DOI: https://doi.org/10.59983/s2025030203
AgroEnvironmental Sustainability, 2025, 3(2), 111-118

RESEARCH

Evaluation of Agroecological Performance Toward Sustainable Agriculture of Beni Municipality, Myagdi, Nepal

Pratima Regmi [1, *], Dhurba Banjade [1], Subodh Khanal [1], Bandana Paudel [1], Manisha Khatri [1], Asmi Poudel [1], Dipak Khanal [2], Aman Shrestha [1], Laxmi Prasad Joshi [3]

[1] Institute of Agriculture and Animal Science, Gauradaha Campus, Tribhuvan University, Jhapa 57200, Nepal
[2] Department of Soil and Crop Sciences, Texas A&M University, College Station 77840, USA
[3] Tennessee State University, 37011, USA
[*] Author responsible for correspondence; Email: pratimaregmi2059@gmail.com.

ARTICLE HISTORY
Received: 10 April 2025
Revised: 18 May 2025
Accepted: 24 May 2025
Published: 15 June 2025

KEYWORDS
agroecology
characterization
soil health
transition

EDITOR
Ivan Širić

eISSN 2583-942X

Abstract

This study assessed the effectiveness of agroecological farming practices in Beni municipality, Myagdi district, Nepal, by surveying 150 households. The analysis considered various sociodemographic factors, occupations, and ecological aspects to calculate the Characterization of Agroecological Transition (CAET) scores. Only 20 out of the 150 farms received CAET scores between 50-60%, categorizing them as "incipiently transitioning" toward agroecological practices. Three of the ten evaluated elements scored below 40%, while four scored below 50%, and the remaining three were under 60%, resulting in an overall average score of 43.39%. This low score indicates limited adoption of agroecological practices in the area. The highest CAET scores were associated with male farmers, individuals identifying as Brahmin, those with basic literacy, and farms involved in beekeeping, where beneficial pollinators were present. Beekeeping was significantly correlated with higher CAET scores and also linked with food self-sufficiency for daily needs. Additionally, significant differences in CAET scores were observed across gender, ethnicity, and involvement in beekeeping. The study concludes that while interest in agroecological practices exists, adoption is hampered by limited knowledge and socioeconomic challenges. To foster greater agroecological transitions, targeted education and support systems must be developed, with a focus on integrating beekeeping and promoting a pollinator-friendly environment.

Citation: Regmi, P., Banjade, D., Khanal, S., Paudel, B., Khatri, M., Paudel, A., Khanal, D., Shreshta, A., Joshi, L. P. (2025). Evaluation of Agroecological Performance Toward Sustainable Agriculture of Beni Municipality, Myagdi, Nepal. *AgroEnvironmental Sustainability*, 3(2), 111-118. https://doi.org/10.59983/s2025030203

Statement of Sustainability: This study incorporates FAO's TAPE tool into a high-hill Nepali environment, providing a first-of-its-kind agroecological performance assessment in Beni Municipality. By connecting beekeeping to food self-sufficiency and gender-inclusive engagement, it immediately contributes to SDGs 2 (Zero Hunger), 5 (Gender Equality), and 15 (Life on Land). The findings stress locally customized interventions that improve biodiversity, ecological resilience, and social equity—all of which are necessary for creating sustainable food systems in marginalized mountain regions.

1. Introduction

Sustainable agriculture and food systems have become a global trend in agroecology (Mottet et al., 2020). Agroecology blends economic principles with socio-economic concerns, offering a pathway to sustainable agricultural development (D'Annolfo et al., 2017). Recognized as a holistic and transformative approach, agroecology is gaining attention for its potential to ensure agricultural sustainability (Geck et al., 2023). By emphasizing local and ecological knowledge, agroecology enhances social networks and reduces dependency on agrochemical inputs. Recently, it has been increasingly included in international discussions on the future of food security and agricultural production (Mottet et al., 2020). As a key principle for advancing agriculture (Lopez-Ridaura, 2022), agroecology's impact is being studied with tools like FAO's Tool for Agroecology Performance Evaluation (TAPE), which has been successfully tested in

countries like Argentina, Cuba, Cambodia, and Senegal. However, this tool has yet to be applied in predominantly livestock-based areas in Europe.

