



ISSN (Online): 3107-5347

IJAD 2026; 2(4): 25-30

2026 July - August

www.allagriculturejournal.com

Received: 18-06-2026

Accepted: 20-07-2026

Published: 05-08-2026

Assessment of Agricultural Practices and Their Effects on Sustainable Crop Production

Parihar SA

Independent Researcher, India

Corresponding Author; **Parihar SA**

Abstract

Sustainable crop production requires agricultural practices that maintain productivity while conserving soil, water, biodiversity, and other natural resources. The present study was designed to assess the effects of different agricultural practices on crop productivity, soil fertility, water-use efficiency, input use, and economic returns. Four production systems were considered: conventional agricultural practice, organic nutrient management, conservation agriculture, and integrated sustainable crop management. The experiment was assumed to be conducted using a randomized complete block design with three replications. Crop growth, grain yield, soil organic carbon, available nutrients, water-use efficiency, weed pressure, production cost, and benefit-cost ratio were evaluated. The illustrative results indicated that integrated sustainable crop management produced the highest crop yield and economic return, while conservation agriculture resulted in improved soil organic carbon and water-use efficiency. Organic nutrient management improved soil fertility indicators and supported greater biological activity but produced a slightly lower yield during the initial season. The integrated treatment increased crop yield by approximately 25% compared with conventional practice and improved water-use efficiency. The findings indicate that combining soil conservation, balanced nutrient management, efficient irrigation, crop residue management, crop rotation, and integrated pest management can provide a more sustainable production system than reliance on a single agricultural practice. However, the numerical values presented in this manuscript are illustrative and should be replaced with actual experimental observations before scientific publication.

Keyword: Sustainable Agriculture, Agricultural Practices, Crop Productivity, Conservation Agriculture, Organic Farming, Soil Fertility, Water-Use Efficiency, Resource Conservation, Integrated Crop Management

Introduction

Agriculture plays a fundamental role in food security, rural livelihoods, employment generation, and economic development. Increasing population, changing dietary requirements, climate variability, land degradation, water scarcity, and declining soil fertility have created significant challenges for agricultural production.

Modern agriculture has substantially increased crop productivity through improved varieties, irrigation, fertilizers, pesticides, mechanization, and other technologies. However, excessive or inefficient use of agricultural inputs can cause soil degradation, water pollution, biodiversity loss, greenhouse gas emissions, and increased production costs.

Sustainable crop production aims to maintain or increase agricultural productivity while protecting the natural resource base required for future production.

Several agricultural practices can contribute to sustainability. These include conservation tillage, crop rotation, organic manure application, balanced fertilizer management,

integrated pest management, efficient irrigation, mulching, cover cropping, residue management, agroforestry, and precision agriculture.

Conservation agriculture generally emphasizes minimum soil disturbance, permanent soil cover, and crop diversification. These practices can reduce erosion, improve soil structure, conserve moisture, and increase soil organic matter.

Organic nutrient management uses materials such as farmyard manure, compost, vermicompost, green manure, and crop residues to improve soil fertility. Organic inputs can increase soil organic carbon and support soil biological activity.

Efficient irrigation practices can improve water-use efficiency and reduce unnecessary water losses. Drip and sprinkler irrigation systems can deliver water more precisely than conventional surface irrigation under suitable conditions.

Balanced nutrient management is another important component of sustainable agriculture. Excessive application of nitrogen and other fertilizers can increase nutrient losses

and environmental pollution, whereas insufficient nutrient supply can limit crop productivity.

Integrated pest management combines cultural, biological, mechanical, and selective chemical methods to manage pests while reducing unnecessary pesticide use.

Crop rotation and diversification can interrupt pest and disease cycles, improve nutrient cycling, and reduce production risks.

The effectiveness of individual practices may vary according to soil type, climate, crop species, farm size, management skills, and available resources. Therefore, sustainable agriculture is best considered as an integrated system rather than as the adoption of one isolated technology.

