PLANT COMPOST-MANURE AND AGRO-CHEMICAL ANALYSIS

Dr. Neeraj Jain

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Regd. Office:
F-10/24, East Krishna Nagar, Near Vijay Chowk, Delhi-110051
Ph. No: +91-11-79669196, +91-9899073222
E-mail: info@booksarcade.co.in, booksarcade.pub@gmail.com
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CONTENT

CHAPTER 1

AN EXPLORATION OF THE ORGANIC AGRICULTURE

Dr. Neeraj Jain, Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-neeraj.jain@muit.in

ABSTRACT:

As a sustainable and eco-friendly alternative to traditional agricultural methods, organic agriculture has attracted a lot of attention lately. An overview of the main facets and importance of organic agriculture is given in this abstract. It draws attention to the tenets, methods, and advantages of organic farming, highlighting its favorable effects on soil health, biodiversity, human health, and the elimination of chemical inputs in food production. Additionally, this abstract examines the difficulties and restrictions experienced by organic farming, including problems with scale and market accessibility. Additionally, it addresses international trends and regulations supporting the expansion of organic farming and its potential contribution to solving urgent agricultural and environmental problems. In light of the mounting ecological and socioeconomic issues, this study emphasizes the significance of organic agriculture as a realistic route to a more robust and sustainable food supply.

KEYWORDS:

Farming Practices, Green Agriculture, Natural Farming, Organic Farming, Sustainable Agriculture, Environmental Farming.

INTRODUCTION

An integrated production management approach known as organic agriculture supports and increases the health of the agro-ecosystem, including biodiversity, biological cycles, and soil biological activity. The utilization of natural inputs, such as minerals and products originating from plants, is emphasized, while synthetic fertilizers and pesticides are discouraged. Organic farming is based on the same principles and logic as a living organism, in which every componentsoil, plants, farm animals, insects, farmers, and environmental factorsis interdependent[1]. When feasible, agronomic, biological, and mechanical approaches are used to achieve this. These methods follow the principles of these interactions and use the natural ecosystem as a model, as shown in Figure 1.

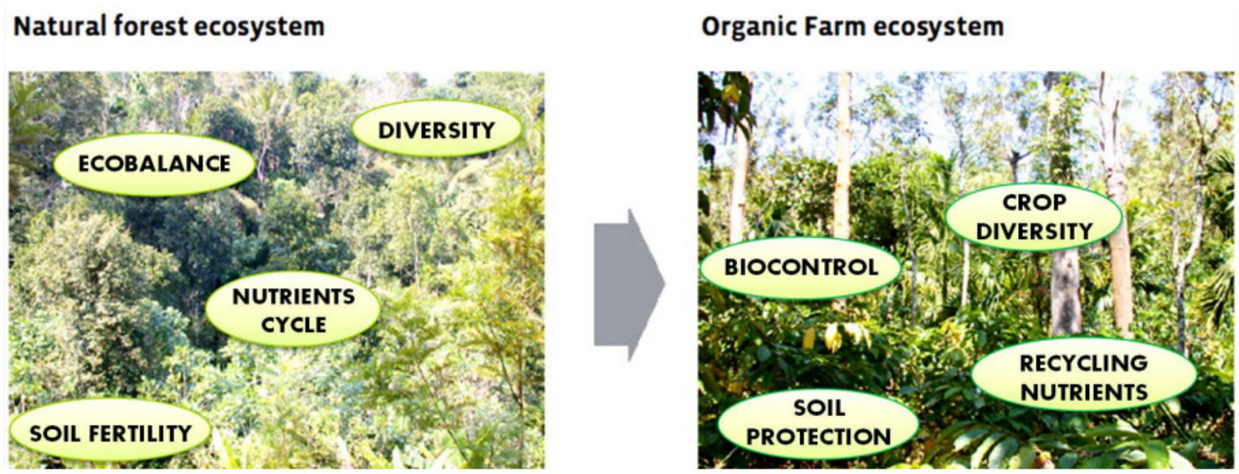

Figure 1: Illustrated the Using Natural Ecosystem as A Model[2]**.**

Many strategies employed in other sustainable agricultural practices, such as intercropping, crop rotation, mulching, and integrating crops and animals, are also utilized in organic agriculture. However, the fundamental principles that constitute organic agriculture a distinct agricultural management system are the use of natural, non-synthetic inputs, the enhancement of soil structure and fertility, and the adoption of a crop rotation plan[3]. The Codex Alimentarius's Guidelines on Organically Produced Food, published in 2007, state that an organic production system should:

- **a)** Increase biological variety throughout the board;
- **b)** Boost biological activity in the soil;
- **c)** Keep the land fertile over the long run;
- **d)** Recycle wastes of plant and animal origin to replenish soil nutrients and reduce the need for nonrenewable resources;
- **e)** Utilize sustainable resources in regionally coordinated agricultural systems;
- **f)** Encourage the wise use of land, water, and air, and reduce any pollution that could be brought on by agricultural operations;
- **g)** Encourage the careful handling of agricultural goods in order to preserve their vitality and organic integrity at all times;
- **h)** stablish a permanent presence on any current farm after a conversion phase, the duration of which will depend on site-specific elements including the land's history and the crops and animals that will be raised there[4].

The International Federation of Organic Agriculture Movements (IFOAM), a non-governmental organization that networks and promotes organic agriculture globally, has also set standards for organic production and processing that are generally accepted by the organic community. IFOAM states that the following tenets form the foundation of organic farming practices:

a) Principle of Health:

The goal of organic agriculture is to preserve and improve the health of ecosystems and species, from the tiniest in the soil to humans, whether it is used for farming, processing, distribution, or consumption. Given this, it should refrain from using fertilizers, pesticides, animal medications, and food additives that might be harmful to one's health[5].

b) Ecology's Principle:

Based on live ecological processes and cycles, organic agriculture should cooperate with them, imitate them, and contribute to their maintenance. Organic management has to be adjusted to the size, ecology, and culture of the area. Reusing, recycling, and managing materials and energy effectively can help reduce inputs, enhance environmental quality, and save resources.

c) Fairness's Principle:

This concept highlights the need of conducting human interactions in organic agriculture in a way that provides justice to all parties, including farmers, employees, processors, distributors, merchants, and consumers. Additionally, it demands that circumstances and possibilities for life be given to animals in accordance with their physiology, natural behavior, and wellbeing.

The management of natural and environmental resources utilized in production and consumption should be fair from a social and ecological perspective and should be done so with regard to future generations. Systems of production, distribution, and commerce must be transparent, equal, and take into account the true costs to the environment and society[6].

d) Care's Principle:

According to this idea, management, technological advancement, and responsibility are the two main considerations in organic agriculture. To guarantee that organic farming is safe, secure, and environmentally sound, science is required. However, it has to take into account workable solutions derived from real-world experience, accumulated traditional knowledge, and indigenous wisdom and avert major hazards by embracing suitable technology and eschewing uncertain ones, like genetic engineering[7].

Organic Culture's Needs

To improve sustainability, organic agriculture aims to have a positive impact. What, though, does sustainability entail? As shown in Figure 2, sustainability in agriculture refers to the effective management of agricultural resources to meet human requirements while also preserving or improving the environment's quality and protecting natural resources for future generations. Therefore, sustainability in organic farming must be seen holistically, taking into account ecological, economic, and social factors.

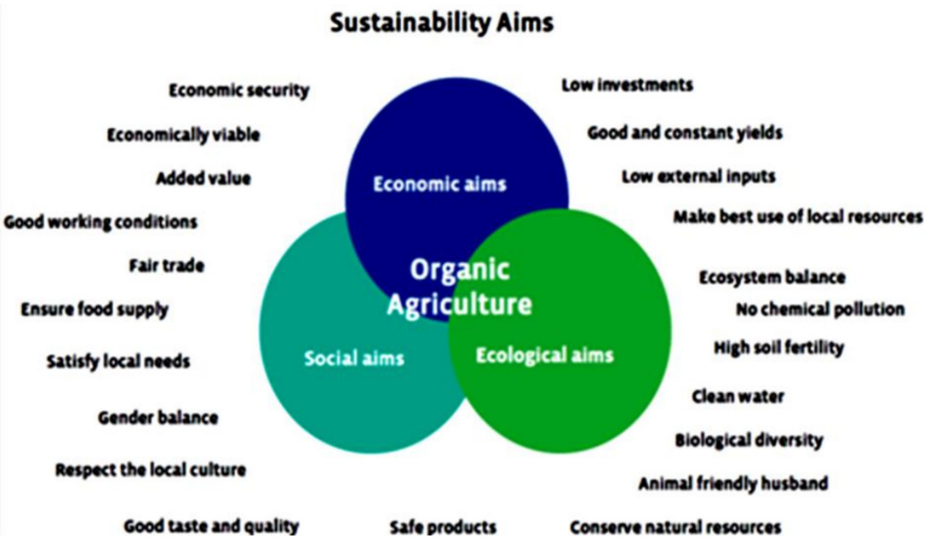

Figure 2: Illustrated the Three Dimensions of Sustainability[8]**.**

An agricultural system can only be said to be sustainable if all three criteria are met. The methods used in organic agriculture are recognized as being environmentally sustainable by:

a) Using crop rotations, organic manure, mulches, and fodder legumes to supply nitrogen to the soil fertility cycle to improve soil structure and fertility.

b) Preventing soil erosion and compaction by growing relay and mixed crops to safeguard the soil.

c) Promoting biological variety by using natural pest treatments, such as biological control or plants with pest control capabilities, as opposed to synthetic pesticides, which are known to destroy beneficial creatures when applied improperly. Natural parasites of pests, such as bees and earthworms, may lead to pest resistance and often contaminate water and land.

d) Performing crop rotations, which promote a variety of food crops, fodder, and underutilized plants; this may help with the conservation of plant genetic resources on-farm in addition to enhancing overall farm output and fertility[9].

e) Utilizing crop leftovers, such as straws, stovers, and other inedible portions, either directly as compost and mulch or through animals as farmyard manure to recycle the nutrients.

f) Making use of renewable energy sources and including livestock, tree crops, and on-farm forestry into the system. In addition to draught animal power, this increases revenue via the sale of organic meat, eggs, and dairy goods. The system's integrated tree crops and on-farm forestry provide food, money, fuel, and timber.

Social Sustainability

Equity between and among generations is another aspect of sustainability. By lowering the loss of arable land, water pollution, biodiversity erosion, GHG emissions, food losses, and pesticide toxicity, organic agriculture improves societal well-being.Traditional knowledge and culture are the foundation of organic agriculture. Its agricultural practices adapt to the specific biophysical, socioeconomic, and environmental limits and possibilities in the area. The economic climate and growth of rural areas may be enhanced by using local resources, local expertise, and establishing connections between farmers, consumers, and their markets.In order to maximize farm production, reduce farm susceptibility to weather whims, and ultimately improve food security, whether via the food the farmers produce or the cash from the items they sell, organic agriculture places a strong emphasis on variety and adaptive management[10].

Economic Sustainability

Organic farming seems to increase employment in rural regions by 30%, and labor productivity is greater for each hour worked. Organic farming helps smallholders access markets and generate revenue by better using local resources. It also relocalizes food production in market-marginalized regions.In wealthy nations, organic yields are typically 20% lower than high-input systems, but in dry and semi-arid regions, they may be up to 180% greater. In humid environments, rice paddy yields are comparable but perennial crop output is lower, while agroforestry adds extra benefits.

Operating expenses in organic agriculture are much cheaper than those in conventional farming, ranging from 50–60% for grains and legumes to 20–25% for dairy cows and 10–20% for horticultural products. These costs include seeds, rent, maintenance, and labor. This is a result of decreased labor cash expenses, which include both paid and family labor, cheaper irrigation costs, and lower input prices for synthetic inputs. However, overall costs are only marginally cheaper than traditional since conversion-related expenditures in additional orchards, animal housing, and certification have increased the expenses of fixed assets including land, buildings, and equipment[11].

Market Opportunity

New export potential are brought about by the demand for organic goods. Exports of organic goods often command premiums of 20% or more over comparable goods grown on non-organic farms. By raising household incomes under the correct conditions, market returns from organic agriculture may be able to support local food security.It's difficult to break into this profitable sector. To ensure that their farms and companies uphold the organic criteria imposed by different trade partners, farmers must yearly hire an agency that certifies organic products. Farmers cannot market their goods as "organic" during the 2-to-3-year conversion phase to organic management, which results in price premiums as shown in Figure 3. Customers anticipate residue-free organic products, which is why this is the case[12]. However, items produced on land under organic management for at least one year but less than the two- to three-year criteria might be marketed as "transition to organic" according to the Codex Guidelines on Organically Produced Food; however, very few markets have arisen for such products.

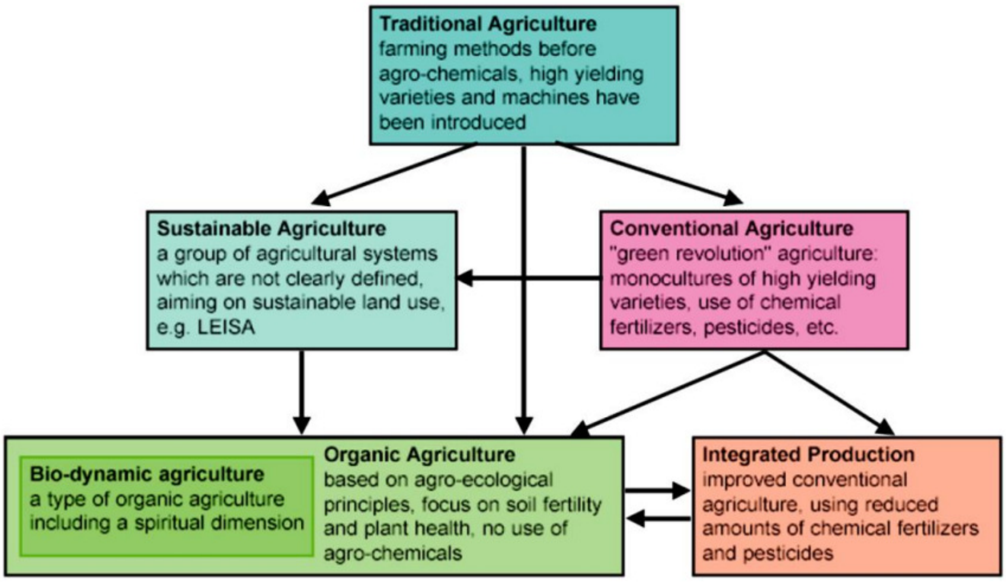

Figure 3: Represents the Distinguish Between Some Commonly Used Terms ofAgricultural Systems[13]**.**

DISCUSSION

In the modern world, the debate over organic agriculture is both very relevant and difficult. Sustainable techniques, less chemical inputs, and the encouragement of soil and ecosystem health are prioritized in organic agriculture, which offers an all-encompassing and ecologically responsible approach to food production. It is an agricultural strategy that places a strong emphasis on using compost, organic materials, and natural processes to improve crop yield and soil fertility. The ban of synthetic pesticides and genetically modified organisms is one of the fundamental tenets of organic agriculture, which strives to lessen the hazards to the environment and human health associated with chemical-intensive farming. Additionally, organic farming strongly emphasizes the preservation of biodiversity within agricultural ecosystems. Organic farms often promote a wider variety of plants and animals, providing a healthier and more robust environment by eliminating chemical pesticides and synthetic fertilizers[14]. By making it easier to manage pests and diseases, biodiversity not only helps the ecosystem but also the agricultural system as a whole. Due to rising customer demand for better-quality, more ethically produced food, organic agriculture has become more and more popular. Organic food sales are on the rise as a result of consumers' growing concern about the effects of conventional agriculture on the environment and their health. Many farmers and agribusinesses have switched to organic agricultural practices in response to this consumer-driven demand. However, there are other issues and concerns that come up when talking about organic farming[15]. Critics contend that organic farming would produce less than conventional agriculture, which might raise questions about food security, particularly in a world where the population is expanding. Additionally, farmers, especially small-scale producers in developing nations, may find the certification procedure for organic goods to be complicated and costly, which may restrict their access to organic markets. The relevance of ecologically friendly and sustainable farming methods is highlighted by organic agriculture in tackling current agricultural and ecological concerns. While there are many advantages to organic farming, such as better soil health, biodiversity preservation, and less chemical inputs, it is crucial to keep looking for methods to increase organic farming's accessibility, scalability, and productivity in order to meet the needs of a changing global environment[16]. It's critical to strike a balance between the benefits and drawbacks of organic farming if we want to support a robust and sustainable food supply.

CONCLUSION

To sum up, organic agriculture is a crucial and developing method of producing food that tackles urgent issues like environmental sustainability, human health, and moral agricultural practices. The fundamental tenets of organic agriculturereduced chemical usage, improved soil health, and preservation of biodiversitycontribute to a more robust and ecologically responsible food supply. It accompanies the shift toward more sustainable agricultural methods by responding to the growing customer demand for wholesome and morally produced food. Organic farming has several advantages, such as less of an influence on the environment and better soil fertility, but it also has drawbacks. To promote the broad adoption of organic farming practices and make them affordable for all farmers, problems including reduced yields and certification difficulties must be resolved. The future of organic farming depends on ongoing study and innovation to meet these difficulties while advancing its guiding principles of sustainability and environmental responsibility. Organic farming offers a potential example of how humans and nature might cohabit more peacefully and sustainably as we confront mounting global concerns about climate change, food security, and ecological preservation. We can strengthen the contribution of organic agriculture to creating a future food system that is healthier, more resilient, and more accountable by combining the best of traditional knowledge with contemporary science and technology.

