological Farming Practices

2.1 Agroecological Farming Entities

Agricultural entities in Ukraine that adhere to the agroecological approaches in their activities include both certified and non-certified organic producers. Both categories of these producers are quite diverse in terms of types of activities, organizational form, legal status, etc., and information about them is rather limited. Official consolidated monitoring data on the organic sector of Ukrainian agriculture reflect only the total number of operators engaged in organic production activities and the total area of agricultural land under organic production. Meanwhile, agricultural producers who, applying various agroecological practices, do not undergo (do not consider it necessary to undergo) certification are not recorded at all.

Based on available information sources and research data, agricultural producers who implemented agroecological approaches during the pre-war and wartime periods have been classified into five categories (see Fig. 2).

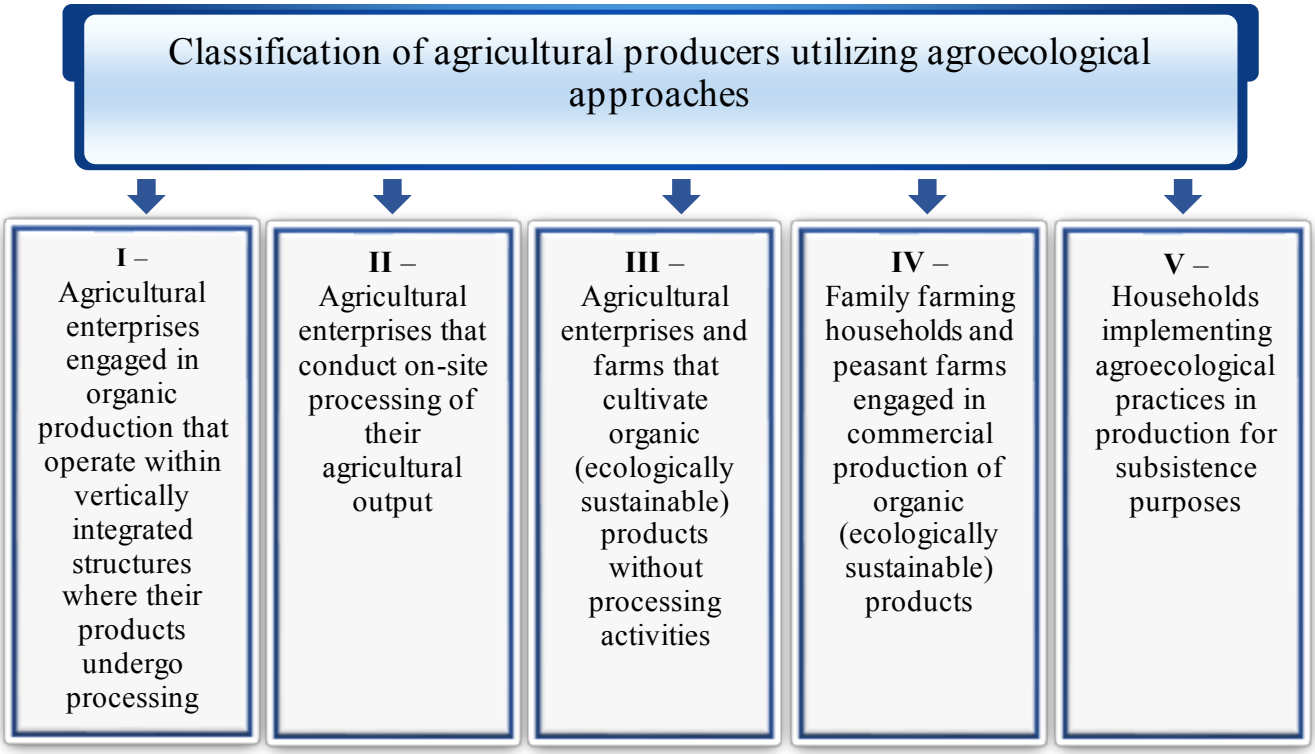


Fig. 2. Classification of Agricultural Producers Utilizing Agroecological Approaches

Source: author's own compilation

According to monitoring data from the Ministry of Agrarian Policy and Food of Ukraine, in 2021, organic production was undertaken by 418 agricultural producers, with certified organic agricultural land covering 370,100 hectares. National market sales totalled 9,800 tonnes of organic products valued at USD 33 million equivalent, accompanied by an expansion in the range of organic products distributed through major supermarket networks. Export volumes reached 245,600 tonnes valued at USD 219 million. In 2023, the sector comprised 383 agricultural producers operating on 390,900 hectares of certified organic agricultural land; national market sales amounted to 7,300 tonnes of organic products valued at USD 27 million, while exports totalled 190,000 tonnes valued at USD 141 million [14].

The 2021 monitoring results provide evidence for the following conclusions:

First. Organic production represents a marginal segment of Ukraine's agricultural sector. In 2021, organic farms accounted for 1.1% of the total number of agricultural enterprises and farms.

Second. Over 96% of commercial organic production in the specified years was marketed internationally, with less than 4% sold domestically, indicating that the country's organic production is as export-oriented as conventional production.

Third. Despite rapid food price increases in the national market during 2022–2025, the export share of organic production remained stable, demonstrating the export orientation of Ukrainian organic production and the absence of a significant positive impact on providing Ukrainians with quality and safe internally produced food.

Among organic producers operating within vertically integrated processing structures is PE "Galex-Agro" – a vertically integrated company comprising four complementary enterprises: "Galex-Agro" and "Agroinvest Group" (engaged

in crop and livestock production), and "Organic Milk" and "Organic Meat" (producing organic dairy and meat products from raw materials supplied by the aforementioned enterprises) [15] (Box 1). Through the integration of crop and livestock production, along with raw material processing, the company fulfils specific socioeconomic functions. Diversified crop cultivation and livestock development particularly generate local employment opportunities: at "Galex-Agro", 40 personnel serve every 1,000 head of cattle. The company also supports rural communities in maintaining roads and bridges [16], and disseminates organic production knowledge through collaboration with the local university (dual education programmes) [17] and agricultural technical college (faculty internships [18].

Box 1

PE "Galex-Agro" operates over 9,000 hectares of agricultural land located in Zhytomyr Oblast, maintaining a cattle herd of 3,200 head, including 1,700 dairy cows, and 2,500 head of swine. The company's agricultural enterprises cultivate grain legumes and fodder crops, including wheat, spelt, rye, barley, oats, broad beans, vetch, buckwheat, millet, soybean, corn for grain, corn for silage, annual and perennial grasses for hay and haylage, and cover crops [19]. The cattle herd is housed in facilities across three villages, employing a loose housing system that complies with organic production requirements, with barns equipped with outdoor exercise areas and adjacent pasture fields [20]. The company specializes in breeding dual-purpose Simmental cattle; animals designated for slaughter are fattened to appropriate market conditions [21].

Generally, such companies typically target external markets as their primary objective. From an agroecological perspective, they fulfil functions such as preserving or creating rural employment and knowledge dissemination in distinctive ways. Employment opportunities here are associated with industrial technology applications: in this context, they are attractive for individuals with adequate professional training, but technology implementation reduces overall labour requirements. Regarding knowledge dissemination, as evidenced by the "Galex-Agro" example, this occurs primarily through training specialized professionals who, in turn, can transfer this knowledge to a broader range of interested stakeholders.

Agricultural enterprises that cultivate organic products and manufacture food commodities, not being a part of vertically integrated companies, possess the same agroecological components as the previous enterprise group. However, they are more fully integrated into the national agri-food system and local community life.

For instance, Private Enterprise "Agroecology", located in Poltava Oblast (8 thousand hectares of land, 5.5 thousand head of cattle, produces cereals, oil, mixed fodder, milk for baby food at its own processing facilities), serves as a raw material supplier for national production of "Agusha" brand dairy products and actively participates in organic product fairs and exhibitions. The enterprise employs 420 people and participates in the implementation of socio-cultural projects. It collaborates with numerous research institutions and educational establishments, hosting practical training for students from higher education institutions at all accreditation levels [22].

Another, considerably smaller representative of this producer group is LLC "Old Porytsk" (Volyn Oblast). This enterprise not only produces for export but also supplies cereals, flour, and dairy products to the Ukrainian market. "Old Porytsk" utilizes approximately 950 hectares of agricultural land, cultivating rye, wheat, spelt, barley, corn, oats, buckwheat, and

legumes, including vetch and peas. The farm maintains approximately 700 head of cattle, including 300 dairy cows. Milk is processed at an on-farm cheese facility, producing premium-class cheeses under the "Cheese Map from Old Porytsk" brand. The farm, fields and cheese facility employ approximately 70 workers, primarily residents of Old Porytsk village and adjacent settlements [23].

The farm founder believes that expanding organic activity requires returning to small-scale production systems. These are more flexible in addressing population needs and finished product supply conditions. The enterprise considers all local retail networks within a 200-kilometre radius as potential markets, including major cities Lviv, Rivne, and Lutsk. Moreover, small producers ensure new employment opportunities in small settlements [24].

An example of agricultural enterprises cultivating diversified organic products without processing is the group of limited liability companies (LLC) "Ritter Bio Agro", "Deddens Agro" and "Kunivske", which lease land in Rivne, Khmelnytskyi and Zhytomyr oblasts (Box 2). All three enterprises are managed by the same individual.

A distinctive feature of the socioeconomic characteristics of these farms is their formation through not only agroecological practices but also "social project" implementation: berry production is specifically organized to increase local population employment, organic products are sold to residents at reduced prices, etc. Simultaneously, the farm manager maintains business-oriented plans: expanding the land bank, increasing production volumes of the most profitable crops, and organizing on-farm product processing. However, social projects may likely be subject to revision.

