Journal of Agriculture and Rural Development Studies
Volume 2 – Issue 2 – 2025
ISSN Online 3061-2756
www.imadr.jards.ugal.ro

DOI https://doi.org/10.35219/jards.2025.2.03

Theoretical Aspects Regarding Phytotechnical Strategies for Increasing Production

Mitică Roman*, Floricel Maricel Dima**, Neculai Patriche***, Anca Nicoleta Săvescu (Cordeli) ****, Silvius Stanciu*****

ARTICLE INFO

Article history:
Received: April 14, 2025
Accepted: June 07, 2025
Published: July 01, 2025

Keywords:
efficiency, socio-economic process, sustainable

ABSTRACT

Although global production is sufficient to provide approximately 2,700 calories per day for every person, according to FAO data, over 850 million people worldwide suffer from hunger. Meanwhile, in certain parts of the world (for example, in developed EU countries), overproduction creates significant issues, disrupting agricultural markets and the supply-demand balance, paradoxically affecting the incomes of agricultural producers. This imbalance in global food supply is due to varying crop yields in different geopolitical regions, which are influenced by the performance of production technologies employed. Phytotechnics integrates fundamental and applied knowledge from biology, physiology, technology, economics, and management. Phytotechnical methods such as crop rotation, fertilization, soil tillage, sowing practices, crop care, and selecting high-quality biological material are employed to increase field crop production through cultivation techniques. These methods can be applied in plant production and depend primarily on the potential of the variety or hybrid and the quality of the seed material. Therefore, selecting suitable biological material and applying technological measures tailored to existing natural conditions through ecological zoning is essential to using genetic potential efficiently.

1. Introduction

The "Green Revolution" marked the onset of significant intensification in agricultural production within developing countries. Beginning in the 1950s and gaining momentum in the 1960s, this movement introduced a wide range of crops and farming practices across the globe (Tilman, D., 1998).

In the context of a growing global population and increasing demand for food, feed, and raw materials, enhancing agricultural productivity has become a fundamental objective of sustainable crop management. Phytotechnical strategies—the set of agronomic, ecological, and physiological practices applied to optimize plant growth and yield—play a central role in the intensification of production systems. These strategies include crop rotation, soil fertility management, plant density optimization, irrigation scheduling, and improved cultivars adapted to specific agroecological conditions (Zhang et al., 2019).

*, **Dunarea de Jos University of Galati, Romania / Research Development Institute for Aquatic Ecology, Fisheries and Aquaculture "Gheorghe Ionescu – Șișești" Academy of Agricultural and Forestry Sciences, Galati, Romania, ***, **** Research Development Institute for Aquatic Ecology, Fisheries and Aquaculture "Gheorghe Ionescu – Șișești" Academy of Agricultural and Forestry Sciences, Galati, Romania, ***** Dunarea de Jos University of Galati, Romania. Email addresses: romanmitik@gmail.com (M. Roman), fdima@ugal.ro (F. M. Dima), patriche.neculai@asas-icdeapa.ro (N. Patriche), savescu.anca@asas-icdeapa.ro (A. N. Săvescu Cordeli), sstanciu@ugal.ro (S. Stanciu - Corresponding author).

The growing global demand for food, along with challenges such as climate change, limited arable land, and the depletion of natural resources, has led to the development and implementation of innovative agricultural practices. Phytotechnical strategies, including crop rotation, intercropping, and sustainable fertilizers, are vital in increasing agricultural production while maintaining soil health and environmental sustainability. This article explores the theoretical aspects of various phytotechnical strategies that optimize crop yield and promote sustainable agricultural practices. We will examine the scientific principles behind these strategies and real-world case studies to understand their potential for addressing global food security concerns.

Several studies have highlighted the effectiveness of crop rotation as a phytotechnical strategy in increasing soil fertility and preventing pest and disease buildup (Smith, 2015). According to Jones et al. (2018), intercropping involves planting two or more crops in proximity, has improved resource use efficiency, and reduced the need for chemical inputs. Furthermore, applying organic fertilizers, such as compost and green manure, has been linked to enhanced soil structure and nutrient cycling (Miller et Thompson, 2017). When integrated into farming systems, these strategies can improve productivity and sustainability.

