Supported by tetfund TERTIARY EDUCATION TRUST FUND

Perception and Attitude of Farmers on Agroecological Farming in Community Neighbouring Old Oyo National Park, Nigeria

[1]Akinsorotan, Oluseun Adesola; [1]Fajinmolu Abdulbasith Olabanji
[2]Ojeleye Abiola Elizabeth; and [1]Wahab Munir K. Adegoke
[1]Department of Wildlife and Ecotourism Management, Osun State University, Osogbo, Nigeria
[2]Department of Agronomy, Osun State University, Osogbo, Nigeria
Corresponding Author: oluseun.akinsorotan@uniosun.edu.ng ; orcid: 0000-0003-2891-1060
Received: March 20, 2022 **Accepted:** June 18, 2022

Abstract: This study evaluated the perception and attitude of the farmers in communities neighbouring Old Oyo National Park (OONP) on their current agricultural practicing and toward adoption of the wildlife friendly agro-ecological farming using a multi-stage random sample technique. Data on demographic characteristics, perceptions levels and descriptive statistics on Farmer's Agricultural Practices and Farming System was randomly collected from 100 respondents within 3km^2 neighboring OONP, via a well-structured questionnaire and subjected into descriptive and cross-tab analysis using SPSS. Results showed that the mean perception scores of the respondents on their current agricultural practices is 2.89±0.75 while their mean perception towards agro-ecological farming is 3.2±0.52. However, 51.00% of the respondents have a satisfactory perception on their current agricultural practices, while 53.00% respondents have a satisfactory perception on adoption of the agro-ecological farming. Conclusively, the main driver of the respondents' Perceptions was age, household size and educational level. Furthermore, the result from this study could be a baseline information on which future research could be built.
Keywords: Agroecology, Perceptions, Attitude, farming systems, Old Oyo National Park

Introduction

Protected areas (PAs) stand as a place of refuge to conserve the declining population of flora and fauna across the globe (Baboo *et al.,* 2017). Most of these PAs, especially in developing countries are surrounded with villages. Majority of these villagers migrated from various places in search of source of livelihood and or land to farm. Therefore, farming remains the primary source of livelihood and sustenance for the villagers. The bulk of the food consumed by the urban and peri-urban populace are produced by these farmers who live in villages around the PAs. In other to maximize their production capacity to meet the demand of food by the growing human population, the farmers engage in convectional agriculture that use of synthetic fertilizers, pesticides, herbicides and other continual inputs, heavy irrigation, intensive tillage etc. (Talaviya *et al* ., 2020)

The conventional agricultural practices have a negative impact on the biodiversity and around the Pas (Von Rintelen *et al.,* 2017). The impact includes, pollution of water bodies due to the toxic pesticides and insecticides, slash and burn, which causes erosion, ecological effects (such as carbon sequestration, energy cycle, surface water quantity regulation etc.), loss of forest soil and forest watershed due to the heavy tillage that is carrying out, loss of wildlife habitat and population which is the great threat to wildlife and has caused the extinction of many wildlife species (Adomako and Ampadu, 2015). Conventional agricultural intensification that is going on around the park land has been a great challenge, from conflict between farmers and wildlife to declining the park attributes. All of these has caused several damages and loss of park biodiversity. Park lands are being encroached to cultivate and hence reduced the level at which the park is serving its ecological functions.

Agroecology is widely acknowledged equally as a science, a practice, and a movement (Gliessman 2015); through the view of agricultural systems as ecosystems, this eco-friendly agriculture combines these branches and thus integrates other areas of the cultural, humanities and social sciences into a broader system of farming. These doctrines position agroecological patterns as an alternative to chemical, monocultural or industrial agriculture and catalyst for more sustainable agriculture. (Dahan, 2018). Agroecological systems are based on the principles of natural ecosystems (Gliessman 2015) and are considered multifunctional and functionally integrated systems of complementary and dynamic relationships between living organisms and their environment (Altieri and Nicholls, 2012).