Box 2

The combined land utilization area of LLCs "Ritter Bio Agro", "Deddens Agro" and "Kunivske" totals 5,500 hectares, with "Kunivske" maintaining 500 head of cattle. The enterprises cultivate wheat, rapeseed, corn, soybean, sunflower, rye, buckwheat, oats, peas, mustard, lentils and common beans, alongside berry crops including raspberries and strawberries, which are exported to EU countries. Berry production is conceptualized as a social project, undertaken specifically to provide employment opportunities for local people. Seasonal employment reaches approximately 400 personnel during peak periods, reducing to 80 during winter months. Berries are sold to landowners and residents at preferential prices, with complimentary distributions to schools. The enterprises actively participate in community problem-solving and rural living condition improvement [25].

LLCs "Ritter Bio Agro" and "Deddens Agro" became Ukraine's first producers of organic sugar beet and manufacturers of organic sugar through toll processing arrangements. However, financial constraints necessitated the discontinuation of this crop cultivation. Their management considers that organic crop and livestock production should be integrated with processing operations and implemented at large scales to maximize value addition and minimize certification costs [26].

Enterprises specializing in limited organic product ranges may be represented by LLC Family Garden. Located near Kyiv, it cultivates organic blueberries on 155 hectares, exporting nearly the entire harvest. Plans include expanding into organic raspberry and strawberry production. Before 2022, the enterprise maintained permanent employment for over 40 workers, increasing to 170 during peak season, primarily local people.

Since LLC Family Garden operates as a highly specialized enterprise, certain agroecological components (recycling, synergy, diversity, etc.) are

absent or limited, though blueberry cultivation as an uncommon crop can be considered a contribution to biodiversity conservation. Simultaneously, specific socioeconomic aspects of agroecology manifest here to an even greater extent than in diversified organic producers. Blueberry cultivation, particularly berry harvesting, represents a labour-intensive activity requiring a substantial workforce. Per 100 hectares of land, employment is 15 times higher than in the "Ritter Bio Agro", "Deddens Agro", and "Kunivske" groups. Workers have opportunities to participate in free training programmes, English language courses, and legal studies. Peasants apply acquired knowledge and skills in their household agricultural activities, sharing them with others.

Examples of small-scale commercial organic producers operating on family farming principles include "Wauberry" farm and Vadym Chykalo's private peasant farm. Both demonstrate the feasibility of agroecological management at small production scales while revealing aspirations to increase volumes and expand operations [27].

"Wauberry" Farm in Kyiv Oblast, established in 2020, cultivates organic blueberries on 15 hectares. Farmer Oleksandr Vovchenko has four children. Besides blueberry cultivation, the family maintains swine, poultry, and fish production. To feed livestock, they annually sow several hectares of wheat, barley, and corn. Seasonal operations currently employ 20 workers. Limited first-year blueberry production was marketed primarily through direct delivery of fresh berries to Kyiv customers. Product promotion utilized social media platforms, though "word-of-mouth" proved most effective: satisfied customers recommended the farm to friends, who, after tasting the berries, recommended it to theirs. In 2022, "Wauberry" Farm was effectively in the combat zone, sustained bombardment damage, and operations were temporarily paralyzed.

Farmer O. Vovchenko is a beneficiary of the national state grant programme supporting horticultural and berry production development, receiving 4.3 million hryvnias for further farm development. Programme conditions require creating seven permanent and over 200 seasonal jobs. He acknowledges this will be challenging, as will repaying 50% of the grant through taxation over five years, but remains determined to fulfil all commitments [28].

The Chykalo family experience confirms the possibility of developing agroecological farming on family principles. In Poltava Oblast, this is the only private peasant farm with certified organic land. Land utilization, including household plots and family member shares, totals 13 hectares. The family comprises four members: a couple and their two sons. The organic farming initiative originated from 25-year-old Vadym, the younger son, a lawyer by education.

The Chykalo family cultivates wheat, barley, oats, sweet corn, sudangrass, buckwheat, oil radish, fodder beet, pumpkins, potatoes, and various vegetables; practices crop rotation and utilizes green manure. They possess soil cultivation equipment, much self-manufactured, and a small tractor purchased by selling the family car. Plant care uses only biological preparations, with manual weed removal when necessary. The farm includes an orchard and a berry garden. They produce preserves from organic blackberries, apples and pears using tested recipes, selling them in Poltava stores. Livestock operations include thirty purebred goats, with milk sales and future cheese production plans. Goat numbers are planned to reach one hundred head.

The Chykalo family achieves complete self-sufficiency from their land, selling surpluses at prices equivalent to intensive technology products. Organic certification confirms land cleanliness and the absence of pesticide and mineral fertilizer applications. This creates market access opportunities and dignified pricing prospects, justifying certification costs. Vadym Chykalo intends to expand, planning greenhouse construction for winter vegetable production using organic technologies.

The "Svitoch" family farm in Sumy Oblast exemplifies small-scale production functioning on agroecological principles while actively promoting agroecological practices. Managed by a couple, Svitlana and Andriy Marchenko, who began early vegetable cultivation in 1999, building a small greenhouse and gradually transitioning to ecologically clean farming principles. Plant nutrition and protection utilize exclusively natural substances, most produced on-farm (including vermiculture and various herbal mixtures, compost teas, wood ash). Currently, the Marchenkos operate four greenhouses on their home garden plot, cultivating over 50 types of environmentally clean vegetables, marketing approximately 20–25 tonnes of vegetables and green products annually throughout Ukraine. Three school-age daughters assist parents.

Initially, the farm sold organic products wholesale primarily to Kyiv stores, proving insufficiently profitable. Gradually, sufficient retail clientele developed, leading to wholesale abandonment. Products are now sold exclusively to retail customers through their website or farm store. During the February–March 2022 siege of Shostka, the farming family distributed harvests free to local volunteers for the first two to three weeks.

Andriy Marchenko established an organic farming movement club in Shostka in 2007, conducting seminars for interested participants. Many small plot owners attended these sessions. Through this initiative, he estimates that at least one thousand vegetable producers converted to organic farming. He notes some producers use no preparations whatsoever: neither chemical nor biological. People create closed ecosystems on tiny 0.06-hectare plots, with beneficial insects (predatory insects feeding on plant pests) and virtually no plant diseases [29].

Generally, small certified organic producers' experience demonstrates expansion orientation and broad market access, including international markets: certification and organic status maintenance serve this purpose. Simultaneously, most are more fully integrated into local agri-food systems, maintain closer consumer connections, advocate and disseminate agroecological practices; biodiversity conservation principles are more fully realized despite some specializing in specific crops, which are typically uncommon varieties.

Fuller integration into local agri-food systems also characterizes many family and private peasant farms applying agroecological practices and marketing portions of production without certification requirements. Unlike certified operations, their numbers and land areas can only be estimated through assumptions. According to our estimates, approximately 600,000 private peasant households (PSHs) in Ukraine met internationally recognized farm criteria during the pre-war period, with land utilization reaching 3.5 million hectares [30]. Assuming the proportion of ecologically clean food producers among them equals that within agricultural enterprises (1%), their total number can be estimated at 6,000 households, with a land area of 35,000 hectares. Information about such operations, though limited in distribution, appears in mass media, particularly print publications.

Examples include the Slutskyi family household from Reutyntsi village, Krolevets rajon, Sumy Oblast. The family operates 3.5 hectares of field land (cereal crops, alfalfa, haymaking) and 0.5 hectares of homestead plots (vegetables, fruit trees, berries); keeps two cows, three swine, dozens of chickens, and ducks. Surplus production sales include regular customers and market sales. The housewife emphasizes: people value ecologically clean products and purchase them readily [31]. Maria Morykin in Krupske village, Stryi rajon, Lviv Oblast, cultivates several lettuce types, cabbage, and pumpkins across six hectares; nine niche crops total. Health-conscious consumers completely purchase all production [32]. In Banyunyn village, 30 kilometres from Lviv, Mykhaylo and Halyna Kostyuk with their children cultivate black and English walnut seedlings, fruit

trees, blueberries, strawberries, potatoes, vegetables, and over 60 pumpkin varieties on six hectares. Ecologically clean pumpkins find high demand. Operators sell primarily through their own shop, with restaurant and cafeteria orders shipped on request [33].

Another group, partially applying agroecological practices, comprises rural households producing solely for personal consumption. By early 2022, land holdings were owned by 3.4 million urban and 4.6 million rural households. Significant portions of these holdings represent plots (shares) received or inherited from the 1990s land reforms; over 70% of the total area was leased. Simultaneously, 21% of urban household land area and 16% of rural household land were used for self-consumption production: average plot sizes were 0.087 and 0.287 hectares, respectively [34]. Calculations show the combined area exceeded 1.6 million hectares.

Logically, all households growing agricultural products for personal consumption have interests in agroecological practices, both for healthy, environmentally clean food consumption and environmental preservation in their locations. Certain agroecological components, such as diversity, cultural and dietary habits, knowledge accumulation and exchange, are traditionally inherent in this activity type. Simultaneously, many self-consumption households use mineral fertilizers and chemical plant disease and pest control agents without possessing application knowledge or following proper procedures.

The foregoing analysis indicates that only a portion of households producing agricultural commodities for personal consumption can be classified as operating on agroecological principles. Obviously, when estimating their land areas, it would be inappropriate to base calculations on, for example, the proportion of organic-certified land in agricultural enterprise land use, yet the significant contribution of this household group to agroecological prevalence in Ukraine should not be overlooked. Specifically, assuming that 5 to 10 percent of households producing agricultural products solely for their own consumption meet the requirements of ecologically sound farming, the area of land they utilize would amount to approximately 120,000 hectares. It is worth emphasizing that these households, their land, and the products grown on it are integral components of local agri-food systems.