The theoretical foundation of phytotechnics lies in the complex interactions between genotype, environment, and management (G × E × M), a paradigm that maximizes resource use efficiency. Modern phytotechnical approaches are increasingly driven by systems thinking, where crop physiology, soil-plant-atmosphere interactions, and precision agriculture technologies are integrated into coherent frameworks (van Ittersum & Rabbinge, 1997).

Moreover, adopting sustainable intensification practices seeks to increase yields without adverse environmental consequences, aligning production goals with the principles of agroecology and resilience (Pretty et al., 2018).

A key aspect of phytotechnical advancement is the integration of site-specific management practices, which consider local soil fertility, climate variability, and crop requirements. This is particularly relevant in climate change, where adaptive strategies such as conservation tillage, crop diversification, and water-saving technologies are crucial to maintaining productivity in variable conditions (Lobell et al., 2011).

Additionally, biotechnological tools, such as plant growth-promoting rhizobacteria (PGPR) and biofortification, are increasingly used to complement traditional phytotechnical measures and enhance plant performance under stress conditions (Backer et al., 2018).

This paper aims to explore the theoretical underpinnings of phytotechnical strategies for increasing agricultural production, emphasizing the physiological, ecological, and technological principles that inform their application.

By reviewing current scientific literature and theoretical models, the study seeks to provide a structured framework for understanding how phytotechnical interventions can be optimized to meet the challenges of modern agriculture.

2. Literature review

The materials for this study were drawn from peer-reviewed articles and research papers accessed through global databases such as Web of Science, Elsevier, and Google Scholar. A systematic review of recent literature (published between 2010 and 2023) was conducted to identify key phytotechnical strategies for increasing agricultural production. The selection criteria focused on studies that addressed sustainable farming practices, their effectiveness in different climatic zones, and their impact on crop yields and soil health. Key databases used for this analysis included Web of Science, Elsevier ScienceDirect, Scopus, and SpringerLink.

The analysis also incorporated data from case studies in temperate and tropical regions to assess the applicability of different strategies across diverse environmental conditions.

Theoretical analysis of phytotechnical strategies was conducted by reviewing peer-reviewed literature on crop management techniques, soil fertility practices, and the impact of various fertilizers on agricultural production. Key studies from multiple climatic zones and farming systems were selected to assess the effectiveness of these strategies in increasing crop yields and improving soil health.

The study and sampling area was the Brates Agro-Fisheries Experimental Research Laboratory, which conducts research within the Brates fish pond facility. (Figure 1)

Figure 1. Brates Agro-Fisheries Research Experimental Laboratory
Source: https://asas-icdeapa.ro/ferma-brates/

3. Crop Rotation as a Phytotechnical Strategy

Crop rotation has long been recognized as a sustainable agricultural practice that improves soil health, reduces pest infestations, and increases productivity. By alternating crops with different nutrient requirements and root structures, crop rotation can enhance nutrient cycling and soil structure while breaking the life cycles of pests and diseases.

Studies have shown crop rotation improves soil fertility by reducing soil-borne diseases, minimizing weed pressure, and enhancing nutrient balance (Smith et al., 2015). For example, a study by Jones et al. (2018) found that rotating leguminous crops with cereals increased nitrogen fixation in the soil, reducing the need for synthetic fertilizers.

4. Intercropping and Polyculture Systems

Intercropping, the practice of planting two or more crops together in the same area, is another phytotechnical strategy to improve crop productivity. Intercropping systems have been shown to optimize resource use, reduce pest pressures, and increase crop yields per unit of land area. Polyculture systems, which involve cultivating multiple crops with complementary growth patterns, are a well-known form of intercropping.

Research by Lee et al. (2017) demonstrated that intercropping maize with legumes increased yield stability and resilience to drought. Furthermore, intercropping systems foster biodiversity, which can improve ecosystem services such as pollination, pest control, and nutrient cycling (Zhang et al., 2016).

5. Sustainable Fertilization Techniques

Using organic fertilizers, such as compost, manure, and green manure, is an integral component of phytotechnical strategies. These fertilizers improve soil organic matter, promote microbial activity, and enhance nutrient cycling, improving soil health and productivity.