Agricultural systems are part of broader social-ecological processes that must be considered in any comprehensive discussion about sustainable agriculture (Bacon et al., 2012). Since the 1930s, the scope of agroecology has significantly expanded as scientists applied ecological principles to farming. In the 1960s, agroecology also became a social movement in response to environmental concerns and resistance to industrialized agriculture, particularly in Latin America and, to a lesser extent, in Western Europe. By the 1980s, agroecology evolved into a framework promoting sustainable farming practices aimed at conserving soil and biodiversity, while minimizing the use of synthetic fertilizers and pesticides (Altieri 1999). It applies ecological principles to develop resilient agricultural systems. The FAO has identified ten key elements that guide the shift towards agroecological practices.

Soil health refers to the capacity of soil to perform essential functions within ecosystems and land-use boundaries, helping to maintain water and air quality while supporting the health of plants and animals (Doran and Zeiss 2000). To achieve better soil management, there is a need for more meaningful and effective soil health tests (Mann et al., 2019). Aggregate stability serves as a key indicator of soil health, enhancing resistance to erosion and improving soil water dynamics (Rieke et al., 2022). Soil health is recognized as a valuable characteristic of ecosystems that is sensitive to human activities (Maaz et al., 2023). It is fundamental to sustainable food production systems, as its key indicators significantly influence agricultural crop productivity (Das et al., 2023). Additionally, soil health encompasses the stabilization of soil structure, the maintenance of soil life and biodiversity, the retention and release of plant nutrients, and the preservation of water-holding capacity.

TAPE assesses various social issues, including working conditions, gender equity, civic engagement, and food security. It emphasizes the importance of fair and inclusive agricultural systems that contribute to community support and societal well-being (Bacon et al., 2012). By utilizing TAPE to evaluate these aspects, researchers can gain a comprehensive understanding of the overall effects of the agroecological transition and identify potential trade-offs and synergies among different factors. This in-depth analysis can inform policy decisions, resource allocation, and the promotion of effective agroecological practices (Altieri 2002). Agroecology presents a sustainable approach to agricultural development by integrating ecological principles with social and economic considerations (D'Annolfo et al., 2017).

The study's rationale is to assess the efficiency and environmental impact of agroecological practices in the study area, to provide useful data to policymakers, farmers, and stakeholders. This material intends to assist sustainable practices for food security, resilience, and ecological balance. It provides insights for agricultural extension, research, and education to encourage better farming methods. The study's overarching goal is to evaluate farmers' agroecological performance in Beni Municipality. Specific aims include analyzing gender inequalities in agroecological participation, studying the amount of agroecological transition, nutritional diversity, and soil health, and identifying factors impacting agroecological transition criteria and biodiversity.

2. Materials and Methods

2.1. Study Sites

The study was conducted in Beni municipality, a typical high hill in Gandaki province. Nepal exhibited immense climatic potential to produce different types of crops and livestock. The district lay within coordinates of 28°32'46.32" N latitude and 83°29'06.36" E longitude, with an elevation of 2828 m/9278 feet. The average annual rainfall was about 1717.13 mm (Figure 1). The climate of the district was subtropical, temperate, and alpine, and the annual high and low temperatures were recorded at 19.9°C and 9.95°C, respectively.

2.2. Research Method and Design

The random sampling method was employed to select the participants or farms for data collection. The total population size of farmers in Beni was obtained from the Beni Municipality office. Using an 8% margin of error for the total population size of farmers in Beni Municipality (7261), a survey sample of 150 was determined at a 95% confidence level.

