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## Potentialities of Permaculture to Emerge as an Alternative for Intensive Agriculture- A Review

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### ABSTRACT

*Permaculture or 'permanent agriculture' is the deliberate design and management of agriculturally productive ecosystems that resembles natural ecosystems in terms of diversification and persistence. The present study focuses on finding out the potentialities of permaculture systems to replace intensive agro-systems of production, thereby creating a sustainable and eco-friendly ecosystem. Intensive farming has been reported to have negative effects on the environment. Agricultural intensification has resulted in soil deterioration, loss of biodiversity, emission of greenhouse gases and many more. Under such a scenario, the principles and practices of permaculture system can be adopted to grow chemical free foods and become self sustainable. However, a mental shift is required because permaculture incorporates diverse ways of valuing the environment and accessible resources, as well as one's role as a human being. Thus, in light of the food crisis, health, and the intake of quality food, adopting Permaculture and growing one's own food will be a better option.*

**Keywords:** *Permaculture, Intensive farming, Greenhouse, Biodiversity.*

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### INTRODUCTION

“Permaculture is the deliberate design and maintenance of a productive agricultural ecosystem that is characterized by sustainability, diversity, stability, and durability with the integration of all ecosystem components so that multiple community objectives are met in a sustainable manner” [1]. The term ‘Permaculture’ for the first time was coined by Bill Mollison, an Australian scientist, and his Co-originator, David Holmgren in the year 1978. Masanobu Fukuoka's natural farming idea influenced permaculture, which was initially known as 'permanent agriculture.'

Permaculture, according to Holmgren, is "deliberately built landscapes that resemble natural designs and relationships while generating an adequate supply of food, fibre, and energy for the provision of local requirements [2]. Permaculture is recognized as a component of an emerging global paradigm shift from a clever but unsustainable techno-industrial culture to a wise but unsustainable ecological culture [3]. Permaculture is a ‘positivistic’ response to the environmental crisis, according to Bill Mollison. The environmental crisis is serious, and it is of such size that it will undoubtedly transform modern global industrial society beyond recognition. The well-being and even existence of the world's rising population are directly affected in the process [2]. Under such circumstances, Permaculture has the utmost potentials to emerge as an alternative reflex.

On the other hand, Intensive agriculture has been practice for many years and has become a basic way of life globally. Scientists have discovered the harmful consequences of intensive farming on the environment as a result of research and technical advances. Agricultural intensification has contaminated water sources and deteriorated soils, caused biodiversity loss

by killing valuable plants, insects, and other creatures, and in some cases poisoned farm workers [4]. Alternatively, the permaculture system aims to reduce the risk and dangers posed by conventional agricultural goods such as fertilizer, pesticide, herbicide, and insecticide [1,2]. The concept of Permaculture is still unknown in many parts of the world and in the present situation, it needs serious attention.

In the realm of agricultural production, the practical application of permaculture shares many parallels with other alternative farming techniques such as organic farming, biodynamic farming, agroforestry, or agroecology. Permaculture is similar to agroecology and agroforestry in that it emphasizes spatial species association such as a combination of trees, animals, and crops; intercropping practices, and diverse landscapes. Permaculture, like organic and biodynamic farming, emphasizes soil fertility [5].

### **NEED OF PERMACULTURE**

The Green Revolution has resulted in increased food production during the last few decades, resulting in a major transformation in agriculture. The technological improvements offered a noticeable increase by boosting yield per unit of land, reducing workload, and improving food safety. However, these benefits came at a cost that was not anticipated [5,6].

Gradually, the exploitation of large lands for intensive agriculture, excessive use of pesticides and synthetic fertilizers, and many more events has led to a devastating impact on the environment. The effects of agricultural intensification have turned out to be detrimental to the ecosystem and elements.

### **Loss of Soil Physical and Chemical Properties**

Soil deterioration brought about by wind and water erosion, salinization, organic matter, and nutrient losses, or soil compactions are major concerns in all agricultural regions across the world [7]. Intensive farming has led to adverse effects on soil health and properties. Soil Organic matter (SOM) is the key indicator of soil health and quality, which is strongly influenced by intensive farming practices. The effects of intensive agriculture on soil result in the destruction of soil organic matter as well as the soil structure [4].

### **Inefficient use of Water**

Unsustainable groundwater usage can have serious and long-term repercussions for ecosystems. Overdependence on diminishing groundwater supplies poses substantial concerns, jeopardizing future food production and global food security as agricultural land becomes less productive, if not nonproductive [8]. Again, excessive irrigation in agricultural lands leads to salinization [6].