Therefore, when assessing Ukraine's agricultural sector incorporating agroecological elements, which formed during the pre-war period and have been preserved (and in some cases further developed) during wartime, it can be stated that it is represented by the following entities:

i) Near four hundred primarily large certified organic producers oriented mainly toward external markets;

ii) Approximately 6,000 farming households produce ecologically clean products for both personal consumption and sale;

iii) Approximately 600,000 rural and urban households producing exclusively for their own consumption. The total area of land they utilize exceeds 500,000 hectares, representing 1.3% of the total agricultural land area.

2.2. Human Resource Provision

Human resource provision for agricultural production utilizing agroecological practices should be examined within the context of agri-food system functioning, as it encompasses the whole agricultural production process, including that conducted for personal consumption. In this context, those involved in agroecological agricultural production include: owners and employees of farms producing certified organic food; owners and members of uncertified farms and farming households applying agroecological approaches in commercial agricultural production; and owners and members of households engaged in agricultural activities to meet personal food needs using agroecological practice elements.

During 2021–2023, Ukraine's certified organic production sector encompassed approximately 400 business entities cultivating over 390,000 hectares of agricultural land. Sector composition constantly changes, but according to the national certification body "Organic Standard" registry, over half represent agricultural enterprises of various organizational-legal forms, with the remainder comprising farms, individual entrepreneurs, and private individuals.

Agroecological practice implementation typically increases production labor intensity and correspondingly increases agricultural employment. In the EU, for example, organic agriculture is considered to provide 10–20% more jobs per hectare than conventional farms [35]. In Ukraine, where the vast majority of agricultural enterprises practice limited field crop cultivation using industrial technologies, this gap between conventional and organic operations is significantly larger. Calculations based on State Statistics Service data on hired agricultural workers and agricultural land area in enterprises and farms [36] indicate an average of 2.14 employed persons per 100 hectares in 2021. However, in individual certified organic farms with publicly available information, this indicator ranged from 5.25 [22], 7.37 [23], to nearly 30 [27] persons per 100 hectares, 2.5 to 14 times the average. Assuming all Ukrainian organic farms employ at least twice as many workers per hectare as the agricultural enterprises and farms average, and considering higher ratios among private individuals and entrepreneurs, total employment may reach 19,000 people.

Previous analysis suggested that approximately 6,000 uncertified peasant farms and farming households apply agroecological approaches. Given that these farms are typically larger than average rural households, agroecological farming requires greater labor input. As some farms additionally hire workers for specific agricultural operations, total employment in these farms may reach levels similar to those in organic farms—19,000 persons.

Certain agroecological components, such as soil conservation technologies, biodiversity, cultural and dietary traditions, recycling, knowledge accumulation and exchange, characterize households cultivating agricultural products for both personal consumption and market sales. Despite this, during the pre-war period, nearly 60% of rural households used mineral fertilizers, while 86% used chemical plant disease and pest control agents [37]. Most likely, the majority adhered to existing synthetic substance application norms and did not apply them to all crop types, but their entire production cannot be definitively classified as ecologically clean or contaminated.

Simultaneously, during the mentioned period, 62% of rural households practiced crop rotation, 55% conducted sanitary livestock facility treatment, 45% performed veterinary inspections, 18% conducted milk sanitary control, and approximately 8% used no-till soil cultivation [37]. Therefore, some portion of the population likely use agroecological approaches consciously while others follow traditional ("ancestral") management methods by habit.

In estimating the number of individuals who may be engaged in agricultural production in their own households, the following factors were considered: the aforementioned approximate proportion of households meeting ecologically sound farming requirements, their household composition, the potential labor participation of pensioners in performing relevant tasks, and persons permanently employed in various sectors of the national economy, students, etc. Their estimated number may reach 250,000 persons - approximately 9% of the total population employed in agriculture in 2021. This includes agricultural workers in organic-certified operations and those producing agroecologically without certification. Since people in the second and third identified population groups apply

agroecological practices on small land areas, the proportion of those involved in ecologically clean production in total agricultural employment significantly exceeds the proportion of land involved in total agricultural area. Among them, the absolute majority (over 90%) used agroecological approaches outside strictly regulated (certified) organic production.

Comparing organic production and other agroecological practice shares in estimated agricultural land and rural population indicators engaged in agroecological agriculture reveals their divergent nature. In agricultural land area, organic production land predominates (with controlled adherence to formalized norms and rules), while in population numbers, people using practically non-formalized agroecological practices predominate. This divergence stems primarily from the differential targeting of these agroecological practices toward agri-food systems at varying hierarchical scales.

Domestic farms currently producing organic food mainly for global and national market sales participate in corresponding agri-food systems dominated by long production-marketing chains. They must certify operations and seek production volume increases, including through expanded land utilization. Much of this production – wheat, barley, soybeans, etc. represents raw materials for processing and food industries requiring minimal labor inputs. Small-scale ecologically clean commercial producers primarily sell in local markets where they often maintain established customer bases and therefore operate without certification. These markets comprise components of local agri-food systems that also include household agricultural production and food for personal consumption.

The distinctive feature of agroecological components in these agri-food systems is that in global and national markets, buyers/consumers of ecologically clean products pay higher prices than for conventional products, with numbers limited by effective demand levels. In local agri-food systems, ecologically clean products also cost more than conventional alternatives but are typically priced below certified products, making them accessible to broader consumer groups. Additionally, significant portions of ecologically clean products are made by their own consumers, whose numbers are determined by dietary habits, awareness of healthy and safe food consumption needs, and production capabilities.



Photo by Jason Ng on Unsplash

3. Typology and Mapping of Production Practices, Scientific-Educational Initiatives and Civil Movements

3.1. System of Agroecological Knowledge Production and Dissemination

This subsection focuses on both formal systems of knowledge production and education in agroecology implemented by officially certified scientific and educational institutions, and informal systems – the production and dissemination of agroecological knowledge through civil initiatives.

Official scientific or educational activities in Ukraine's agroecological sphere are conducted by various categories of state and private institutions, non-governmental organizations, communities, volunteers, enthusiasts, and activists. For some, such activity represents their core mission. For others, it is auxiliary to their main activities or supplementary, while for still others it constitutes a life's work or its important

component. The latter primarily concerns the educational direction, whether specially organized educational events and activities or the dissemination of agroecological knowledge in the process of other primary activities and interaction with different groups of people. While conducting quality research requires appropriate executive qualifications, material-technical provision, and scientific infrastructure, the dissemination and enhancement of agroecological knowledge, as one educational effect, occurs and is ensured not only through specialized organizational activities but simply through societal interaction among various agents (government, food producers, natural resource users, rural residents), rural household functioning, etc. Many farms have production as their main activity, yet organize master classes, invite visitors, and encourage agritourism-educational visits; many communities and centers (officially registered as legal entities, business subjects, or unregistered civil initiatives) place important emphasis on disseminating agroecological knowledge and practices; there are also cases where producers conduct scientific activities. An example of the latter is the private enterprise "Agroecology," which is an associate member of the National Academy of Agrarian Sciences of Ukraine (NAASU), collaborates with many scientific institutions, including those within the NAAS Ukraine system, and educational institutions. Scientists from various institutions conduct research at this enterprise, while students from educational institutions of different accreditation levels complete practical training. However, this operation focuses primarily on agricultural technological aspects, leaving socioeconomic dimensions of agroecology unaddressed.

Formalized System of Agroecological Knowledge Production. The main state specialized scientific institutions traditionally oriented toward agroecological research were National Academy of Agrarian Sciences of Ukraine institutions structurally belonging to departments of: agrarian economics and food; scientific support for innovative development; agriculture, land reclamation and mechanization; plant production; animal husbandry; and veterinary medicine. However, most focus on research problems related to technological aspects of agroecological practices.

Among NAASU institutions whose sphere of interest includes other elements of agroecology in its modern multivectoral understanding are the Institute of Agroecology and Nature Management, National Scientific Center "Institute of Agrarian Economics," Institute of Food Resources, and several others. However, in most of them, non-technological agroecological aspects fall within the potential focus of only a few individual divisions.

Given agroecology's multivectoral and multicomponent nature as a scientific direction, scientific institutions of social orientation – economic, sociological, legal, socio-demographic – have potential no less than NAASU institutions for researching its primarily diverse non-technological aspects and manifestations. Universities and narrowly specialized educational institutes combining educational and scientific activities also possess significant agroecological research potential.

In Ukraine, agroecology constitutes an important component of curricula in several specialties, particularly specialty 101 "Ecology," but may also be part of agronomist and environmental protection specialist training. Universities have certain autonomy in curriculum formation while being subordinate to the general Ministry of Education and Science of Ukraine.

In national higher education institutions, agroecology is represented as a separate course, an elective subject, or part of core subjects in specialty curricula. The discipline is taught in all agricultural educational institutions, including the National University of Life and

Environmental Sciences of Ukraine (NUBiP), Polissia National University, Poltava State Agrarian University, Sumy National Agrarian University, Lviv National University of Veterinary Medicine and Biotechnologies n.a. Stepan Gzhytskyi, Vinnytsia National Agrarian University, classical universities, and other higher education institutions with agronomic or ecological faculties (e.g., Lesya Ukrainka Volyn National University).

Specialty 101 "Ecology" is offered by 116 higher education institutions of various accreditation levels, though not all teach the "Agroecology" discipline. Of these 116 institutions, the "Agroecology" discipline is represented in 46 as a mandatory program component, separate course, or elective discipline. These courses or disciplines are taught at various faculties: plant protection, biotechnology and ecology; natural sciences and management; natural-geographical education and ecology; ecology, forestry and landscape gardening; chemistry and ecology; forestry and ecology; community development and health; biological; ecological; geographical; biotechnology; agrotechnology and nature management; chemical-biological; agrotechnology and ecology; human health and natural sciences; economics and nature management; horticulture, ecology and plant protection, etc.