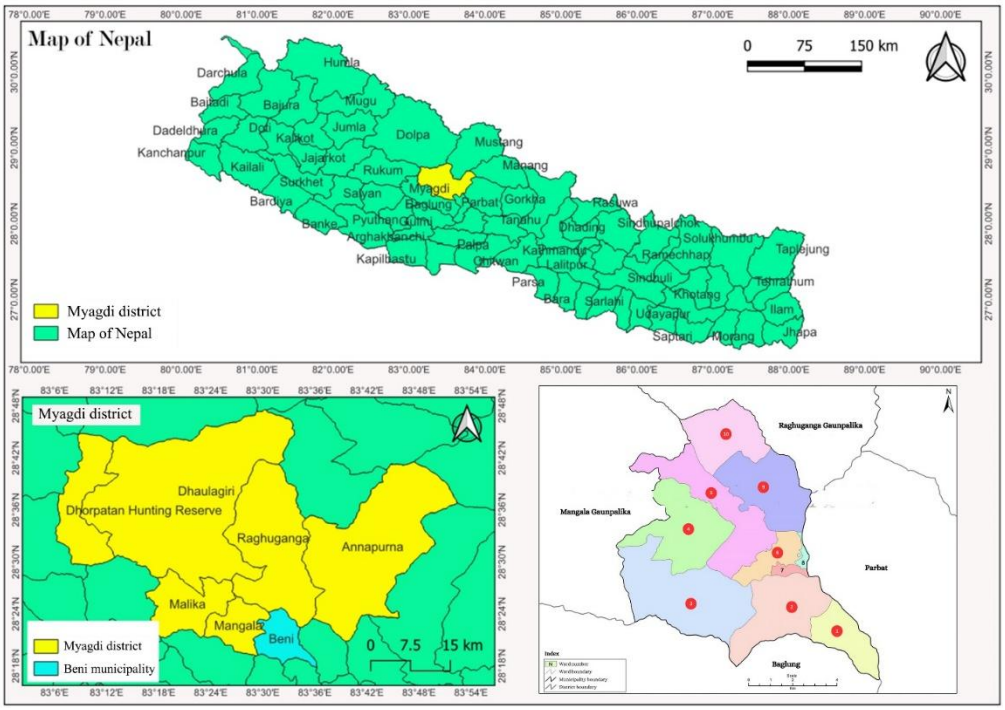

Figure 1. Map of the study area in Beni Municipality, Myagdi, Nepal.

2.3. Data Collection

A structured survey questionnaire was prepared through TAPE and administered to a sample of farmers in the study area to collect quantitative data on various aspects of their farming practices. A direct interview was conducted with key informants and farmers for data collection. Existing literature on agriculture and agroecology was consulted to provide a theoretical framework for the research. In this study, specific parameters and variables such as demographic information, CAET, agriculture biodiversity, income, productivity, dietary diversity, and soil health were measured and analyzed during the research.

2.4. Data Entry and Analysis

The survey was conducted using the m-Water Surveyor, while additional experimental data were entered into MS Excel for tabulation and organization. Both descriptive and inferential statistics were employed to analyze the data. The statistical analysis was performed using R version 4.2.1, with mean separation conducted through Tukey's HSD test at a 5% significance level. The "Agricolae" package was utilized for mean separation, while "Rstatix" was used to compute standard error. The results were interpreted logically, and the final report included tables and figures as needed.