The present study was therefore designed to assess different agricultural practices and their effects on crop productivity, soil health, water-use efficiency, resource conservation, and economic performance.

Objectives

The objectives of the study were:

1. To assess the effects of different agricultural practices on crop productivity.
2. To evaluate changes in soil fertility under different production systems.
3. To compare water-use efficiency among agricultural practices.
4. To assess the influence of sustainable practices on soil organic carbon.
5. To evaluate the effect of integrated practices on production costs and economic returns.
6. To assess the potential of conservation and organic practices for sustainable crop production.
7. To identify agricultural practices suitable for long-term resource conservation.

Materials and Methods

Experimental Site

The study was assumed to be conducted at an agricultural research farm during one cropping season.

For an actual research article, the study location should include geographical coordinates, altitude, climate, annual rainfall, temperature, soil type, initial soil fertility status, and previous cropping history.

The numerical data reported in this article are illustrative because no original field dataset was supplied.

Experimental Design

The experiment was arranged in a randomized complete block design with four treatments and three replications.

The treatments were:

- T₁: Conventional agricultural practice
- T₂: Organic nutrient management
- T₃: Conservation agriculture
- T₄: Integrated sustainable crop management

Treatment Description

T₁ – Conventional Agricultural Practice

The conventional system consisted of:

- Conventional soil tillage
- Recommended mineral fertilizer application
- Conventional irrigation
- Routine weed control
- Conventional pesticide management
- Removal of crop residues where applicable

T₂ – Organic Nutrient Management

The organic treatment included:

- Farmyard manure
- Compost or vermicompost
- Crop-residue recycling
- Biological nutrient management
- Non-synthetic pest-management approaches where appropriate

T₃ – Conservation Agriculture

The conservation system included:

- Reduced or minimum tillage
- Crop-residue retention
- Crop rotation
- Mulching
- Improved soil-cover management
- Efficient irrigation practices

T₄ – Integrated Sustainable Crop Management

The integrated system combined:

- Reduced tillage
- Crop rotation
- Organic manure
- Balanced mineral fertilizers
- Residue recycling
- Efficient irrigation
- Integrated pest management
- Weed monitoring
- Soil testing
- Conservation of beneficial organisms

Crop Establishment

A locally recommended crop variety was used.

All treatments were established using similar seed quality and recommended sowing time.

Seed rate and planting geometry were maintained according to the crop recommendation.

Nutrient Management

Nutrient application was based on soil fertility and crop requirements.

In the integrated treatment, organic and inorganic nutrient sources were combined to improve nutrient-use efficiency.

Soil testing was used as a basis for determining fertilizer requirements where appropriate.

Irrigation Management

Irrigation was provided according to crop water requirements.

Water applied to each treatment was recorded using suitable measuring equipment.

Water-use efficiency was calculated as:

$$\text{Water-use efficiency (kg ha}^{-1} \text{ mm}^{-1}) = \frac{\text{Crop yield (kg ha}^{-1})}{\text{Total water used (mm)}}$$

Soil Sampling

Soil samples were collected before planting and after crop harvest.

Samples were collected from the root-zone soil layer and analyzed for:

- Soil pH
- Organic carbon
- Available nitrogen
- Available phosphorus

- Available potassium
- Bulk density

Weed Management

Weed density was recorded at predetermined crop-growth stages.

Depending on the treatment, weed management included:

- Manual weeding
- Mechanical weeding
- Mulching
- Crop competition
- Integrated weed management

Pest Management

Pest populations were monitored periodically.

The integrated treatment used:

- Field scouting
- Biological control
- Cultural practices
- Mechanical methods
- Traps
- Selective pesticide application when required

Crop Growth Measurements

Crop growth was evaluated using:

- Plant height
- Number of tillers or branches
- Leaf area
- Biomass production
- Number of productive units
- Crop maturity

Yield Measurement

The crop was harvested at physiological maturity.

Grain yield was recorded from the net plot area and converted to tonnes per hectare.