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CHAPTER 2

AN OVERVIEW OF THE CONSIDERATIONS FOR CONVERSION TO ORGANIC AGRICULTURE

Dr. Neeraj Jain, Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-neeraj.jain@muit.in

ABSTRACT:

Growing concerns about food safety, environmental sustainability, and consumer demand for organic goods have sparked a paradigm change in contemporary agricultural techniques that has led to the move from conventional to organic agriculture. An overview of the important factors for farmers thinking about switching to organic agriculture is given in this abstract. It draws attention to the transformation's many facets, such as soil management, pest control, legal requirements, market dynamics, and financial repercussions. We examine the advantages of organic farming from an ecological and socioeconomic standpoint, as well as the difficulties and trade-offs that farmers can experience when they make the transition. This abstract aims to provide individuals, policymakers, and agricultural stakeholders with a comprehensive understanding of the factors influencing the choice to embrace organic agriculture and to contribute to the larger discussion on sustainable food production systems by synthesizing current knowledge and useful insights.

KEYWORDS:

Agriculture, Certification, Conversion, Environmental Sustainability, Farming Practices, Organic Farming.

INTRODUCTION

The switch from conventional to organic agriculture has become a crucial and topical topic for the world's farmers in an age characterized by increased environmental awareness, worries about food safety, and a growing market for organic goods. The Considerations for Conversion to Organic Agriculture, perfectly captures the core of a significant change that has been gaining ground in agricultural communities all over the globe [1]. To increase crop yields, the traditional agricultural paradigm, which has dominated for decades, mainly depends on synthetic fertilizers, pesticides, and genetically modified organisms. While it has unquestionably contributed significantly to feeding a rising global population, it has also raised serious questions about its sustainability over the long run. Uncontrolled use of agrochemicals has resulted in loss of biodiversity, soil degradation, water contamination, and significant health problems for both consumers and farmers [2], [3].

In response to these difficulties, organic farming has arisen as a practical alternative that places an emphasis on ecological harmony, soil health, and a reduction in chemical inputs. The comprehensive and ecologically conscious approach to food production is the core of organic agriculture. It emphasizes methods that nurture and improve soil health, foster biodiversity, and reduce the usage of synthetic chemicals. The goal of organic farming is to develop a resilient and regenerative agricultural environment via practices including crop rotation, cover crops, and organic pest management. The outcome includes not only the production of organic food products but also the revitalization of the soil, the preservation of ecosystems, and the reduction of agriculture's negative environmental effects.

The switch from conventional to organic agriculture is not an easy one, however. Complex interactions between scientific, economic, logistical, and regulatory issues are present. Farmers that are thinking about this change must go through a complex web of issues, including soil preparation, insect control, adherence to organic certification criteria, market dynamics, and financial ramifications. Each of these aspects offers particular difficulties and chances that need for careful consideration [4]. These issues will be thoroughly covered in this conversation, which will also provide a thorough examination of the complex conversion to organic agriculture. It will clarify the advantages of such a shift from an ecological and socioeconomic standpoint, as well as any challenges and trade-offs that farmers could experience along the road. Additionally, in a world where consumer tastes and governmental actions are increasingly aligning with sustainability and organic principles, it will assess the changing environment of organic agriculture [5]. It is important to understand that when we begin our journey through the considerations for switching to organic agriculture, this transformation symbolizes more than simply a change in agricultural techniques; it denotes a significant change in our connection with the earth and how we feed ourselves. It represents a dedication to environmental responsibility, sustainability, and the future of our world. This investigation intends to provide farmers, decision-makers, and all other interested parties a thorough and analytical roadmap for transforming our food systems toward better sustainability and environmental harmony.

The process of studying and implementing adjustments on the farm toward a more sustainable and natural style of farming is referred to as conversion to organic agriculture. The way the process unfolds differs from farm to farm and is influenced by the environment, the farmer, and the community. The transition to organic farming will be simpler for a farmer if they are more familiar with its principles and methods. Even while organic farming doesn't need certain land conditions to begin with, if soils are depleted, for instance, it could take more time and work to set up a sustainable production system and provide satisfactory harvests. Here are some tips to help you succeed in the conversion to organic agriculture as well as the considerations to take into account.

Analysis of the Location

A transitional phase is necessary when switching from a conventional to an organic system, during which the organic practices are gradually implemented in accordance with a set plan. It is crucial to thoroughly analyze the farm's current position during this time and decide what steps need to be performed.

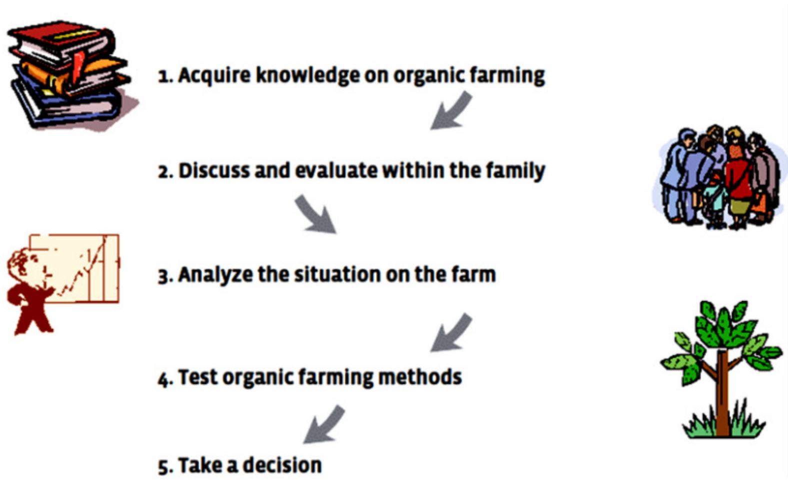

Figure 1: Represented the Preparing for The Conversion[6]**.**

The analysis of the farm must include in Figure 1.

a) Farm characteristics: size, distribution of plots and crops, types of crops, plants, and animals included in the farm system.

b) Soil analysis: a review of the soil's composition, structure, organic matter concentration, erosion rate, and/or amount of contamination.

c) Climate: frequency and amount of rain, air temperature, danger of frost, and humidity.

d) Sources and treatment of organic matter (manures).

e) The presence of equipment or habitat for animals [7].

f) Restrictive elements like money, labor, and market access, among others.

Form Related Challenges to Conversion

Depending on the farm situation, different challenges are to be expected during conversion.

a) **Farms With High External Input Use**:

Larger farms make up the bulk of intensively managed farms in Asia, Latin America, and Africa that heavily depend on outside inputs. These farms mostly cultivate a small number of annual or perennial revenue crops and significantly depend on the use of pesticides, herbicides, and fertilizers for plant nutrition. On these farms, farm animals are often not included in the nutrient cycle and crops are frequently planted without a scheduled rotation. On these farms, diversification is often minimal[8]. To allow for considerable automation, trees and shrubs are often cut down, and crops are typically cultivated alone as seen in Figure 2.

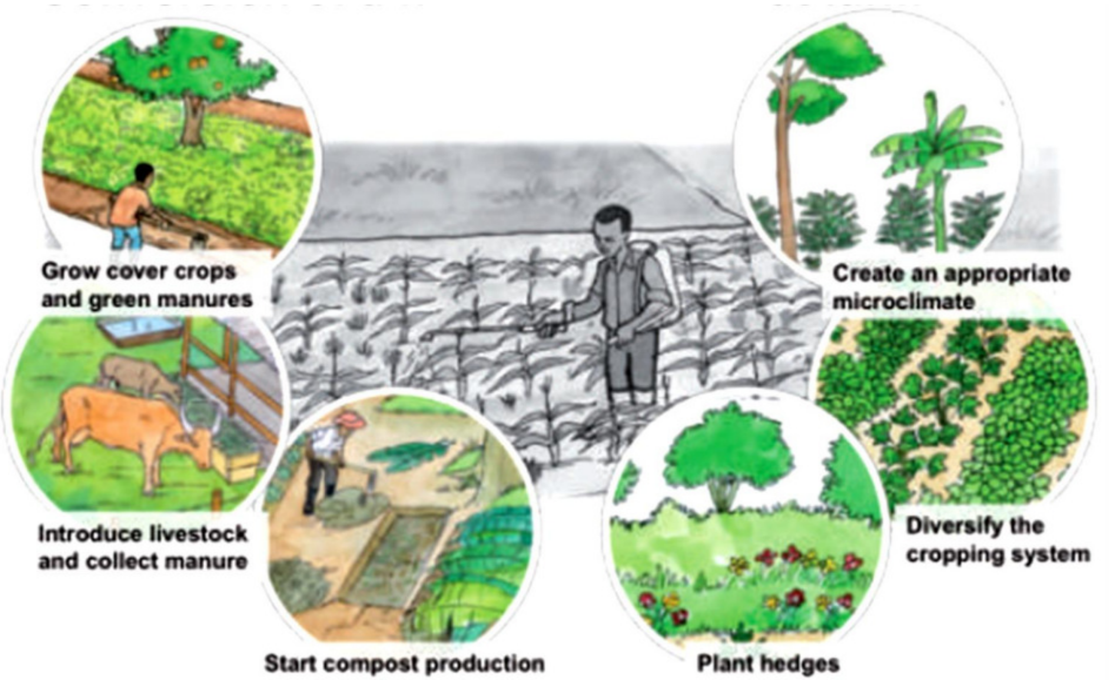

Figure 2: Illustrated the Conversion of a High External Input Farm[9]**.**

Potential challenges in conversion of such farms mention in Figure 3.

a) It often takes many years to establish a diversified, balanced, and self-regulatory agricultural system.

b) Significant efforts may be required to replenish the soil's natural fertility by adding a sizable quantity of organic matter.

c) Giving up high input external fertilizers causes a decrease in production during the first years of conversion until soil fertility is restored and yields increase once again [10].

d) Learning a lot and closely monitoring crop growth as well as the dynamics of pests, diseases, and natural enemies are often required for new techniques and practices.

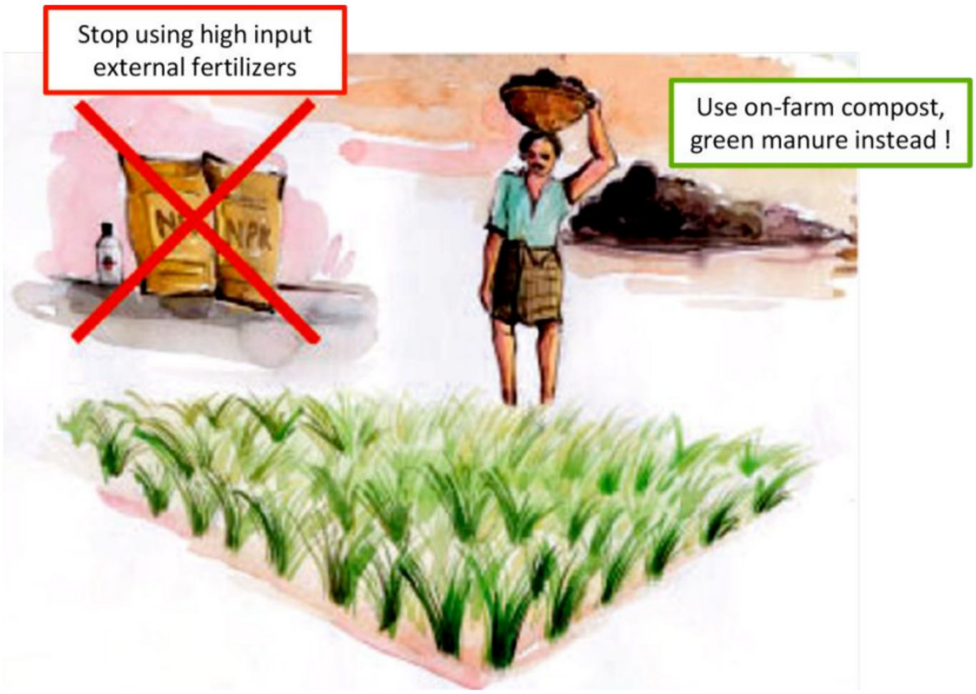

Figure 3: Illustrated the Minimizing External Input.

However, the conversion process can be achieved, if the following practices are implemented:

a) Diversify the agricultural system: Choose annual crops that are suited for the region and cycle them in a deliberate order. Include legume crops in the rotation to provide nitrogen to the following crops, such as beans or leguminous feed crops. To promote insect control and natural enemies, plant hedges and flower strips [11].

b) Commence recycling priceless agriculture byproducts. Establish a composting operation on the farm using harvest waste and, if available, manure, and combine the compost with topsoil. By introducing stable organic matter into the soil, this will strengthen the soil's structure and increase the soil's ability to feed plants and retain water. As shown in Figure 4, green manures may provide an abundance of plant material to feed soil organisms and increase soil fertility.

c) Incorporate livestock into the system. Animals raised for farming provide extra animal products and supply essential manure.

d) Cultivate cover crops. The soil is protected by using cover crops or mulching perennial crops.

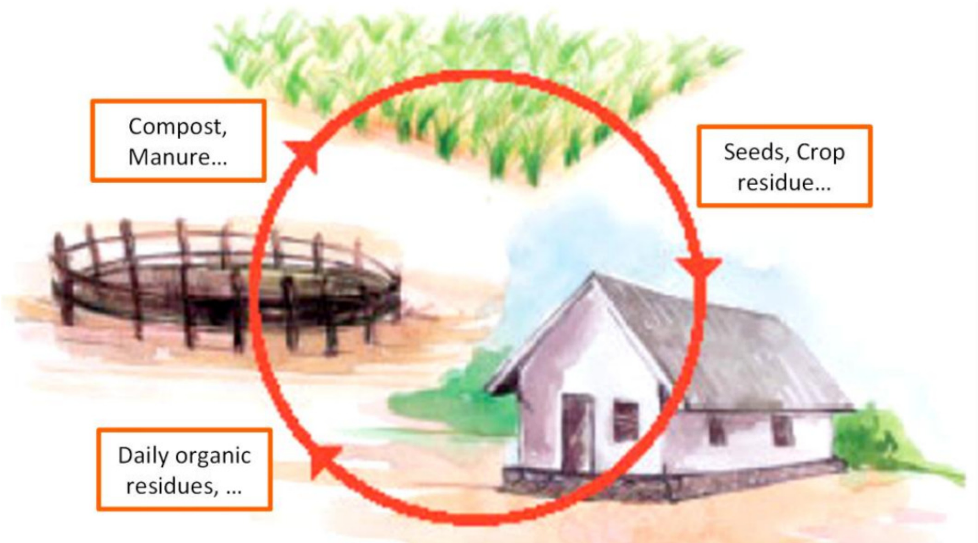

Figure 4: Illustrated the Recycling Valuable Farm By-Products[12]**.**

DISCUSSION

A transitional time, referred to as the conversion period, is necessary for the implementation of an organic management system and the development of soil fertility. Although the conversion phase may not always be long enough to enhance soil fertility and restore the ecosystem's balance, it is the time during which all the steps necessary to accomplish these objectives are initiated. A farm may be transformed with the help of a detailed conversion plan. This plan must include all criteria that must be accomplished in order to comply with these standards, and the manufacturer must update it as needed[13]. During the conversion phase, the criteria outlined in these standards must be complied with. From the start of the conversion period until it is over, all of these standards must be followed. Beginning on the date of the first operator inspection by the Certification Body, the conversion period may be determined. When de facto criteria outlined in these standards have been satisfied for a number of years and can be confirmed on the basis of existing evidence, a complete conversion period is not necessary. Before the first harvest, inspections in these situations must be done at regular intervals. When the conditions outlined in these Standards have been followed throughout the conversion period of at least two years (organic Management) prior to seeding the commencement of the production cycle, plant products grown from annual and biennial crops may be certified as organic. After at least 36 months of organic management in accordance with the specifications outlined in these Standards, the first harvest of perennial plants other than grassland, excluding pastures and meadows, may be certified as organic[14]. Depending on the historical status/use of the property and the state of the environment, the approved Certification Bodies may opt to extend or shorten the conversion term in specific circumstances. For both annuals and perennials, a decrease in the conversion time of 12 months may be considered if documentation evidence is submitted to the certified Certification Body demonstrating that the standards have been satisfied for a minimum of three years or longer. This may include land that has been certified for a minimum of three years under the "Participatory Guarantee System" put in place by the Ministry of Accredited Certification Bodies shall also take into account such a reduction in conversion period, if it has sufficient proof to show that the land has been idle for three years or more and/or it has been treated with the products approved for use in organic farming. When the conditions outlined in these Standards have been followed for at least a year, organic goods in conversion may be marketed as "produce of organic agriculture in conversion" or under a similar heading[15], [16].

CONCLUSION

The complexity of this transition to organic agriculture has been shown by our analysis of the issues to consider. Because organic farming focuses on sustainability, soil health, and using less chemicals, it offers numerous benefits for the environment, consumers, and farmers alike. The opinions of our panelists have helped us better grasp the challenges and advantages of this journey.Dr. Sarah Green's expertise emphasized the value of organic farming for improving soils and reducing environmental impact. Mr. John Anderson's personal experience highlighted the practical challenges that farmers face throughout the transition period, and Ms. Maria Rodriguez shed insight on the economic drivers and incentives that are crucial to this process.As we move along, it becomes more and more obvious that there are a number of considerations to make while moving to organic agriculture. Farmers must weigh the long-term benefits of organic farming against regional conditions, market accessibility, and economic considerations. Academics, farmers, governments, and consumers must collaborate in this dynamic and expanding business to ensure that agriculture has a sustainable and successful future.This conversation should serve as a reminder that switching to organic agriculture is desirable since it will improve food systems, promote environmental stewardship, and promote the welfare of both present and future generations. We value the panelists' and audience's contributions to this thoughtful debate.