3. Results and Discussion

3.1. Agro-ecological Performance Evaluation

The average biodiversity score of 43.67 was lower than anticipated. The study area was mainly characterized by 2-3 widely cultivated crops, a few animal species, multiple tree species, and 2-3 income-generating activities (Table 1). The average synergy score was 35.67, lower than the anticipated score. Farmers moderately integrated crops and animals, using farm-produced feed or grazing for livestock, while manure was used as fertilizer. The efficiency score of 41.04 was higher than synergy. Over half of farmers used community-sourced inputs, while one-third relied on market-bought inputs. Synthetic fertilizers and chemical pesticides were used selectively, while organic pesticides were more common. Most farmers produced only enough to meet household needs, with little ability to save. The recycling score averaged 44.3, which is lower than expected, but there are signs of improvement. Farmers recycle a small amount of waste, such as utilizing crop residues for animal feed and manure for composting. Most farms do not have the necessary equipment for water harvesting, resulting in water wastage. Over half of the farmers use self-produced or exchanged seeds, and about half of the breeding is conducted with neighboring farms. Most energy is purchased, with only a small portion generated through methods like animal traction, biogas, and wood. The resilience score averaged 57.38, with half of the farms achieving stable income despite variations in production or input costs. Although income and production typically

rebound aftershocks, community support and access to credit are limited. Insurance coverage is infrequent and often insufficient to cover all risks. Many farms face challenges in adapting to climate change, and the local environment is adversely affected by climatic shocks. Farmers scored above 50 in cultural and food traditions, indicating a strong proficiency in this area. While most farms maintained food security over time, they exhibited a lack of diversity in food groups. Although farmers were aware of good nutritional practices, they did not consistently implement them. Traditional identity and knowledge were acknowledged but not always utilized effectively. A considerable amount of the food consumed originated from local varieties, and traditional practices were frequently employed in food preparation.

The score for co-creation and knowledge sharing was significantly lower than expected, with farms achieving only 30.11%. In over half of the farms, at least one social mechanism for co-creating and sharing knowledge was identified, but these mechanisms had limited functionality and were unable to disseminate information on agroecology effectively. Most farmers were largely unaware of agroecological principles, although younger generations showed interest. Producers maintain regular relationships with their local communities and occasionally participate in events organized by grassroots organizations, although women's involvement is comparatively lower. Human and social values scored just above 40%, at 43.5%. Although women can influence decisions at home and within their communities, they are not the primary decision-makers and often lack access to resources. Some women's associations exist, but they are not fully operational. Agriculture primarily depends on family farms, yet producers have limited access to capital and decision-making authority. Workers face inadequate labor conditions. Many young people perceive agriculture as too difficult and express a desire to emigrate. While animals do not experience hunger, thirst, or diseases, they can suffer from fear, discomfort, and stress, particularly during slaughter.

The score for the circular and solidarity economy was 44.64. While most products and services are sold locally, the networks among producers are underperforming, leading to limited connections with consumers. Intermediaries manage the majority of marketing, and food and inputs are frequently sourced from outside the community, despite some goods and services being exchanged or sold among local producers. The average score for responsible governance was lower than expected at 41.67. While producers' rights are acknowledged, they are not consistently upheld. Producers have limited bargaining power and few resources to enhance their livelihoods or develop their skills. Although there is at least one organization representing producers, its role is minimal, primarily providing support for market access. Producers are involved in the governance of land and natural resources, but their influence on decision-making is restricted. Gender equity is not consistently honored. The gap in CAET scores could be attributed to women's reduced access to resources and training. Tavenner and Crane (2018) discovered that such barriers frequently limit women's ability to participate in agroecological techniques. A greater emphasis on household food security, combined with limited access to resources, has led to a reliance on traditional techniques (Sharma and Raut, 2023).

Table 1. Agroecological transition score of the study area.

Particulars	Score
Diversity	43.67
Synergies	35.67
Efficiency	41.04
Recycling	44.3
Resilience	57.38
Culture and food tradition	51.94
Co-creation and sharing of knowledge	30.11
Human and social value	43.5
Circular and solidarity	44.64
Responsible governance	41.67
CAET total score	43.39

3.2. Soil Health and Dietary Diversity

Based on this, the average score for soil health (1.15) in the study area indicates unsustainable soil conditions for sustainable farming practices. Based on this, the average score for dietary diversity (6.02) in the study area indicates that dietary diversity is acceptable (Table 2).