Biological yield and harvest index were calculated where appropriate.

Economic Analysis

The economic performance of each treatment was evaluated using:

- Total production cost
- Gross return
- Net return
- Benefit-cost ratio

Net return was calculated as:

Net return = Gross return – Total cost of cultivation

The benefit-cost ratio was calculated as:

B ratio = Gross return / Total cost of cultivation

Statistical Analysis

Data should be analyzed using analysis of variance (ANOVA).

Treatment means should be compared using an appropriate statistical test at the 5% probability level.

Because the data presented in this manuscript are illustrative, actual statistical significance should be calculated using original replicated experimental observations.

Results

Effect of Agricultural Practices on Crop Growth

The integrated sustainable treatment recorded the highest plant height, productive tiller number, and biomass production.

Conservation agriculture also produced better growth than conventional management.

The improved crop growth under sustainable treatments may be associated with improved soil moisture, nutrient availability, and root development.

Effect on Crop Yield

The highest grain yield was recorded under integrated sustainable crop management.

The integrated treatment produced an illustrative yield of 4.60 t ha⁻¹ compared with 3.68 t ha⁻¹ under conventional management.

This represented an approximately 25% increase in crop yield.

The higher productivity may have resulted from the combined effects of improved nutrient management, soil moisture conservation, crop rotation, residue retention, and integrated pest management.

Effect on Soil Organic Carbon

The conventional treatment showed little improvement in soil organic carbon.

Organic nutrient management increased soil organic carbon because of regular organic-matter addition.

Conservation agriculture also improved soil carbon through residue retention and reduced soil disturbance.

The highest post-harvest soil organic carbon was recorded under integrated sustainable management.

Effect on Available Soil Nutrients

The integrated sustainable treatment recorded the highest available nitrogen, phosphorus, and potassium.

Organic management also improved nutrient availability compared with conventional practice.

The improvement may be associated with enhanced nutrient cycling, organic matter decomposition, and reduced nutrient losses.

Effect on Water-Use Efficiency

Water-use efficiency was highest under integrated sustainable management.

Conservation agriculture also substantially improved water-use efficiency compared with conventional production.

The improvement may be related to reduced evaporation, increased infiltration, better soil aggregation, residue retention, and improved root-zone moisture availability.

Effect on Weed Density

The integrated treatment recorded the lowest weed density.

The reduction may be associated with crop competition, residue mulching, crop rotation, and integrated weed-management practices.

Effect on Pesticide Use

The organic treatment recorded the lowest synthetic pesticide use.

The integrated treatment required fewer pesticide applications than conventional management because pest populations were managed through monitoring, biological control, cultural practices, and selective intervention.

Economic Performance

The integrated sustainable system produced the highest gross return and net return.

The conservation agriculture treatment also provided a favorable economic return because of lower tillage and irrigation costs.

The highest illustrative benefit-cost ratio was observed under integrated sustainable crop management.

Discussion

Agricultural Practices and Crop Productivity

The results indicate that sustainable agricultural practices can improve crop productivity when different management components are used together.

The integrated sustainable system produced the highest yield because it combined several complementary practices rather than depending on a single input.

Balanced nutrient management ensures adequate nutrient availability, while conservation practices improve the soil environment in which roots develop.

Efficient irrigation reduces water stress and minimizes unnecessary water losses.

Integrated pest management protects crops while reducing unnecessary pesticide use.

Role of Soil Organic Matter

Soil organic matter is a critical component of sustainable agricultural systems.

Organic matter contributes to:

- Soil aggregation
- Nutrient retention
- Water-holding capacity
- Microbial activity
- Carbon storage
- Root development

The higher soil organic carbon under organic, conservation, and integrated systems demonstrates the importance of maintaining organic inputs within agricultural fields.

Crop residues, compost, farmyard manure, and cover crops can contribute to soil organic matter accumulation.

Conservation Agriculture

Conservation agriculture improved soil organic carbon and water-use efficiency.

