UNEARTHING THE ENVIRONMENT IMPACTS OF AGRICULTURE: A COMPREHENSIVE ANALYSIS

Abstract

Environment and agriculture are interdependent. Both positive and negative effects of agriculture on the environment are significant. Not only does agriculture have an impact on the environment, but also environmental changes pose a threat to agriculture. Changes and fluctuations in the climate pose a severe threat to world agriculture. It is widely accepted that changes in temperature, distribution of rainfall, sea level, and concentrations of carbon dioxide in the atmosphere would have the worst consequences on agricultural production.The chapter focuses on the manner in which agriculture affects the environment and how to mitigate those consequences. so that we might fulfil the rising demand for food supply as the population expands. Agriculture also provides people a livelihood while destroying other fauna's habitat. Environment plays a significant role in determining agricultural productivity. A third of the planet's land area is devoted to agriculture, which is reliant on the natural ecosystem as a whole. Due to global warming, catastrophic occurrences like floods, tornadoes, and water shortages will become more powerful and frequent in the upcoming years. The water balance and farm production will suffer as a result of these occurrences. Through the production of greenhouse gases including nitrous oxide, methane, and carbon dioxide, agriculture is impacted by climatic change. The direct causes of these emissions are the use of tillage techniques, fossil fuels, livestock dung, and, to a great extent, fertilised agricultural soils. Research of this kind examines possible physical effects of environmental change on agriculture.

Keywords: agriculture, environment, climate change, global warming, crop production

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I. INTRODUCTION

The agricultural science and environmental science deal with the management of natural resources, hence they are closely intertwined. Environmental science is concerned with the study of the natural environment and how human activities affect it, while agricultural science is concerned with the production of food, fibre, and other goods from plants and animals. Sustainable agricultural techniques, which attempt to produce food and other products while limiting adverse effects on the environment, are one way that these fields are connected. This includes methods that can enhance soil health, preserve water, and lower greenhouse gas emissions, such as crop rotation, conservation tillage, and integrated pest control. The investigation of how agricultural practices affect animals and biodiversity is another way that agricultural and environmental researches are tied to one another.