Table 2. Average ratings of soil health in the study area.

Particulars	Score
Soil structure	1.49.
Soil compaction	0.74
Soil depth	1.29
Status of residue	0.94
color	1.17
Water retention	1.17
Soil cover	1.14
Erosion	1.24
Presence of invertebrates	1.17
Soil health total score	1.15

The average score is <2.5 (Municipalities et al. 2023).

3.3. Mean Differences in Gender with CAET, Bee Keeping, Pollinators, and PAC

Females (mean = 42.7, SD = 5.34) scored significantly lower than males (mean = 44.8, SD = 5.42), with a t-value of -2.239 and a p-value of 0.026 (Table 3). A significant difference was seen in this case (p-value<0.05). Kleijn et al. (2019) found limited gender inequalities in specific agricultural operations in which both men and women are actively engaged. As a result, future CAET studies in Beni should prioritize investigating external socioeconomic determinants that influence beekeeping adoption and success rather than relying primarily on gender dynamics. To promote inclusive and sustainable beekeeping development, it is vital to challenge gender stereotypes, provide targeted assistance to women, involve them in decision-making, and remove cultural barriers (Singh and Raut 2023). Studies show that men and women in farming communities frequently play similar responsibilities in environmental management, which leads to similar perspectives on pollinators (Gliessman 2015). In places with a high concentration of pollinators, all genders experience them similarly, hence the lack of perceived difference. Men and women have similar levels of environmental awareness in rural areas focusing on sustainable farming (Sachs 2018). This study's findings are similar to prior studies (Boserup 1970; Meinzen-Dick et al., 2014), indicating that while gender differences can be important in specific agricultural situations, they do not have a universal impact on all agroecological indicators. Over the last 20 years, the demand for honey has increased tremendously, and organic lifestyle changes have changed the diet of the rich and prosperous (Ahmad et al., 2007).

Table 3. Mean differences in CAET with respect to the gender of respondents at Beni Municipality.

Gender	Number	Mean	SD	t-value	p-value
Female	101	42.7	5.34	-2.239	0.026
Male	49	44.8	5.42		

3.4. Association of Bee Keeping with Self-Sufficiency of Food

The results showed that there was a significant difference observed in beekeeping with respect to Self-sufficiency of food for daily consumption (p-value<0.05). This means that when the activities of beekeeping increase then the self-sufficiency of food will increase or vice versa (Table 4).

Table 4. The scenario of beekeeping with respect to self-sufficiency of food at Beni Municipality.

Self-Sufficiency of Food	Bee Keeping			Total	p-value
	Yes (Raised)	No (Widespread)	No (Rare)		
0-3 months	0	9(7)	0	9(7)	0.003
3-6 months	3(10)	46(38)	0	49(48)	
6-9 months	11(38)	22(18)	0	33(56)	
Above 9	15(52)	44(36)	0	59(88)	

3.5. Mean Difference in CAET with Ethnical Group and Bee Keeping

A significant difference was seen in this case (i.e., p-value= 7.2e-05< 0.001) (Table 5). The presence of bees likely enhances pollination efficiency, contributing to greater biodiversity and improved ecosystem services within agroecosystems. Previous studies have demonstrated that integrating pollinators, especially bees, into agricultural practices not only boosts crop yield but also contributes to the resilience of the agroecosystem (Aldasoro Maya et al., 2023). The promotion of biodiversity, through the presence of bees, leads to a reduction in the dependency on synthetic inputs such as pesticides and fertilizers, a cornerstone of agroecological practices (Ngegba et al., 2022). Previous studies

have indicated that ethnic background can play a role in cognitive or attitude-based assessments (Pépin et al., 2021). Similarly, the higher scores observed in the Brahmin group may reflect underlying socio-economic advantages, such as access to better educational facilities or learning environments, as indicated by several studies on educational disparities among ethnic groups (Asitik and Abu 2020). The Wachagga as the traditional dominant group of the Kilimanjaro area had the most arable land at their disposal, were much more likely to own the land they cultivated, and showed higher levels of subsistence than any other ethnic group (Schlesinger et al., 2015). Maximum CAET score was seen with Bhramin (45.2a ± 5.42) which was significantly higher than another ethnic group. While the maximum CAET score was seen with yes, bees are raised within the agroecosystem (44.46 ± 4.32) which was significantly higher than another type. A significant difference was seen in this case (i.e., p-value=0.02 >0.05) (Table 6).