Regarding agroecological discipline content in higher educational institutions, there is a noticeable emphasis on ecological and agronomic aspects, while socioeconomic dimensions of agroecology remain uncovered. This concerns, for example, such agroecological components as: co-creation and sharing of knowledge, presupposing that agricultural innovations will help solve local problems more effectively if developed through broad participation; human and social values, meaning the important role of strengthening and protecting livelihoods, equality, and social welfare of rural residents in ensuring agri-food system sustainability; cultural and food traditions, meaning that by supporting healthy and diverse nutrition corresponding to cultural traditions, agroecology promotes food security and nutrition while preserving ecosystem health; responsible governance, meaning that sustainable food production and agriculture require responsible and effective governance mechanisms at all levels from local to national and global; diversity, meaning that diversification is key to transitioning to agroecological production methods to ensure food security and nutrition alongside natural resource conservation, protection, and improvement.

Informal System of Knowledge Production and Dissemination – Civil Initiatives

In Ukraine, the spread of civil agroecological initiatives such as ecovillages, permaculture centers, and others represents an important segment of agroecological knowledge production. Analysis of the agroecological civil initiative database formed during this research indicates they are highly diverse and multifaceted: by participants and character of involved people's participation, official status, activity directions and types, functions (education, production, culture, etc.), organizationally, by interaction character among involved parties, level of interconnections and integration into local communities, and other characteristics.

Based on the number of participants involved, ecovillages can be categorized as: single-household ecovillages (typically up to 10 people), small multi-household communities (10-50 people), medium-sized communities (50-100 people), and large communities (more than 100 people).

Based on primary activity directions, the following subgroups of ecovillages can be identified: agricultural ecovillages – those focused on food production and conducting

ecologically clean agriculture; educational ecovillages – focused on providing educational services, such as alternative schools and eco-centers; cultural ecovillages – focused on preserving and promoting cultural traditions; spiritual ecovillages – focused on spiritual practice and development. Although educational ecovillages in this classification represent only one group, the educational function through generating and disseminating agroecological knowledge is performed to varying degrees by ecovillages assigned to other groups as well.

Ecovillages demonstrate distinct organizational and operational typologies that can be systematically classified into three primary categories: (1) self-sufficient models, characterized by aspirations toward self-provision and minimal external dependency; (2) networked configurations, distinguished by collaborative partnerships with other ecovillages and communities for resource sharing and knowledge transfer; and (3) outreach-oriented establishments, which engage with broader community networks to promote ecological and sustainable practices. Further taxonomical refinement may incorporate additional classificatory variables, including temporal factors (operational duration), spatial considerations (geographical positioning), functional specializations, and socio-cultural dimensions such as shared spiritual or religious orientations among community members.

A significant number of the entities examined exhibit characteristics spanning multiple typological categories, simultaneously engaging in production activities alongside educational, promotional, marketing, and other operational functions. Numerous initiatives self-identify across overlapping classifications as both ecovillages and permaculture centers, creating taxonomical challenges for definitive categorical assignment. Field observations reveal instances where self-designated ecovillage communities consist primarily of urban-to-rural migrants who maintain only seasonal or intermittent rural residence patterns. Additionally, various agricultural economic actors, while not formally affiliated with the agroecological movement, nevertheless fulfill critical socioeconomic and agroecological functions. These include contributions to human rights advancement, rural community social cohesion, and human capital development initiatives.

This multi-functional and cross-categorical nature of rural sustainability actors demonstrates the complex, interconnected landscape of contemporary alternative agriculture and rural development models. Certain difficulties in determining main activity direction and civil initiative classification relate to the fact that initiative creators and ecovillage and permaculture community representatives self-identified and assigned themselves to various self-named non-unified groups that didn't always accurately reflect these initiatives' main tasks or functions (Table 1).

The "farm" and "household" categories illustrate the conditional nature of assigning different initiatives and practices to particular groups. In this review of agroecological practices, farms are precisely small-scale households. Often in real life, there is no substantial difference between those who identified themselves as "household" and "farm," and they can be considered as one group. The overwhelming majority of rural households engage in food production on their own land plots but do not always identify themselves as "farm" because food production for them (both for self-sufficiency and for sale) constitutes an organic part of rural lifestyle, rural life. Households that identified themselves as "farms" primarily emphasize that food production stands out among other aspects of rural life for them; they often highlight that they have found a production niche, specialization, and are increasingly oriented toward commercial production.

Table 1

Grouping of Permaculture and Ecovillage Agroecological Practice Entities[2]

Groups	Examples
Educational institution	"Berehynia"
Community / Settlement	"Green cliffs"
City garden	"Krin-Krin"
Household	"Rodaria", "Ozarennia", "Garden of Eve"
Farm	"Mirina cheese workshop"
Spiritual community	"Vrinda Ashram"
Ecovillage	"Settlement of masters", "Living house"
Artistic farm	"Obyrok"
Common house	"A common house in Baranivka"
Settlement of ancestral homesteads	"Cranes", "Lada", "Lyubske"
Partners (friends) of the network of ecovillages in Ukraine	"Podil ethno-huts"
Centre for communication with nature	"The family estate of the Buryakivskys"
Human Development Centre	"Living house"
Family eco-estate	"The circle of the forest"
Personal ancestral estate	"Lobodarove (Tomasz Gardens)
Public organisation	"Permaculture farm "Earthquake"
Permaculture centre	"Prysamarya Space"
Green tourism farmstead	"Ya Manor"
Eco-centre	"The potter's estate"
Hub	"School of Life"
Ancestral community	"My Ukrainian dream"
Fan project	"The state of Zhyvostvit"
Holistic eco-centre	"Hobbit Terra"
Total	***98***

Source: developed by the authors based on data from the NGO "Permaculture in Ukraine", the NGO "Global Network of Ecovillages of Ukraine", and other sources.

The groups mentioned in Table 1 were combined for mapping purposes into several types: community/settlement; educational, permaculture, tourism, ecological centers, including registered non-governmental organizations; farms; households; and other initiatives. These groups are presented in Table 2 and Figure 2

Table 2

Community eco-settlement and permaculture agroecological initiatives by consolidated categories

No	Category	Number
1	Community / Settlement	56
2	Educational / permaculture / tourist / environmental centre / NGO	12
3	Household	26
4	Farm	3
5	Other (urban garden)	1
	Total	*98*

[2] Available in the database used for mapping as of November 1, 2024 (98 units)

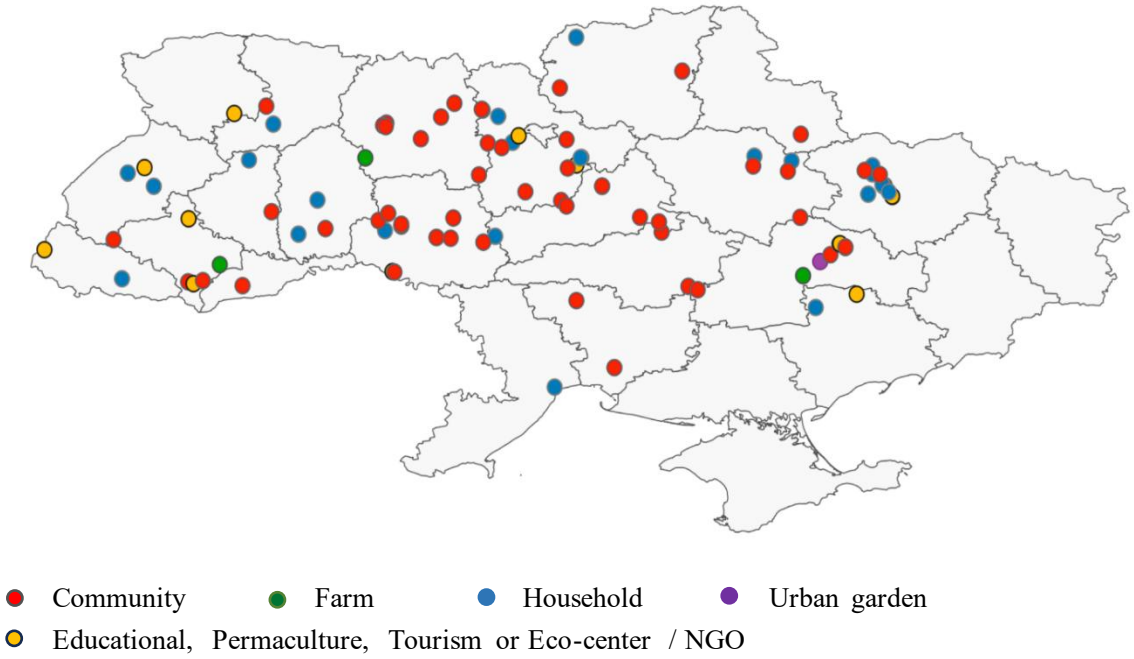


Fig. 2. Community agroecological permaculture and eco-settlement initiatives

Source: Author's compilation based on information data from official state registers, NGO data, agroecological initiatives, and other open sources.

Agroecological community initiatives demonstrate the highest degree of social orientation. These initiatives exhibit pronounced social interaction patterns that foster human capital development and facilitate the transfer of agroecological knowledge and practices, constituting a significant socioeconomic impact. Such initiatives frequently evolve into networks of stakeholders with shared objectives, become institutionalized as civil society organizations, and actively engage (through both formal associations and independent mechanisms) with analogous international structures. Notable examples include the network of permaculture learning and demonstration centers, institutionalized under the Public Union "Permaculture in Ukraine," and the ecovillage network, formalized as the NGO "Global Ecovillage Network of Ukraine."