### **Loss of Biodiversity**

Human population increase, along with competitive land usage, results in land scarcity, conversion of natural lands to agricultural and other uses. Biodiversity is greatly influenced by land use, particularly agriculture. Another factor contributing to biodiversity loss is the fact that people currently rely on a small number of tamed wild species for survival.

The conversion of natural ecosystems to semi-natural ecosystems or artificial systems resulted in significant changes in biodiversity make-up and ecological processes [9]. The intensification of agriculture thereby led to a decline in biodiversity.

### **Emission of Greenhouse gas (GHG)**

Intensive agriculture is a substantial contributor to global greenhouse gas emissions. The majority of agricultural GHG emissions occur during the primary production stage, when agricultural inputs, farm machinery, soil disturbance, residue management, and irrigation are produced [10]. The manufacturing of synthetic nitrogen (N) fertilizers, which are used in agricultural production processes, contributes significantly to greenhouse gas (GHG) emissions. In addition, the use of synthetic N fertilizers is widely acknowledged as the most significant contributor to direct Nitrous oxide gas emissions from agricultural soils [11].

The above-mentioned factors have the potential to devastate the key processes of the Earth's ecosystem and adversely affect food security. This review aims to discuss and point out the potentialities of Permaculture to emerge as an alternative to intensive agricultural practices.

### **Ethics of Permaculture**

'Permaculture is a holistic design system based on direct observation of nature, traditional knowledge, and modern scientific findings. Permaculture is a concept of positive action and grassroots education that strives to reconstruct society by returning control of basic living resources such as food, water, shelter, and means of livelihood to ordinary people in their communities as the sole antidote to centralised power' [12]. The art of permaculture thrives on three basic ethics:

#### **Earthcare**

The primary motivation for permaculture is earth care and there are two approaches to this. The two approaches include Environmentalism and Ecology [13]. In the most basic sense, caring for the Earth entails caring for living soil, which is the source of life and for which we bear the most responsibility [2]. Environmental stewardship or Environmentalism comprises plants, animals, water bodies, and soil as resources. Again, the ecology encompasses mankind, other sentient species, and the planet's overall health: good is what serves the whole Earth [13].

#### **Peoplecare**

People care begins with the individual, but it spreads in ever-widening circles to encompass our families, neighbors, local and larger communities. The people care ethic is concerned with caring for people and satisfying their different needs (physical, emotional, social, intellectual, and so on) in a long-term manner. It is widely acknowledged that in order to care for the Earth, we must also care for humans [2,14].

#### **Fairshare**

This third permaculture ethic is the consequence of integrating the other two [13]. The fair share ethic recognizes that we have to live within boundaries and not exploit nature or others via our choices in lifestyle [14, 15]. Moreover, this ethic is concerned with the transfer of excess from the privileged to the poor, since the disparity between the two is considered to generate anger and distrust [15].

On a more practical level, in many agricultural communities, planting durable and valuable trees and forests has been a traditional means of transferring surplus time and resources for benefitting the upcoming generations and the land itself, thereby leading to an overall balance in the ecosystem [2].

## **Permaculture Design Principles**

Permaculture seeks to build resilient living systems inspired by natural processes, patterns, and structures. David Holmgren has developed 12 principles of permaculture design that claim to give a framework for designing sustainable land use and a community within ecological limits [2].

### **OBSERVE AND INTERACT**

This principle represents a technique of observing and interacting with a specific system to obtain information and experience from it [6]. Permaculture designers utilize careful observation and mindful interaction to decrease the need for repetitive physical labor, as well as nonrenewable energy and expensive technology [2]. People can develop solutions that are specific to their circumstances by taking the time to connect with nature, which forms the basis of the principle.

### **Catch and Store Energy**

This principle suggests that as much energy as feasible should be kept inside the system [2,6]. Efficient utilization of the resources should be done and stored for further use. Examples that help to define the principle include organic mulch application, rainwater harvesting and efficient use of groundwater, planting of valuable trees and shrubs for storage of carbon, etc [6]. In an era of fast change and short-term thinking, we must restore the element of our culture that emphasizes care for the future, as well as decide what is worthwhile to invest in for the benefit of our grandchildren and successors [2].

### **Obtain a Yield**

The idea behind this principle is that the permaculture-based farming systems must provide a sufficient output while also providing food, energy, and resources to humans. Bill Mollison's original Permaculture concept of cultivating gardens of food and valuable plants rather than worthless ornamentals is still an important illustration of this principle in action [2]. This principle is particularly important since it demands a sufficient production of agricultural goods yet ensuring high efficiency in resource, energy usage, and ecological and social returns [6].