However, the perennial and sustainable production strategies formulated by early farmers are now being processed and returned as best practices in a framework called agro-ecological farming, which is defined as a combination of discipline, practices, and systems to archive social change, challenging convectional agricultural framework that have resulted in unsustainable situations for both the environment and human (Gliessman. 2015). Agroecological farming is an everlasting eco-friendly solution that will minimize negative consequences of agricultural intensification on the protected area (such as loss of wildlife habitat, human and wildlife conflict, degradation of soil fertility, erosion, health hazard etc.) and other hand maximize the agricultural production that could meet the consumption level of the population growth likewise sufficient the market demand, using little land space.

Some different sets of agroecological principles have been articulated by many publications (Stassart *et al.,* 2016; Nicholls *et al.,* 2016) that are summarised in Migliorini and Wezel *et al.,* (2018). Agroecology is a set of principles for the agricultural and ecological management of agricultural and food systems and not just a major social, economic, cultural, and environmental policy (wezel *et al.,* 2020). These different principles contain normative aspects that assert values (e.g., food systems should be equitable) and causative aspects. As in scientific usage, that explain relationships (e.g. more biodiverse agricultural systems are likely to be more resilient) and are applied at different scales (e.g. field, farm, landscape, or whole food system) or to different dimensions of food systems such as production or governance (HLPE 2019).

In this study we scrutinized the perception and attitude of the farmer about the practicing of agro-ecological farming in the buffer zone of the Old Oyo National Park, and to know the level and impact of their current farming system on the national park values.

Materials and Methods

The Study Area

Old Oyo National Park (OONP) was established from the two earlier native administrative forest reserves, Upper Ogun established in 1936 and Oyo-lle established in 1941. These were converted to game reserves in 1952, then combined and upgraded to the present status of a national park.

Old Oyo National Park is geographically located between North latitudes 8° 10' and 9° 05', and East longitudes 3° 35' and 4° 21', and centered on North latitude 8° 36' 00 and East longitude 3° 57' 05'. The Park covers a land area of approximately 2,512 km2 making it the fourth largest national park in Nigeria.

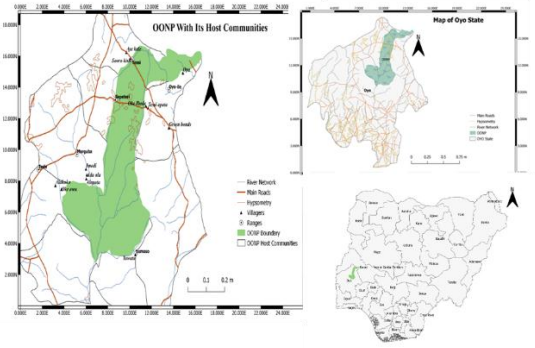

Figure 1: Map showing the location of the respondents surveyed around Old Oyo National Park

Materials and Sampling Method of Data Collection

A fact-finding study was conducted to collect information on awareness and perception of agro-ecological farming practices among farmers in communities neighboring (OONP. Purposive sampling technique was used to villages within 3km radius to OONP boundary. Twenty-one (21) villages were randomly selected across the six (6) ranges. **Tede range** (Oke-owu, Alakuko, Abaa-paanu, Erin and Elekede village), **Marguba range** (Imodi, Ada n'la and Alapata village), **Sepeteri range** (Oke-ibode, and Tessi-apata village), **Tessi range** (Sooro-kish, Aye-kale and Tessi-garuba village), and **Oyo-ile range** (Oopa, Ogbaani and Baba aro village), **Yemoso range** (Yawata and Oke-owu village)

A well-structured questionnaire is randomly administered to a Hundred farmers met in each selected village base on the objectives of this research. Data were obtained using two complimentary methods: farmer interview, and direct observations. The interview was carried out by interpreting the question into their local language (Yoruba). Socio-Demographic information about the respondents and perception of the respondents about the agricultural intensification and type of agricultural practice was asked.