The PU "Permaculture in Ukraine" operates as an integral component of the pan-European and Visegrad LAND networks (Permaculture Learning and Demonstration Network) and the global iLAND network. The network's permaculture centers provide capacity-building opportunities, facilitate social integration and development, enable access to certified organic products, deliver technical advisory services, and support seeds and planting material exchange. The network defines educational-demonstration permaculture centers as agricultural enterprises operating under permaculture ethical frameworks with the primary objective of knowledge dissemination and technology transfer in permaculture practices.

The NGO "Global Ecovillage Network of Ukraine" serves as an umbrella organization for diverse sustainable community initiatives. Its socioeconomic mandate is explicitly articulated in the organizational mission: to consolidate and advance ecovillage development and other sustainable community models in Ukraine for the promotion of environmental values and conscious living philosophies within society. The Ukrainian network functions as a national

chapter of the Global Ecovillage Network and maintains institutional linkages with international partner organizations.

The socioeconomic orientation of network-affiliated ecovillages manifests through diversified project portfolios and routine operational activities of member communities. A demonstrative case study is the collaborative initiative between the NGO "Global Ecovillage Network of Ukraine" and PU "Permaculture in Ukraine" – the "Green Road of Ecovillages" project, through which network participants provide rural accommodation and support services for internally displaced people. This initiative exemplifies how agroecologically-oriented civil society organizations contribute to resilience-building in crises and global challenges while providing humanitarian assistance. Following the full-scale war in Ukraine, permaculture and ecovillage network organizations initiated coordinated short-term and long-term shelter provision for displaced people. By spring 2022, approximately 70 locations were operational within Ukraine, complemented by approximately 300 sites in Western Europe facilitated through the European Ecovillage Network. These facilities provided accommodation for several thousand individuals, many of whom subsequently became knowledge carriers and advocates for community-disseminated principles, with a significant portion integrating permanently into network structures and local communities.

3.2. Typology and Mapping

For typological purposes, the terms "agroecological practices" and "agroecological initiatives" are used as interchangeable categories, although they are not absolutely identical and carry somewhat different connotations. Agroecological practices are most commonly understood as specific actions and methods for implementing agroecological principles – for example, cultivating crops and raising livestock in ecologically safe ways, preserving soil fertility, reducing chemical inputs, enhancing biodiversity, etc. In this context, "practices" primarily reflect the technological aspects of agroecology. The term "agroecological initiatives" better reflects the socioeconomic aspects of agroecology, as initiatives represent measures aimed at promoting and implementing agroecological practices across larger territories, which involve economic and social interactions with all the complex interdependencies between economic and social processes.

For the spatial characterization of the current state of agroecological development in Ukraine, based on understanding agroecology as the interaction of science, practice, and social movement, three main typological groups have been identified for formal analysis:

- organic producers
- community agroecological permaculture and ecovillage initiatives
- scientific and educational centers.

These main types of agroecological practices and initiatives are represented by a broad range of activity subtypes and characteristics, which are often simultaneously present in the objects of classification.

For mapping, the QGIS geographic information system software (version 3.34.7) is used. GIS shape files of administrative-territorial units were obtained from the State Enterprise "Cartography." Database population was carried out using Numbers spreadsheets and exported to QGIS attribute tables, where geospatial referencing was performed based on information from official state registers and other open sources regarding the registration location of economic entities and/or actual location of economic activity.

The database on agroecological development in Ukraine used for mapping was updated as of 2024 and contains 630 records. This includes

information on economic entities, including agricultural producers' activities, official practices of state and private institutions and organizations, as well as unofficial civil initiatives.

Data on certified organic agricultural producers and organic production infrastructure were obtained from the State Register of operators engaged in production in accordance with legislation requirements in the field of organic production, circulation, and labeling of organic products. It is understood that in practice, organic production principles are followed by a significantly larger proportion of producers than those who have undergone official certification. As noted, such approaches are followed, in particular, by a significant portion of rural households that produce both for self-sufficiency and for sale. Certified economic entities, however, are commercial farms oriented primarily toward occupying their niche in the organic products market. The group of certified organic producers includes various subtypes of economic entities, ranging from representatives of vertically integrated holdings or their legally separate units to individual entrepreneurs. This group will be examined in greater detail later.

Data on educational and scientific institutions were taken from official state registers. During mapping, this group primarily included state institutions, although private institutions, producers, and civil movements also engage in agroecological research and educational activities. However, in the latter cases, this activity is often not primary, unlike in state educational and scientific institutions; moreover, it was important to examine specifically how state-funded institutions perform educational and research functions in this field. Regarding scientific institutions, the foundation of this subgroup consisted of institutions of the National Academy of Agricultural Sciences of Ukraine. Among educational institutions, higher education institutions of third and fourth accreditation levels have been selected that provide specialist training for master's, bachelor's, associate bachelor's, and professional associate bachelor's degrees.

Information on civil initiatives, particularly ecovillages and permaculture centers and initiatives, was compiled from various sources: data from national and international networks – the Global Ecovillage Network (European branch), the Ecovillage Association "Homestead Club," the Visegrad Permaculture Partnership, the Network of Permaculture Learning and Demonstration Centers in Ukraine, and personal websites of initiatives and farms. This sample represents only a portion of the most active farms and initiatives that have declared themselves in one way or another. Alongside this, many farmers and household farms apply permaculture approaches, share this information with others, and practice an agroecological lifestyle in their families.

When registration and economic activity locations differed (there were numerous cases of economic activity being conducted in regions different from the registration location), geospatial referencing was performed, where possible, to the location of actual activity. Regarding certified organic producers, organic production infrastructure, permaculture centers, ecovillages, and educational and scientific institutions, the objects displayed on the map predominantly show the location of actual activity. This primarily concerns organic producers. In practice, the location of producers' actual economic activity may differ from their official registration address. There are numerous cases where certified organic producers are registered in a regional or district center of one region, while the land plots they farm are located in another. Also, in some cases with educational and scientific institutions, addresses from official state registers were used (at the time of mapping, addresses in actually occupied territories were still indicated for them), although

in fact these institutions, whose official address is in the occupation zone, were relocated to Ukraine-controlled territory, where they continue activities in full or limited scope.

The cartogram presented in Fig. 3 shows the territorial distribution of agroecological practices and initiatives in Ukraine, classified by the following types: organic producers (and organic production infrastructure), civil agroecological permaculture and ecovillage initiatives, and scientific and educational practices.

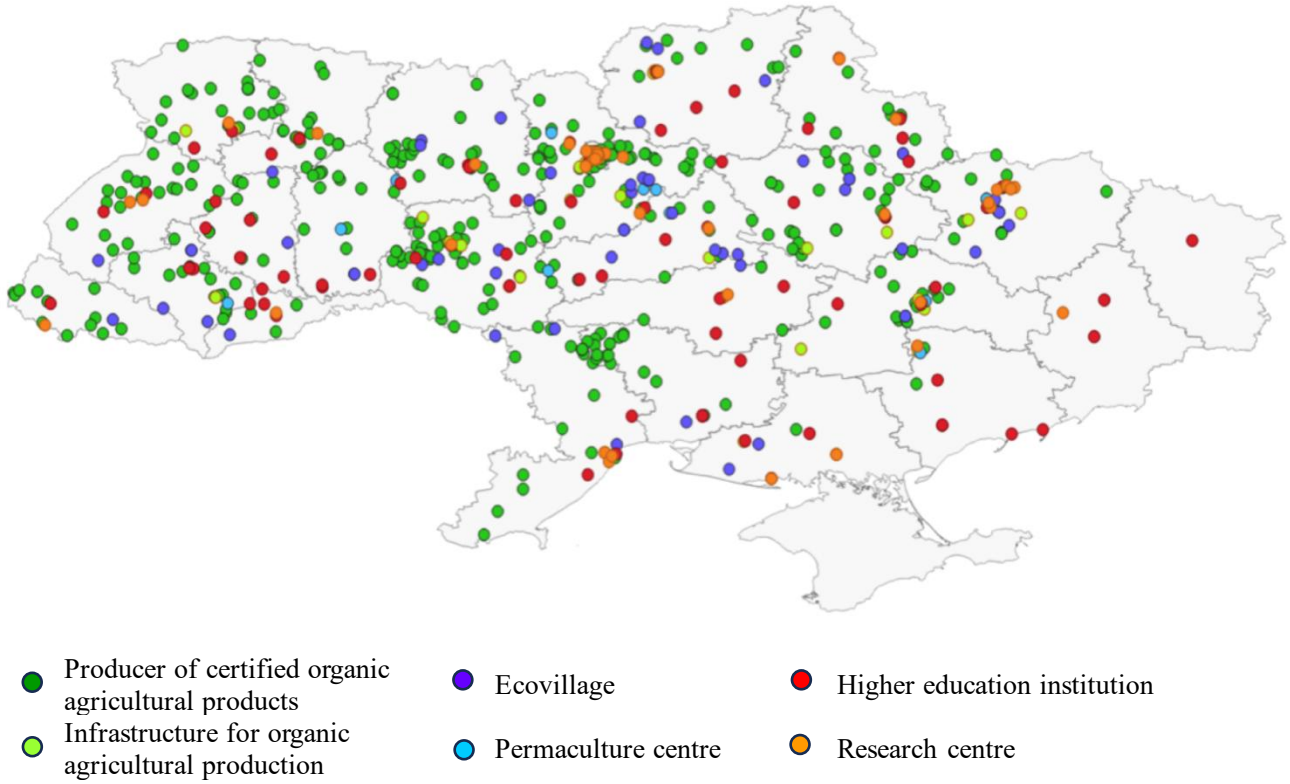


Fig. 3. Agroecological map of Ukraine

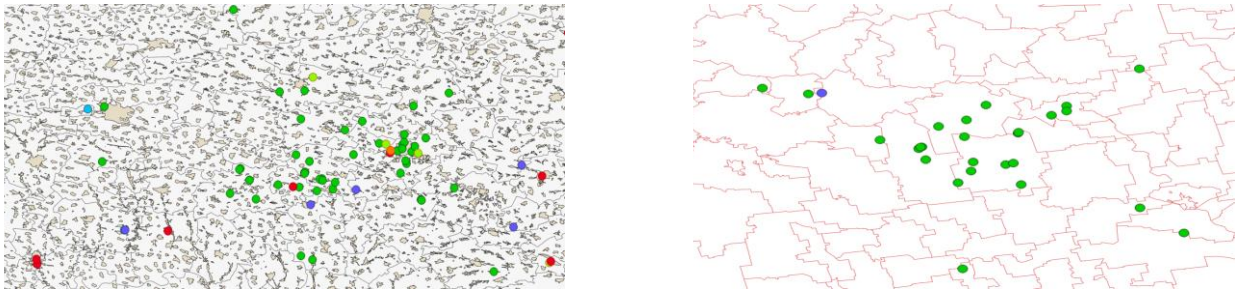
Source: Author's compilation based on information data from official state registers, NGO data, agroecological initiatives, and other open source