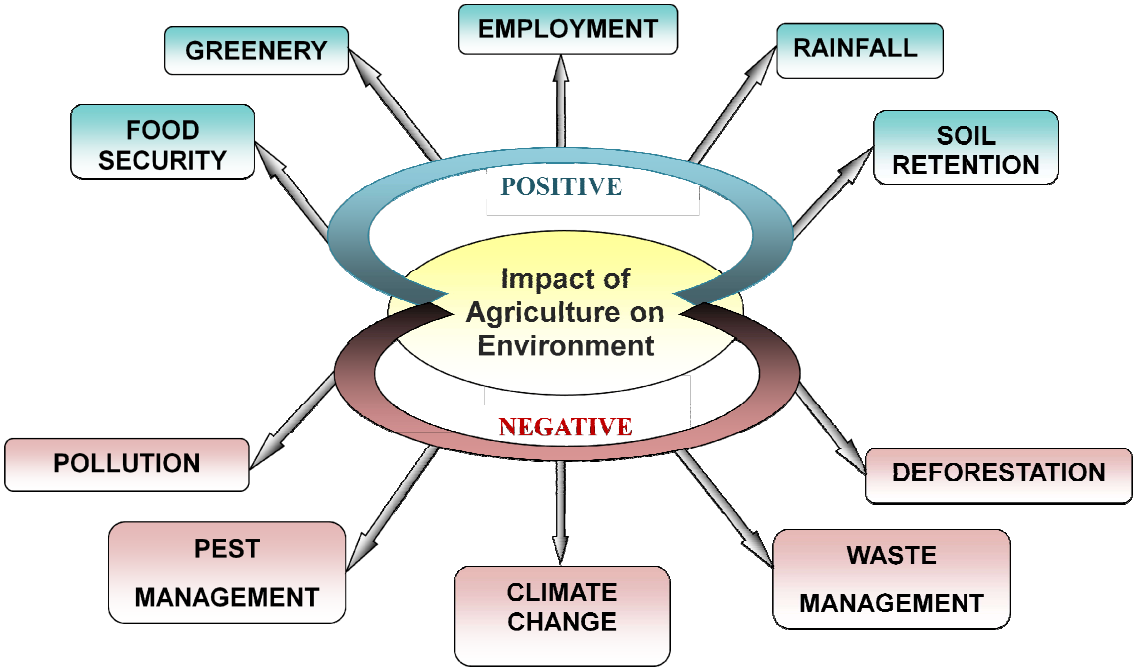

Figure 1. *Positive and negative impacts of agriculture on environment*

For instance, ecologists may research how changes in land use affect the distribution of plant species, while conservation biologists may investigate how various farming practices affect bird populations. The subjects of agricultural science and environmental science are intertwined and collaborate to manage natural resources for the environment's sake as well as the production of food. According to an article, it has been surveyed that despite an overreliance on rain-fed agriculture (Kogo et al., 2021), Kenya is already undergoing episodes of climate change, which are reflected by seasonal fluctuations in precipitation and temperature of different severity and duration. The results also show that the already vulnerable populations in the arid and semi-arid regions would continue to suffer from the adverse effects of climate change on crop productivity and food security. Agriculture productivity is primarily determined by the environment. About one-third of the world's land surface is used for agriculture, which is directly dependent on the environment as a whole. Extreme occurrences will become more frequent and stronger as a result of global warming

i.e. water deficient condition, flood, tornado that would greatly harm the water balance and agriculture production in upcoming years (Toor et al., 2020).

II. IMPACT OF AGRICULTURE ON ENVIRONMENT

The production of food is responsible for 26% of the world's greenhouse gas emissions. About half of the world's arable land is used for agriculture. Habitable land is defined as that which is free of ice and deserts.70% of the freshwater harvested worldwide are used for agriculture. Agriculture is to blame for 78% of the world's freshwater and ocean eutrophication. Eutrophicated waterways are those that have been contaminated by nutrient-rich water. Ninety four percentage of the biomass of non-human mammals comes from livestock. This shows that domesticated animals weigh 15 to 14.1 times as much as wild animals. This percentage is 97% when only land-based species are considered.The biomass of birds is made approximately 71% by poultry livestock. This shows that livestock poultry weighs more than thrice what wild fowl does (Ritchie et al., 2020).

1. Positive Impacts

- **Provides Food Security**: Agriculture is the basic source of food for humans which is necessary for survival. Although food can be procured from animals and sea but for most of the population today agriculture is the most important source of food since plant diet, dairy and meat are dependent on farming and is obtained by it. In India where 20-39% of population is vegetarian individuals are dependent on crops such rice, wheat, maize, bajra, ragi etc.

- **Supports Livelihood and Creates Habitat:** For farmers farming and agriculture is a source of their living. Farming also creates homes for insects and some animals. Examples of waterfowl, amphibians and other pollinating insects can be taken. Providing a living for 2.5 billion people and generating an average of 23.7 million tonnes of food each day, agriculture is one of the primary sources of revenue and employment for rural, low-income households.

- **Opportunities of Employment**: Various employment opportunities like farming, researchers, scientists, machinery, technology and business options. In emerging countries, agriculture accounts for 29% of the GDP and 65% of all jobs.The single greatest job in the world, agriculture employs 40% of the world's population today. One topic which has received quite lot of attention in recent years is digitalization of agriculture, which could usher in the next agricultural revolution.Technology may help farmers better comprehend their land and crops by providing information and capturing data on crops, predictions for the weather, soil conditions, crop quality, and fertiliser management. Farms will be able to save money by leveraging robotics and autonomous equipment as well as the concept of digital tools (Shridhar et al., 2023).

- **Retention of Soil and Prevention of Soil Erosion**: These days where soil erosion is a major issue agriculture is the biggest remedy as vegetation holds the soil together and prevents erosion. Practices such as crop rotation can be helpful. Different crops may alter the soil differently (e.g., through variable rates of water and nutrient

extraction) quality, and periodicity of C inputs may each have a different effect. This may have an impact on the rate of soil transformation and the growth of subsequent crops (Page et al., 2020).

- **Enhancement of Rainfall and Greenery**: As part of agriculture, people usually build water recharging stations and grow an abundance of plants. As a result, there is an increase in rainfall and vegetation, which enhances the greenery. With specific increase in the vegetation, the water cycle regulation is also balanced which enhances the rainfall also.