Description of Respondent

The Yoruba tribe is majorly (82.00%) dominating the study area of which the highest (86.00%) number of them were male. 93% of the respondents in this study area were married. 30.00% of them were between the age group of 40-49 years old, and the average age of the respondents was 48.03 years. Majority (40.00%) of the respondents have a household size between 10-15, and the average household size is 10.44. 59% of the respondent have farming experience of less than 20years, and the average farming experience of the respondents is 22 years. 57.00% of the respondent have no formal education, while only a few (1.00%) have tertiary education. Half (50.00%) of the respondents obtained their farmland via lease, however, 40% of them inherited land used for farming. Most of the respondents (72.00%) engaged in commercial farming. See Table 1 below.

The interview guide is also aim to collect information on the local people's perception toward the impact of their current agricultural practices on the park, and evaluating the perception and attitude of the respondents on the adoption and/or practicing of wildlife-friendly agro-ecological farming system.

Data Analysis

Data obtained were summarized using Microsoft Excel 2019 and analyzed utilizing the Statistical Package for the Social Sciences (SPSS) software, v.21. To summarize the obtained data, the demographic characteristics of respondents were subjected to descriptive statistics (frequency and proportions). To access the perceptions levels of the respondents, a numeric scoring pattern was used, and outcome (dependent) variable was then computed, which was further categorized as binary (satisfactory or unsatisfactory) based on cut-off (mean scores) marks. Respondents receiving scores greater than the mean scores for perception was deemed to be satisfactory responses and vice versa. Chi-square test via crosstab model was used to test for association between independent variables (demographics) and outcome variables (perception of respondents on the impact of their current agricultural practices and perception of respondents toward practicing of agroecological farming) at a 95% confidence interval with significant variables ($p < 0.05$) subjected to a binary logistic regression model.

Results and Discussions

Perception of Farmers toward the Impact of Their Current Agricultural Practices.

Regarding farmers perception toward the impact of their current agricultural practices within the boundaries of OONP, more than half (>50) of the respondents were of the opinion that their agricultural practices does not have a negative impact on item 1,2,3,5,8 and 9 in and around OONP. A sizeable number of the respondents (≤50) indicated that their farming activities does not cause pollution, deforestation and leaching (item 4,6 and 7) in the study area (See Table 1).

On perceptions and attitudes toward adopting agroecological farming practices, more than half (54) of the farmers were of the opinion that organic manure are more effective than the synthetic fertilizers. One possible reason could be the cost implication of using fertilizer compared to manure that will be gotten at little or no cost (See Table 1).

Table 1; Results of descriptive statistics on farmers' perception toward the impact of their current agricultural practices. Key: SA=strongly and agree A=Agree (merged to be Agree); ID=Indifferent; DA=Disagree, and SD=strongly disagree (merged to be Disagree), N= number of respondents, S.D= standard deviation, mean scores > General mean score (2.98± **0.75**) = satisfactory*

S/N	Item (N= 100)	A (N)	ID (N)	DA (N)	Mean ± S.D
1	Many wild animals have been lost due to the use of synthetic chemicals on the farm.	28	7	65	2.5±1.3
2	The chemicals used on farmlands contaminate the nearby water bodies.	17	11	72	2.3±1.2
3	wild animals could die or fall sick after eating plants or drink water contaminated by chemicals	33	15	52	2.8±1.3
4	The use of machines (bulldozer, plough, etc.) on farmlands have led to deforestation and leaching	28	35	38	2.8±1.2
5	Forest soil have drastically lost due to heavy tillage practicing on your farmland	57	9	34	3.3±1.3*
6	Slash and burning method of clearing land has resulted to loss of wildlife habitat	32	18	50	2.7±1.1
7	Slash and burning method of clearing land has resulted to air pollution	40	13	47	2.9±1.3*
8	Loss of wildlife habitat is a great threat to wildlife and have led to the extinction of some wildlife species	55	13	32	3.4±1.4*
9	Human-wildlife conflict is the result of agricultural practices in the buffer zone	84	2	14	4.0±1.1*

Perception and Attitude of Farmers toward Agroecological Farming Practices.