Table 5. The mean difference in CAET with respect to ethnical groups at Beni Municipality.

Ethnicity	CAET (Mean ± SD)
Brahmin	45.20^{a} ± 5.42
Chhetri	44.58^{a} ± 4.83
Janajatis	43.66^{ab} ± 5.70
Madhesis	39.84^{ab} ± 4.93
Dalits	39.67^{b} ± 5.10
Grand Mean	43.39
CV (%)	11.69
MS Error	25.72
MSD (0.05)	3.90
F-value	6.54***

Note: Mean followed by the different letters in a column are significantly different by Tukey test at a 5% confidence level. CV=Coefficient of variation; MS error=Mean standard error; ***: significant at 0.1% level of significance.

Table 6. The mean difference in CAET with respect to beekeeping at Beni Municipality.

Beekeeping Status	CAET (Mean ± SD)
Yes, bees are raised	45.50^{a} ± 5.62
No, bees are not raised	42.88^{b} ± 5.29
No, bees are not raised and are rare	0.00
Grand Mean	43.38
CV (%)	12.34
MS Error	28.67
MSD (0.05)	2.79
F-value	5.594*

Note: The mean followed by the same letter in a column is not significantly different by the Tukey test at a 5% confidence level.CV=Coefficient of variation; MS error=Mean standard error; *: significant at 5%.

4. Conclusion

The study underscores the necessity for enhanced awareness, education, and support to promote agroecological practices in Beni municipality. It emphasizes that addressing socioeconomic challenges, improving resource accessibility, and providing targeted support for women are crucial for fostering sustainable agricultural development. By integrating beekeeping and focusing on the unique needs of diverse demographic groups, stakeholders can strengthen the transition to agroecological farming, ultimately contributing to long-term agricultural sustainability and resilience in the region. This research provides valuable insights for policymakers and practitioners seeking to advance sustainable agricultural strategies.

Authors contribution: Conceptualization: Pratima Regmi, Subodh Khanal, Dhurba Banjade; Methodology: Pratima Regmi, Subodh Khanal, Dhurba Banjade, Bandana Paudel, Asmi Poudel, Aman Shrestha, Manisha Khatri; Software: Pratima Regmi, Dhurba Banjade, Bandana Paudel, Manisha Khatri, Subodh Khanal; Validation: Prabina Bhattarai, Dhurba Banjade, Subodh Khanal; Formal analysis: Prabina Bhattarai, Dhurba Banjade, Subodh Khanal; Investigation: Pratima Regmi, Dhurba Banjade, Subodh Khanal; Resources: Suresh Bhattarai; Data curation: Pratima Regmi, Subodh Khanal, Dhurba Banjade; Writing—original draft preparation: Pratima Regmi, Dhurba Banjade, Dipak Khanal, Bandana Paudel, Dipak Khanal, Subodh Khanal, Laxmi Prasad Joshi, Asmi Poudel, Aman Shrestha, Manisha Khatri; Writing—review and editing: Pratima Regmi, Dhurba Banjade, Subodh Khanal, Bandana Paudel; Visualization: Dhurba Banjade, Pratima Regmi, Bandana Paudel, Asmi Poudel; Supervision: Subodh Khanal; Project administration: Pratima Regmi; Funding acquisition: Pratima Regmi, Laxmi Prasad Joshi. All authors have read and agreed to the published version of the manuscript.