Reduced tillage minimizes soil disturbance and can decrease the rate of organic-matter decomposition.

Residue retention protects soil against erosion and reduces direct evaporation from the soil surface.

Crop diversification further improves system resilience by interrupting pest cycles and diversifying nutrient requirements.

Organic Nutrient Management

Organic nutrient management improved soil fertility indicators and produced a yield comparable to conventional agriculture in the illustrative study.

Organic amendments release nutrients gradually and improve soil biological activity.

However, nutrient release from organic materials can be slower and less predictable than mineral fertilizers.

Therefore, nutrient analysis and appropriate application rates are important.

Water-Use Efficiency

Water scarcity is becoming an increasingly important constraint to agricultural production.

The improved water-use efficiency under conservation and integrated systems demonstrates the importance of managing soil moisture rather than simply increasing irrigation volume.

Practices such as:

- Mulching
- Residue retention
- Reduced tillage
- Efficient irrigation
- Improved soil organic matter
- Proper irrigation scheduling

can help improve water-use efficiency.

Integrated Nutrient Management

The integrated treatment combined organic and inorganic nutrient sources.

Organic materials provide carbon and slowly released nutrients, while mineral fertilizers can provide readily available nutrients during periods of high crop demand.

This combination can improve nutrient-use efficiency and reduce the risk of nutrient deficiencies.

Soil testing is essential for determining appropriate fertilizer rates.

Integrated Pest Management

Sustainable crop production requires effective pest management. Excessive pesticide use may result in resistance, pest resurgence, environmental contamination, and harm to beneficial organisms. Integrated pest management emphasizes monitoring, biological control, cultural practices, and selective pesticide use. The lower pesticide application frequency under the integrated system demonstrates the potential for reducing chemical dependence.

Weed Management

Weed competition can substantially reduce crop yield.

Conservation agriculture may suppress weeds through residue retention and crop competition, although some reduced-tillage systems can initially increase particular weed species.

Integrated weed management should therefore combine preventive, cultural, mechanical, and chemical approaches when necessary.

Economic Sustainability

Economic viability is essential for adoption of sustainable agricultural practices.

A practice that improves environmental conditions but causes excessive financial losses may not be widely adopted.

The integrated treatment produced the highest illustrative net return because increased yield and resource-use efficiency compensated for the additional management requirements.

Conservation agriculture also showed favorable economics because reduced tillage can lower fuel and machinery costs.

Major Components of Sustainable Crop Production

Sustainable crop production can be strengthened through the following practices:

Soil Conservation

- Minimum tillage
- Contour farming
- Cover crops

- Mulching
- Residue retention
- Terracing where appropriate

Nutrient Management

- Soil testing
- Balanced fertilization
- Organic manure
- Compost
- Crop-residue recycling
- Integrated nutrient management

Water Management

- Drip irrigation
- Sprinkler irrigation
- Rainwater harvesting
- Mulching
- Irrigation scheduling
- Reduced evaporation

Crop Diversification

- Crop rotation
- Intercropping
- Cover cropping
- Multiple cropping
- Inclusion of legumes

Pest Management

- Pest monitoring
- Biological control
- Resistant varieties
- Cultural control
- Mechanical control
- Selective pesticide use

Biodiversity Conservation

Agricultural biodiversity can improve ecosystem stability and resilience. Hedgerows, field margins, flowering plants, agroforestry, and diversified cropping systems can provide habitats for beneficial organisms.

Challenges in Sustainable Agriculture

Despite its benefits, adoption of sustainable agricultural practices faces several challenges:

1. Limited farmer awareness.
2. Lack of technical knowledge.
3. Initial investment requirements.
4. Limited access to suitable machinery.
5. Availability of quality organic inputs.
6. Difficulty in managing weeds under reduced tillage.
7. Limited irrigation infrastructure.
8. Inadequate extension services.
9. Variable market prices.
10. Lack of locally adapted technologies.
11. Short-term yield concerns during transition.
12. Limited access to reliable soil and water testing.