2. Negative Impacts

- **Pollution:** The use of fertilizers for betterment of crops causes damage to soil sometimes. Some areas still carry out slash and burn agriculture which is leading cause of land and air pollution. The use of pesticides is also harmful. Pesticides may contaminate grass, water, and other vegetation. In addition to killing weeds and insects, pesticides can also be fatal to a variety of other animals and plants, including fish, birds, important insects, and non-target plants. It also effects health a great deal causing eye stinging, scabs, rashes, cataracts, vertigo, nausea, diarrhoea, and death. Cancers, birth deformities, reproductive injury, immunotoxicity, cognitive and developmental impairment, and endocrine system disturbance are a few examples of documented chronic consequences. For example, we can take *hexaclorobenzene, flupyradifurone, primicarb, DDT, melathione, I,3dichloropropene, imidacloprid, isoproturon*etc. When used on a particular plant or when they are disposed, pesticides have the potential to contaminate the environment. After being discharged into the environment, pesticides can undergo processes including transmission (or migration) and degradation (Scholtz and Bidleman, 2007). Pesticide degradation in the environment leads to the creation of new chemicals. Pesticides travel from the target site to other environmental media or non-target plants through mechanisms include adsorption, leaching, volatilization, spray drift, and runoff (Robinson et al., 1999). The variations in environmental behaviour among the many chemical types are evident. For example, whereas organochlorine compounds like DDT have a low acute toxicity, they display a significant propensity to accumulate in tissues and cause long-term harm to organisms (Tudi et al., 2021).

- **Deforestation:** Agriculture results in cutting of forest and vegetation for growing crops. As it provides home to many species but could became also the reason for loss of many wild species due to loss of biodiversity. Increasing food demand necessitates the need for more area to be used for pastures or crops, which leads to the quick cutting and burning of forests, which is one of the main causes of deforestation.

- **Climate Change:** Agriculture and climate change are two globally interrelated phenomena that develop concurrently. As a consequence, climate change, which includes temperature swings, inconsistent precipitation, and glacier run-off, has a negative impact on agricultural output and contributes significantly to global warming. As a result, these characteristics have a significant impact on an ecosystem's capacity to provide sufficient nourishment for the population. The primary manner in

which the agriculture affects the global climate is by emitting greenhouse gases like CO_2, CH_4, and nitrous oxide. Additionally, present agricultural practises including the use of synthetic fertilisers, tillage, etc. release ammonia, nitrate, and various other residues of synthetic chemicals into the atmosphere. These leftovers harm biodiversity and natural resources like soil, water, and air. Metrics for erosion and soil desertification are affected by increased amounts of heavy rain (Mestre-Sanchís and Feijóo-Bello, 2009). High evapotranspiration rates lead to an increased frequency of times when the soil's surface is dry, making it more vulnerable to wind erosion. As a result of nitrogen lixiviation, changes in soil fertility brought on by modifications in pluviometric regimes may become more pronounced with time. Since more fertilisers are required to restore fertility, this issue directly affects the economy (Mestre et al., 2009).

- **Pest Management:** Due to uncontrolled use of pesticides pest problem is being increased because they are getting resistant to these pesticides. Because of the shift in how crops are harvested, the expansion of irrigated land, and the increased intensity of cultivation, the insect problem is getting steadily worse. Due to habitat loss, climate change, and a reduction in bird and insect populations, there is no longer any natural biological control over these populations. The health of farmers, consumers, and animals is directly impacted by the widespread and unrestrained use of dangerous pesticides. However, persistent pesticides pose a much greater threat to both people and animals' health.

- **Waste Management**: The most hazardous waste for both humans and the ecology is industrial and agricultural waste. The overproduction of agricultural waste is a major contributor to environmental pollution and contamination problems. The characteristics of waste materials have changed over time, and these modifications can now have dangerous and detrimental effects on people. In rural areas, agriculture-waste production averages 2 tonnes per day. Additionally, 20 million tonnes of waste—a rich source of nutrients and manures—were produced annually by the sugar industry and cow barns. In the past, farmers would burn their trash or simply leave it in the fields, but this causes serious soil and air pollution (Iqbal et al., 2020). Agricultural waste includes crop remnants from a variety of crops, such as rice straw and hull, that were handled improperly. Farmers typically burn this trash, which produces high levels of CO_2 and CO in the air and causes serious respiratory issues in both humans and animals. Through the processing of byproducts by businesses like fishery, poultry, dairy, etc., as well as plough for retaining organic matter, agricultural waste needs to be recycled.

- **Irrigation**: Around the globe, more than 70% of all available freshwater is used for agriculture. Because of this water is depleting leading to shortage of freshwater. Other problems due to irrigation are waterlogging, water pollution by leftover chemicals and garbage, flow of contaminated water into water reservoirs.

III. REMEDIES

The management of natural resources is one component of agriculture that relates to environmental science. Farmers need to develop ways to use water, fertilizers, and pesticides as efficiently as possible while reducing their harmful effects on the environment. By using technology to accurately administer inputs depending on crop needs, techniques like precision agriculture can help minimize loss and lower the risk of pollution.