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CHAPTER 3

CHALLENGES AND STRATEGIES FOR TRANSITIONING TO ORGANIC FARMING IN DIVERSE AGRICULTURAL SYSTEMS

Dr. Madhu Prakash Srivastava, Associate Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-madhu.prakash@muit.in

ABSTRACT:

In many agricultural systems, the switch to organic farming poses a complicated mix of potential and problems. The main concerns and tactics related to this shift are summarized in this abstract. Numerous advantages of organic farming include a less negative influence on the environment, enhanced soil health, and better food production. But making the switch from conventional to organic methods may be challenging, particularly in agricultural systems with a range of resources, practices, and technological advancements. The difficulties traditional, mixed, and degraded land agricultural systems have while implementing organic practices are examined in this abstract. Traditional farmers, who often get little outside aid, must stop using methods like burning agricultural waste and haphazard crop change. In this setting, advice on diversity, managing soil fertility, and integrating animals is essential. Farms that raise both crops and animals may need to increase composting and replace chemical inputs with organic ones in order to improve nutrient recycling. The use of organic methods for managing weeds and pests is explored. Additionally, degraded soil that is the consequence of overcultivation or waterlogging needs significant restoration. We investigate methods like terracing, adding organic matter to the soil to enhance it, and recovering saline soil.

KEYWORDS:

Organic Farming, Agricultural Systems, Sustainable Agriculture, Traditional Farming, Mixed Farming, Degraded Land.

INTRODUCTION

On the same plot of land, farmers using traditional methods and minimal outside assistance may cultivate a wide variety of crops in a densely mixed system, switching crops at random. There may be a small number of animals maintained, including chickens, pigs, cattle, and/or goats, who distribute the excrement in their feeding areas and provide relatively little manure for the plants. For the purpose of making charcoal and firewood, the trees may be drastically chopped. Burning rubbish and bushes could be a popular practice, particularly while preparing land. Due to unpredictable and inadequate precipitation, harvests are definitely low and becoming harder[1]. As shown in Figure 1, the harvests could just be enough to feed the family and leave little to sell for revenue.

Crops and farm animals may coexist on mixed farms, where the animal manure is collected and used to the gardens after rotting for a few weeks. There are a few soil conservation techniques that may be used, such mulching perennial crops and digging trenches to stop erosion. Weeds may sometimes be controlled in the production of fruits and vegetables by using herbicides, insecticides, and treated seeds. It goes without saying that the farmers of these mixed farms are conversant with certain organic farming techniques. These farmers will have no trouble implementing organic practices over their whole farm and learning new techniques from other farmers or a trainer[8].

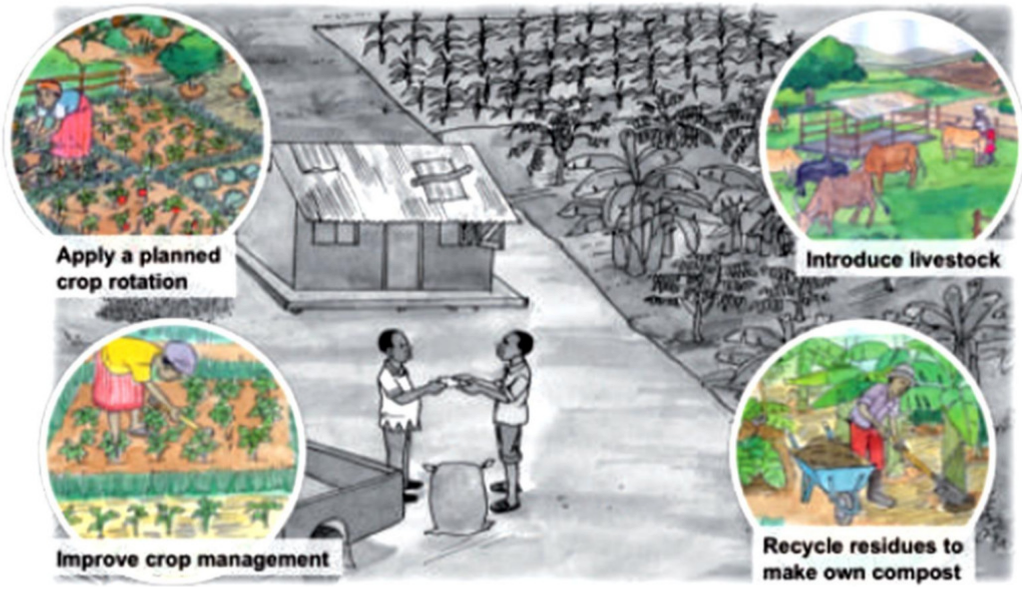


Figure 1: Illustrated the Conversion of a Low External Input Farm[2]**.**

Traditional farmers already adhere to certain organic farming principles by using farm-owned resources, cultivating many crops at once, and rearing animals. However, there are still several methods that set such farms apart from organic farms. The following issues must be resolved in order to convert:

- **i.** Avoid burning agricultural wastes after harvesting them; doing so usually isn't a good idea since it eliminates vital organic material and harms soil organisms.
- **ii.** Create a well-organized strategy for diversification that includes intercropping and a "planned" crop rotation[3].
- **iii.** Develop expertise and experience in the effective management of farm-owned resources, particularly for the creation of compost to control and enhance soil fertility.
- **iv.** Refrain from indiscriminately felling trees for fuel and charcoal.
- **v.** Create a method for gathering animal waste for composting.
- **vi.** Take action to stop soil from eroding and to keep it from drying out.
- **vii.** Give the farm animals' nutritional and medical needs careful consideration[4].
- **viii.** Prevent illness from infecting seeds by learning about disease cycles and protective measures.
- **ix.** Prevent harvest and storage losses, item.

Some practices for conversion in this system are mention in Figure 2:

- **a)** Put intercropping and planned crop rotation into practice. Leguminous green manure cover crops and a mix of annual and perennial crops are required. Crop and soil management will be made easier by the use of 15 carefully chosen or upgraded crop types with high resistance to plant pests and diseases.

b) The growing conditions for annual crops will be improved and encouraged to stimulate greater development, while planting rows of nitrogen-fixing trees between annual crops will provide extra feed for the ruminant animals and ensure proper animal integration into the agricultural system. Better housing is also required to make it easier to gather animal excrement for use in fields [5].

c) Increasing the soils' fertility, for instance by adding high-quality compost to them. In organic gardening, compost is a very important fertilizer. After harvest, gather the crop wastes for composting or incorporate them into the soil instead of burning them. The plant matter and animal manures should be routinely gathered for composting.

d) Input of nitrogen Another way to nourish the soil and the crops is to plant legumes in between annual crops [6].

e) It is recommended to take additional steps to prevent soil erosion, such as constructing trenches, planting trees along the slope, and covering the soil with live or dead plant matter.

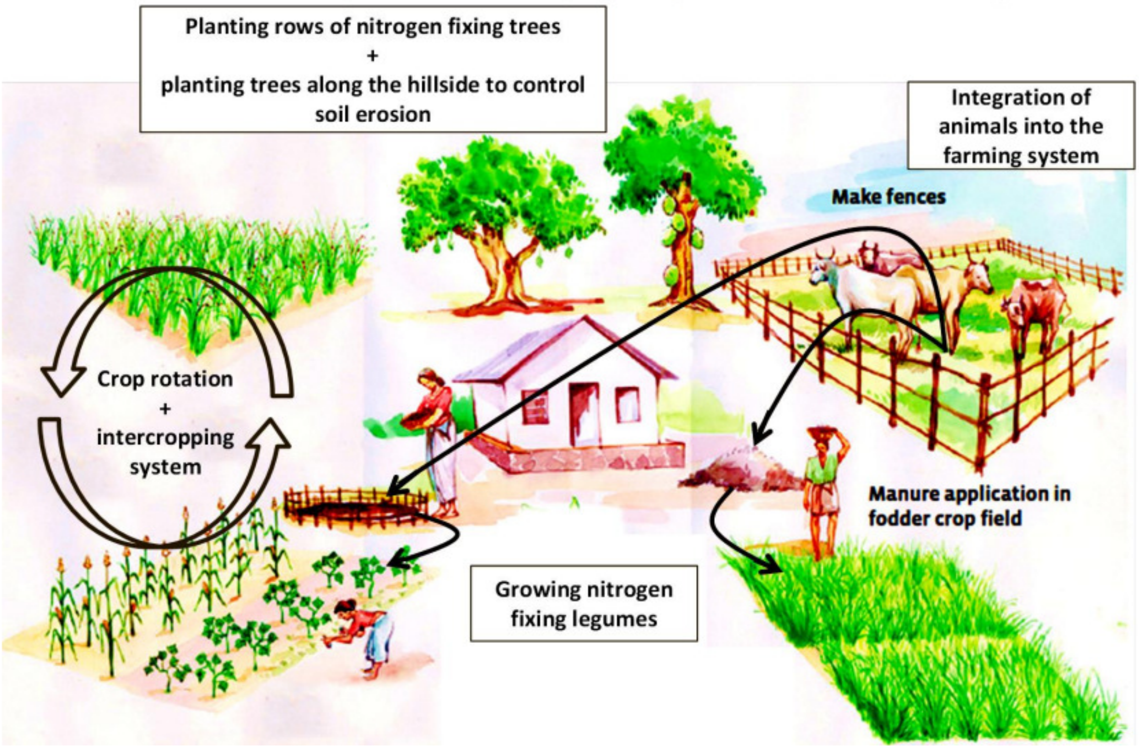


Figure 2: Illustrated the Some Organic Farming Methods to Test in Your Own Farm[7]**.**

Recommendations for organic conversion mention in Figure 3:

a) Use organic methods rather than chemicals to manage the soil and control weeds. Grow a leguminous cover crop, for instance, in fruit orchards to cover the soil. Alternately, plant a planned crop rotation with weed-suppressing green manure or feed crops in vegetable and arable crops.

b) Enhance the reuse of farm-owned nutrients from animal waste and crop leftovers to get the most out of them, such as by composting them with crop waste. To prevent nitrogen losses, improve the storage of animal manures.

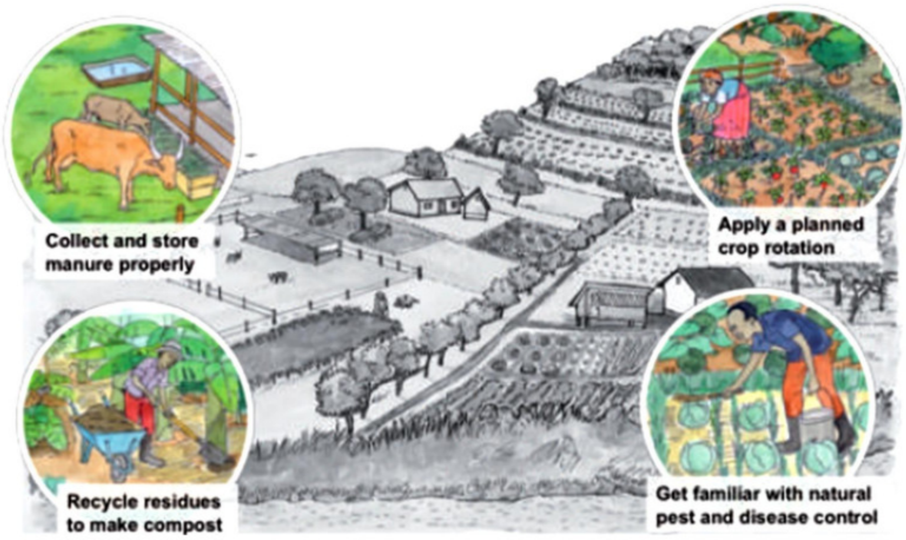
c) If pesticide-free seeds are available, use them. Make careful you only utilize healthy seeds, and learn about non-chemical seed treatment methods.

d) Become acquainted with the strategies and techniques used to manage disease and pests naturally [10].

e) Study beneficial insects while monitoring pest population dynamics regularly during crop development.

f) Increase the agricultural system's diversity to boost soil production and provide homes for helpful insects and spiders.

g)



h) Figure 3: Represented the Conversion of a Mixed Farm[9]**.**

Degraded Land

Due to shifting agriculture, excessive grazing, overcultivation, or deforestation, salinity from years of extensive groundwater irrigation, or water logging and floods, land may become degraded. On such ground, creating favorable growth conditions can need more time and effort. Organic methods are a great way to rehabilitate such soils at the same time. To halt soil erosion and restore soil fertility, particular actions can be necessary[11]. These techniques include creating terraces or, as shown in Figure 4, establishing an extensive fallow with a leguminous green manure crop that thrives on deficient soils.

Figure 4: Illustrated the Conversion of Degraded Land[12]**.**

Numerous examples demonstrate that organic farming is a potential strategy for restoring damaged land to productivity. The majority of the time, adding more organic matter is crucial to restoring the quality of damaged soils. When there is barren, eroded soil on a slope, organic farming requires the creation of fanya juu terraces. In order to create fanya juu (Kiswahili meaning "throw it upwards") terraces, trenches are dug following contour lines, and the dirt is then thrown uphill to create embankments (bunds), which are stabilized with multifunctional agroforestry plants and fodder grass like Napier (Pennisetum purpureum). Crops are grown in the area between the embankments, and the fanya juu eventually transform into bench terraces. They help gather and save water in semi-arid environments. Compost and green manures may also be utilized to improve soil structure and promote healthy crop harvests.

a) Saline soils have a high concentration of salts that are soluble in water and prevent seed germination and plant development. Particularly in dry and semi-arid areas, the overuse of irrigation water may have contributed to the salt buildup. By maintaining regular watering and improving the soil's structure with compost, one may gradually lower these salt levels and enable natural drainage of the surplus salts. Crops that can withstand salt may be cultivated in the beginning.

b) Acidic soils may be restored by adding lime and high-quality compost.

c) By constructing drainage channels to remove the surplus water, flooded soils may be improved.

Climate Related Challenges to Conversion

It will be more difficult to convert a farm to organic farming in a region with little rainfall, high temperatures, or strong winds than in an area with widespread rainfall and comfortable temperatures. The benefits of adopting organic methods will also be more apparent in dry environments than they would be in ideal humid environments. For instance, adding compost to the topsoil or planting holes would improve the soil's ability to retain water and raise the tolerance of the crop to water shortage. Water is lost via transpiration from plants and soil evaporation at significant rates in hot, dry climates. Strong winds may further increase these losses by accelerating soil erosion.

Because biomass output is often low and the soils have low organic matter contents, there are much less nutrients available to the plants, as seen in Figure 5. Protecting the soil from intense sun and wind, as well as boosting the amount of organic matter and water that the soil receives, are the keys to enhancing crop yield under these circumstances[13]. Composting or growing green manure crops may both enhance the amount of organic matter in the soil. Increasing the output of plant biomass, which is required for compost manufacturing, is the issue in the case of compost production.

High aboveground biomass output and quick breakdown of soil organic matter suggest that nutrients are readily accessible to the plants in warm, humid climates. However, there is a significant chance that the nutrients will be lost and readily washed away. To prevent soil depletion under these circumstances, it's crucial to maintain a balance between the production and breakdown of organic matter. Combining several methods to safeguard the soil and provide it with organic matter turns out to be the most fruitful course of action. These techniques include planting a variety of crops in many layers, preferably including trees, cultivating nitrogen-fixing cover crops in orchards, and adding compost to the soil to improve its organic matter content and hence boost its ability to hold onto water and nutrients.

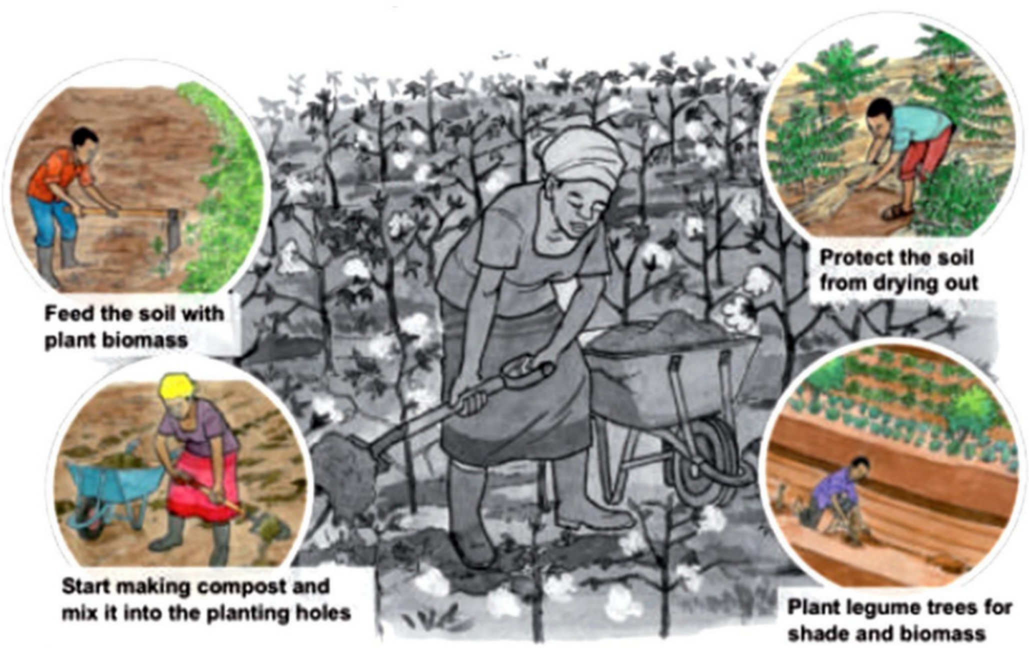


Figure 5: Illustrated the Conversion In Dry Climate[14]**.**

DISCUSSION

The examination of the challenges and solutions for converting to organic farming in diverse agricultural systems is an essential study of the problems and opportunities involved in the transition to more environmentally friendly and sustainable agricultural practices. Due to its numerous benefits, including fewer chemical inputs, improved soil health, and better food production, many farmers find organic farming to be an enticing choice. However, given that agricultural systems vary greatly across different places and situations, there are a number of challenges that must be overcome in order to adequately facilitate this transition [15]. One of the main challenges in the transition to organic farming is traditional agricultural techniques. These systems often rely on outmoded practices, little outside resources, and practices like burning agricultural waste and randomly rotating crops. Implementing measures for variety, effective soil fertility management, and animal participation in these systems is essential. The main challenges are convincing traditional farmers to adopt these new strategies and providing them with the knowledge and resources they need. Systems of mixed farming, which raise both plants and animals, have particular challenges. The change in this case comprises increasing nutrient recycling via composting and replacing typical chemical inputs with organic ones [16]. The development and inclusion of organic weed and pest control methods is also required. Mixed-system farmers often need guidance and support in order to execute these changes correctly. In the setting of degraded land, a significant challenge also emerges. This might occur as a result of overfishing, overgrazing, deforestation, or floods. Such terrain requires lengthy rehabilitation utilizing specific biological techniques. Terracing, soil improvement via the addition of organic matter, and the recovery of saline soils are a few techniques for repairing damaged land. This approach requires a deep understanding of the current situation and a commitment to long-term adjustments. The transition to organic farming is significantly impacted by climate-related issues such as little rainfall, excessive temperatures, and strong winds, to name a few. In regions with dry or semi-arid climates, water management is crucial. Success relies on the creation of methods that increase soil's capacity to hold onto water, protect it from the sun and wind, and increase the amount of organic matter in the soil.