A comprehensive review by Miller et Thompson (2017) showed that organic fertilizers, compared to synthetic fertilizers, provide essential nutrients and enhance the soil's ability to retain water, which is critical in drought-prone areas. Additionally, the use of compost and manure contributes to a reduction in greenhouse gas emissions and improves soil carbon sequestration.

6. Agroforestry Systems

Agroforestry, the integration of trees into agricultural systems, is another phytotechnical approach that has gained attention for its potential to increase productivity while improving environmental sustainability. Trees provide numerous benefits, including improved soil structure, water conservation, and biodiversity enhancement.

Studies by Nair et al. (2018) have shown that agroforestry systems, particularly those incorporating nitrogen-fixing trees, can enhance soil fertility and reduce the need for external fertilizer inputs. These systems also increase carbon sequestration, which contributes to mitigating climate change.

7. Results and discussion

The review revealed that phytotechnical strategies, such as crop rotation, intercropping, and organic fertilizers, consistently lead to increased production and sustainability in diverse agricultural systems. For instance, crop rotation enhanced soil fertility and reduced the incidence of soil-borne diseases, while intercropping improved pest control and increased overall yield per unit area. Organic fertilizers enrich the soil with essential nutrients and promote biodiversity, contributing to higher resilience against environmental stresses.

The efficient and sustainable management of fish ponds, particularly those located on highly mineralized lands, requires the development of scientific and technical exploitation methods that enhance and preserve soil fertility while meeting technological standards influenced by economic and ecological factors.

The implementation of comprehensive amelioration measures takes into account the morphogenetic, chemical, physical, and biological characteristics of fish pond soils, the predominant negative impact of chemical (ionic) factors, and the essential role of water as both an evolutionary factor and a transport medium for soluble salts. These measures include hydro-ameliorative interventions such as flooding and drainage, pedo-ameliorative techniques like leveling, phosphorus-calcium amendments, and soil loosening, as well as agro-ameliorative practices involving soil aeration, organo-mineral fertilization, surface modeling, and specific crop rotations adapted to different growth stages. Phytotechnical measures and specific monitoring methods are also employed to ensure long-term sustainability.

The objectives of agro-fishery management, particularly agro-fishery rotation, aim to optimize resource utilization at a lower cost than the exclusive use of ecosystems for fish farming or agriculture. These objectives focus on preventing soil degradation and improving fish pond soils, increasing and maintaining fertility and biological productivity to support the development of plant and animal biomass, and minimizing losses caused by diseases, pests, and other harmful factors. Furthermore, they seek to enhance fish and agricultural production in aquatic basins situated on various soil types, thereby increasing naturally produced biomass to meet the specific requirements of aquaculture biotechnology.

The theoretical analysis revealed several key findings regarding phytotechnical strategies:

It was consistently found that **crop rotation** improved soil nutrient content, reduced pest populations, and enhanced overall yield stability. In particular, rotations that include legumes increased soil nitrogen levels, reducing the need for synthetic fertilizers.

Crop rotation is an essential agricultural practice involving alternating crops on the same land area according to a well-defined plan. This technique improves soil quality, controls pests and diseases, and maximizes agricultural yields. *Crop rotation is a key practice in sustainable agriculture, helping to conserve natural resources and protect the environment*.

The principle of crop rotation is a more complex term because, in addition to crop rotation, it also involves adjusting agricultural practices, including sowing, plant protection schemes used, fertilization, and irrigation.