Analysis of national agricultural enterprises that actively advocate for the implementation of agroecological approaches and practices in their operations demonstrates that the conceptual understanding of agroecology among the majority of such agricultural producers, as well as among numerous researchers and practitioners, remains predominantly confined to technological aspects of agricultural production systems. This approach overlooks a substantial corpus of social, economic and institutional considerations that encompass not only human-environment interactions within agricultural production processes, but also the complex dynamics among economic actors, local communities, and rural populations. For many large-scale certified organic producers, certification serves primarily as a market access mechanism for penetrating international markets with high-value crop commodities, while demonstrating limited orientation toward domestic market development.

The practical operationalization of agroecological principles within the subgroup of large-scale organic producers in addressing agroecological objectives often exhibits a reductionist approach, as production motivations are predominantly driven by commercial

considerations. The majority of such practices can be characterized as pseudo-agroecological, lacking the foundational prerequisites, systemic linkages, and enabling factors that derive from the socioeconomic principles of agroecology.

A distinct specialized subgroup within this category comprises small-scale niche producers who similarly pursue international market penetration strategies. Exemplary of such specialization are apiary operations producing honey and related bee products. These enterprises frequently develop spatial clustering patterns within single or multiple adjacent territorial communities. Figure 4 illustrates the territorial concentration of small-scale certified organic apiary producers across several contiguous territorial communities in Odesa Oblast. Such spatial clustering is not exclusively attributable to favorable agroecological conditions for specific production systems; while environmental suitability constitutes an important precondition for cluster formation, it remains insufficient as a sole explanatory factor. Local knowledge transfer mechanisms evidently played a critical role in cluster development, particularly regarding production processes, marketing and distribution systems, and certification procedures. It is specifically at the community level that intensive knowledge, information, and experience exchange typically occurs.



а) in relation to the boundaries of territorial communities and settlements

б) in relation to the boundaries of territorial communities

Fig. 4. Examples of territorial concentration of small certified organic producers

Source: Author's compilation based on information data from official state registers, NGO data, agroecological initiatives, and other open sources.

This practice subtype demonstrates pronounced socioeconomic orientation, with critical development prerequisites including proactive local government engagement in knowledge dissemination, community-level mobilization of financing through small producer support initiatives, participation in collaborative rural entrepreneurship development programs, implementation of effective local economic development frameworks, cooperative development, inter-producer networking, and the presence of local change agents within territorial communities.

Educational and Scientific Institutions. Agroecological education and research activities are conducted by diverse categories of legal entities and individuals for whom such activities constitute either primary or secondary functions, or integral lifestyle components. Many such economic actors or communities engaged in agroecological knowledge production and dissemination were classified under alternative typological categories for mapping purposes – organic producers, permaculture centers, or ecovillages. Additionally, Figure 3 separately illustrates selected certified educational scientific institutions and state research

organizations for whom educational and scientific functions represent core mandates and which demonstrate primary focus on agroecological issues, or possess the capacity and institutional rationale to do so based on operational specificity, specialization, or existing potential.

Educational institutions selected for mapping comprised third and fourth-level accreditation institutions providing degree programs at master's, bachelor's, associate bachelor's, and professional associate bachelor's levels where the academic discipline "Agroecology" is integrated into curricula.

Permaculture Centers and Ecovillage Initiatives. These two categories of civil agroecological initiatives – permaculture and ecovillage – are presented in aggregated form without subgroup differentiation; certain initiatives may simultaneously qualify for both classifications. Methodologically, these categories present the greatest taxonomic complexity and exhibit the least internal homogeneity. Permaculture centers, for instance, encompass commercial agricultural enterprises promoting permaculture approaches in harmony with natural processes while minimizing labor inputs and ecological impact, as well as households (or their associations) whose members pursue nature-harmonized lifestyles, community gardens, environmental advocate networks and like-minded associations developing rural community initiatives, educational-research stations, and others. The primary criterion for classification within the permaculture centers subgroup was membership as of 2023 in the national network of permaculture learning and demonstration centers. Analogously, classification within the ecovillage category was based on self-identification of highly diverse households, communities, settlements, ecological farming operations, and projects that either maintained membership in the Global Ecovillage Network of Ukraine or engaged with this network while sharing common values.



Photo by Anil Sharma on Pexels

4. Strategic Framework for Agroecological Transition Promotion

4.1 Roadmap Development

The strategic framework for agroecological transition in Ukraine requires institutionalization through a comprehensive roadmap for transitioning Ukraine's agricultural systems and rural territories toward agroecologically-based development, incorporating specific implementation solutions with defined chronological sequences. The agroecological transition roadmap should function as a coordination instrument delineating transformation pathways and timelines for converting the currently predominant industrial agricultural model toward desired agroecological configurations across specific sectors and domains, utilizing national scientific achievements, ecological technologies, rural innovations, digital instruments, and related tools. As a strategically oriented coordination framework, the agroecological transition roadmap will guide for establishment of an ecologically neutral, competitive, economically viable, socially responsible, equitable, and future-oriented agri-food system serving current and future generations. Long-term agroecological transition priorities defined within the roadmap will subsequently constitute

the foundation for developing and implementing sustainability-based agricultural sector and rural territorial development programs eligible for financing from both national budget allocations and European Union common budget resources.

The initial phase in constructing this roadmap as a strategic planning mechanism for transitioning Ukraine's agriculture and rural territories toward agroecological development requires defining transition objectives. This process must be predicated on several fundamental positions. Primarily, agroecology in contemporary conceptualization represents an innovative approach to establishing sustainable agri-food systems across all hierarchical levels, grounded in adherence to socially equitable and ecological principles governing food production and consumption, encompassing food sovereignty assurance for human communities, livelihood guarantees for rural populations within their residential localities, agroecosystem ecological integrity achievement, environmental quality maintenance, and health safety assurance for humans, soils, and animals. Additionally, agri-food systems constitute complex formations integrating activities and corresponding relationships among agricultural products and food producers and consumers, incorporating both determinants and outcomes of these activities. Furthermore, rural territories constitute the fundamental foundation of agroecology, as their populations and local cultures ensure harmonious human-nature relationships, manifested through food producers' stewardship of land and environmental resources and, ultimately, consumer welfare.

Considering these principles, the agroecological transition roadmap objective within Ukraine's EU accession preparation and post-war recovery processes should focus on strengthening sustainability, equity, and inclusiveness of local, regional, and national agri-food systems through favorable institutional and economic condition creation for agroecological practice implementation, particularly by small-scale (including family-type) agricultural and food producers; establishing direct producer-consumer linkages and enhancing capacities for producing and consuming safe, ecologically sound, and universally accessible food while preserving natural resource and environmental quality.

Agroecological transition goal achievement indicators could include increases in: agricultural land area (proportion) under ecologically sound production; number of agricultural sector economic entities utilizing agroecological methods and associated employment levels; ecologically clean product share in population food consumption value; population numbers (proportion) consuming ecologically clean products. Methodologies for determining such indicators require development. Potential approaches include incorporating relevant indicators into household living conditions sample survey programs.

These metrics may also be integrated into agricultural enterprise activity surveys. Given Ukraine's prolonged absence of comprehensive agricultural producer activity information coverage (and collection), establishing a dedicated "Agricultural producer activity information collection system creation" priority – rather than subsidiary consideration – becomes essential, requiring both organizational and financial resource allocation for system establishment and data collection initiation in subsequent action plans.

This requirement is further emphasized by government-approved action plans specifying the Q1 2027 establishment of EU-unified FSDN

systems[3]. Such systems represent enhanced farm accounting datasets based on FADN (Farm Accountancy Data Network) frameworks.

Given agroecology's transdisciplinary characteristics, national-level agroecological transition roadmap formulation requires engagement of central executive bodies responsible for agricultural and rural development, food policy, community and territorial development, education and science, health protection, environmental and natural resource protection; scientific and educational community representatives, ecological movements, and other interested civil society organizations. This necessitates establishing appropriate coordination mechanisms. Analogous bodies require establishment for regional and local (territorial community) level agricultural and rural territory agroecological development transition roadmap formulation.

To achieve roadmap-defined agroecological transition objectives, incorporating FAO recommendations, measures should address: regulatory and legal foundation strengthening for agroecology promotion as a sustainable agri-food system establishment approach; sustainability, resilience, and socioeconomic effectiveness assessment of existing agricultural production and food consumption systems; agroecological practice dissemination promotion and transition scaling; scientific research expansion, result utilization method improvement, and agroecological knowledge dissemination system enhancement for quality of life improvement; institutional environment formation for agroecological transition promotion.