1. Another crucial factor is soil health and conservation. Healthy soils are essential for crop production and provide numerous ecosystem services. Environmental scientists work alongside farmers to implement techniques like crop rotation, cover cropping, and conservation tillage to improve soil fertility, reduce erosion, and maintain soil structure.These practices not only enhance agricultural productivity but also safeguard against soil degradation and loss, preventing detrimental effects on nearby water bodies and biodiversity.

2. The issue of water management is of utmost importance in agriculture. Environmental science plays a critical role in monitoring water quality and developing strategies to conserve water resources**.** Techniques such as drip irrigation, rainwater harvesting, and efficient irrigation systems are promoted to minimize water wastage and ensure sustainable water use in agriculture. Additionally, the conservation of wetlands and riparian zones helps to maintain water quality, regulate water flows, and provide habitat for various species.

3. Ensuring biodiversity in agriculture is another area where environmental science comes into play. Sustainable farming practices aim to maintain and enhance biodiversity, recognizing its crucial role in natural pest control, pollination, and ecosystem balance. By creating habitat corridors, preserving agroforestry systems, and implementing integrated pest management strategies, farmers can promote biodiversity on their farms while maintaining productivity.

4. One of the most important environmental issues today is climate change, to which agriculture both contributes and is subjected. Analysis of the effects of climate change on crop output, water availability, and pest dynamics is aided by environmental science. It also aids in the creation of adaptation plans, such as the use of crop types that can withstand drought, the adoption of climate-smart agricultural methods, and the application of carbon sequestration measures to reduce agriculture's greenhouse gas emissions.

IV. SUSTAINABLE AGRICULTURE

In recent decades, awareness of the necessity of sustainable action has considerably increased. The term "sustainability" was coined in 1983 by the United Nations' "World Commission for Environment and Development". Since then, "development that meets the needs of the present while safeguarding the ability of subsequent generations to meet their own needs" has been the commonly recognised definition of sustainable development (Gauglar et al., 2020).

Sustainable agriculture aims to maximise food production while limiting environmental effect by working with ecology instead of against it. This strategy entails protecting the environment, developing natural resources, and improving conditions for both people and animals in order to guarantee a long-term viability of sources of nourishment while minimising reliance on conventional agricultural methods and offering substitute food options. Utilising local resources, conserving water, and utilising organic fertilisers to preserve soil health and stop erosion all contribute to sustainable agriculture practises, which safeguard natural resources for future generations. It is crucial to emphasise the importance of sustainable agriculture. We must practise farming in an environmentally friendly manner to meet the growing demands of the increasing population and its increased appetite for food. Sustainable agriculture encourages social fairness and economic success while helping to protect the environment. The conventional agriculture system is less harmful to the environment, boosts yields, and gives consumers healthier products. Sustainable agricultural practises aim to preserve vital resources like soil fertility, which is necessary for farming success. These new productive systems may benefit areas with scarce or limited resources.

V. ORGANIC FARMING

Generally speaking, organic agriculture requires 2.5 times as much labour compared to conventional farming, but it generates 10 times as much profit. This can increase employment as well as meet our needs for more food. Organic farming captures the essence of holistic and regenerative farming since it is founded on concepts that work with nature, promote healthy soil, and support clean water, biodiversity, and thriving farm communities. Organic, however, is frequently disregarded as a climate answer. No harmful pesticides are used in organic farming which is good for environment. It also helps in maintain soil fertility, provides clean water, discourages growth of algal blooms, prevents erosion of soil, non renewable energy is limited thus slowing climate change by reducing carbon emissions. It also helps in maintaining biodiversity. Leguminous crops that are commonly utilised in organic farming, (e.g*., Sesbania* spp. and *alfalfa*), have been found to improve soil organic matter.In comparison to conventional systems, organic systems using compost and peat sources have larger microbial populations and enzyme activities, according to a long-term study with the crops of maize (*Zea mays*) and rice (*Oryza sativa*). In organic versus conventional banana (*Musa acuminata*) farms, the diversity and dominant soil bacterial population (β-proteobacteria, acidobacteria, and α-proteobacteria) were noticeably higher.Growing vegetables like tomatoes (*Solanumly copersicum*), snap beans (*Phaseolus vulgaris*), and lettuce (*Lactucasativa*) under organic and conventional culture for three years shown that organic farming using compost boosted soil CO2 respiration (soil health indicator) and enzyme activities (fluorescein diacetate hydrolysis, phosphatase, and arylsulphatase activities) in comparison to conventional mineral fertiliser (NPK). Furthermore, compared to traditional culture systems, organic culture demonstrated the ability to reduce soil pathogens such *Fusarium* wilt in cucumber (*Cucumis sativus*) and plant parasitic nematodes such as *Pratylenchus* and *Meloidogyne* in maize and bean (Tahat et al., 2020).