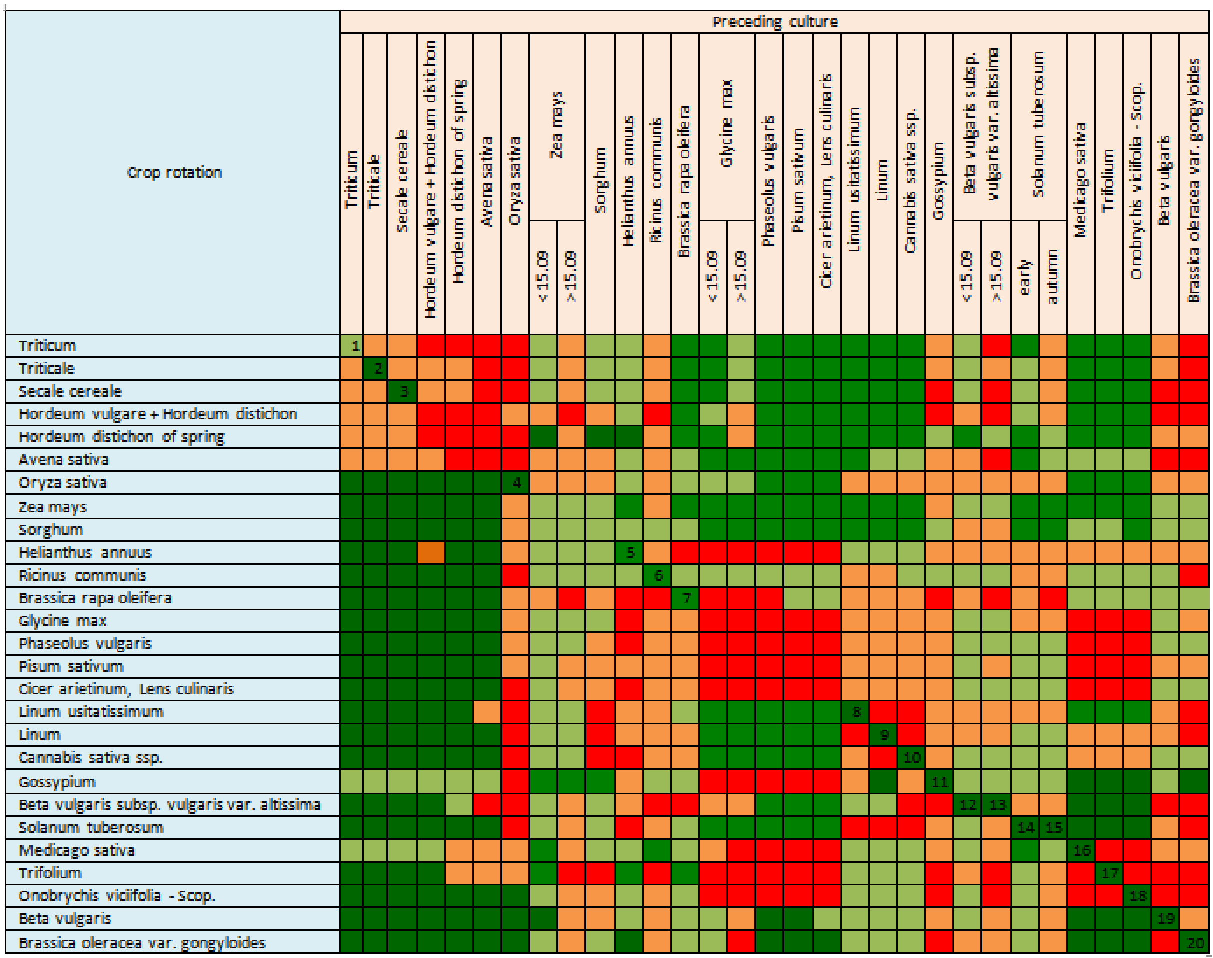
Crop rotation refers to the system of crop rotation carried out over a specific period, usually 3 to 5 years. Each crop has requirements regarding nutrients, moisture, and soil conditions, and alternating them helps prevent soil depletion.

Creating a structure for the crops to be sown is necessary to achieve an efficient crop rotation. First, all the species cultivated on the farm must be established, the area allocated to each species, and how the crop rotation will be carried out during the agricultural years.

To create the structure, the particularities of each plant that will be cultivated must be taken into account. Among the most important are water and nutrient requirements, the dimensions of the root system in terms of length, depth, and degree of branching, and the length of the vegetation period.

As is known, each species consumes different amounts of elements, which can contribute to accumulating some of them and releasing others. For this reason, the choice of crops in the rotation is significant. Plants that consume more nutrients, such as sunflower, must alternate with plants with low consumption, such as cereals. Grassy cereals use more N and P; sunflower corn more K. (table 1).