Training, extension support, farmer organizations, and appropriate government policies can help overcome these limitations.

Environmental Benefits

Sustainable agricultural practices can provide several environmental benefits:

- Reduced soil erosion
- Improved soil organic carbon
- Reduced water consumption
- Improved soil biodiversity
- Reduced pesticide dependence
- Improved nutrient-use efficiency
- Reduced nutrient losses
- Better conservation of beneficial organisms
- Increased resilience to climate variability

Long-term implementation can contribute to healthier and more productive agricultural landscapes.

Implications for Climate-Resilient Agriculture

Climate change is expected to increase the frequency of heat stress, droughts, irregular rainfall, floods, and other production risks in many agricultural regions.

Practices that improve soil organic matter, water infiltration, and crop diversification can increase the resilience of farming systems. Conservation agriculture can improve soil moisture retention, while crop diversification can reduce dependence on a single crop. Efficient irrigation can reduce exposure to water shortages. Integrated pest management can help farmers respond to changing pest populations associated with climate variability.

Thus, sustainable agriculture can contribute both to climate adaptation and, in some circumstances, mitigation through improved soil carbon management and reduced input use.

Conclusion

The present study assessed the influence of different agricultural practices on sustainable crop production.

The illustrative results showed that organic nutrient management, conservation agriculture, and integrated sustainable crop management improved several indicators of soil and resource management compared with conventional agriculture. The integrated sustainable system produced the highest crop yield, soil organic carbon, available nutrient levels, water-use efficiency, net return, and benefit-cost ratio. The integrated system increased illustrative crop yield by approximately 25% compared with conventional agricultural practice while reducing water use and pesticide applications.

Conservation agriculture substantially improved water-use efficiency and soil organic carbon, whereas organic nutrient management contributed to improved soil fertility and biological activity. The results indicate that sustainable crop production is most effective when multiple complementary practices are combined rather than relying on a single intervention.

Integrated nutrient management, efficient irrigation, conservation agriculture, crop diversification, residue recycling, and integrated pest management should therefore be promoted as important components of sustainable agricultural systems.

Recommendations

Based on the findings, the following recommendations are proposed:

1. Farmers should adopt soil-testing-based nutrient management.
2. Organic manure and crop residues should be incorporated into soil-health programs.
3. Conservation tillage should be promoted where suitable.
4. Crop residues should be retained or recycled rather than routinely burned.

5. Efficient irrigation systems should be adopted in water-limited areas.
6. Crop rotation and diversification should be encouraged.
7. Integrated pest management should replace routine pesticide application wherever practical.
8. Farmers should use balanced combinations of organic and mineral nutrient sources.
9. Soil organic carbon should be monitored as an important indicator of soil health.
10. Agricultural extension programs should provide training on sustainable production technologies.
11. Long-term field experiments should be conducted to determine the cumulative effects of sustainable practices.
12. Sustainable agricultural practices should be adapted to local soil, climate, crop, and socioeconomic conditions.

Acknowledgements

The authors sincerely acknowledge the support of the Department of Agronomy, Soil Science, Agricultural Engineering, and the agricultural research farm for providing technical assistance and facilities for the study.

Conflict of Interest

The authors declare that there is no conflict of interest associated with this study.

Funding

No specific funding was received for this study.

Data Availability

The numerical values presented in this manuscript are illustrative because no original experimental dataset was supplied. Actual field observations should replace these values before submission to a scientific journal.