As outlined in section 1.2, Ukraine maintains regulatory and legal frameworks governing environmental protection and food safety, and quality relations. Concurrently, within the agricultural sector where industrial economic formations predominate, significant agricultural production portions involve exhaustive land and natural resource utilization with destructive environmental and rural social development impacts; agri-food systems demonstrate insufficient sustainability, particularly evident during COVID-19 pandemic conditions and full-scale military operations.

The Agricultural and Rural Development Strategy for the period until 2030 identifies among primary directions for achieving defined strategic objectives: state agricultural and rural development policy adaptation within EU accession preparation contexts; agricultural and sanitary/phytosanitary control legal act harmonization process acceleration with EU standards; small producer and rural territorial community development promotion. Specifying these directions regarding agroecological transition, supportive factors include: Ukrainian agricultural structure legislative regulation according to European Common Agricultural Policy formation and implementation principles for 2023-2027 and the fundamental "leaving no one behind" principle; regulatory and legal act adjustments governing food safety and quality relations incorporating EU requirements, financial and institutional support for agroecological principle adherence by small agricultural producers and territorial communities.

Regarding national agricultural structure legislative regulation, this primarily concerns "Agricultural System" law adoption, requiring agricultural sector producer category documentation, including agricultural enterprises and their associations (agricultural holdings), farms, and households. To integrate

[3] FSDN is a network of data on the sustainability of agricultural development in EU countries. Creating a transparent, operational, and consistent data collection system is a necessary condition for supporting the transition of European agri-food systems to greater sustainability and social justice, as such a system will enable higher quality monitoring, impact assessment, research, and policy analysis.

farmers and rural households into general state support frameworks, particularly agroecological transition support, the EU CAP "active farmer" concepts should be applied. Active farmers are defined across all EU countries based on objective and non-discriminatory criteria, including negative indicator lists excluding specific economic entities.

Sanitary and phytosanitary control legal act harmonization with EU standards is presumably addressed in other Ukraine-European Union Association Agreement implementation documents, but should also be reflected in the agroecological transition roadmap. Agricultural products and food goods produced according to Ukraine's "Basic Principles and Requirements for Organic Production, Circulation and Labeling of Organic Products" law receive EU country recognition, but remain minimally accessible in domestic markets due to high costs (including substantial certification expenses). Therefore, expanding local trade market operator recognition practices for peasant farms and farming households producing various ecologically clean products ("craft," "artisanal food" products, etc.) is advisable, alongside formalizing alternative agroecological activities beyond organic production and establishing ecological product and service producer identification systems.

4.2 Agroecological Transition Scaling

Strategic measures for promoting agroecological scaling encompass the following priority areas:

Agroecological awareness enhancement among food system actors. A fundamental prerequisite for agroecological transition dissemination involves comprehensive awareness-building among all population demographics regarding agroecological benefits for human health, environmental integrity, and sustainable natural resource utilization. Prevailing societal perceptions attribute agroecological transition responsibility exclusively to agricultural producers, with innovation and knowledge transfer confined to production processes. However, empirical research demonstrates that successful agroecological transformation scaling requires socioeconomic factor integration, particularly consumer demand formation for agroecological products and societal awareness and commitment to supporting and financing these characteristically higher-cost initiatives during implementation phases.

Consequently, agroecological knowledge dissemination necessitates comprehensive approaches targeting diverse population segments and social constituencies: producers, consumers, researchers, government officials, policymakers, youth demographics, etc.

Within educational frameworks, agroecological curricula integration is essential, with "Agroecology" programs implemented not exclusively within agricultural educational institutions but integrated across economic and social disciplines for broader student constituencies. Additionally, foundational knowledge establishment at primary and secondary education levels is critical, developing ecological consciousness, sustainable food consumption practices, and sustainable development principle awareness. For farmers and agricultural producers, capacity-building interventions, including workshops, webinars, and demonstration field projects, should be conducted, facilitating horizontal knowledge exchange mechanisms and traditional local knowledge integration with evidence-based approaches.

Contemporary knowledge dissemination methodologies include agroecological benefit popularization through media and digital platforms via documentary production and reportage featuring successful agroecological practice narratives, eco-blogger experience sharing, and farmer product quality testimonials;

social media content development highlighting organic farming advantages; article publication and blog maintenance providing accessible agroecological benefit explanations.

Local eco-festival and market organization for eco-product familiarization and food sampling; farm open-house events demonstrating agroecological operation functionality; public lecture and discussion facilitation involving expert and farmer participation in open dialogue will promote agroecological methodologies and practices while benefiting consumer constituencies.

Recognizing youth potential in ecological innovation implementation and healthy lifestyle adoption, youth creative campaign promotion through comic, meme, and animation contests featuring agroecological initiatives, youth conferences, eco-camps, international student exchange programs, etc., should be prioritized.

Youth engagement strategies. A critical component of food system sustainability enhancement and rural population retention involves rural youth agricultural career opportunity creation. European empirical evidence indicates agroecological potential for achieving these objectives through knowledge-intensive characteristics and explicit social value orientation, including equity and collective innovation. Given agroecological production's labor-intensive nature relative to conventional and industrial agriculture, employment generation potential exists alongside decent income opportunities, thereby incentivizing youth agricultural career initiation. Essential conditions include supplementary financial support provision for youth initiating such agricultural activities.

Young farmer support (generational renewal) exemplification includes EU CAP funding programs. Dedicated financial support allocation specifically for youth demographics is justified by young farmers' contribution of novel knowledge, energy, and agricultural sector transformation acceleration; they typically demonstrate innovation utilization expertise and production investment openness, ensuring sustainable agricultural development and rural territory viability impact. EU regulatory frameworks mandate member state allocation of a minimum 3% direct payment package proportions with implementation flexibility: additional income support, new young farmer start-up assistance, or investment support mechanisms (Regulation Annex XII)[4]. Individual countries determine support volumes for generational renewal stimulation, with 22 of 27 member states allocating beyond minimum requirements, demonstrating agricultural generational renewal priority recognition.

Local market development and short value chain creation. Local market organization and short food supply chain establishment constitute critical agroecological transition dissemination instruments, ensuring equitable farmer conditions, quality food consumer accessibility, and local economic strengthening.

Primarily, agroecologically produced food marketing through local markets establishes equitable economic foundations for farmers and consumers. Producers engage in direct consumer sales, achieving enhanced profitability through intermediary elimination. Consumers maintain producer knowledge, enabling product sampling, producer inquiry, and food quality monitoring.

One producer-consumer collaboration model involves solidarity agriculture, predicated on

[4] Regulation (EU) 2021/2115 of the European Parliament and of the Council of 2 December 2021 establishing rules on support for strategic plans to be drawn up by Member States under the common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulations (EU) № 1305/2013 and (EU) № 1307/2013. PE/64/2021/REV/1. URL: https://eur-lex.europa.eu/eli/reg/2021/2115/oj

social interaction and direct producer-consumer communication, ensuring consumer food quality and safety alongside producer sales guarantees. Consumers share production responsibility, benefits, and risks with producers. Comprehensive information regarding solidarity agriculture models and societal behavioral strategy formation is provided in “Solidarity responsibility of producers and consumers in agriculture. CSA – community supported agriculture” [38].

Public procurement support and agroecological product demand stimulation for public needs satisfaction. State agroecological initiative support development, beyond production activity financing, should encompass organizational conditions and regulatory mechanism creation during product commercialization phases. State agroecological transition support instruments should include environmentally-produced product demand stimulation and state-guaranteed organic product sales channel expansion (state safe food procurement orders). This involves safe agroecological product utilization quota establishment within public catering sectors. Educational institution networks, including schools, kindergartens, child development centers, municipal hospitals, and social sector institutions providing public catering services, require mandatory environmentally safe product utilization norms in institutional menus. This approach serves dual objectives: proper nutrition and public health goal achievement through enhanced nutritious food product access produced under high safety and quality standards, particularly for children and vulnerable populations; and agroecological practice scaling promotion.

Box 3.

Analogous initiative support frameworks are exemplified in Denmark's "Ecological Action Plan for 2020" [39], which positions organic product utilization quota establishment in public catering institutions and corresponding state procurement financing as organic food market expansion mechanisms. Similarly, Finland's National Public Procurement Strategy, aligned with Organic 2.0 program objectives, has institutionalized a 25% organic food utilization quota for public catering establishments [40].

Implementation of corresponding quota mechanisms within national regulatory frameworks will enhance internal market capacity for agroecological products and stimulate quality and safe food production.

State land utilization for agroecological farming method scaling. Ukraine has experienced fundamental land tenure transformations over the past five years: agricultural land sales moratorium termination effective July 1, 2021; legal entity purchase rights establishment effective January 1, 2024, with maximum acquisition limits of 10,000 hectares. Legislative conditions enhanced land concentration possibilities and strategic resource transformation into exclusively financial assets. Preventive measures intended to establish civilized land market frameworks lacked ecological restrictions, with social priorities confined to Ukrainian legal purchase-sale rights for agricultural lands. From sustainable development goal achievement and agroecology promotion perspectives, excessive land market liberalization demonstrates no positive impact.

Currently, state agricultural lands remain excluded from market circulation, distributed through State Land Bank leasing mechanisms. Acknowledging agricultural land social functions and considering agroecological multiplicative advantages for human health, sustainable natural resource utilization and conservation, climate change mitigation, etc.,

state support through appropriate measures is warranted. Within this context, state agricultural lands could facilitate demonstration farm promotion, agroecological initiative development pilot project creation, innovative technological change development and implementation for digital (precision) agriculture advancement, biotechnology applications, environmentally clean product cultivation for specialized applications such as children's nutrition requirements, etc.