Table 1. The summaries of the favorability of the main crop plant species towards rotation.



very good precursor crops	good preceding crops	preceding medium cultures	contraindicated preceding crops

1.	< 2 years	6.	after 2-3 years	11.	after 2 years	16.	after 5-6 years
2.	< 2 years	7.	after 2-3 years	12.	after 3-4 years	17.	after 3-4 years
3.	< 2 years	8.	after 6 years	13.	after 4-5 years	18.	after 4-5 years
4.	4 years	9.	after 5-6 years	14.	after 2-3 years	19.	after 4-5 years
5.	after 6-7 years	10.	after 2-3 years	15.	after 3-4 years	20.	after 4-5 years

Source: Vasile Surd et al, 2005.

The solubilization capacity of P compounds differs from one plant to another. Barley uses the nutrients from the superficial layer and sunflower, corn, peas, rapeseed, soybeans, etc. from a deeper layer. Pea's lupine has a high solubilization power, and barley wheat has a low solubilization power of chemical nutrients from the soil. Crops with a higher biological capacity to use phosphorus from forms complex for plants to access in the soil, such as buckwheat, mustard, and rapeseed, deserve special attention.

Plants that leave more considerable amounts of organic residues (perennial herbs, cereals, annual legumes, etc.) will be alternated with those that leave small amounts of organic residues in the soil (technical crops).

By growing plants with different root systems, we ensure the exploration of various soil layers. Thus, after plants with deep roots (alfalfa, clover, beet, sunflower), it is recommended that plants with more superficial roots (beans, peas, wheat) be grown. The placement of crops with the same root system contributes to insufficient moisture. For this reason, the time interval between two crops with a deep root system should not be less than 2-3 years.

Integrating legumes, cereals, and vegetables in **intercropping systems** increased overall productivity per hectare. It was also noted that intercropping systems had higher resilience to pest attacks and environmental stress, such as droughts.

Organic fertilizers were linked to improved soil health, increased water retention capacity, and reduced chemical fertilizer use. In long-term studies, soils treated with organic amendments showed enhanced microbial activity and a more remarkable ability to withstand extreme weather events.

Most plants grow at a pH between 4.5 and 8.0. Soil pH is important because the acidity or alkalinity of the soil determines which plant nutrients are available to the roots. From a plant nutrition perspective, pH directly impacts the mobility and accessibility of nutrients in the soil.

Knowing the soil pH allows the selection and grouping of plants according to their pH needs. It will ensure the cultivation of plant species with similar pH needs, temperature tolerances, and similar nutritional needs.

Along with amendments, organic fertilizers are essential in improving physical and biological properties. Among organic fertilizers, manure and green fertilizers are of particular importance. The following can be grown as green fertilizers: sorghum, sunflower, and sorghum. Fertilization with green fertilizers is associated with chemical fertilizers. Nitrogen is recommended first among chemical fertilizers, and ammonium sulfate is also recommended. This fertilizer is physiologically acidic, so the SO4 radical remaining in the soil after using ammoniacal nitrogen forms sulfates with the salts in the soil, which are soluble and can be washed away by rainwater. Ammonium nitrate has a physiologically neutral reaction, so that it can be used in both saline and alkaline soils. Phosphorus and potassium fertilizers applied alone do not increase production on saline soils. When phosphogypsum is used as an amendment, fertilization with phosphorus fertilizers is no longer necessary.

Agroforestry systems, particularly those incorporating nitrogen-fixing species, were found to enhance soil fertility and increase the sustainability of farming systems. These systems also contributed to incredible biodiversity and improved ecosystem services such as pollination and pest control.

The findings suggest that phytotechnical strategies have a significant potential to improve agricultural productivity while promoting environmental sustainability. The key benefit of these strategies is their ability to increase efficiency in resource use (such as water and nutrients) while reducing dependency on synthetic inputs.

However, successfully implementing these strategies requires careful planning, especially in selecting appropriate crops for rotation or intercropping and determining the optimal use of organic fertilizers. Local climate, soil type, and socio-economic conditions must all be considered when designing farming systems incorporating these strategies.

8. Conclusions

Phytotechnical strategies are crucial in enhancing agricultural production while promoting environmental sustainability. The integration of crop rotation, intercropping, and organic fertilization can help farmers increase yields, reduce dependency on chemical inputs, and improve soil health. Further research is needed to explore the optimal combinations of these strategies across different geographic regions and crop types to understand their long-term benefits fully.