Of the eight items on agroecological farming practices, a considerably number (≥33) of farmers have perception that is regarded as satisfactory on items 1,2,5,6 and 8. On attitude questions, majority (N= 70) of the farmers indicated their likelihood of practicing shifting cultivation (See Table 2)

To the farmers in this study, mulching was believed to help reduce weed control costs, erosion and foster soil conservation. Mulch act as physical obstacles in the emergence of weeds and also reduce the irrigation requirement of crop plants, (Ahmad et al., 2015; Ahmad et al., 2020; Iqbal et al., 2020). The findings in this present study shows that the farmers are aware of the importance of mulching, and there is a possibility that they are practicing it on their farm. Hence irrigation farming is not practiced by these farmers since they mulch their crops.

Generally, the farmers show a favourable attitude towards agroecological farming as the majority (60) were of the opinion that wildlife would be less threatening if agroecological farming is practised. Past researchers have reported similar observation that farmers were favourably disposed to the practice of sustainable agriculture and realized its potentials as an alternative to industrial agriculture in Southwest Nigeria (Adeola and Adetunbi 2015). Although, the farmers (≥56) in this present study, attested that they will like to practice agroforestry and traditional shifting cultivation (See Table 2). However, less than half of the farmers confirmed that practicing agroecological farming will increase their annual income. This present finding could be linked to the current practice of the farmers which is not different from traditional method of cultivation, avoiding chemical fertilizers, pesticides, and advanced tools, so there is less damage to the environment.

Table 2; results of descriptive statistics on perception and attitude of farmers toward agroecological farming practices. Key: SA=strongly and agree A=Agree (merged to be Agree); ID=Indifferent; DA=Disagree, and SD=strongly disagree (merged to be Disagree), N= number of respondents, S.D= standard deviation, mean scores > General mean score (3.2±0.52) = satisfactory*

S/N	Item (N=100)	A (N)	ID (N)	DA (N)	Mean ± S.D (3.2±0.52)
1	Uses of organic manure or compost are more effective on crop output than synthetic fertilizer.	54	16	30	3.4±1.2*
2	Organic manure and compost reduce the risk of ground and surface water contamination and also enhance soil biological activity	45	21	34	3.2±1.1*
3	Uses of biological pest and weed control will enhance ecological functions and soil biota activities.	45	25	30	3.1±1.2
4	Biological pest and weed control reduce the soil and water bodies' contamination from pesticides and also minimize the risk of both wildlife and humans' health	33	30	37	3.0±1.2
5	Using of machines on farmland increases air and land pollution	35	41	24	3.2±0.9*
6	Mulching will help reduce weed control cost, erosion and as well foster soil conservation	48	18	34	3.2±1.2*
7	Drip irrigation will lessen the risk of salinization of soils and reduce evaporation with cover crops or mulch	8	85	17	3.0±0.5
8	Wildlife will be less threaten if agroecological farming is being practices	60	20	20	3.6±1.2*
	Attitudinal items				
1	Will you like to practice Agroforestry?	56	11	43	2.5±1.2
2	Will you like to practice traditional shifting cultivation?	78	1	21	3.9±1.3*
3	Practicing agroecological farming will increase your annual income?	42	15	43	3.0±1.3

Farmers Agricultural Practices and Farming System around OONP

On farmers present agricultural practices and farming system, more than half (>59) practices slash and burning process of clearing farmland; use chemicals on their farmland; till their farmland before planting at the beginning of the planting season; engaged in minimum tillage; uses chemical to control pests on farmland and control weed culturally and/or uses chemical. The majority (60) of the respondents are not applying any fertiliser to their plants. Nearly all (94) of the farmers practices crop rotation (See Table 3)