Additionally, the production of biomass for composting may be challenging due to the lack of resources and nutrients in such places [17]. The necessity for context-specific strategies is shown by the analysis of the challenges and solutions for transitioning to organic farming in diverse agricultural systems. It requires a combination of guidance, inspiration, and innovative techniques that are tailored to each unique agricultural system. The benefits for sustainability, soil health, and food quality outweigh the challenges, making this change a compelling endeavor in the quest for a more resilient and environmentally aware agriculture.

CONCLUSION

In conclusion, the difficulties and solutions for converting to organic farming in various agricultural systems reflect a complex path towards a more ecologically friendly and sustainable method of food production. While there are many advantages to switching to organic farming, such as less chemical inputs, increased soil health, and healthier food, the process is not without its challenges.For farmers to embrace new, organic techniques, traditional agricultural systems often need a fundamental change in mentality and behaviors. This requires outreach, education, and assistance. Holistic, organic approaches must be developed in order to negotiate the challenges of incorporating organic techniques into both livestock and crops in mixed farming systems. Restoring degraded land to productive status by organic methods brings its own set of difficulties that must be overcome with patience and perseverance. Additionally, locations that have climate-related difficulties, such dry environments and high winds, need creative solutions to improve water retention, prevent soil erosion, and increase organic matter content. Despite these difficulties, switching to organic farming has enormous potential. It not only encourages more ecologically responsible and sustainable agriculture methods, but it also improves the general wellbeing of ecosystems and communities. The tactics for an organic transition must be as varied as the agricultural systems themselves and flexible in order to be successful. This emphasizes the need of education, support structures, and research. Addressing these issues and putting specific plans in place are crucial for achieving a more resilient and responsible agricultural future. A key component of attaining sustainability, improving food security, and protecting the planet's natural resources for future generations is the dedication to organic farming.

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CHAPTER 4

AN EXPLORATION OF STEP-BY-STEP CONVERSION TO ORGANIC AGRICULTURE

Dr. Madhu Prakash Srivastava, Associate Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-madhu.prakash@muit.in

ABSTRACT:

The conversion to organic agriculture involves a meticulous and phased approach that addresses soil health, pest management, crop rotation, and the elimination of synthetic inputs. Each step is outlined with practical recommendations and case studies from diverse agricultural settings to illustrate the feasibility and adaptability of the process. Furthermore, this guide explores the economic, ecological, and social benefits associated with organic farming practices. It discusses the potential challenges and obstacles that may arise during the conversion process and offers strategies to overcome them. Emphasis is placed on the importance of knowledge sharing, community engagement, and policy support to facilitate a smooth transition for both small-scale and large-scale farming operations. In this comprehensive guide on step-by-step conversion to organic agriculture serves as a valuable resource for individuals and organizations seeking to align their agricultural practices with sustainability goals. It underscores the potential for organic farming to promote environmental stewardship, enhance food security, and foster resilient and healthy agricultural systems in the face of global challenges.

KEYWORDS:

Agriculture Conversion, Farming Transition, Organic Farming, Sustainable Agriculture, Environmental Farming, Organic Practices.

INTRODUCTION

Three phases are typically included in the conversion of a farm. It is advised to gather data on suitable organic farming methods as a first step. The most promising organic techniques should be tested out on a few chosen plots or fields as a second step to familiarize yourself with them. In a third phase, the whole farm should solely use organic practices. Support from a knowledgeable farmer or extension officer is often highly beneficial to provide direction during the process[1].

Good Information First

Successful organic farming demands a deep understanding of how natural processes work and what management options are available. For organic farming to be effective, there must be a desire to understand how to support natural processes and preserve and enhance harvests[2]. It is advised that farmers who are interested in adopting organic farming techniques get in touch with local farmers who currently practice organic farming so they may learn from them. Some farmers may excel at composting, cultivating green manures, and brewing tea from plants or manures. It is possible to learn about the benefits and potential difficulties of applying organic farming practices as shown in Figure 1 by seeing more seasoned farmers in action[3].

Figure 1: Illustrated to Get Information on Organic Agriculture[4]**.**

Basically, farmers who want to switch to organic farming need to be aware of the following:

a) How to increase soil fertility, to start.

b) How to maintain healthy crops.

c) The greatest way to broaden the farm's variety.

d) How to maintain the health of cattle.

e) How to evaluate organic goods and effectively market them.

Step 2: Getting Familiar with Organic Practices

Farmers should start learning from their own experience on their farms after they have gathered knowledge on the conversion needs, potentials, and primary activities. Farmers are advised to apply organic activities gradually and to a limited level, choosing certain techniques at a time and testing them on individual plots or specific animals alone. This will reduce the likelihood of crop failure and animal losses and prevent frustrated overload[5]. But which techniques should one choose first? It would seem logical for farmers to begin by using techniques that are low risk, cheap investment, need minimal specialized expertise, involve little more effort, and have a significant short-term benefit. Examples of suggested treatments are shown in Figure 2:

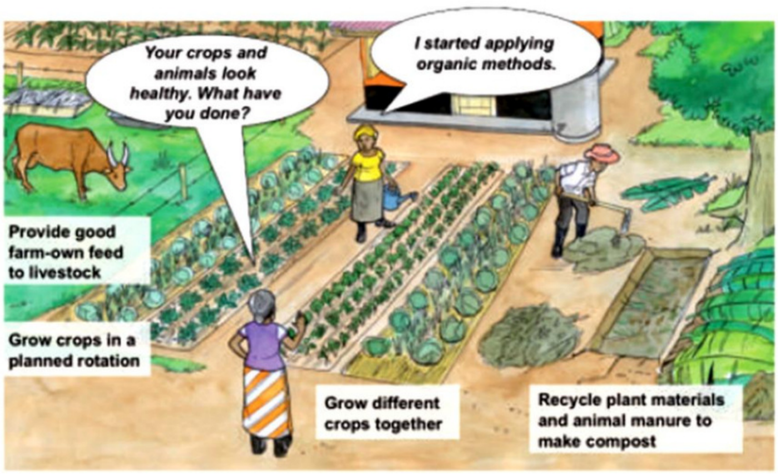

Figure 2: Illustrated the Start Implementing Organic Practices[6]**.**

a. Mulching:

In annual crops, weed management and soil protection may be accomplished simply by covering the soil with dead plant debris. Most current cropping methods may include this strategy. Where to get suitable plant material, however, may be the primary concern[7].

b. Intercropping:

Growing two annual crops simultaneously is a frequent method in organic farming to diversify output and optimize advantages from the land. Leguminous crops, such beans or green manure crops, are often grown in alternating rows with maize or another cereal crop or vegetable. To prevent crop competition for light, nutrients, and water during intercropping, extra care must be taken. Understanding of arrangements that support the development of at least one crop is necessary for this[8].

c. Composting

The development and yields of crops may be significantly impacted by the application of compost to the fields. Farmers will need enough plant materials and animal manures, if any are available, to start compost manufacture. In the event that these resources become limited, farmers would first need to start creating plant 22 materials on their farms by planting quickly growing legumes that produce large amounts of biomasses and, if necessary, introducing cattle for the purpose of producing manure. Farmers should get training from an expert individual to become acquainted with the composting process. Although it costs nothing to produce compost properly, it does need some knowledge, expertise, and extra effort[9].

d. Green Manuring:

Most farmers may be unfamiliar with the technique of cultivating a type of leguminous plant for biomass generation and integration into the soil. In spite of this, this approach may significantly boost soil fertility. Improved fallows, seasonal green manures in crop rotation, or strips between crops are all possible ways to cultivate green manures. Information on relevant species is initially needed for proper green manuring[10].

e. Organic Pest Management:

judicious pairing and control of plants and animals to stop the spread of pest and disease. Although bio-control agents may be used at first, ecological methods that create a pest/predator balance are the most effective way to manage organic pests. While selecting resistant crop varieties is essential, there are other ways to prevent pest outbreaks, such as choosing sowing times that do not coincide with pest outbreaks, enhancing soil health to resist soil pathogens, rotating crops, encouraging natural biological agents for disease, insect, and weed control, using physical barriers for protection from insects, birds, and animals, altering habitat to encourage pollinators and natural enemies, and trapping pests in pheromone attractants[11].

f. Appropriate Seeds and Planting Material:

Crop output may alter dramatically with the use of healthy seeds, planting materials, and cultivars that are strong and/or enhanced. Information about the choice of seeds and planting materials, particularly the availability of better kinds and seed treatments, may be necessary for this activity. Because of their resistance to local circumstances, locally adapted seeds are often favored.

g. Planting of Leguminous Trees:

Leguminous trees like gliricidia, calliandra, and sesbania may be planted in perennial crop plantations for crops like banana, coffee, or cocoa to enhance the growth conditions for the fruit crop by providing shade, mulching material, and nitrogen via nitrogen fixation. Additionally, certain leguminous plants provide suitable cattle feed. This procedure requires some understanding of the leguminous trees' optimal planting patterns as well as the shade and space needs of tree crops[12].

h. Growing Farm-own Animal Feeds:

Farmers may plant grasses and leguminous fodder crops nearby, between other crops, or in rotation to increase the quality of the feeds available to cattle. Farm-grown feed is the greatest option when evaluating feed sources since animal feed must be of organic origin.

i. Terraces and Soil Bunds:

A crucial step in soil conservation is the building of terraces and soil bunds along the contours of hills. This procedure lays the groundwork for future increases in the soil fertility on slopes. Although it is very relevant, its implementation calls for a lot of work and specialized skills[13].

DISCUSSION

Compared to conventional agriculture, organic farming represents a significant shift in agricultural practices and agricultural philosophy. This gradual shift to organic farming is a challenging process that demands farmers' careful planning, adaptability, and commitment. In this session, we'll examine the crucial processes and elements in making this transformation, as well as the potential benefits and challenges of using organic farming methods. The first crucial step in transitioning to organic agriculture is thorough preparation. Farmers must assess their current farming practices, the condition of their soils, and the surrounding environment in order to develop a specific transition strategy[14]. This tactic often involves picking the right organic crops, using organic pest control measures, and using organic soil management approaches. In addition to setting up a clear timetable and budget for the conversion process, farmers who are considering the switch should look for potential sources of assistance, such as government programs or organic farming associations. A journey of soil rejuvenation is often undertaken by farmers throughout the conversion process since soil health is essential to organic farming. This includes reducing or eliminating the use of synthetic chemical fertilizers and pesticides, as well as using organic resources to increase soil fertility. The long-term viability of organic farming depends on building a robust soil structure, even if this process could take some time[15].

Crop selection is another essential aspect of organic agriculture. Farmers should choose crops that are well suited to organic farming practices and local growing circumstances. Crop rotation and diversity are vital to reduce the risk of disease and pest outbreaks. In organic farming, cover crops and companion planting are recommended to improve soil health and biodiversity, which contributes to the development of resilient and long-lasting agricultural systems. Better soil health, less environmental impact, and maybe even access to premium markets are just a few of the benefits of switching to organic agriculture, but it is not without its challenges. Organic farming often needs more work and management rigor than conventional farming. Farmers may experience increased weed pressure, the need for more advanced pest management methods, and a transitional period during which productivity may temporarily decline[16]. Patience and a commitment to long-term sustainability are required to overcome these challenges. The gradual shift to organic agriculture is a difficult process that calls for meticulous preparation, pliability, and dedication from farmers. It entails choosing suitable crops, assessing and improving soil health, and implementing sustainable agriculture practices. Despite the difficulties, this transformation is advantageous for those who are committed to a more holistic and ecologically friendly approach to farming because of the advantages in terms of environmental sustainability, improved soil fertility, and access to organic markets[17]. The switch to organic farming is ultimately a critical step in building a more robust and sustainable agricultural system.

CONCLUSION

In conclusion, the gradual transition to organic agriculture is a transformational process that has enormous potential for both farmers and the environment. The advantages of organic farming are significant, despite the fact that it needs careful planning, adaptability, and persistence. Farmers may help create a more ecologically friendly and sustainable food system by putting a priority on soil health, choosing the right crops, and adopting sustainable methods. Organic farming provides prospects for increased soil fertility, less chemical inputs, and access to premium markets in addition to lowering the environmental effect of farming. Despite the difficulties encountered along the road, the switch to organic farming is an essential step towards a more resilient and sustainable future for agriculture, where farming works in harmony with nature rather than exploiting it. The agricultural landscape as a whole may change toward a healthier, more sustainable, and more ecologically aware future as more farmers embark on this crucial path.

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CHAPTER 5

AN OVERVIEW OF THE CROPS TO GROW DURING CONVERSION

Dr. Kanchan Awasthi, Associate Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-kanchan.awasthi@muit.in

ABSTRACT:

Climate change, customer preferences, and sustainable practices are all causing significant changes in the agricultural sector. In order to convert old agricultural methods to more ecologically friendly and sustainable ones, it is essential to carefully choose the crops that will be grown during the conversion. This essay examines the vital factors to take into account and the best conversion crop cultivation practices. It explores the intricate interactions between variables such soil quality, climatic adaptability, market demand, and ecological sustainability. This study intends to provide a complete manual for farmers, policymakers, and stakeholders involved in the transition towards a more resilient and sustainable agricultural future by looking at case studies and best practices. During the conversion process, the information offered here may help decision-makers strike a balance between economic viability and environmental sustainability.

KEYWORDS:

Agriculture, Farming, Gardening, Horticulture, Crop Selection, Sustainable Farming, Crop Rotation.

INTRODUCTION

The organic farm is seen as 'one organism,' therefore growing certain crops is not the only thing that is being done. Instead, the emphasis is on selecting crops that can be quickly incorporated into the current agricultural system and will help to enhance it. But the decision also relies on the farmer's understanding of the best ways to manage the crops, how they contribute to a varied family diet, and how much demand they have on the market[1]. Farmers may need to produce leguminous cover crops in addition to food crops so that they can nourish the soil and provide animals high-protein feed. In most cases, it is advisable to plant trees for shade, windbreak, firewood, feed, mulch, or other purposes. Some selection criteria for crops during conversion are shown in Figure 1:

- **a)** Organic farmers should first and foremost provide adequate food for the household. To earn money for other household needs, individuals can also desire to raise crops for the market. Additionally, farmers want to cultivate crops that boost soil fertility. Legumes and pasture grass are necessities for farmers who raise cattle.
- **b)** In general, farmers should choose crops that have a low failure risk. Maize, sorghum, millet, beans, and peas are just a few examples of cereals and legumes that are particularly well suited for conversion since they are inexpensive to grow, often have modest nutritional requirements, and are resistant to pests and diseases. Many of the conventional crops may also be kept and sold in local marketplaces. Most vegetables are one example of a high-value short-term crop that is more delicate to develop and extremely vulnerable to pest and disease assault. Therefore, unless the farmer can tolerate certain harvest losses, they shouldn't be planted on a wider scale [3].

c) Crops that can be sold at the farm gate, at a roadside market, or that can be transported directly to markets in close-by metropolitan areas should be included in the list of crops to be grown for sale. It can be necessary to have some market knowledge in order to choose the best harvest to sell. Traders or exporters must provide precise information on the crops, required types, quantities, quality, regularity, and season before making decisions on crops for local or export markets [4].

d) High-value perennial crops, such fruit trees, need at least three years from the date of planting until the first harvest. They are thus suitable crops during the time of conversion. types and varieties must be carefully chosen for 24 new plantings to meet the needs of the organic market and production. Old existing cultivars may need to be replaced in order to convert an existing orchard if they are very sensitive to diseases and their product quality does not meet market expectations [5].

e) Providing favorable growth conditions is another factor in crop performance. A crop variety will grow more successfully if it is well-suited to the local soil and climatic conditions as well as to prevalent pests and illnesses.

f) To build a diversified agricultural system, planting hedges, other crops, and/or agroforestry trees might be beneficial. b. Growing leguminous green manures feeds the soil with nutrients. Although green manures don't provide cash right away, they do make the soil more fertile and productive in the long run [6].

Farmers often inquire about the length of time organic crops take to develop because they want to see results quickly. Crop growth speed is not a goal of organic farming. When growth circumstances are better than previously, crops will expand more quickly and broadly. Although excessive use of synthetic fertilizers and sprays may be used to accelerate the growth of crops produced traditionally. In order to be less vulnerable to pests and illnesses and to have a healthy physical and nutritional structure, organic crops are encouraged to grow at their normal, natural pace. However, organic farmers take great care to ensure that their crops develop healthily and offer high results[7].