Digitalization frameworks. Contemporary digital technologies present substantial potential for agroecological method implementation, facilitating ecological impact reduction, resource efficiency enhancement, and farming sustainability and youth attractiveness improvement. Large-scale agricultural enterprises actively utilize GPS and drone technologies for field mapping and plant condition monitoring, soil sensors for moisture, temperature, nitrogen level, and elemental control, satellite imagery for yield forecasting and plant disease detection, intelligent irrigation systems, etc. For small-scale agriculture predominantly employing agroecological methodologies, these digital solutions represent significant cost barriers. Rural internet access limitations additionally constrain farmer digital application utilization.

Given Ukraine's robust digital infrastructure and digital industry employment levels (Ukraine ranked first in Europe and fourth globally in digital platform employment during 2013-2017 [41]), state agroecological transition support program frameworks could incorporate digital solutions and application development procurement for small-scale agroecological production. Considering digitalization's resource utilization optimization potential, ecological footprint reduction capacity, and agroecological practice dissemination facilitation, technology implementation will accelerate sustainable agriculture advancement and economically viable farmer solutions.

4.3 Institutional Environment Enhancement

Agricultural and rural territorial transition toward agroecologically-based development requires comprehensive organizational frameworks, stakeholder mobilization, and coordinated efforts among all bodies, organizations, movements, and communities engaged in or committed to sustainable agri-food system formation. Regarding organizational provision, national-level establishment of a specialized institution – an inter-ministerial committee for agroecological transition promotion within Ukraine's agri-food sector – appears essential. Coordination responsibilities within this institution could be undertaken by the Ministry of Agrarian Policy and Food of Ukraine as the central executive authority ensuring state policy formation and implementation in food safety and quality indicators, quarantine, and plant protection domains. Committee composition should incorporate representatives from all stakeholders participating in Agroecological Transition Roadmap formulation. Analogous committees should be established at the regional levels.

Agroecological transition scaling depends fundamentally on strengthening the agroecological approach over *local* agricultural and food system formation/transformation processes. This necessitates enhanced territorial community (TC) roles in creating favorable environments for ecologically sound agricultural and food production development within their jurisdictions, while ensuring quality food product access for the broadest possible consumer constituencies, including vulnerable population demographics. Given that territorial community executive self-governance bodies, particularly urban administrations, currently demonstrate inadequate attention to agricultural and rural development concerns, organizational

support for fulfilling these functions requires: first, structural subdivisions within these bodies responsible for agricultural and rural development; second, an inter-departmental working group for community-level agroecological transition promotion.

The designated structural subdivision should facilitate not only successful agricultural producer operations across TC territories, but also community resident interest realization regarding ecologically safe local natural resource utilization and environmental protection, safe and healthy food access needs satisfaction, and local employment with adequate compensation, focusing activities on the community agri-food sector and rural area transition toward agroecologically-based development.

Given that TC agri-food sectors encompass all agricultural producer categories within community territories (agricultural enterprises, farms, rural households, etc.), economic entities engaged in agricultural raw material processing and food production, and local food market operators, establishing inter-departmental working groups for community agroecological transition roadmap development with stakeholder representation, including designated TC self-governance executive body subdivision representatives, is advisable.

Territorial community agroecological transition roadmaps should incorporate:

- TC-level public oversight and quality assurance mechanisms for agricultural products and food produced within community territories using agroecological methodologies, with appropriate public labeling authority;
- Knowledge and experience dissemination among all TC members from farms (including households) currently implementing agroecological practices;
- Institutional cooperation establishment with entities conducting agroecological scientific and educational activities for relevant knowledge dissemination and research implementation within TC territories;
- Local market development promotion and locally-produced environmentally clean product sales volume increases, direct consumer-producer linkage establishment for ecologically clean products, solidarity agriculture development, etc.;
- Agricultural production development stimulation based on agroecological principles at territorial community levels.

4.4 Agroecological Transition Implementation Monitoring and Evaluation System Formation

A critical component of agricultural and rural territorial transition toward agroecologically-based development requires a comprehensive monitoring and evaluation system development and implementation for key agroecological principle implementation effectiveness assessment. Analogous frameworks operate within the European Union – Performance Monitoring and Evaluation Framework (PMEF); other countries, including the United States and China, track implementation of specific regulatory instruments targeting agricultural production greening [42].

Ukraine's monitoring and evaluation system should be predicated on comprehensive target indicator complexes encompassing economic, ecological, and social characteristics, with achievement levels constituting research focal points. The architectural framework should encompass minimally three hierarchical levels:

- Agricultural producer level, monitoring resource utilization volumes including proprietary and purchased inputs, mineral fertilizers, synthetic plant protection products, individual agroecological practice implementation, land area withdrawal from circulation for soil fertility restoration, etc.;
- Territorial community/rajon level, analyzing ecological practice implementation pace/scale, women's and youth engagement in

agroecologically-based agricultural management, specialized local market/trading establishment creation for environmentally sound agricultural product marketing and alternative distribution channel development, organic farming land area dynamics, population employment in agroecologically-oriented operations, etc.;

- National level, tracking comprehensive agroecological transition provision indicators: agricultural producer numbers implementing agroecological principles, land areas allocated for ecological practice implementation, ecologically-produced food volumes, population shares preferring ecologically clean product consumption, citizen health status changes, educational institution, research establishment, consulting agency, advisory service numbers engaged in knowledge generation and dissemination and agroecological practice implementation expert support provision, etc.

Monitoring and evaluation system functionality requires appropriate information resources. Within this context, by Q1 2025, under the Agricultural and Rural Territory Development Strategy implementation framework for the period until 2030, automated land relations public monitoring system creation within State Land Cadastre maintenance is planned; by Q1 2027, IACS principle-based data control systems and Farm Sustainability Data Network (FSDN) principle-based agricultural enterprise data accounting.

Information gap resolution attempts included Ukraine's Law "On Information and Communication System 'State Agrarian Register'" adoption [43], designating SAR as a comprehensive information system ensuring data collection, accumulation, integration, storage, display, and processing, including registry information utilization. The register provides separate subsystem (section) formation, enabling current SAR transformation into the State Farmers' Register; agricultural state support, assistance, grant targeted utilization monitoring introduction; SAR electronic information interaction with other information-communication systems, electronic information resources, cadastres, etc. Concurrently, information list expansion during SAR system registration through environmental indicator incorporation appears advisable, with financial resource payments contingent upon good agricultural practice requirement compliance.

At territorial community levels, TC profiles should incorporate agricultural production greening indicators, rural population involvement in these processes (particularly youth and women), product marketing channels, etc., while "Household Living Conditions Survey" statistical observation forms should include environmentally clean product production and consumption indicators.

Simultaneously, Ukrainian statistics harmonization with European Union requirements is essential; agricultural enterprise survey introduction according to European Parliament and Council Regulation (EU) No 2018/1091 of July 18, 2018 [44], on integrated agricultural holdings statistics; modern objective agricultural information acquisition approach implementation, including satellite data utilization; systematic large-scale agricultural producer survey establishment regarding operational conditions and implemented practices. This would enable agricultural sector development trend spatial and temporal comparisons, production process greening and comprehensive agroecological principle implementation effectiveness monitoring and analysis, policy measure targeting, and goal achievement progress assessment.



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IV. Conclusion

Agroecology within global economic systems demonstrates accelerating momentum as a comprehensive sustainable agricultural and rural territorial development approach encompassing ecological principles, social equity, and economic viability. At European Commission levels, agroecology receives recognition as guidance toward enhanced sustainable and circular food system development, aligning with EU Green Deal implementation and 2030 "Farm to Fork" and "Biodiversity" Strategy principles. Europe's trajectory toward comprehensive agroecological practice implementation employs multidimensional approaches incorporating research, innovation, policy support, and farmer engagement mechanisms. Substantial EU budgetary allocations support the practical implementation of agroecological scaling initiatives, as contemporary global challenges, including climate change, biodiversity loss, water resource management, and food insecurity, intensify requirements for innovative and holistic food production, agricultural, and rural development approaches. Growing recognition exists regarding agricultural sector transformation to enhance sustainability, resilience, and contemporary and strategic societal and political demand responsiveness. As articulated in the EU Strategic Dialogue on Agricultural and Rural Area Futures, these priorities are delineated across numerous European Commission policy instruments and initiatives [45].

Within Ukraine's active European integration pursuit, the process's success will substantially depend on agricultural and rural development progress. Consequently, strategic recovery programs and projects should align with global and EU agri-food system transformation strategic objectives and intentions. Ukraine's enhanced European integration status currently provides tangible opportunities for European agroecological transition financial support program during preparatory phases. Orientation should recognize that the European agricultural and rural development vision through 2040, toward sustainable agri-food system formation based on agroecological principles, extends beyond innovation stimulation exclusively within climate change mitigation, natural resource conservation, environmental protection, biodiversity preservation, and safe production technology domains. Contemporary food security threat and challenge dynamics, beyond enumerated factors, involve comprehensive interconnected action systems across diverse agricultural sector operational spheres—education, healthy nutrition, consumption culture, rural identity and family farming preservation, cultural tradition maintenance, domestic food security, and associated social relations—constituting agroecological socioeconomic potential.

Ukrainian agricultural sector's potential war-related losses demonstrate unprecedented scale.

Extended military operations increasingly damage land resources, environmental systems, rural communities, and the Ukrainian population's access to quality and affordable food products. Ukrainian agricultural futures will substantially depend on the production and export potential restoration processes' capacity to halt soil, water resource, biodiversity, and rural human capital degradation while protecting natural and environmental resources for future generations. Within these circumstances, agroecological transition can facilitate not only successful European integration advancement but also parallel nationally-rooted agricultural and rural development processes, enabling sustainable agricultural and rural development within strategic European-oriented perspectives. Contemporary limited resource utilization complexity and future management system and food security design cannot be effectively addressed through exclusive focus on production aspects and short-term agricultural export economic benefits.

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