In this present study, nearly all the farmers engaged in slash and burn method of clearing farmlands (See Table 3). This practice has implication on both land and soil biodiversity. Some authors reported that the deleterious effect of burning on wildlife is not limited to the destruction of nesting sites and the possible killing of birds, reptiles or mammals trapped in the fire (Yadav 2013). Also, the burning of plant debris contributes to temporary changes in air quality and releases poisonous gases into the atmosphere. Farmers in this study are ignorant of the adverse effects of pesticides on wildlife organisms and their environment. However, past researchers have reported the use of pesticides, its abuse or misuse causes acute mortality effects of on wildlife especially soil organisms (Köhler *et al.*, 2013). In addition, pesticides have contaminated almost every part of our environment, and their residues are found in soil, water, land and air (Sharma and Singhvi, 2017). On the use of machine (bulldozer, plough, tractor.), having sizeable number indicating that there is no adverse effect of the use on the environment shows that they do not have deep knowledge of the disadvantages of farm machinery. One possible reason for this result could be attributed to the low level of education in the study area and not being aware of the impact of the use of machinery on soil. More than half (57) of the respondents were of the opinion that the forest soil nutrient has drastically lost due to heavy tillage practising on their farmland. Without prejudice, this study has revealed that the farmers' have been feeling the negative effect of continuous tillage on their farm output. It has been documented that continuous tillage have cause major changes in soil structure as well as having a negative impact on the soil biota, nutrient uptake, microbial activity, ground water recharge, and, finally, on crop yield (Gürsoy 2020). Almost (84) of the respondents agreed on agricultural practices in the park's surroundings as the causes of human-wildlife conflicts. This result corresponds with the past findings, which reported that crop-raiding and illegal hunting of wildlife intensities are high in villages close to protected landscapes (Andrew *et al.*, 2014). Generally, using the item mean score, it is obvious that the farmers in this present study have a perception that is satisfactory towards the impact of their current farming activities (see table 3).

Table 3: Results of descriptive statistics on Farmer's Agricultural Practices and Farming System

ITEMS(N= 100)	Yes (N)	No (N)
Method of clearing farmland		
Slash and burning	97	3
Chemical (herbicides)	16	84
Machine (bulldozer)	5	95
Do you till your farmland before planting	97	3
How frequently do you till your farmland		
Yearly	34	66
Beginning of planting season	66	34
Do you use mulch on your farm	4	96
How do you control weeds on their farm?		
Cultural method	83	17
Mechanical method	3	97
Biological method	1	99
Chemical method	64	36
How farmers control pests on their farms.		
Physical method	2	98
Chemical method	61	39
Cultural method	54	46
Biological method	0	100
What type of fertilizer are do you apply to your crop		
Synthetic fertilizer	28	72
Compost	7	93
Organic manure	9	91
No fertilizer	60	40
Do you practice irrigation on your farmland	3	97
Cultivation system		
Crop rotation	91	9
Intercropping	94	6
Mono-cropping	74	26
Cover cropping	71	29

Source: Year 2021 questionnaire survey conducted on Farmers neighbouring Old Oyo National Park

Factor influencing Farmers Perception on Impact of their Current Agricultural Practices and Practicing *Agroecological Farming*

Two variables (household size and education attainment) were indicated to have significantly ($p<0.05$) determined the farmers' perception of the impact of their current agricultural farming. Having a household size of 1-5 and 6-10 significantly (0.026 and 0.025 respectively) influenced farmers' perceptions of the impact of their current agricultural practices. However, lack of education and having secondary level of education significantly ().009 and 0.003 respectively) influenced farmers' perception on their current agricultural practices respectively (See Table 4).

On practising agroecological farming, perception of farmers with no formal education and were above 60 years of age were significantly influenced satisfactorily at ($p=0.018$; 0.037). This study shows that low educational levels persisted in the National Park areas.

Table 4: Factors Influencing Farmers' Perception on the Impact of their Current Agricultural Practices and Practicing Agroecological Farming. Keys: S=satisfactory; UNS=unsatisfactory; X^2=chi-square; CI: confidence interval; B=relationship direction *=significant at $p < 0.05$