VI. CONCLUSION

In conclusion, agriculture and environmental science are inseparable fields, deeply connected by the need to ensure sustainable food production while safeguarding the

environment. By integrating scientific knowledge, innovative technologies, and best management practices, we can foster agricultural systems that are environmentally sustainable, ecologically resilient, and capable of meeting the growing global food demand without compromising the health and integrity of our planet. Regarding carbon dioxide, changes in plant nutrition and defence mechanisms may affect many plants' susceptibility to herbivorous insects as a result of rising atmospheric CO_2 concentrations (Tudi et al., 2021). Techniques for biological fertilization are important approaches for an effective and sensible use of agricultural resources with little development of negative environmental effects that may impair ecosystems, water resources, or the quality of human life. Biological fertilisers also offer a variety of opportunities for the growth of conservative agriculture in various geographical, economic, and cultural contexts. Current studies unambiguously demonstrate that biofertilization methods require fewer chemical inputs on the soil and make it easier to incorporate residues that would otherwise end up inlandfill and dump, which represents significant reductions in the environmental impacts connected to agriculture activities globally (Carvajal et al., 2012). Therefore, agriculture and environment go on simultaneously. Agriculture effects the environment and vice versa. They are complementary to each other. Many ways have been adopted to get the best results from agriculture and they are done in a way so that our environment is not harmed.

REFERENCES

[1] Kogo, B. K., Kumar, L., & Koech, R. (2021). Climate change and variability in Kenya: a review of impacts on agriculture and food security. *Environment, Development and Sustainability*, *23*, 23-43.
[2] Toor, M. D., Rehman, F. U., Adnan, M., Kalsoom, M., & Shahzadi, L. (2020). Relationship between environment and agriculture: a review. *SunText Rev. Biotechnol*, *1*(2), 1-5.
[3] Ritchie, H., & Roser, M. (2020). Environmental impacts of food production. *Our world in data*.
[4] Sridhar, A., Balakrishnan, A., Jacob, M. M., Sillanpää, M., & Dayanandan, N. (2023). Global impact of COVID-19 on agriculture: role of sustainable agriculture and digital farming. *Environmental Science and Pollution Research*, *30*(15), 42509-42525.
[5] Page, K. L., Dang, Y. P., & Dalal, R. C. (2020). The ability of conservation agriculture to conserve soil organic carbon and the subsequent impact on soil physical, chemical, and biological properties and yield. *Frontiers in sustainable food systems*, *4*, 31.
[6] Scholtz, M. T., & Bidleman, T. F. (2007). Modelling of the long-term fate of pesticide residues in agricultural soils and their surface exchange with the atmosphere: Part II. Projected long-term fate of pesticide residues. *Science of the total environment*, 377(1), 61-80.
[7] Robinson, D. E., Mansingh, A., & Dasgupta, T. P. (1999). Fate and transport of ethoprophos in the Jamaican environment. *Science of the total environment*, 237, 373-378.
[8] Tudi, M., Daniel Ruan, H., Wang, L., Lyu, J., Sadler, R., Connell, D., ... &Phung, D. T. (2021). Agriculture development, pesticide application and its impact on the environment. *International journal of environmental research and public health*, 18(3), 1112.
[9] Mestre-Sanchís, F., & Feijóo-Bello, M. L. (2009). Climate change and its marginalizing effect on agriculture. *Ecological economics*, 68(3), 896-904.
[10] Iqbal, N., Agrawal, A., Dubey, S., & Kumar, J. (2020). Role of decomposers in agricultural waste management. In *Biotechnological Applications of Biomass*. IntechOpen.
[11] Gaugler, T., Stoeckl, S., &Rathgeber, A. W. (2020). Global climate impacts of agriculture: A meta-regression analysis of food production. *Journal of Cleaner Production*, *276*, 122575.
[12] Tahat, M., M., M. Alananbeh, K., A. Othman, Y., & I. Leskovar, D. (2020). Soil health and sustainable agriculture. *Sustainability*, *12*(12), 4859.
[13] Carvajal-Muñoz, J. S., & Carmona-Garcia, C. E. (2012). Benefits and limitations of biofertilization in agricultural practices. *Livestock Research for Rural Development*, 24(3), 1-8.