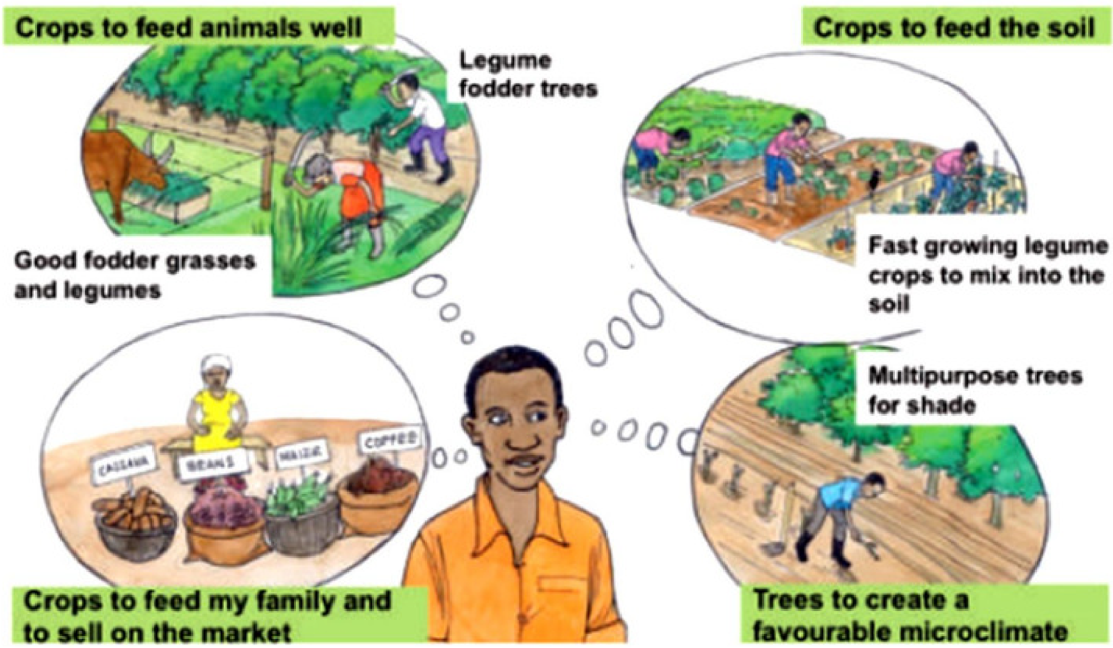

Figure 1: Illustrated the Criteria for Crop Selection during Conversion[2].

Full Conversion to Organic Forming

Once sufficient experience with various approaches has been accumulated, a third stepthe deployment of organic practices over the whole farmshould be explored. A farmer may call themselves an organic farmer as soon as organic farming methods are used on the whole farm. Usually, implementing organic methods consistently is the first step in a protracted process of enhancing the production system:

a) Increasing the production of farm-owned biomass and recycling organic waste to improve soil fertility.

b) Promoting beneficial interactions among all elements of the agricultural system (the farm ecosystem) to improve pest and disease self-regulation.

c) Improving the harmony between livestock and feed production [8].

Growing your organic farm sustainably also requires ongoing learning from your own experience, outside experiences, sharing of experiences with other organic farmers, and incorporating new ideas.

Mitigating Contaminating Risks

a) Pesticides:

As shown in Figure 2, it is the duty of organic farmers to prevent synthetic pesticides from being sprayed on organic areas. A farmer that practices organic farming may still cultivate organic foods and fibers even if their neighbor doesn't. The following steps should be taken by organic farmers to protect their fields against chemical drift from other farms onto their crops:

i. By planting natural hedges along the edge of adjacent fields, the danger of pesticide spray drift by the wind or run-off water may be reduced. The boundary region around the fields should be as broad as possible [9].

ii. Organic farmers should channel water away from upstream fields to prevent runoff or consult with farmers upstream to discuss ways to collaborate to reduce the danger of contamination via water. Neighbors of organic farmers who care about preserving nature can benefit from their knowledge and experiences in order to either embrace organic farming methods or reduce the danger of damaging the environment [10].

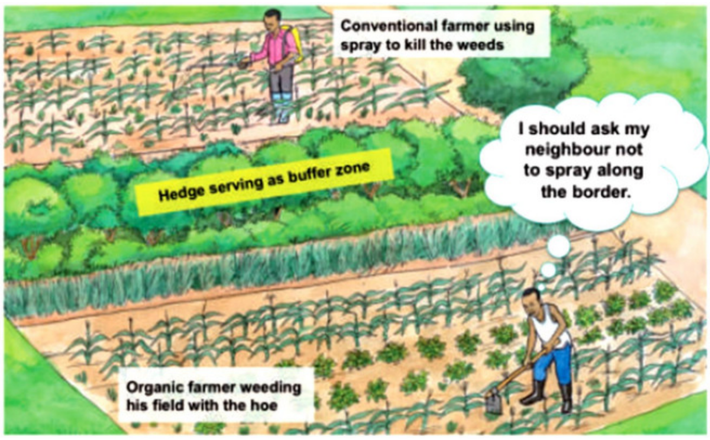

Figure 2: Illustrated the Protect Crops from Pesticide Drift[11]**.**

b) Genetically Modified Organisms (GMO):

By employing techniques other than pollination and overcoming natural barriers, isolated genes from plants, animals, or microbes are transferred into the crop genome to create genetically engineered seeds and planting materials[12]. As a result, using genetically modified goods in organic farming is prohibited, and organic farmers need take precautions to prevent GMO contamination of their crops as given in Figure 3.

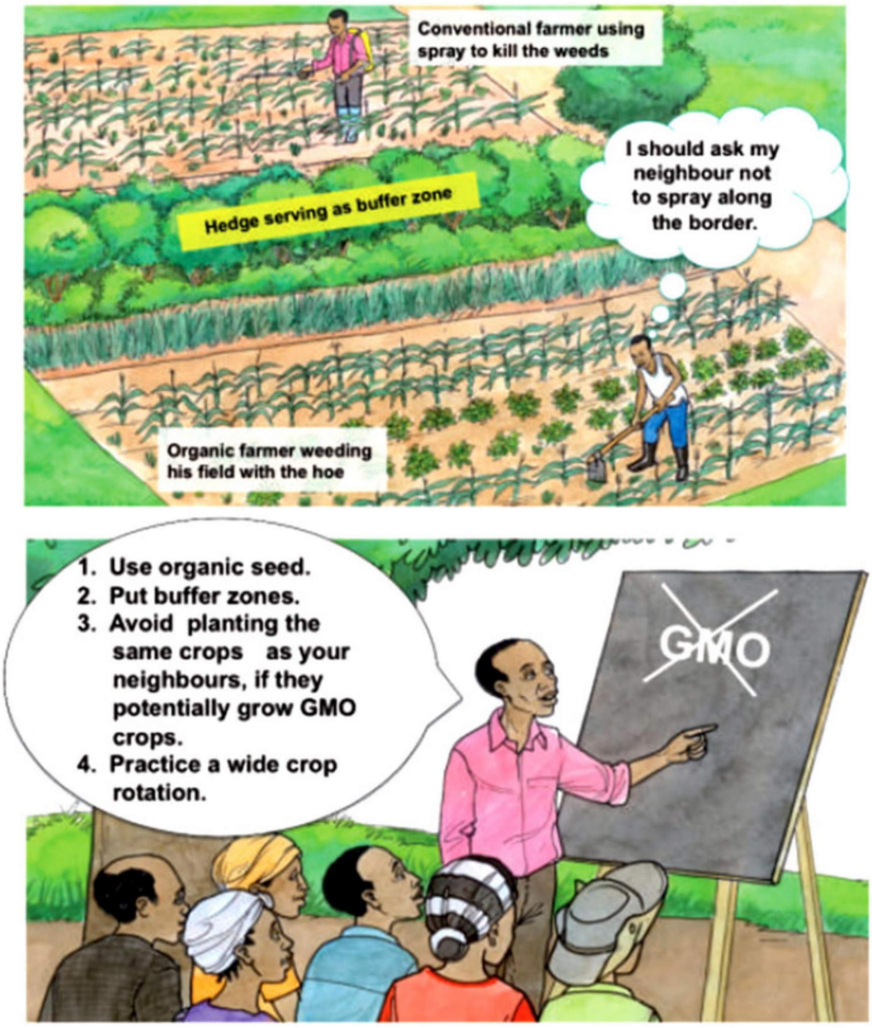

Figure 3: Illustrated the Reduce the Risk of GMO Contamination[13]**.**

The danger of GMO contamination is anticipated to rise with the expanding usage of GM crops in traditional agricultural methods. A neighboring genetically modified crop has a greater chance of contaminating species that cross-pollinate, like rapeseed or maize, or insect-pollinated crops, like soybean or cotton. The danger of GMO contamination is reduced for species that are mostly vegetatively pollinated, such as potatoes, cassava, and bananas. If GMO and organic goods are not adequately separated during storage and transit, there is a danger of physical contamination in addition to genetic contamination throughout the production and market chain[14]. Farmer recommendations for lowering the danger of GMO contamination:

i. Purchase organic or untreated seeds, or use individually chosen seeds. Check the seeds' provenance to ensure that they didn't originate from farms nearby or from farms that were in close proximity to GM crops (at least a 1 km radius).

ii. If you purchase seeds from a trader, ensure sure they are registered and able to provide proof of the source of the seed. Verify that he is not a part of GM reproduction and production. Ask your merchant for a certificate attesting to the presence of non-GM seeds, and find out whether they participate in the GM seed market [15].

iii. Research the breeding practices of the particular crops that interest you. The majority of hybrid plants, like maize, can travel up to 3 kilometers through wind or bee dispersal.

iv. Some plant seeds may remain viable in the soil for five to twenty years. As a result, care must be taken to ensure that no GM crops have been planted on land intended for organic farming.

v. If GM crops are grown in this area, establish precautionary safety (buffer) zones surrounding your fields to lower the danger of GMO pollen spread. It is important to construct isolation distances between GM crops and organic fields that are around 2-3 times greater than what is necessary for a species' seed production. The isolation distance shouldn't be less than 2 to 3 km for the dissemination of crucial GM crops like maize. This will significantly lessen the spread of GMOs via pollen. Additionally, boundaries or hedges with higher plant species, such sugarcane or trees, might hinder cross-pollination with GM crops for wind-pollinated crops like maize [16].

vi. Use equipment for seeding and harvesting, transportation, processing, and storage that are not used by GM farmers to prevent any physical GM contamination. If you must continue using the same equipment, a thorough cleaning is required. Do not keep GM goods next to organic ones in storage.

vii. GMO-free zones should be promoted wherever feasible, notably for the development of one's own seeds.

DISCUSSION

When switching from conventional to organic farming, choosing which crops to produce is a crucial choice that needs considerable thought. This change, known as a "organic conversion," entails moving away from artificial chemicals and traditional agricultural techniques and toward more ecologically friendly and sustainable practices. Choosing crops that adhere to organic agricultural practices and can flourish without the use of synthetic fertilizers and pesticides is crucial at this time [17]. Crop variety and rotation are important factors to take into account. Crop rotation systems are often used in organic conversion because they may interrupt the cycle of pests and diseases, enhance soil health, and minimize the need for chemical inputs. Rotating crops that are complementary to one another is essential for preserving soil fertility and avoiding soil depletion. Additionally, the local climate, soil types, and market demand should be considered while selecting crops. While certain crops could be more advantageous for organic farming in some areas, others might command a greater price for their organic product. The choice of crops to cultivate during the conversion is crucial to the success of the move to organic farming. Crop rotation, soil health, regional circumstances, and market considerations must all be carefully evaluated [18]. Farmers may encourage ecologically friendly and sustainable agricultural practices by choosing the correct crops, resulting in a more seamless transition to organic farming techniques.

CONCLUSION

In conclusion, selecting the crops to plant during the transition from conventional to organic farming is a crucial option that paves the way for a future of agriculture that is more ecologically friendly and sustainable. It demands a thorough comprehension of elements including crop rotation, soil health, regional climatic circumstances, and market dynamics. Farmers may not only assure a successful transition but also enhance the health of the soil, lessen dependency on synthetic inputs, and produce high-quality organic products by making educated decisions that are in line with organic farming principles and local circumstances. In the end, the choice of crops made during this conversion might have an impact on the long-term viability and sustainability of organic farming techniques, helping to create a robust and environmentally aware agricultural system that is advantageous to both people and the environment.

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CHAPTER 6

AN OVERVIEW OF THE MULCHING IN ORGANIC AGRICULTURE

Dr. Kanchan Awasthi, Associate Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-kanchan.awasthi@muit.in

ABSTRACT:

Organic farming is gaining popularity as a sustainable agricultural practice that fosters ecological balance and uses fewer synthetic inputs. Within this paradigm, mulching has emerged as a crucial technique for preserving soil health, conserving water, and boosting crop yields. This abstract discusses the multifaceted role of mulching in organic agriculture, including how it impacts soil fertility, weed management, moisture retention, and overall farm sustainability. Mulching is the process of covering the soil's surface with organic or synthetic materials, such as crop residue, straw, plastic, or organic compost. This offers a number of benefits, including the ability to manage weeds without the need of pesticides or strenuous physical effort. Mulching is crucial for managing soil temperature and moisture, preventing erosion, and promoting microbial activity. In the end, these combined effects lead to improved soil structure and nutrient availability, which in turn leads to higher crop yields in organic farming systems.

KEYWORDS:

Agriculture, Crop Productivity, Farming Techniques, Organic Farming, Soil Health, Sustainable Agriculture.

INTRODUCTION

The act of mulching involves covering the topsoil with plant matter, such as straw, grass, leaves, twigs, and agricultural leftovers. The activity of soil organisms, such as earthworms, is increased by a mulch layer[1]. They contribute to the formation of a soil structure with a variety of smaller and bigger holes that allow rainfall to quickly permeate the soil and reduce surface runoff. The amount of organic matter in the soil rises as the mulch material breaks down. A excellent soil with a solid crumb structure is produced with the aid of soil organic matter. As a result, water won't be able to quickly carry the dirt particles away. Mulching is thus essential for stopping soil erosion. The earth is sometimes covered with things like plastic sheets or even stones[2]. But in organic farming, the word "mulching" solely refers to the utilization of natural, biodegradable plant components.

Using Mulch

- **a)** Preventing soil erosion from wind and water: Soil particles cannot be swept away by wind or rain.
- **b)** Improving infiltration of irrigation and rainwater by preserving a healthy soil structure, which prevents crusting and keeps pores open.
- **c)** Maintaining soil moisture by lowering evaporation: in dry regions or seasons, plants can use available rain more effectively and need less watering.
- **d)** Feeding and safeguarding soil creatures: Organic mulch material serves as a great food source and creates favorable circumstances for the development of soil organisms.

e) Reducing weed growth: Weeds will struggle to penetrate a thick enough layer of mulch.

f) Preventing the soil from overheating: Mulch gives the soil shade, and the moisture it retains keeps it cool [3].

g) Providing nutrients to the crops: As organic mulch material decomposes, it constantly releases nutrients that fertilize the soil, as shown in Figure 1.

h) Increasing the amount of organic matter in the soil: Some of the mulch will be converted to humus.

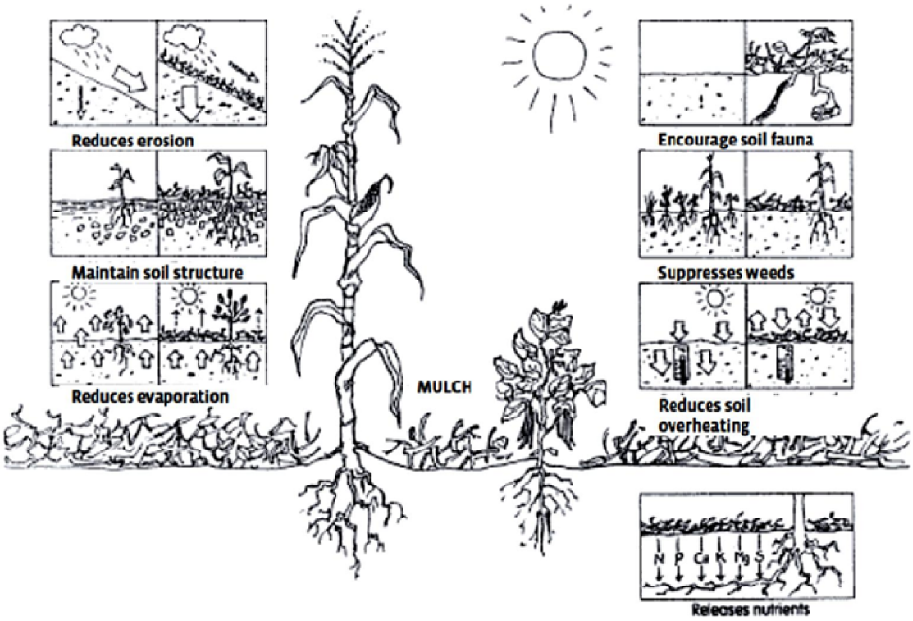

Figure 1: Illustrated the Effects of Mulching[4].

Selection of Mulch Materials

The kind of substance used for mulching will have a significant impact on its outcome. Material that breaks down quickly will only protect the soil for a little period of time, but will nourish the crops while it does so[5].

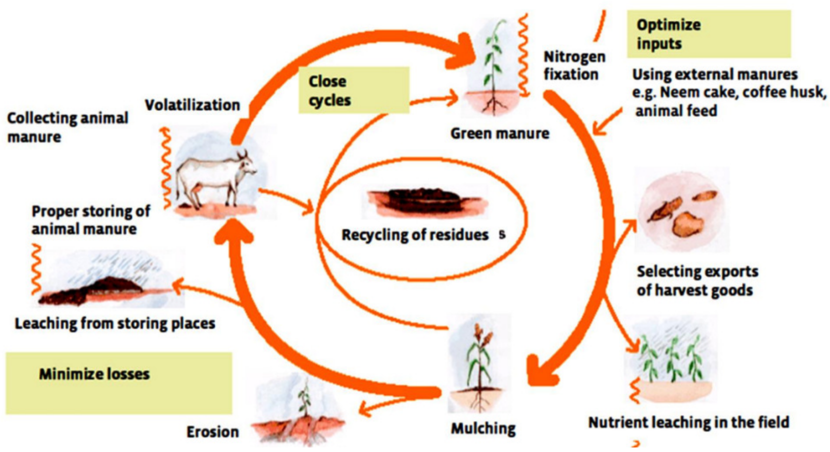

Figure 2: Illustrated the Optimizing Nitrogen Cycling in The Farm[6].