Variables	S (%)	UNS (%)	p-value(X^2)	B	95%CI	p-value
(a) Perception on the Impact of their Current Agricultural Practices						
Household size			0.024*			
1-5	8(15.7)	11(22.4)		-0.320	0.16-3.68	0.026*
6-10	24(47.1)	13(26.5)		1.387	0.11-4.72	0.025*
11-15	16(31.4)	13(26.5)		1.578	0.89-17.9	0.071
>16	3(5.8)	12(24.5)		-.320	1.08-21.58	0.222
Educational Attainment			0.001*			
no formal	21(41.2)	36(73.5)		-23.144	0.88-7.69	0.009*
Primary	13(25.5)	11(22.4)		-22.185	2.42-84.96	0.082
Secondary	16(31.4)	2(4.1)		-20.002	-	0.003*
Tertiary	1(2)	0(0)		21.522	-	1.000
b) Perception toward practising agroecological farming						
Age			0.050*			
<29	5 (9.4)	2(4.3)		1.522	0.10-4.86	0.279
30 – 39	14(26.4)	9(19.1)		1.418	0.72-57.75	0.094
40 – 49	17(32.1)	13(27.7)		1.614	0.96-21.82	0.056
50 – 59	14(26.4)	10(21.3)		1.866	0.93-18.41	0.062
>60	13(27.7)	3(5.7)		-21.292	1.09-23.03	0.037*
Educational Attainment			0.029*			
No Formal	23(43.40)	34(72.3)		-20.367	0.89-7.16	0.018*
Primary	16(30.2)	8(17)		-20.298	0.51-5.65	0.999
Secondary	13(24.5)	5(10.6)		19.681	-	0.999
Tertiary	1(1.9)	0(0)		1.866	-	0.999

Source: Year 2021 questionnaire survey conducted on Farmers neighbouring Old Oyo National Park

Two variables (household size and education attainment) were indicated to have significantly ($p<0.05$) determined the respondents' perception of the impact of their current agricultural farming at 0.024 and 0.001 significant level, respectively, as shown in table 4a. Those respondents with household size range between 1-5 and ranges between 6-10 household sizes were indicated to have significantly influenced the respondents' perceptions on the impact of their current agricultural practices at significant levels ($P\leq0.05$). This study revealed that respondents with a household size of less than 10 have satisfactory perception toward their current agricultural practices; this implies that they can provide their household daily needs through the type of farming they are engaged in. However, farmers with small household size might not be able to engage in commercial farming that requires extensive labor, a dominant type of farming in the study area. Hence, farmers with larger household sizes would have invested more in the farming enterprise and would be eager to dwell more on the farming system that would satisfy their livelihood needs. This study, similar to the previous study of Adeola and Adetunbi (2015), reported that household size influences the perception of Southwest Nigeria farmers on adopting sustainable farming. However, lack of education and having secondary level of education influenced perception of respondents on their current agricultural practices, which is significant at ($p\leq0.009$ and 0.003), respectively. Education is key to knowledge, and since the majority of the respondents are not educated, they might probably lack the understanding of the adverse effect of their current agricultural practices.

Only two socio-economic characteristic variables (respondent age and education attainment) were revealed in table 4b to have significantly ($P<0.05$) determined the perceptions of respondent toward practicing agroecological farming significantly at ($p\leq0.050$ and 0.029), respectively. Respondents age influence their perceptions (satisfactory) towards practicing agroecological farming at ($p\leq0.056$ and 0.037), respectively. This study indicates that the higher the farmer's age, the more experienced and knowledgeable they are to develop a rightful perception of any issue that affects their biodiversity welfare. This study shows that low educational levels persisted in the National Park areas. Past study has that household age and educational level were among the socio-economical characteristic which influences the adoption of Conservation Farming Practices in Zambia (Arslan *et al.*, 2014).

In conclusion, farmers in this present study lack basic education and hence have no understanding of the implication of some of their current agricultural practices on their immediate environment i.e. OONP. There should be a policy that will regulate the uses of chemicals (herbicides) within the surrounding of the park. In addition, outreaches, capacity buildings and conservation education should be organised for the locals in and around conservation areas on topics pertinent to the biodiversity conservation and the reason why they must practice agroecological farming.

There is a need for more elaborate work due to the small sample size in this study. However, findings from this study serves as a baseline information on which future research could be built on.

References

Adeola, R. G. And Adetunbi, S. I. (2015). Farmers' Perception of Sustainable Agriculture in South Western Nigeria: Implications for Rural Economy. International Journal of Applied Agricultural and Apicultural Research, (1&2): 86-92.

Adomako, T., & Ampadu, B. (2015). The impact of agricultural practices on environmental sustainability in Ghana: a review. Journal of Sustainable Development, 8(8), 70.