### **Apply Self-Regulation and Accept Feedback**

The self-regulatory characteristics of Permaculture design that restrict or inhibit abnormal development or behaviour are addressed in this principle. With a clear vision of how positive and negative feedbacks function in nature, we can build self-regulating systems that reduce the labor needed infrequent and severe corrective management. The most typical uses of this principle include the augmentation of controlling ecosystem services, such as pollination and natural pest control, nutrient cycling, and water and soil quality regulation [2,6].

### **Use and Value Renewable Resources and Services**

Permaculture design should seek to make the optimum use of renewable natural resources to manage and sustain yields, even if certain non-renewable resources are required in the system's establishment. Permaculture systems should make the best use of non-consuming natural services to reduce our demands on consumable resources while emphasizing the harmonious potential of human-nature connection [2]. The use of nitrogen-fixing plants (legumes) or animal dung in place of inorganic nitrogen fertilizer is a well-studied illustrative example of this principle. Another important example associated with this principle is the symbiotic behavior between fungus and plants [2,6].

### **Produce No Waste**

This principle aims at making proper use of the available goods and wastes are observed as resources and opportunities. Bill Mollison defines a pollutant as “an output of any system component that is not being used productively and effectively by another system component”. This statement urges us to seek methods to reduce pollution and waste by developing systems that make use of all outputs [2]. Important examples for this principle include the application of animal manure, human excreta on agricultural land for enhancing soil fertility [6].

### **Design from Patterns to Details**

The Permaculture concept arose from the idea of using natural ecosystems, particularly forests, as agricultural models. From a scientific background point of view, this principle is regarded as “natural ecosystem mimicry”. The site design tools of zone, sector, and slope can be used to develop effective patterns in the permaculture system. Moreover, Grasslands, tropical rainforests, and dry forests are some important patterns that can be utilized in agricultural ecosystems.

### **Integrate Rather than Segregate**

The links or interactions that exist between the components of an integrated system might vary considerably. Some are competitive or predatory, while others are cooperative or even symbiotic. However, building mutually beneficial and symbiotic connections is emphasized significantly in permaculture. Examples that support this principle are included integrating livestock in cropping systems like chickens, integrating fish into rice cropping systems, etc.

### **Use Small and Slow Solutions**

This principle explains that small and slow systems that make greater use of the available resources are easier to maintain as compared to bigger systems. Slow-growing systems turn out to be more stable and effective thereby contributing to sustainability. Based on a study, smaller farms have the potentials to generate more production per unit area and are comparatively more stable [6].

### **Use and Value Diversity**

The very core of permaculture rests in diversity. In permaculture, four aspects of diversity are significant, which include species diversity, genetic diversity, ecological and cultural diversity. Again, there are three approaches to increase diversity in the field: Mixing crop varieties, mixing crop species & mixing crop and non-crop plants. Crop mixtures can improve yield stability. In the failure of one component of the mixture due to some reason, the other may boost its yield to compensate [13].

### **Use Edges and Value the Marginal**

This principle reminds us to be mindful of and utilize edges and margins at all scales in all systems [6]. Edges and field margins in an agroecosystem have the potentials of being more diverse and productive comprising a wide range of flora and fauna. Plantation of perennial plants around the edges of a garden will help to create a microclimate consisting of beneficial insects that in turn, will enhance the productivity inside the garden.

### **Creatively Use and Respond to Change**

Permaculture is concerned with the long-term viability of natural living systems and human cultures, yet this long-term viability is paradoxically dependent on change and adaptability. In a permaculture system, comprehending change is much more important than statistical

analysis. Natural systems at all levels must acquire resilience to calamitous events brought about by large-scale forces. Again, when confronted with overwhelming external influences, flexibility takes precedence over resistance and stringency.

## **PRACTICES INVOLVED IN PERMACULTURE SYSTEMS**

### **No-Till**

No-till is the technique of directly planting crops on a field without ploughing and is one of the crucial practices followed in permaculture systems. The benefits of adopting no-till management include improvement in soil structure, higher moisture retention in soil, reduction in soil erosion, and storage of Carbon [16] (Ogle et al., 2019). Under a No-till soil management system, the surface layer of the soil gets enriched with the organic matter due to the accumulation of crop residues thereby leading to an increase in the microbial population [17].

### **Mulching**

Covering the soil with either mulch or living plants is a direct replica of nature. Mulching keeps the weeds under control, conserves moisture in the soil, protects the soil from eroding, encourages soil biological activities, and also adds to the organic matter composition of the soil [13].