Hardy materials will break down more gradually and keep the soil covered for a longer period of time. Spreading organic manures like animal dung on top of mulch may increase the nitrogen content and speed up the breakdown of the mulch material, as shown in Figure 2. Where soil erosion is an issue, mulch with a slow decomposition rate (low nitrogen concentration, high C/N) will provide longer-lasting protection than mulch with a rapid decomposition rate[7].

The source of mulching materials can be following:

- **a)** Weeds or cover crops
- **b)** Crop residues
- **c)** Grass
- **d)** Pruning material from trees
- **e)** Cuttings from hedges
- **f)** Wastes from agricultural processing or from forestry

Recommendation while using Mulching

While mulching has a lot of advantages, it can also cause problems in specific situations:

- **a)** In the wet, safe environment of the mulch layer, several organisms may overproliferated. Under a mulch layer, slugs and snails may swiftly grow in number. Ants or termites that may harm crops could potentially discover the perfect environment to survive.
- **b)** In certain instances, there is a higher danger of contracting pests and illnesses when agricultural leftovers are employed as mulch. As seen in Figure 3, damaging species like stem borers may persist in the stalks of crops like cotton, maize, or sugar cane. If there is a chance that the disease can spread to the next crop, diseased plant material should not be utilized [8]. Crop rotation is crucial to minimizing these dangers.

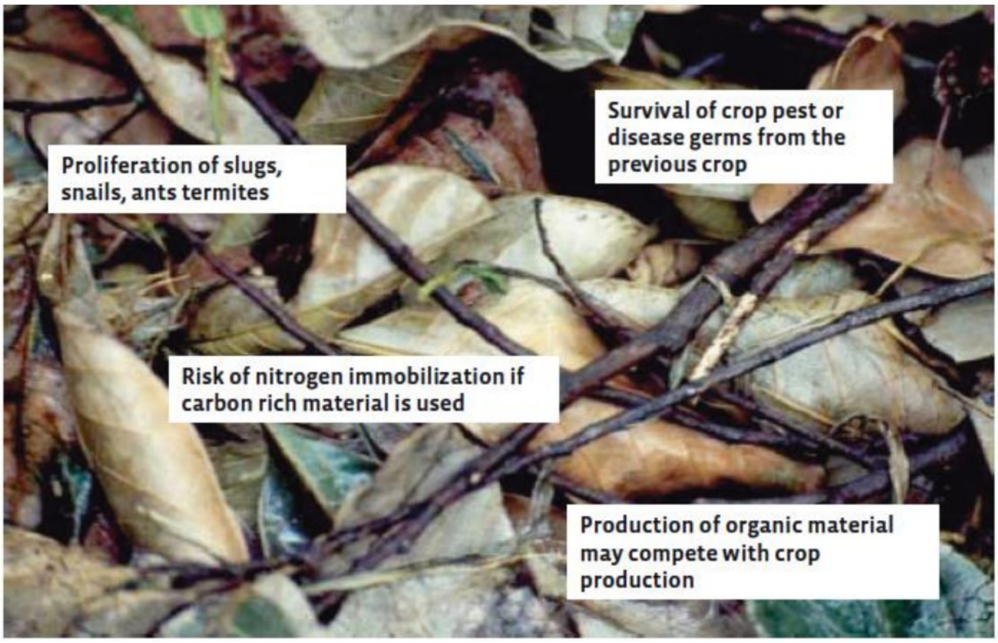

Figure 3: Illustrated the Potential Problems Related to Mulching[9]**.**

c) When mulching with carbon-rich materials like straw or stalks, microbes may utilize nitrogen from the soil to break down the mulch. As a result, nitrogen may not be accessible for plant development right away.

d) The availability of organic material is often the main barrier to mulching. Its production or collection often requires labor and may be in competition with crop production.

Application of Mulch

The soil is most susceptible towards the beginning of the rainy season, therefore if at all feasible, the mulch should be spread then. Seeds or seedlings may be directly sown or planted in between the mulching material if the layer is not too thick. It is recommended to wait to add mulch to vegetable plots until the young plants have grown a little more resilient since the byproducts of decomposition from new mulch material might hurt them [10].

If mulch is used before planting or sowing, the mulch layer shouldn't be too thick to prevent seedling encroachment. Mulch may also be used on established crops, ideally just after soil preparation. Between the rows, directly around individual plants (particularly for tree crops), or uniformly distributed throughout the field are all options for application. Mulch is used in a variety of gardening, landscaping, and agricultural applications. It has benefits that go beyond aesthetics since it is crucial for promoting healthy plant growth and resource conservation. Here are some common applications for mulch:

a) Retention of Moisture:

Mulch reduces water evaporation by acting as a shield over the soil. This lessens the need for regular watering by allowing the soil to hold moisture for a longer period of time. It is especially useful in areas with limited water supplies or during dry times.

b) Weed Elimination:

Mulch shields weeds from sunlight, which slows their development. The need for human weeding or the use of chemical pesticides is reduced since it serves as a natural weed barrier[11].

c) Controlling Temperature:

Mulch keeps the soil warm in cold weather and cool in hot weather by acting as an insulator. This temperature stability helps soil microbes and plant roots, encouraging the establishment of healthier plants.

d) Controlling erosion

Mulch helps stop soil erosion on slopes and other erosion-prone locations by stabilizing the soil and absorbing the force of wind and rain[12].

e) Enhancing the Soil:

Organic mulch enriches the soil with beneficial nutrients as it breaks down. This enhances soil fertility, structure, and microbial activity, which benefits plant health in the long run.

f) Prevention of Illness:

By forming a barrier between plant leaves and the soil, mulch prevents soil-borne illnesses from spreading to plants during watering or rainfall.

g) **Improved Appearance:**

Mulch improves the aesthetic appeal of landscapes and gardens. It gives planting beds a tidy, well-kept look and may be selected to go well with the overall theme.

h) **Control of Soil Temperature:**

Mulch helps keep the soil cool in warmer regions, minimizing root stress and preserving the general health of the plant. In contrast, it serves as an insulating covering in colder areas, shielding plants from subfreezing temperatures[13].

i) **Less Compaction of the Soil**

Mulch may assist in preventing soil compaction caused by heavy machinery or foot movement, which might injure root systems and decrease water penetration.

j) **Simpler Upkeep:**

Mulch decreases the frequency of soil cultivation and watering, requiring less time and labor to maintain the garden.

k) **Ecologically sound landscaping**

By recycling organic waste and lowering the need for chemical inputs, using organic mulch derived from materials like wood chips, straw, or leaves supports sustainable gardening techniques[14].

l) **Enhancing Plant Health:**

Increased growth, blooming, and fruiting are the results of enhanced overall plant health, which is facilitated by healthy soil and moisture retention supplied by mulch. Different mulch kinds may be more appropriate for various purposes, thus it's important to take these applications and the local environment into account when choosing mulch[13]. To continue reaping its benefits, routine upkeep is also required, such as replacing mulch as it decomposes.

DISCUSSION

Mulching is a significant and well-respected technique used in organic farming that is necessary to environmentally friendly and long-term agricultural operations. By using this technique, various organic materials, such as straw, leaves, compost, or cover crops, are placed on the soil's surface around the plants. The importance of mulching in organic agriculture is shown by the fact that it is a subject that is addressed in several significant areas. Mulching is mostly used in organic farming as a very effective weed control method. Mulch creates a barrier over the soil, blocks sunlight, and suppresses weed germination to stop weed growth[15], [16]. This reduces the need for synthetic pesticides or labor-intensive hand weeding, totally in keeping with the principles of organic agriculture, which provide the least amount of emphasis possible to chemical input and environmental preservation. Mulching is crucial in organic farming for improving soil fertility and health. Organic mulch materials progressively decompose over time, enriching the soil with organic matter and essential nutrients. By encouraging a robust ecosystem of advantageous bacteria and earthworms, this approach improves the soil's structure, moisture retention, and nutrient availability. By resulting in stronger, more resilient plants that are better able to ward off pests and diseases, it reduces the need for synthetic fertilizers and pesticides[17]. Mulching also significantly contributes to the efficient use of resources and water in organic farming.

Mulch increases the soil's capacity to retain water and reduces evaporation, helping to maintain consistent soil moisture levels. Less intensive irrigation is thus needed, conserving precious water resources and reducing the risk of soil erosion, particularly in regions with erratic rainfall patterns[18]. Mulching has a role in the framework of combating and adjusting to climate change. It helps to control soil temperature, preventing sudden changes that might hurt plants. Being able to adjust to shifting climatic conditions is becoming more and more crucial for organic agriculture because it equips farmers with the knowledge, they need to mitigate the consequences of weather-related issues and organic agricultural methods like mulching preserve the core principles of sustainable development, healthy soil, and resource conservation[19], [20]. This strategy is effective for weed control, soil enrichment, and water conservation while reducing environmental impact and enhancing resistance to climate change, which contribute to the greater goals of organic farming. It highlights the need of an all-encompassing agricultural plan that prioritizes organic goods, natural processes, and long-term sustainability.

CONCLUSION

In conclusion, mulching is an essential technique in organic agriculture that exemplifies the principles of ecologically friendly and sustainable farming. It performs several essential tasks, such as weed control, soil enrichment, water conservation, and climate resistance. With an emphasis on avoiding synthetic inputs, fostering soil health, and fostering ecological balance, this holistic approach is perfectly in line with the core principles of organic agriculture.The importance of mulching in organic agriculture grows as the global response to resource shortages and climate change becomes increasingly urgent. It provides farmers with a useful and efficient way to adjust to changing environmental circumstances, lessen their environmental impact, and improve the long-term profitability of their agricultural systems.Mulching also demonstrates how agricultural practices are interrelated and have a wider influence on ecosystems and people. It promotes a change to more sustainable and regenerative farming practices, where the preservation of natural resources, crop health, and soil health are all interrelated goals.In organic agriculture, mulching is much more than simply a method; it stands for a comprehensive concept that acknowledges the complex interrelationship between agricultural activities and the environment. It serves as an example of how collaborating with nature rather than fighting it may result in better crops as well as a more resilient and long-lasting agricultural industry for future generations. Mulching is still a crucial and enduring tool in the toolbox of the organic farmer, creating harmony between production and conservation, as we look for new ways to solve the problems of contemporary agriculture.

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CHAPTER 7

THE ROLE OF MICROORGANISMS IN SOIL FERTILITY AND SUSTAINABLE AGRICULTURE

Dr. Neeraj Jain, Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-neeraj.jain@muit.in

ABSTRACT:

Microorganisms are essential for preserving soil fertility and advancing sustainable farming. An urgent problem in agriculture is the loss of soil fertility, which will result in lower crop yields, mostly because of the drop-in ecosystem services provided by soil microbes. The complex interactions between microbes, animals, and plants in soil ecosystems are examined in this article, which also highlights their importance in sustaining a variety of habitats and boosting resistance to environmental stressors. Agriculture uses soil microbes to manage illness, degrade pollutants, reduce greenhouse gas emissions, cycle nutrients, and more. This highlights the necessity to comprehend and support soil microbial populations for environmentally friendly and sustainable agricultural operations. Composting is a significant strategy for soil rehabilitation and one of the oldest and most successful ways to increase soil biodiversity. In addition to supplying necessary nutrients, compost also enhances soil fertility, productivity, and structure while promoting healthy microbes and stifling soil pathogens.

The composting process, which includes many thermophilic phases and transforms complicated biomass into nutrient-rich, durable substance called humus, has a significant impact on the quality of compost production and the applications for which it is used. The identification of microbial communities engaged in composting has been made possible by high-throughput sequencing techniques. Both bacteria and fungus are essential for decomposing organic materials.

KEYWORDS:

Soil Biodiversity, Soil Fertility, Sustainable Farming, Sustainable Practices, Microorganisms.

INTRODUCTION

The loss of soil fertility, which results in a decrease in crop output, is one of the major issues facing agriculture. This is mostly because the ecosystem services performed by soil microorganisms have been lost. Microorganisms, animals, and plants interact in soil, which is a highly dynamic repository of biodiversity that supports the variety of ecosystems. Biodiversity promotes ecosystem resilience and production during harsh climates and/or climatic events because it stabilizes ecosystems functioning under variable environmental circumstances. Agriculture uses soil microorganisms to provide ecosystem services such disease control, pollutant degradation, decrease of greenhouse gases (GHG), availability, nutrient cycling, soil electrical conductivity, and regulation of organic matter decomposition.

The understanding of soil microbial communities is crucial for the development of ecologically friendly and sustainable agriculture, and it's vital to support their growth in conjunction with the kind of fertilization [1].

One of the oldest and most popular fertilizers to support soil biodiversity is compost. Applying compost to the soil is a helpful technique for soil rehabilitation. It is a significant source of nutrients, enhances soil structure, maintains and improves fertility, boosts agricultural soil productivity, speeds up the establishment of vegetation, encourages root growth, and enables the establishment of beneficial microorganisms while suppressing soil pathogens.

The quality of the compost's manufacturing process and finished product heavily influences its possible applications. Composting, a biological process mediated by various microorganisms, is a method for obtaining compost [2]. Composting is characterized by different thermophilic stages called mesophilic, thermophilic, cooling, and maturation phase, where the entire composting process takes place, and it converts complex compounds from biomass to simpler molecules through a process of oxidative or enzymatic hydrolysis.

The finished product has a humus-like consistency, is stable, dark, and packed with nutrients. The composition will vary depending on where the composted trash was produced. Starting material and environmental operating conditions (temperature, aerobiosis, moisture content, organic matter, and C/N ratio), both of which have an impact on the proliferation of various species, are two important factors that affect the establishment and activity of microbial communities in the composting process.

High-throughput sequencing methods have recently made it possible to identify the populations of soil microorganisms involved in the composting process. On the one hand, it has been said that bacteria play a significant role because they have a vast surface area that enables them to quickly absorb soluble substrates [3].

As a result, bacteria are often significantly more abundant than fungus. On the other hand, fungi play an equally important part in the composting process because they generate a significant amount and diversity of extracellular enzymes that enable the breakdown of resistant plant components like lignin and cellulose.

The Microbiota in the Composting Process

Firmicutes, Actinobacteria, Proteobacteria, Bacteroidetes, and Chloroflexi are the major bacterial phyla involved in composting. Proteobacteria are closely related to the mineralization of nitrogenous organic substrate; Bacteroidetes are involved in the degradation of a wide variety of complex carbohydrates; Firmicutes play a significant role in the breakdown of lignocellulose; Actinobacteria are efficient microbes for producing hydrolytic enzymes involved in the breakdown of lignocellulose and recalcitrant cellulose; and they are also capable of suppressing pathogenic microbes through the secretion of Figure 1 describes the major microbial species involved in the composting process[4].

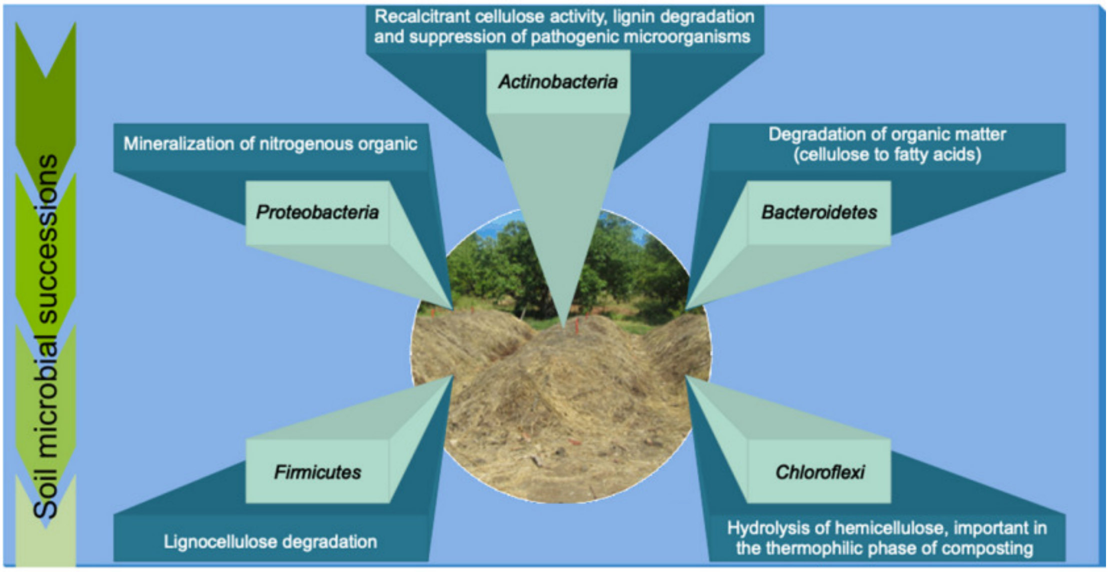

Figure 1: Illustrated the Dominant Bacterial Phyla in the Composting Process and their main Function[5]**.**

a) Firmicutes:

The majority of Firmicutes bacteria are Gram-positive, non-filamentous, common in plant rhizospheres, and some species can form spores, inactive, severely dehydrated resting stages that are highly resilient to environmental stresses. Firmicutes species are the subject of extensive research because they can help create sustainable agricultural systems. One of the advantages is the stimulation of plant growth, which aids in the acquisition of nutrients like nitrogen, iron, phosphorus, or other minerals. Additionally, they enable the control of plant hormone production or the synthesis of direct analogues of plant hormones, which aid in the biological management of plant pathogens (biocontrol agents)[6]. By utilizing their unique metabolic pathways, these microorganisms are able to break down recalcitrant molecules, addressing other soil-related issues such as soil desertification, decreased salt content in the soil, contamination by organic pollutants (such as pesticides), and contamination by inorganic pollutants (such as metals). Due to their involvement in the breakdown of plant biomass, firmicutes have been recognized as the bacterial group with the best representation in composting processes. Firmicutes predominate during the mesophilic stage of the composting process and gradually decline as the process moves forward. However, some Firmicutes can thrive in high-temperature environments as thermophiles, or living at temperatures above 50 °C, or as thermotolerants, i.e., at 30°C to 50°C. *Brevibacillus, Geobacillus, Bacillus*, and *Aeribacillus* are typically the genera that can survive in a wide temperature range (20-60 C). *Thermoanaerobacterium* (including the species formerly known as *Clostridium thermosaccharolyticum*), *Pseudoclostridium*, *Caldibacillus*, and *Thermohydrogenium* are some members of the Firmicutes that play an important role in the degradation of lignocellulolose by synthesizing various proteases and pectinases and are able to degrade non-digestible carbohydrates such as cellulose[7], [8].

b) Actinobacteria:

Actinobacteria are a large group of Gram-positive bacteria with a cosmopolitan distribution. The actinobacteria species are distinguished from other bacteria by their morphology, resembling fungi because of their elongated cell branches into filaments as fungal hyphae by DNA rich in guanine and cytosine, and by generating the typical wet soil odor. Thus, they show pleomorphic morphology and even coccoid elements, forming long filaments that extend through the soil and many of them produce spores that are easily detached. Actinobacteria species are valuable microorganisms that play a crucial role in plant growth and yield and possess a multifunctional role beneficial for sustainable agricultural production. Among actinobacterial species, free-living symbiotic or diazotrophic bacteria able to solubilize potassium and/or phosphate, plant growth promoting and biocontrol bacteria (antivirus, antifungal, etc.), and abiotic stress mitigators and plant probiotics have been described[9].