Funding: No funding was obtained for this study.

Acknowledgment: We would like to express our sincere gratitude to all who supported us throughout this journey. We are especially thankful to our adviser, Assistant Professor Mr. Subodh Khanal, Department of Agriculture and Animal Science (IAAS), for his constant support, guidance, and mentorship during both the research and writing phases. Our thanks also go to Gauradaha Agriculture Campus for providing essential resources and a supportive environment, and to Mr. Ram Krishna Tamang for his valuable guidance. We appreciate the collaboration of our group members and the help of our college colleagues, directly or indirectly. Most importantly, we are deeply grateful to our family—especially our parents—for their unwavering love, support, and encouragement that kept us going throughout this journey.

Conflicts of Interest: No potential conflict of interest was reported by the author(s).

Institutional/Ethical Approval: Not applicable.

Data Availability/Sharing: The datasets used and analyzed during the current study will be made available from the corresponding author upon a reasonable request.

Supplementary Information Availability: Not applicable.

References

Ahmad, F., Joshi, S. R., & Gurung, B. M. (2007). Beekeeping and rural development. International Centre for Integrated Mountain Development. Available online: https://scispace.com/pdf/beekeeping-and-rural-development-1wh52gen7c.pdf (accessed on 10 May 2025).

Aldasoro Maya, E. M., Rodríguez Robles, U., Martínez Gutiérrez, M. L., Chan Mutul, G. A., Avilez López, T., Morales, H., Ferguson, B. G., & Merrida Rivas, J. A. (2023). Stingless beekeeping: Biocultural conservation and agroecological education. *Frontiers in Sustainable Food Systems*, 6, 1081400. https://doi.org/10.3389/fsufs.2022.1081400

Altieri, M. A. (1999). The ecological role of biodiversity in agroecosystems. *Agriculture, Ecosystems & Environment*, 74(1–3), 19–31. https://doi.org/10.1016/S0167-8809(99)00028-6

Altieri, M. A. (2002). Agroecology: The science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems & Environment*, 93(1–3), 1–24. https://doi.org/10.1016/S0167-8809(02)00085-3

Asitik, A. J., & Abu, B. M. (2020). Women empowerment in agriculture and food security in Savannah Accelerated Development Authority zone of Ghana. *African Journal of Economic and Management Studies*, 11(2), 1–10. https://doi.org/10.1108/AJEMS-03-2019-0102

Bacon, C. M., Getz, C., Kraus, S., Montenegro, M., & Holland, K. (2012). The social dimensions of sustainability and change in diversified farming systems. *Ecology and Society*, 17(4), 41. https://doi.org/10.5751/ES-05226-170441

Boserup, E. (1970). Women's role in economic development. St. Martin's Press.

D'Annolfo, R., Gemmill-Herren, B., Graeub, B., & Garibaldi, L. A. (2017). A review of social and economic performance of agroecology. *International Journal of Agricultural Sustainability*, 15(6), 632–644. https://doi.org/10.1080/14735903.2017.1398123

Das, S., Liptzin, D., & Maharjan, B. (2023). Long-term manure application improves soil health and stabilizes carbon in continuous maize production system. *Geoderma*, 430, 116338. https://doi.org/10.1016/j.geoderma.2023.116338

Doran, J. W., & Zeiss, M. R. (2000). Soil health and sustainability: Managing the biotic component of soil quality. *Applied Soil Ecology*, 15(1), 3–11. https://doi.org/10.1016/S0929-1393(00)00067-6

Geck, M. S., Crossland, M., & Lamanna, C. (2023). Measuring agroecology and its performance: An overview and critical discussion of existing tools and approaches. *Outlook on Agriculture*, 52(3), 349–359. https://doi.org/10.1177/00307270231196309

Gliessman, S. R. (2015). Agroecology: The ecology of sustainable food systems (3rd ed.). CRC Press.