Ahmad S, Raza MAS, Saleem MF, Zaheer MS, Iqbal R, Haider I, Aslam MU, Ali M, Khan IH (2020) Significance of partial root zone drying and mulches for water saving and weed suppression in wheat. J.Anim.Plant.Sci. 30:154–162

Ahmad S, Raza MAS, Saleem MF, Zahra SS, Khan IH, Ali M, Shahid AM, Iqbal R, Zaheer MS (2015) Mulching strategies for weeds control and water conservation in cotton. J. Agric. Biol. Sci 8:299–306.

Altieri MA, and Nicholls, C. (2012) Agroecology and the search for a truly sustainable agriculture. United Nations Environment Programme, Mexico www.agroeco.org/doc/agroecology-engl-PNUMA.pdf

Andrew J, Bamford H, Ferrol-Schulte D and Wathan J (2014) Human and wildlife usage of a protected area buffer zone in an area of high immigration. Oryx61–10. doi:10.1017/s0030605313000215.

Arslan, A., McCarthy, N., Lipper, L., A few, S., and Cattaneo, A. (2014). Adoption and intensity of adoption of conservation farming in Zambia. Agricultural, Ecosystem and Environment, 187, 72-86.

Baboo, B., Sagar, R., Bargali, S. S., & Verma, H. (2017). Tree species composition, regeneration and diversity of an Indian dry tropical forest protected area. Tropical Ecology, 58(2), 409-423.

Gliessman, S. R. (2015). Agroecology: The Ecology of Sustainable Food Systems (p. 386). Taylor and Francis Group, London. https://doi.org/10.1201/b17881.

Gürsoy Songül. 2020. Soil Compaction Due to Increased Machinery Intensity in Agricultural Production: Its Main Causes, Effects and Management. Technology in Agriculture, DOI: http://dx.doi.org/10.5772/intechopen.98564

HLPE (2019) Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World FoodSecurity. http://www.fao.org/cfs/cfshlpe/en/https://borgenproject.org/agroecological-farming/#.

Iqbal, R., Raza, M. A. S., Valipour, M., Saleem, M. F., Zaheer, M. S., Ahmad, S., & Nazar, M. A. (2020). Potential agricultural and environmental benefits of mulches—a review. Bulletin of the National Research Centre, 44, 1-16.

Köhler, H.R. and Triebskorn, R. (2013). Wildlife ecotoxicology of pesticides; can we track effects to the population level and beyond?. Journal of Science 341, 759–765.

Migliorini P, Wezel A (2018) Converging and diverging principles and practices of organic agriculture regulations and agroecology. Review Agron Sustain Dev 37:63. https://doi.org/10.1007/s13593017-0472-4

Sharma, N., and Singhvi, R. (2017). Effect of chemical fertilizer and pesticides on humans' health and environment: a review. International Journal of agriculture, environment and biotechnology, 10(6), 675-680.

Stassart PM, Baret PV, Grégoire JC, Hance T, Mormont M, Reheul D, Stilmant D, Vanloqueren G, Vissser M (2016) L'agroécologie: trajectoire et potentiel. Pour une transition vers des systèmes alimentaires durables. In: Van Dam D, Streith M, Nizet J, Stassart PM(eds)Agroéocologie,entrepratiquesetsciencessociales.Dijon, France, Educagri, pp 27–51

Talaviya, T., Shah, D., Patel, N., Yagnik, H., & Shah, M. (2020). Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides. Artificial Intelligence in Agriculture, 4, 58-73.

Von Rintelen, K., Arida, E., & Häuser, C. (2017). A review of biodiversity-related issues and challenges in megadiverse Indonesia and other Southeast Asian countries. Research Ideas and Outcomes, 3, e20860.

Wezel, A., Herren, B. G., Kerr, R. B., Barrios, E., Gonçalves, A. L. R., & Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. Agronomy for Sustainable Development, 40(6), 1-13.

Yadav PK (2013) Slash-and-Burn Agriculture in North-East India. Expert Opin Environ Biol 2:1.