Especially, species belonging to the genus Streptomyces are involved in crop growth and health. Streptomyces species are considered inhibitors of phytopathogenic microorganisms since they can produce antibiotics It has also been considered as plant growth-promoting bacteria (PGPB) since they synthesize phytohormones, solubilize phosphate, or induce nitrogen fixation. Actinobacteria have a special interest in compost production due to their ability to decompose plant biomass[10]. The Actinobacteria possess the ability to decompose the lignocellulose present in plant tissues, as well as chitin or insect exoskeletons, thanks to the extracellular enzymes they produce, such as alpha-amylase, glucoamylase, glucose isomerase, proteases, lignin peroxidase, among others. They can grow in compost in both mesophilic and thermophilic conditions, up to 50–60 ◦C, and at neutral and alkaline pH.

Studies on Actinobacteria development in compost have shown a predominance of Streptomyces spp., with grey aerial mycelium, *Micromonospora spp*, *Thermoactinomyces* , *Thermomonospora* and *Actinobifida spp.* Some species of actinobacteria are thermotolerant, living in the warmth of a hot active compost, where the members of the genus Microbacterium predominate. The species of this genus live at the widest range of temperatures up to the long maturation stage of compost, and they spread their hyphae-like threads throughout the compost[11]. *Thermoactinomyces spp.* and *Microtetraspora spp.* usually colonise composts prepared from animal manure and straw, growing abundantly during the thermophilic phase and release many spores. Composts made from household green waste are often colonised by *Streptomyces spp.* and *Thermoactinomyces spp.*, such as *T. vulgaris*, *T. thalpophilus*, *S. rectivirgula*, *T. fusca*, T. *alba*, and *T. curvata*. Members of the genus Thermoactinomyces are particularly advantageous because, during the composting phase at high temperatures, they can degrade bioplastics such as polyethylene succinate (PES), poly(e-caprolactone) (PCL), and poly(3-hydroxybutyrate) (PHB).

c) Proteobacteria:

The biggest and most diverse phylum of bacteria, proteobacteria, is significant from a phylogenetic, ecological, and pathogenic standpoint. They all have a lipopolysaccharide-containing outer membrane and are Gram-negative. This phylum of bacteria exhibits significant variation in appearance, motility, and metabolism. Although the majority of Proteobacteria are non-motile and have polar or peritrichous flagella, the uncommon gliding movement has also been seen, as in Myxobacteria. The class Proteobacteria are a varied group of important environmental bacteria, many of which are present in the soil rhizosphere of weeds and agricultural crops[12]. They are distinguished by a notable capacity to withstand the selection pressures of agriculture. They are thought to play a significant role in the cycling of nutrients and have the ability to retain moisture. Proteobacteria are the only producers of the quorum-sensing chemical n-acyl-homoserine lactone (ahl), which may be both useful and detrimental depending on the situation. It can be damaging since it can promote the dynamics of plant diseases. They perform the anaerobic breakdown of organic materials necessary for composting, which plays a significant part in the sulfur and nitrogen cycles and contributes to the carbon cycle.

Proteobacteria are the most prevalent phylum found in the mesophilic stage of composting, where they are also the most plentiful, and their relative abundance declines throughout the remainder of the process. In the mesophyll stage of composting, the proteobacteria genera Stenotrophomonas, Halotalea, Pseudomonas, and Acinetobacter are the most prevalent[13].

d) Bacteroidetes:

Bacteroidetes is a fairly varied group of bacteria. These bacteria, which range in physiological kinds from strictly anaerobic Bacteroides to strictly aerobic Flavobacteria, are all Gram-negative. They are extensively spread in many environments, particularly in soil, and are either non-motile, flagellated, or gliding motile. They are well-known polymeric organic matter degraders and have a significant ecological function. They are responsible for the anaerobic decomposition of lignocellulosic biomass, which produces short-chain fatty acids, during the composting process. They are more plentiful while the composting process is cooling and maturing, when cellulose and xylan are mostly utilised as carbon sources. Flavobacterium, Pedobacter, Cytophaga, and Spirosoma are the principal Bacteroidetes species connected to soil[14].

e) Chloro-flexi:

Members of the Chloroflexi are reported to be both non-motile and motile (via gliding and flagella), and they are filamentous Gram-negative chemo-lithotrophic or heterotrophic bacteria. The majority of Chloroflexi bacteria are mild thermophiles and are often found in hot springs or aquatic settings, such as marine and freshwater sediments, however they have also been found in soil. The majority of cultured strains have so far been isolated from thermal settings because they are challenging to isolate in pure culture. Chloroflexi members have a variety of metabolic processes, but they stand out for their capacity to fix inorganic CO_2 and oxidize carbon monoxide and nitrite in an aerobic manner. Additionally, they aerobically degrade ferrous iron and nitrate[15]. Chloroflexi is one of the primary phyla in the maturation stage of the composting process. The most significant function of the phylum Chloroflexi is the degradation of hemicellulose through the hydrolysis of the internal glycosidic linkages of the heteroxylan backbone (endoxylanase) under the thermophilic phase of composting; this explains its strong increase throughout the entire process, being the most abundant phyla in the compost. Compost often contains members of the phylum Chloroflexi, including members of the Anaerolinaceae family. It is recognized that members of the Anaerolinaceae family take involved in the breakdown of hydrocarbons.

f) Fungi:

In both nature and the composting process, fungi play a significant role in the decomposition of organic materials. The phylum Ascomycota, basidiomycota, and the subphylum Ascomycota have the most prevalent fungi throughout the composting process. Composting of cow dung, food, garden waste, sewage sludge, and maize straw have all been linked to mucoromycotina. More fungal species, including those of the genera Arthrobotrys, Nectria, Thermomyces, Coprinus, Cryptococcus, Conocybe, Mortierella Candida, Leucoagaricus, Malassezia, Phialopora, and Cercophora, have been reported in later stages of composting than yeast species of the orders Saccharomycetales and Tremellales. It has been shown that fungi do not significantly grow during the thermophilic phase of the composting process when the temperature exceeds 65 °C. One of the key elements influencing fungal development is temperature. The ideal temperature range for most fungus is 25–30 °C. During the thermophilic stage of composting, yeasts vanish, but when the temperature drops to 54 C, a number of fungal genera that can break down cellulose, carboxymethylcellulose, hemicellulose, xylan, and arabinoxylan may be discovered once again[16].

Conditions That Affect the Succession of Microbial Communities in the Composting Process

When a species' ability to carry out its physiological functions is impeded by environmental variations (physical or chemical), other organisms take over as the main players in the process. This is how the various microorganisms involved in compost production are organized into communities that follow one another in a non-random manner during the process. Environmental changes relating to temperature, aerobiosis, feedstock, and humidity generally have an impact on communities. As shown in Figure 2, controlling these factors will have a direct influence on how long each community will be in existence as well as how long the process will take and how well the compost will turn out.

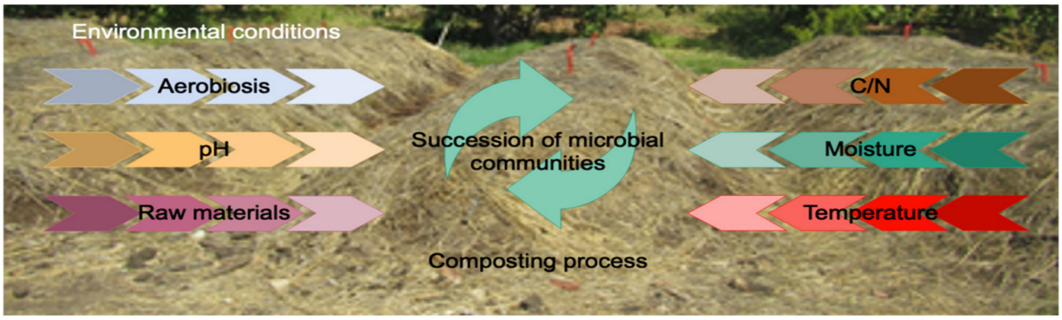

Figure 2: Illustrated the Environmental conditions influencing the composting process and soil microbial successions[17].

DISCUSSION

The discussion around microorganisms in soil fertility and sustainable agriculture is crucial to comprehending the intricate relationship between microorganisms, soil health, and the development of sustainable agricultural methods. Microorganisms have a variety of roles in conserving soil fertility and advancing sustainable agriculture. They are crucial components of soil ecosystems.One of the key areas of research is the essential ecological functions that microorganisms provide in agricultural settings[18]. The control of organic matter decomposition, disease prevention, pollutant degradation, and nutrient cycling are some of these duties. In order to ensure that crops get the nutrition they need for optimal growth, microorganisms play a critical role in the conversion of complex organic molecules into simpler nutrients that plants can consume. Because of nitrogen cycling, less synthetic fertilizer is required and there is less likelihood of nutrient runoff, which might be detrimental to aquatic ecosystems and water quality.The discussion also looks at how microbes could enhance soil structure and fertility. Microorganisms have a role in the formation and upkeep of soil structure by creating aggregates and improving nutrient availability, water retention, and aeration. Composting, one of the sustainable agricultural practices, raises the soil's fertility and total productivity by using microorganisms' capacity to transform organic waste into nutrient-rich humus. This exemplifies how understanding soil microbiology can be used realistically to enhance soil quality and sustainably manage the property.

A hotly debated issue is the importance of biodiversity in soil ecosystems. Microorganisms, together with plants and animals, are primarily responsible for the rich biodiversity seen in soils. Biodiversity not only enhances the resilience of ecosystems in the face of environmental pressures and climate instability, but it also increases agricultural productivity. Sustainable agriculture strives to protect and cultivate this type in order to ensure long-term food security and environmental stability. The discussion also highlights the necessity for environmentally friendly farming practices that encourage the growth and activity of beneficial bacteria while inhibiting the negative ones. Crop rotation, minimal tilling, and the use of compost-like organic fertilizers are a few examples of such methods. It is necessary to have a fundamental knowledge of the composition and functions of soil microbial communities in order to design solutions that support sustainable agriculture without relying on agrochemicals. Microorganisms in soil fertility and sustainable agriculture is essential for deepening our knowledge of how microorganisms impact crop yield, soil health, and the overall sustainability of agricultural systems. We can develop and implement more resilient and environmentally friendly agricultural approaches that will ensure the long-term sustainability of our food production systems by comprehending the critical functions that bacteria play in these processes.

CONCLUSION

In conclusion, a subject of utmost significance in the field of contemporary agricultural methods is the delicate interaction between microorganisms, soil fertility, and sustainable agriculture. We have emphasized the critical contributions that microorganisms make to soil health, nutrient cycling, disease prevention, and the long-term sustainability of agricultural ecosystems throughout this debate.Under our feet, driving the essential processes that support agricultural output, microorganisms are the unsung heroes. It is impossible to overestimate their capacity to decompose organic materials, release crucial nutrients, and improve soil structure. We can lessen our dependency on synthetic fertilizers, cut down on environmental pollution, and promote a more harmonious connection between agriculture and the environment by utilizing the power of these microbes. Understanding and appreciating soil microbial populations is essential for sustainable agriculture, which is a crucial aspect of global food security. Composting, crop rotation, and decreased tillage are a few techniques that show how we may use these microbes to improve soil fertility, increase agricultural yields, and lessen the effects of climate change. Additionally, we may develop agricultural systems that are less reliant on chemical inputs and more adaptable to environmental challenges by protecting soil biodiversity and encouraging beneficial microbes. In essence, research on microorganisms in soil fertility and sustainable agriculture serves as a practical guide to developing a food production system that is more robust and environmentally sound. We can get closer to a day when agriculture supports both the planet, we call home and our expanding global population by investigating and putting the knowledge we've learned from this area of study to use. In this future, soil microbes will be seen as valuable allies in the pursuit of plentiful, healthy, and sustainable food production.

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CHAPTER 8

AN OVERVIEW OF THE ESSENTIAL FACTORS INFLUENCING COMPOST GENERATION AND SOIL HEALTH

Dr. Neeraj Jain, Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-neeraj.jain@muit.in

ABSTRACT:

In order to generate compost, they need food carbon and nitrogen, air, and water since certain environmental conditions have an impact on the composting process. They also need favorable temperature and pH levels for quick composting. Surface area, particle size, and volume are other physical aspects that influence how quickly composting occurs. Every naturally occurring chemical has an associated microbial enzyme complex that may transform it into trash, carbon dioxide, and humic material. The population of microorganisms in organic waste, such as bacteria, fungus, and actinomycetes, which are obtained from the atmosphere, water, or soil, is often highly polluted. For microorganisms to function properly, they also need a supply of nutrients, air, water, and hospitable circumstances. These macro-organisms, such as mites, centipedes, snails, millipedes, springtails, spiders, slugs, beetles, ants, flies, nematodes, flatworms, rotifers, and earthworms, etc., play an important role in tearing, cutting, and chopping the organic substrate so the micro-organisms may find it suitable to act upon. A sufficient quantity of them ensures the formation of high-quality compost.

KEYWORDS:

Compost Generation, Environmental Conditions. Microbial Activity. Organic Matter, Soil Health, Temperature, Water Content.

INTRODUCTION

They need food carbon and nitrogen, air, and water to generate compost since certain environmental conditions have an impact on the composting process. They also need a temperature and pH that are favorable for quick composting. Surface area, particle size, and volume are other physical elements that influence composting's rate of progress. There is a comparable microbial enzyme complex that may transform any naturally existing substance into carbon dioxide, humic material, or trash. Organic waste is often highly polluted by the population of bacteria, fungus, and actinomycetes that are found in the soil, water, and environment[1]. To function properly, microorganisms also need a source of nutrients, air, water, and hospitable circumstances. The macro-organisms, such as mites, centipedes, snails, millipedes, springtails, spiders, slugs, beetles, ants, flies, nematodes, flatworms, rotifers, and earthworms, etc., play a crucial role in tearing, chopping, and cutting the organic substrate so the micro-organisms may find it suitable to act upon. The creation of high-quality compost is ensured by their presence in appropriate numbers.

Aeration:

The main environmental component is aeration, which is defined as the volume of oxygen in the system. Organic materials may be broken down by organisms in the compost pile either aerobically or anaerobically. Aerobic bacteria are one example of an organism that needs oxygen to make energy, develop, and reproduce. The oxygen concentration of the system is connected to the kinds 80 of organisms present in the pile and the metabolic mechanism employed to break down organic molecules[2]. Rapid composting is favored over aerobic deterioration. Aeration in a compost pile happens spontaneously when oxygen-deficient air that was previously present departs the pile after warming up from composting and is replaced by fresh air from the surroundings. The wind, moisture content, and porosity (the distances between compost pile particles) may all have an impact on the aeration process. Compaction happens when the decomposition process advances and reduces the porosity of the stacked material.

Additionally, the porosity is decreased by the substrate's increased proportion of fine organic debris, such as pine needles, grass clippings, or sawdust. If materials get wet, air circulation may also be hampered. When there is insufficient aeration, stirring the material with a shovel improves airflow and promotes porosity[3].

Moisture Content:

Moisture affects how quickly the microbial population multiplies, aiding in the appropriate and speedy decomposition of composted material. It is crucial to maintain a sufficient moisture level since it gives microorganisms the humidity they need for the best disintegration. The ideal moisture level for composting is often thought to be between 50 and 60 percent.

The thin liquid films that are present on the surfaces of the organic particles are where microbial-induced breakdown happens the fastest because water dissolves the organic and inorganic nutrients contained in a pile and makes them accessible to microorganisms. When there is insufficient moisture, anaerobic decomposition takes place slowly, producing odors and nutrient leakage. To manage the degree of moisture, composting should be done beneath some kind of cover[4].

pH:

The majority of the composting substrate has a pH of 6.0, which is somewhat acidic. Early on, organic acid is produced; as a result, the pH returns to being acidic (4.5–5.0). As the process of decomposition progresses, the temperature drops, and the pH of the composted matter begins to rise. It changes from acidic pH to alkaline pH 7.5–8.5.The mature compost has a pH between 7.5 and 8.5[5].