Kleijn, D., Winfree, R., Bartomeus, I., Carvalheiro, L. G., Henry, M., Isaacs, R., & Potts, S. G. (2019). Ecological and socio-economic factors in beekeeping. *Journal of Agroecology*, 45(3), 456–472.

Lopez-Ridaura, S. (2022). Agroecology and systems analysis for sustainable agriculture. *Journal of Rural Problems*, 58(1), 31–35. https://doi.org/10.7310/arfe.58.31

Maaz, T. M., Heck, H., Glazer, C. T., Loo, M. K., Zayas, J. R., Krenz, A., Beckstrom, T., Crow, S. E., & Deenik, J. L. (2023). Measuring the immeasurable: A structural equation modeling approach to assessing soil health. *Science of the Total Environment*, 870, 161900. https://doi.org/10.1016/j.scitotenv.2023.161900

Mann, C., Lynch, D., Fillmore, S., & Mills, A. (2019). Relationships between field management, soil health, and microbial community composition. *Applied Soil Ecology*, 144, 98–106. https://doi.org/10.1016/j.apsoil.2019.06.012

Meinzen-Dick, R., Quisumbing, A. R., Behrman, J. A., & Markelova, H. (2014). Gender and sustainability in agricultural development. In R. Evenson & P. Pingali (Eds.), Handbook of Agricultural Economics (Vol. 4, pp. 632–665). Elsevier.

Mottet, A., Bicksler, A., Lucantoni, D., De Rosa, F., Scherf, B., Scopel, E., López-Ridaura, S., & Gemmill-Herren, B. (2020). Assessing transitions to sustainable agricultural and food systems: A tool for agroecology performance evaluation (TAPE). *Frontiers in Sustainable Food Systems*, 4, 579154. https://doi.org/10.3389/fsufs.2020.579154

Ngegba, P. M., Cui, G., Khalid, M. Z., & Zhong, G. (2022). Use of botanical pesticides in agriculture as an alternative to synthetic pesticides. *Agriculture*, 12(5), 600. https://doi.org/10.3390/agriculture12050600

Pépin, A., Morel, K., & van der Werf, H. M. G. (2021). Conventionalized vs. agroecological practices on organic vegetable farms: Investigating the influence of farm structure in a bifurcation perspective. *Agricultural Systems*, 190, 103129. https://doi.org/10.1016/j.agsy.2021.103129

Rieke, E. L., Bagnall, D. K., Morgan, C. L. S., Flynn, D. K., Howae, J. A., Greub, K. L. H., MacBean, G., Cappellazzi, S. B., Cope, M., Liptzin, D., Norris, C. E., Tracy, P. W., Aberle, E., Ashworth, A., & Bañuelos Tavarez, O. (2022). Evaluation of aggregate stability methods for soil health. *Geoderma*, 428, 116156. https://doi.org/10.1016/j.geoderma.2022.116156

Sachs, C. E. (2018). Gender, agriculture, and agrarian transformations. In C. Sachs (Ed.), Gender, Agriculture and Agrarian Transformations (pp. 253–277). Routledge. https://doi.org/10.4324/9780429427381

Schlesinger, J., Munishi, E., & Drescher, A. (2015). Ethnicity as a determinant of agriculture in an urban setting – Evidence from Tanzania. *Geoforum*, 64, 138–145. https://doi.org/10.1016/j.geoforum.2015.06.019

Sharma, M., & Raut, D. (2023). Gender roles in sustainable agriculture: A comparative study. Agricultural Sustainability Review, 17(2), 67–81.

Singh, A., & Raut, D. (2023). Challenges and opportunities for women in beekeeping. *Sustainable Agriculture and Rural Development Review*, 12(4), 87–102.

Tavenner, K., & Crane, T. A. (2018). Gender power in Kenyan dairy: Effects of women's intra-household position on dairy income. *Feminist Economics*, 24(3), 110–131. https://doi.org/10.1080/13545701.2017.1391185