### **Application of Animal wastes as fertilizer**

Application of animal manure in the soil results in the increase of soil organic matter as well as water holding capacity. Moreover, applied animal manure improves the fungal and bacterial activity of the soil [18] (Rayne and Aula, 2020). When compared to other animal manure, poultry manure contains a higher concentration of the nutrients needed for plant growth; it is rich in organic manure because solid and liquid excreta are discharged without urine loss [19].

### **Agroforestry**

Agroforestry has the potential to adopt resilient farming systems while mitigating the effects of climate change. According to existing research, the incorporation of trees on farms may reduce environmental decline, enhance agricultural production, boost carbon sequestration, and promote healthy soil and ecosystems, while maintaining steady revenues and other advantages for human well-being [20].

### **Polyculture**

Industrial farming relies on monoculture systems for the large-scale growing of one particular crop species, which is not environmentally friendly. The utilization of polyculture for growing crops is a common feature in the practice of Permaculture. This framework provides the variety of components required to provide diverse ecosystem services and socio-cultural activities [21].

### **Raised Beds**

Raised beds in permacultural systems are an important feature that contributes to sustainable food production. Various types of vegetables along with other crops can be grown in the raised beds. Raised beds have the potential to extend the planting season and even minimize weed growth if correctly built and planted [22].

### **Stacking**

Stacking refers to the utilization of vertical spaces, such as walls, fences, trellis, and balconies, for growing food. It involves the combination of the short and tall plants in the same place, thereby making maximum use of the available space. An example that implies this practice is the growing of sweetcorn and vegetables of pumpkin family-like squashes, marrows, and courgettes in the same place [13].

### **Growing perennials**

Growing perennials fruits and vegetables like asparagus and globe artichoke may be more sustainable than annuals in permaculture systems. In addition to that, perennial plants have a better chance of developing efficient mycorrhizas than annual ones. The only disadvantage is that the harvesting takes a longer time and the yield are usually low [13].

## **ZONES IN PERMACULTURE**

Zoning is a designing method that enables maximum energy use in permaculture-based systems. There are six zones into which the land can be split [13].

**Zone 0:** The house itself. It is centre of activities.

**Zone I:** This zone includes home garden where vegetables, fruit trees, and herbs are grown. Tender and exotic plant species are also found to be growing in this region.

**Zone II:** Orchards, poultry, and other animal housings, maincrop vegetables requiring more area are considered under this zone.

**Zone III:** Field-scale crops along with pastures for rearing livestock are available in this zone. Moreover, water storage structures can be found in the zone.

**Zone IV:** The impact of humans on the landscape is greatly diminished in this zone. Grazing and forest lands are included under this zone.

**Zone V:** This zone implies the natural ecosystem full of wilderness and is free of human intervention.

## **FUTURE CHALLENGES**

Practically, Permaculture may be a complete framework for planning, developing, and building human communities, including farms, more sustainably and ethically. But, Permaculture has been chastised for lacking a scientific foundation, which is seen to lead to unfounded, overbroad, or simplistic assertions [23]. Permaculture provides opportunities to be self-sufficient and become economically independent. A prevalent subtheme shared by the majority of people is that implementing permaculture necessitates a significant commitment of time and effort, as well as a mental shift. However, a change in mentality is required because permaculture encompasses different ways of valuing the environment and available resources, as well as one's role as a human being [24].

Farming beneath the open sky has gradually declined. Any food grown in an artificial environment is a far cry from foods grown under natural conditions (Fukuoka, 1985). So, growing own foods and becoming self-sufficient through the practice of permaculture should

be a priority among the consumers. There are several ecological benefits in people growing their food, compared to buying supermarket food [13]:

- 1) Food is consumed fresh, which increases its nutritional worth.
- 2) Transportation is eliminated which reduces both energy use and pollution.
- 3) Food waste that happens in the distribution chain is eliminated.
- 4) People become aware of the source of food.
- 5) Carbon footprint is significantly reduced.
- 6) Gardening is a beneficial hobby for those who have sedentary jobs since it reconnects us with nature.

## CONCLUSION

Considering the issues of the food crisis, health, and quality food consumption, practicing Permaculture and producing one's food will be a better option. Permaculture involves gardening rather than farming, which can in fact restore the damages due to intensive agricultural practices. Presently, there has been a positive response from the permaculture practitioners, and in the coming days, there is a firm belief that more people will engage themselves in such ecological activities and work for a better and sustainable future.

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