ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating: 4.97
IJAFS 2025; 7(4): 94-96
www.agriculturaljournals.com
Received: 21-02-2025
Accepted: 26-03-2025

Anuhya Shiny Reddypogu
Lovely Professional University, Jalandhar, Punjab, India

Sanikommu Vishnu Vardhan Reddy
Lovely Professional University, Jalandhar, Punjab, India

Thulisekari Prasanna
Lovely Professional University, Jalandhar, Punjab, India

Dr. Burra Shyamsunder
Assistant Professor, and Head, Department of Agronomy, Gurunanak University, Hyderabad, Telangana, India

Corresponding Author:
Dr. Burra Shyamsunder
Assistant Professor, Department of Agronomy, Gurunanak University, Hyderabad, Telangana, India

Improving intercropping through the synthesis of plant physiology and ecology

Anuhya Shiny Reddypogu, Sanikommu Vishnu Vardhan Reddy, Thulisekari Prasanna and Burra Shyamsunder

DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i4b.338

Abstract
Intercropping is the practice of growing two or more plant species simultaneously in the same field for a significant part of their growth cycles. The use of intercropping in sustainable agriculture is becoming more and more popular, and there is an increasing amount of scientific research on this issue. The current understanding of the factors influencing yield, yield stability, and resource efficiency in intercropping as opposed to solitary cropping is examined in this paper. Intercrops increase acquiring efficiency more than conversion efficiency when resource usage is broken down into acquisition and conversion. Additionally, we try to assess the importance of decreased biotic stressors from weeds, diseases, and pests. We're especially interested in knowledge gaps and potential bias in existing literature, and we're wondering what research methodologies are needed to progress the area and pave the way for more intercropping in modern sustainable agriculture.

Keywords: Intercropping, sustainable agriculture, yield stability

Introduction

Intercropping is a centuries-old practise that coexists with "modern agriculture," which is characterised by monocultures of resource-demanding, higher-yielding crops (Vandermeer, 2010; Zhang *et al.*, 2010) [17, 19]. Obstinately, intercropping is a way to some of the major problems associated with modern farming, including low yield, insect and pathogen buildup, soil degradation, and environmental degradation (Vandermeer, 1989) [18]. As a result, they are helping to deliver sustainable and effective agriculture (Lithourgidis *et al.*, 2011) [8]. Intercropping has drawn the attention of a broad range of agricultural, ecological, and environmental professionals with a variety of scientific interests. (for instance, Smith *et al.*, 2013) [15], enabling multidisciplinary syntheses including different knowledge on the potential of intercropping In this review, intercropping is defined, the processes and mechanisms that drive it are examined, as well as recent findings from agronomy, plant physiology, and ecology. The potential integration of these innovations to improve intercropping systems is also covered. First, we'll look at the definition, uses, and possible benefits of intercropping. Intercropping is still used in European agroforestry systems such as the Mediterranean coltura promiscua (vegetables and cereals cultivated under trees, usually fruit and olive trees) and the Swiss paturages boises (wooded grassland systems). However, many systems have lost it. For instance, in Italy, the production area for walnut agroforestry decreased from 140 000 to 10 000 hectares between 1960 and 1990. (Eichhorn *et al.*, 2006) [4]. Despite being rare in traditional farming, it is becoming more frequent in organic systems (Hauggaard-Nielsen *et al.*, 2009; Pappa *et al.*, 2011, 2012) [7, 10, 11].

Applying ecological knowledge to intercropping systems

Negative interactions like competition, parasitism, and amensalism, as well as positive interactions like mutualism and complementarity, are characteristics of intercropping systems (Odum, 1968) [9]. For a long time, ecologists have studied the ecology of agricultural systems to follow how different species interact (see, for example, Vandermeer, 2010) [17]. In return, ecological study into species interactions in various natural systems, such as the concept of context dependency (Brooker *et al.*, 2008) [1], can be used to enhance intercropping systems.