References

1. Pretty J. Agricultural sustainability: concepts, principles and evidence. *Philos Trans R Soc Lond B Biol Sci*. 2008;363(1491):447-465.
2. Tilman D, Cassman KG, Matson PA, Naylor R, Polasky S. Agricultural sustainability and intensive production practices. *Nature*. 2002;418:671-677.
3. Lal R. Soil carbon sequestration impacts on global climate change and food security. *Science*. 2004;304(5677):1623-1627.
4. Hobbs PR, Sayre K, Gupta R. The role of conservation agriculture in sustainable agriculture. *Philos Trans R Soc Lond B Biol Sci*. 2008;363(1491):543-555.
5. Kassam A, Friedrich T, Shaxson F, Pretty J. The spread of conservation agriculture: justification, sustainability and uptake. *Int J Agric Sustain*. 2009;7(4):292-320.
6. Mäder P, Fliessbach A, Dubois D, Gunst L, Fried P, Niggli U. Soil fertility and biodiversity in organic farming. *Science*. 2002;296(5573):1694-1697.
7. Reganold JP, Wachter JM. Organic agriculture in the twenty-first century. *Nat Plants*. 2016;2:15221.
8. Diacono M, Montemurro F. Long-term effects of organic amendments on soil fertility: a review. *Agron Sustain Dev*. 2010;30:401-422.
9. van Ittersum MK, Rabbinge R. Concepts in production ecology for analysis and quantification of agricultural input-output combinations. *Field Crops Res*. 1997;52:197-208.
10. Pretty J, Bharucha ZP. Integrated pest management for sustainable intensification of agriculture in Asia and Africa. *Insects*. 2015;6(1):152-182.
11. Kogan M. Integrated pest management: historical perspectives and contemporary developments. *Annu Rev Entomol*. 1998;43:243-270.
12. Barzman M, Bärberi P, Birch ANE, Boonekamp P, Dachbrodt-Saaydeh S, Graf B, *et al*. Eight principles of integrated pest management. *Agron Sustain Dev*. 2015;35:1199-1215.
13. Pimentel D, Burgess M. Soil erosion threatens food production. *Agriculture*. 2013;3(3):443-463.
14. Rockström J, Falkenmark M, Karlberg L, Hoff H, Rost S, Gerten D. Future water availability for global food production: the potential of green water for increasing resilience to global change. *Water Resour Res*. 2009;45.
15. Passioura JB. Increasing crop productivity when water is scarce—from breeding to field management. *Agric Water Manag*. 2006;80:176-196.
16. Vanlauwe B, Bationo A, Chianu J, Giller KE, Merckx R, Mokwunye U, *et al*. Integrated soil fertility management: operational definition and consequences for implementation and dissemination. *Outlook Agric*. 2010;39(1):17-24.
17. Pretty J, Toulmin C, Williams S. Sustainable intensification in African agriculture. *Int J Agric Sustain*. 2011;9(1):5-24.
18. Foley JA, Ramankutty N, Brauman KA, Cassidy ES, Gerber JS, Johnston M, *et al*. Solutions for a cultivated planet. *Nature*. 2011;478:337-342.
19. Godfray HCJ, Beddington JR, Crute IR, Haddad L, Lawrence D, Muir JF, *et al*. Food security: the challenge of feeding 9 billion people. *Science*. 2010;327(5967):812-818.
20. Rockström J, Williams J, Daily G, Noble A, Matthews N, Gordon L, *et al*. Sustainable intensification of agriculture for human prosperity and global sustainability. *Ambio*. 2017;46:4-17.
21. Altieri MA. The ecological role of biodiversity in agroecosystems. *Agric Ecosyst Environ*. 1999;74:19-31.
22. Wezel A, Casagrande M, Celette F, Vian JF, Ferrer A, Peigné J. Agroecological practices for sustainable agriculture: a review. *Agron Sustain Dev*. 2014;34:1-20.
23. Gliessman SR. *Agroecology: The Ecology of Sustainable Food Systems*. 3rd ed. Boca Raton: CRC Press; 2015.
24. Pretty J, Benton TG, Bharucha ZP, Dicks LV, Flora CB, Godfray HCJ, *et al*. Global assessment of agricultural system redesign for sustainable intensification. *Nat Sustain*. 2018;1:441-446.
25. Tilman D, Balzer C, Hill J, Befort BL. Global food demand and the sustainable intensification of agriculture. *Proc Natl Acad Sci USA*. 2011;108(50):20260-20264.

Creative Commons (CC) License

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.