The organization of crop rotation at the level of an agricultural holding aims at rational use of the soil, long-term soil fertility maintenance, and increasing the agroecosystem's biodiversity.

The organization of a rational crop rotation, which will increase production and economic efficiency, must consider the farm's natural conditions, the economic-organizational requirements, and the agrobiological requirements of the plants. Suppose the natural conditions of the farm are generally known at the beginning of each agricultural year. In that case, the farmer must analyze the economic-organizational conditions and the agrobiological requirements of the plants to achieve the most efficient crop rotations. The requirements of the market economy represent the economic-organizational conditions, the road network, the need for rational use of labor and mechanical means, the existence in sugar, oil, and canning factories, the distance from populated centers, the prices and possibilities of capitalizing on organic agricultural production. Agrobiological conditions refer to the requirements of cultivated plants for rotation depending on their biological characteristics and ensuring a rational rotation of plants in crop rotation.

Phytotechnical strategies, including crop rotation, intercropping, organic fertilizers, and agroforestry, offer practical and sustainable methods for increasing agricultural production. These strategies improve soil health, enhance productivity, and help farmers adapt to changing climatic conditions. Further research is needed to fine-tune these practices for specific regions and crop types and to explore the synergistic effects of combining multiple strategies. Overall, these approaches hold great promise for achieving sustainable food production in the face of global challenges.

Acknowledgments

The article's principal author thanks "Dunărea de Jos" University of Galați, which, through the University Degree Program, the doctoral studies contract has supported the achievement.

References

1. Backer, R., Rokem, J. S., Ilangumaran, G., Lamont, J., Praslickova, D., Ricci, E., et Smith, D. L. (2018). Plant growth-promoting rhizobacteria: Context, mechanisms of action, and roadmap to commercialization of biostimulants for sustainable agriculture. *Frontiers in Plant Science*, 9, 1473. https://doi.org/10.3389/fpls.2018.01473

2. Jones, L., Thomas, P., Williams, H. (2018). Intercropping: A strategy for increasing crop yield and sustainability. Agricultural Research Review, 23(4), 101-112.
3. Lee, W., et al. (2017). The role of intercropping in increasing drought tolerance in maize. Agricultural Systems, 154, 67-74.
4. Lobell, D. B., Schlenker, W., & Costa-Roberts, J. (2011). Climate trends and global crop production since 1980. Science, 333(6042), 616–620. https://doi.org/10.1126/science.1204531
5. Miller, A., et Thompson, R. (2017). Organic fertilizers and soil health: A review of recent developments. Environmental Sustainability Journal, 8(2), 34-47.
6. Nair, P.K.R., et al. (2018). Agroforestry for sustainable agriculture in tropical climates. Agroforestry Systems, 92(1), 56-65.
7. Pretty, J., Benton, T. G., Bharucha, Z. P., Dicks, L. V., Flora, C. B., Godfray, H. C. J., ... & Wratten, S. (2018). Global assessment of agricultural system redesigns for sustainable intensification. Nature Sustainability, 1, 441–446. https://doi.org/10.1038/s41893-018-0114-0
8. Surd, V., Zotic V., Bold I., Chira, C. (2005). Amenajarea teritoriului și infrastructuri tehnice, Editura Presa Universitară Clujeană, Cluj-Napoca.
9. Smith, J. (2015), The impact of crop rotation on soil fertility and yield improvement. Journal of Agricultural Science, 12(3), 45-59.
10. Tilman, D. (1998), The greening of the green revolution. Nature, 396: 211-212. DOI: 10.1038/24254
11. van Ittersum, M. K., & Rabbinge, R. (1997). Concepts in production ecology for analysis and quantification of agricultural input-output combinations. Field Crops Research, 52(3), 197–208. https://doi.org/10.1016/S0378-4290(97)00037-3
12. Zhang, L., et al. (2016). The role of biodiversity in agricultural systems: Benefits and challenges. Biodiversity and Conservation, 25(7), 1717-1729.
13. Zhang, X., Davidson, E. A., Mauzerall, D. L., Searchinger, T. D., Dumas, P., & Shen, Y. (2019). Managing nitrogen for sustainable development. Nature, 568, 516–520. https://doi.org/10.1038/s41586-019-1221-1