Intercropping research's future prospects

Ecology and agronomy both contribute to the advancement of intercropping systems. Intercropping is a viable alternative for "sustainable intensification," especially in regions with poor soils and economies, where the benefits have been most thoroughly studied. They can increase crop productivity and resource efficiency while reducing farming's environmental impact (Rusinamhodzi *et al*., 2012) [13]. Biotechnology for rootstock improvement. Some of these have already been explored, such as breeding for intercrops and a better understanding of the interactions between plants and other species in crop systems. However, significant scientific challenges still exist in order to achieve these benefits. Here, we briefly go over some more research areas that, in our opinion, are essential to the advancement and broad use of intercropping systems.

Ecosystem services and intercropping

To find out if intercropping can offer ecosystem-related benefits including better soil and water quality, landscape enhancement, insect management, and climate change delaying in addition to crop yield, more research is required. Ecosystem service approaches suggest that intercrops could provide food security while requiring fewer environmental and human resources. For instance, better microbial diversity, microbial abundance, soil carbon sequestration, and gross C-allocation below ground are now linked to greater plant (trait) diversity in grasslands (De Deyn *et al*., 2008, 2011) [2]. Therefore, more plant diversity in fields may improve the physical stability of the soil and the resilience of nitrogen cycling processes mediated by microbes. Garcia-Pausas & Paterson (2011) [5]; Peres *et al*. (2013) [12]; Gregory *et al*. (2009) [6]. Intercropping's potential to supply a wider range of services and goods could increase its adoption, but to get there we'll need more (and better) service performance indicators. Benefits are frequently assessed using common metrics like agricultural output or resource efficiency. However, due to the lack of widely accepted metrics for measuring soil health or cultural advantages, they are rarely evaluated using these methods. But it's important to have a balanced understanding of the benefits and drawbacks of intercropping and other alternative food production methods.

Systems understanding of Intercropping

Numerous studies have focused on certain processes rather than the links between the numerous activities that take place concurrently in an agricultural system. Finding limitations to the primary mechanisms causing variation in yields or other ecological services provided by intercrops is therefore difficult. True systems research, on the other hand, takes a lot of time and requires input from other domains in order to be successful. In this review study, agronomy, ecology, and plant physiology have all been incorporated. Even more extensive multidisciplinary research projects might use a systems-level strategy to comprehend the mechanisms at play in intercropping systems, expanding beyond the typical resource-focused approach to take into account the roles of above- and below-ground plant-organism interactions.

Intercropping for ecology

We still have a lot to learn about important organismal interactions, like those between parasites and hosts, above- and below-ground communities, and plants and soil organisms, despite recent advances in ecological knowledge (including legacy effects). The study of intercropping may have significant implications for our understanding of natural and seminatural systems, in addition to the previously mentioned idea of a flow of ecological information necessary to the improvement of intercropping systems. The obvious question is whether the mechanisms and processes that support sustainable intercropping or higher yield per unit area also work in natural systems. For instance, mechanisms to improve soil mineral availability have been developed. These mechanisms, while observed in intercropping systems, haven't been put to the test in real or simulated natural settings. A prime example of this is the potential for some species in the United States. Alkaline soils becoming acidic due to the rhizosphere becoming more acidic. Expanding the availability of elements like P and Fe and, consequently, the mineral nutrition of adjoining plants. Plant properties for resource acquisition and the underlying mechanisms section. To our knowledge, this facilitation mechanism has not been investigated in natural or seminatural plant communities, despite the fact that it may be utilized.

Conclusion

In many parts of the world, intercropping systems have the potential to improve the long-term sustainability of low-input food production. They still have a lot of potential to enhance intercropping systems so that yield (or other advantages) may be maintained with the same inputs or enhanced with the same inputs, even though some of the ways they employ to provide benefits are well-known. Reduced inputs as a result of a better understanding of agriculture's ecological and economic aspects as well as how the two fields interact. Experimenting with new crop combinations may be the simplest short-term strategy to take advantage of previously recognized beneficial processes, especially emerging plant-microbe interactions. The improved knowledge of organismal interactions gained from ecological research may have an impact on these breeding initiatives as well as the creation of management plans that modify intercropping systems to fit the local environment.

Probably the least likely to be used are the techniques that depend upon advanced ecological ideas, such as interaction and evolutionary distance. The apparent magnitude of these effects in certain ecological studies, however, demonstrates that they should at least be considered when developing a research ideology for intercropping systems: do these processes occur in intercropping systems, to what a certain extent, and how can we employ this knowledge to enhance breeding or crop management practices? Improved coordination between ecologists, environmental scientists, agronomists, crop scientists, soil scientists, and eventually social researchers will be required to properly understand the potential of intercropping as a sustainable agricultural system (e.g., exploring attitudes toward uptake and developing wider cost-benefit analyses).

References

1. Brooker RW, Maestre FT, Callaway RM, Lortie CJ, Cavieres LA, Kunstler G, *et al*. Facilitation in plant communities: the past, the present, and the future. Journal of Ecology. 2008;96:18-34.

2. De Deyn GB, Shiel RS, Ostle NJ, McNamara NP, Oakley S, Young I, *et al*. Additional carbon sequestration benefits of grassland diversity restoration. Journal of Applied Ecology. 2011;48:600-608.
3. Dupraz C, Liagre F. Agroforesterie – des arbres et des cultures. 2nd ed. Paris, France: Groupe France Agricole; c2011.
4. Eichhorn MP, Paris P, Herzog F, Incoll LD, Liagre F, Mantzanas K, *et al*. Silvoarable systems in europe – past, present and future prospects. Agroforestry Systems. 2006;67:29-50.
5. Garcia-Pausas J, Paterson E. Microbial community abundance and structure are determinants of soil organic matter mineralisation in the presence of labile carbon. Soil Biology and Biochemistry. 2011;43:1705-1713.
6. Gregory AS, Watts CW, Griffiths BS, Hallett PD, Kuan HL, Whitmore AP, *et al*. The effect of long-term soil management on the physical and biological resilience of a range of arable and grassland soils in England. Geoderma. 2009;153:172-185.
7. Hauggaard-Nielsen H, Gooding M, Ambus P, Corre-Hellou G, Crozat Y, Dahlmann C, *et al*. Peabarley intercropping for efficient symbiotic N2 fixation, soil N acquisition and use of other nutrients in European organic cropping systems. Field Crops Research. 2009;113:64-71.
8. Lithourgidis AS, Dordas CA, Damalas CA, Vlachostergios DN. Annual intercrops: an alternative pathwayfor sustainable agriculture. Australian Journal of Crop Science. 2011;5:396-410.
9. Odum EP. Fundamentals of ecology. 2nd ed. London, UK: Saunders; c1968.
10. Pappa VA, Rees RM, Walker RL, Baddeley JA, Watson CA. Nitrous oxide emissions and nitrate leaching in an arable rotation resulting from the presence of an intercrop. Agriculture, Ecosystems and Environment. 2011;141:153-161.
11. Pappa VA, Rees RM, Walker RL, Baddeley JA, Watson CA. Legumes intercropped with spring barley contribute to increased biomass production and carry-over effects. Journal of Agricultural Science. 2012;150:584-594.
12. Peres G, Cluzeau D, Menasseri S, Soussana JF, Bessler H, Engels C, *et al*. Mechanisms linking plant community properties to soil aggregate stability in an experimental grassland diversity gradient. Plant and Soil. 2013;373:285-299.
13. Rusinamhodzi L, Corbeels M, Nyamangara J, Giller KE. Maize-grain legume intercropping is an attractive option for ecological intensification that reduces climatic risk for smallholder farmers in central Mozambique. Field Crops Research. 2012;136:12-22.
14. Sch€ob C, Callaway RM, Anthelme F, Brooker RW, Cavieres LA, Kikvidze Z, *et al*. The context dependence of beneficiary feedback effects on benefactors in plant facilitation. New Phytologist. 2014;204:386-396.
15. Smith J, Pearce BD, Wolfe M, Martin S. Reconciling productivity with protection of the environment: Is temperate agroforestry the answer? Renewable Agriculture and Food Systems. 2013;28:80-92.
16. Stomph TJ, van der Werf W. Advances in Agronomy. 2020.
17. Vandermeer J. The ecology of agroecosystems. Sudbury, MA, USA: Bartlett and Jones; c2010.
18. Vandermeer JH. The ecology of intercropping. Cambridge, UK: Cambridge University Press; c1989.
19. Zhang F, Shen J, Zhang J, Zuo Y, Li L, Chen X, *et al*. Rhizosphere processes and management for improving nutrient use efficiency and crop productivity: implications for China. Advances in Agronomy. 2010;107:31-32.