Temperature:

In addition to optimum air and moisture levels, temperature is a crucial element in the composting process. Due to the fact that aerobic decomposition is an oxidative process, a significant amount of heat is produced by microbial activity, which in turn raises the temperature of the pile. The temperature ranges in which soil microorganisms are metabolically active are well-defined. Different groups of creatures become active as the pile's temperature rises. If enough oxygen, moisture, carbon, and nitrogen are available, a compost pile with substrates of the right particle size may reach temperatures of 65 to 750 C. Temperatures between 32 and 6000C are typical of a well-run system and show that composting is happening quickly.

A temperature over 7000C becomes fatal to the majority of microorganisms, and higher temperatures start to restrict microbial activity. Most weed seeds, insect larvae, and possible plant or human infections that may be present in the composting materials are mostly eliminated at this temperature[6]. Even though temperature control is not strictly required for composting, keeping it between 32 and 600 C is essential for a quick composting process.

Surface Area:

The whole microbial process takes place on the surface of the particle, thus the amount of organic material that is exposed to soil organisms has a significant impact on how quickly it decomposes. To maximize the surface area and speed up decomposition, composting materials should be shred, diced, or otherwise reduced in size. On the other hand, air movement inside the pile is hampered when particles are excessively tiny and compact. It lessens the amount of oxygen that is accessible to the microorganisms in the pile, which eventually slows down the pace of microbial activity [7].

Composting System Dimensions and Shape:

Size affects how well a compost pile retains heat. A compost pile may be small enough to allow for efficient air circulation, but it must be large enough to prevent quicker heat and moisture evaporation. The optimal pile size is one cubic meter; however, the size is mostly determined by the composting process. Smaller composting heaps will still breakdown the material, but it may take longer since there may not be enough heat to also kill bacteria and destroy weed seeds. The pile's form aids in regulating the moisture content. In humid areas, outdoor compost systems may be protected from precipitation; however, in desert areas, concave-topped heaps are favored to collect rain and any additional water. The compost pile's form aids in controlling moisture levels. In the majority of humid and temperate areas, a triangular or egg-shaped pile will function well. Even in areas with more rainfall, protection from the elements is preferred. In a dry region, it may be preferable to chop off the pyramid's tip and create a depression to collect precipitation. Using a pit will be a preferable alternative if the soil is too dry to keep the right moisture. As the pile dries, the decomposition process stops, killing all the creatures [8].

Composting Period:

The compost pile should be constructed in the fall and spring. Many weeds and grasses will be blossoming or have already begun to set seed in the fall, making substrate with a significantly higher C/N ratio accessible. Fresh, green vegetation with much higher nitrogen (N) will emerge in the spring. When the pile is created in the middle of the summer, it is more likely to get too hot and lose a significant quantity of organic matter. When it is erected in the middle of winter, it is more likely to be too cold and damp, which might lead to anaerobic decay and the loss of essential nitrogen. The pile may be kept cold in the summer by keeping it in the shade and by adding additional carbonaceous materials, and it can be kept heated in the winter by positioning the pile on a building's south side [9]. The earth's thin outer layer, the soil, serves as the foundation for all life on the planet. The many types of soil deterioration have a profound impact on the thin skin that sustains life on our planet. In the last 150 years, the topsoil on earth has been destroyed by half. On 147 million hectares (Mha) of land, soil degradation is thought to be taking place. In India alone, this includes 94 Mha from water erosion, 16 MHA from acidity, 14 MHA from floods, 9 MHA from wind erosion, 6 MHA from salt, and 7 MHA from a combination of causes. India sustains 15% of the world's cattle and 18% of the world's human population, yet it only has 2.4% of the planet's geographical area, making it a highly serious situation. India ranks second globally in agriculture production despite having a small share of total land area. Our food and environmental security are most at risk from land degradation and low soil quality. Regions with hills and plenty of rain are more prone to soil erosion. In certain areas, soil erosion results in the loss of top fertile soil, organic matter, nutrients, and other helpful bacteria, which has a negative impact on the health of the soil. Aside from nutritional supplementation, organic matter aids in lowering soil susceptibility and safeguards against nutrient loss.

Agriculture has long used waste products from human, animal, and vegetable sources to increase crop output. The prospect of maintaining agricultural yields and soil health is provided by these organic wastes. Due to the fact that it provides the necessary nutrients, it also aids in avoiding the use of artificial fertilizers, pesticides, etc. Crops absorb nutrients from the soil during growth and production, and these nutrients must be replaced to maintain soil productivity. The ideal method of refilling is to deliver the nutrients from accessible, digested, and decomposed organic wastes. Composting, also known as humus or compost, is the process of allowing plant wastes and other non-living organic matter to break down into an earthy, black, crumbly substance that is ideal for nourishing and replenishing the soil. Returning humus, or organic matter that is safe and readily mineralized, to the soil is done via composting. Despite making up a relatively minor portion of the soil, organic matter may have a significant impact on how healthy the soil [10]. Compost may be referred to as "The Black Gold" since it is black, can enrich the soil, and provides the nutrients crops need to perform better, as seen in Figure 1.

Figure 1: Displayed the Finished Compost 'the black gold'[11]**.**

Depending on the composting techniques and raw materials used, compost may provide important nutrients and organic matter to the soil. The total nitrogen status, available nitrogen, phosphorus, and potassium amounts of various types of compost are determined by chemical analysis, but the majority of them are relatively low in one or more nutrients and are not regarded as good "fertilizers"; however, as soil amendments, they are good sources of organic matter.

Compost typically contains both organic and plant-available forms of nitrogen and phosphorus, including NO_3, NH_4, and P_2 O_5. The nutrient will be transformed from its "plant available" form after breakdown when it is present in organic forms. Therefore, the amount of immediately usable nutrients in compost may be significantly smaller than in raw waste, but compost has a "timed-release" effect. Compost is nutrient-efficient because it reduces nutrient loss, which often happens with fertilizers due to the nutrients being slowly released after being originally "bound" in organic forms.

Utilizing the nutrients in the trash to boost crop development is the main benefit of producing compost. Composting primarily stabilizes organic resources to enable them secure storage, simple transportation, and timely use. Additionally, compost may be turned into a saleable product and distributed in metropolitan and peri-urban regions. Municipal wastewater treatment facilities, agricultural producers, industrial waste generators, and commercial composters who are in the business of composting wastes gathered from diverse sources all engage in large-scale composting [12].

These bulk manufacturers may fill 1–5-kilogram packets for retail sale to the general public or sell their goods to nurseries, large farms, landscaping businesses, etc. Prices of commercially available compost may vary greatly depending on market conditions and compost output. There are restrictions on the times when raw organic waste may be put to crops. Additionally, it may not be possible to maintain the ideal moisture and temperature for effective decomposition across the whole field; as a result, there will be incorrect decomposition and nutrient loss. In addition to this dispersal, the wastes to the vast region may result in pollution, a bad odor, and an unhealthy environment. However, compared to raw garbage, compost is simpler to manage and store. It does not smell bad and is less prone to cause water pollution. The farmer has more freedom when organic waste is composted simultaneously because he may choose the application time and method. The only issue a farmer could run into is storage since compost is big and needs a lot of room. Therefore, the following information may be useful to farmers as they assess if composting will be a good fit for them.

Conditions for Composting

The availability of raw materials (feedstock), composting area, equipment, and labor all affect how feasible composting is. Microorganisms (bacteria, fungus, and actinomycetes) break down complex organic materials into simpler, more stable forms during the biological process of composting. During the course of their growth and development, they consume organic waste, which they then break down into more easily digestible components. Simply said, we are giving these creatures a healthy food and a pleasant habitat to enable them to function well [13].

Therefore, having access to high-quality feedstock with a balanced quantity of nutrients is crucial for composting. Excreta and manure from animal farms are the richest sources of macro and micronutrients that can be composted as they are, but by combining them with low-nutrient feedstock like straws and other crop residues, the feedstock may be made into a balanced food supply for microorganisms. Furthermore, since cattle waste is so high in nitrogen, it may become ammonia, which can evaporate and be wasted if composted alone. One may sometimes smell a very strong odor next to a compost pit; this may be caused by ammonia volatilization. The carbon: nitrogen (C: N) ratio is balanced by mixing feedstock with a high carbon: low nitrogen content with animal farm waste. For optimum microbial activity and producing high-quality compost, a C:N ratio of 20:1 to 30:1 is a suitable range. Composting conditions become anaerobic when feedstock is compacted, which prevents aerobic decomposition. It might result in the formation of foul odors and dangerous gases like methane, etc. To improve aeration and lessen the bulk density of the composted mass, materials such as straws, sawdust, wood chips, and leaves may be added [14], [15].

DISCUSSION

Composting space is still another crucial consideration. Due to the bulkiness of the feedstock and the compost, transportation becomes crucial. The composting area should be close to a location with a lot of trash and feedstock since it saves on transportation costs. The composting pit should be sufficiently far from the residential area, however, since improper decomposition may occasionally result in an unpleasant stench. Residents of the region may find the foul smell and flies coming from the feedstock and compost heaps bothersome. Composting on a modest scale at home only needs a few pieces of small household equipment, such as a spade, shovel, rake, etc [15]. On a commercial scale, however, the material must be transported, mixed, and composted using machines. Crop residues are the plant leftovers that are still in the field after the crops have been harvested and thrashed. These leftovers are a rich source of plant nutrients because they still contain a large portion of the nutrients that were taken from the soil. These leftovers may be used to create compost of higher quality, which can help maintain or even increase crop productivity. As a result, effective crop waste management may be very important for both enhancing fertilizer use efficiency (FUE) and recovering soil productivity. Regular production of organic wastes both at the home and agricultural levels poses a significant disposal challenge. It is a bad use of a highly valuable resource to burn or utilize landfills to store this trash. Waste that is not properly disposed of my often become dangerous and can harm the ecology. On the other hand, when properly degraded, this organic waste may be an excellent source of nutrients [16]. In addition to having positive effects on the environment, the minerals included in these wastes may be employed successfully as organic manure to boost agricultural production.

CONCLUSION

Farmers sell their leftovers to other landless families or utilize them for their own purposes. Farmers purposefully burn extra leftovers to cleanse the land, improve fertility by adding ash, control pests, and maintain pastures. Farmers believe that burning eliminates dangerous germs. Burning residue boosts certain minerals' short-term availability, such as calcium and potassium, and lowers soil acidity, but it also causes the loss of other nutrients, such as nitrogen and sulphur, organic matter, and microflora in topsoil. Root biomass improves proportionally to an increase in biomass output, with a substantial percentage returning to the soil. To improve soil health and crop productivity in rainfed areas, some key strategies include recycling crop residues to increase soil organic carbon, including legumes in the cropping sequence or as intercrops, green manure crops, green leaf manuring, tank silt addition, farmyard manure, biofertilizer, composting/vermicomposting alongside fertilizers, and integrated nutrient management. Organic waste, such as food scraps, leaves, and paper, may be converted into a resource that is beneficial to the environment via the composting of agricultural waste, which is a significant process. The trash is broken down by bacteria and microorganisms to create a paste-like material. The end product is nutrient- and oxygen-rich. Growing in popularity as a method of improving soil organic matter is composting. Compost amendments boost the soil's microbial populations in addition to its organic matter content, which enhances the soil's quality. There are many different types of composting.

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CHAPTER 9

AN EXPLORATION OF THE POWER OF COMPOST AND SOIL HEALTH, AND ENVIRONMENTAL BENEFITS

Dr. Madhu Prakash Srivastava, Associate Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-madhu.prakash@muit.in

ABSTRACT:

Composting has significant effects on soil health, disease resistance, and environmental wellbeing. This abstract explores the compost's complex effects on these important factors. Compost acts as a powerful soil conditioner, improving water dynamics, texture, structure, and nutrient availability. Its use significantly affects soil fertility and long-term sustainability. Additionally, compost supports the inhibition of pathogens by a number of methods, including induced resistance, direct parasitism, nutritional competition, and antibiotic release by helpful bacteria. Additionally, it encourages microbial activity, which improves the general health of the soil. On a larger scale, the appropriate use of compost reduces environmental pollution brought on by disease spread, methane emission from waste decomposition, and organic waste disposal in landfills. For compost to reach its full potential, it is crucial to comprehend the rules for composting and the significance of balancing the carbon-to-nitrogen ratios in organic waste. Composting is a significant tool for solving today's environmental concerns since it provides a sustainable answer for disease control, soil enhancement, and waste management.

KEYWORDS:

Environmental Benefits, Soil Conditioning, Soil Health, Disease Resistance, Nutrient Availability, Sustainable Agriculture.

INTRODUCTION

Compost aids in creating a soil that inhibits the formation of diseases and promotes the healthy growth of plants. Induced resistance, direct parasitism (one organism eating another), nutrient competition, and direct inhibition via antibiotics released by beneficial organisms are some of the processes that keep disease-causing species in check in these soils (Sullivan, 2004). Compost increases a plant's vigor and capacity to withstand pathogenic assault. On the other side, it also encourages the development of microflora that may parasitize pathogens or may create antagonistic microbial compounds, such as parasitism and the creation of antibiotics, which inhibit the growth of harmful organisms. Pathogens are adversely affected by the organic acids and ammonia in the compost. Additionally, several substances found in compost encourage the pathogens' early hatching, which lowers their harmful burden[1].

Utilizing Compost and Soil Fertility

A nutrient-rich soil conditioner, compost enhances the quality of the soil. It not only provides nutrients but also affects how readily available they are to the plants, enhancing soil health largely through enhancing the physical and biological qualities of the soil. The nutritional condition, texture, structure, erosion, and water dynamics of the soil are all affected over the long term by compost. It lessens soil separation, water runoff, and the transfer of ammonium and nitrate ions to the water. As a result, applying compost improves soil fertility overall in addition to giving nutrients[2].

Application of Compost

The greatest results may be obtained by applying at the right time. Timing is heavily influenced by edaphic elements. The optimal time to apply compost is just before the monsoon since that is when the bacteria will flourish the greatest. Compost encourages microbial activity. However, if you want to prevent any of the vital nutrients being washed away, spring is the ideal time to apply it in a region with a lot of rain. Compost distributes nutrients gradually, so the plant may not be able to absorb them right once after application. After the composting process is complete, the majority of the nitrogen is bonded into organic forms and released gradually.

Compost application rates may be established using compost nutrient analyses and fertilizer recommendations from soil testing. It is important to keep in mind that only 10 to 25% of the nitrogen (N), 40% of the phosphorus (P_2O_5), and 60% of the potassium (K_2O) present in compost will be available to plant during the first year of application when calculating the amount of compost based on the results of the soil test and the crop requirements. It is crucial to understand that the actual availability of nutrients will depend on the kind of composting input material and the surrounding environment[3].

The typical method of garbage disposal involves depositing it away from the public's view. But instead of resolving the issue, it just serves to grow it indirectly and, occasionally, beyond of everyone's control. The negative effects of this practice, including health risks, contamination of the land, water, air, and food supply, unfavorable environmental conditions, and the depletion of valuable resources that might have been recovered from solid waste, are well documented. When we go through any hamlet, we often come across piles of half decaying organic waste that have been left by the paths, generating an unpleasant odor and damaging the environment. When the hamlet lacks proper sanitary facilities due to a growing population and dwindling natural cover, the situation becomes even more dire. On the other side, it demonstrates a lack of knowledge about how to turn garbage into a superior product, such as compost, and does not provide a favorable impression of the locals[4].

Local environmental contamination is often caused by garbage decomposing into its component substances. In poor countries, this issue is quite serious. Decomposing waste poses a serious environmental risk by releasing obnoxious fumes. The anaerobic respiration process produces methane as a byproduct, which contributes to the greenhouse effect and climate change. The organic material is susceptible to the actions of several bacteria throughout the degradation process.Disease-causing organisms often use decaying rubbish as a safe environment to grow, after which they spread everywhere and infect people, animals, and plants with illnesses. Although it appears ugly, this breakdown is a necessary evil that aids in cleaning. Imagine what would have occurred if the process of dissolution and decay had not taken place.

The area on which we now reside would have been littered with waste and dead animals. Even the faces themselves would not vanish from the planet. We have no trouble imagining what kind of place the world may develop into. No plant will be able to take up nutrients from the soil or produce food via photosynthesis, and neither will any animal or human be able to consume and digest food. As a result, rotting or decomposition is essentially a gift in disguise that has made the world a lovely place to live and cultivate since nature has designed the process to purify the surroundings so that the new may have enough room to reside[5]. Decomposition must be handled carefully since it is inevitable and essential. Microorganisms may thus be used to decompose biomass and organic waste in the presence of oxygen without causing unclean conditions or even producing useful products like organic manures.

Guidelines For Composting

Crop leftovers, animal farm waste, and other non-living organic materials may be aerobically decomposed to produce compost, an earthy, black, crumbly product that can improve and restore the soil. Numerous microfauna, including nematodes, mites, spiders, centipedes, earthworms, ground beetles, etc., participate in this process. Additionally, in an aerated atmosphere, bacteria, fungus, and actinomycetes break down organic waste into simpler compounds to produce compost or humus. Environmental elements including aeration, temperature, moisture, substrate, microbial populations, etc. have an impact on how well composting occurs[6].

All living things have the ability to develop and reproduce, therefore the microorganisms present there also multiply and expand in size. For this process, they need nutrients, oxygen, and moisture, which they get by breaking down the organic waste and environment. They acquire oxygen and moisture from the surrounding environment, but they obtain a significant quantity of energy, carbon, nitrogen, phosphorus, macro and micro minerals from the residue itself. The residue's complex organic molecules are converted to carbon dioxide, water vapor, and energy. The microorganisms use some of this energy for their biological functions, but a large percentage of it is converted to heat, raising the temperature within the compost pit or heap. The pit or heap may reach temperatures of up to 700 C, which is hot enough to kill a variety of pathogens, dangerous insects, and weed seeds. The volume decreases as a result of the significant quantity of carbon dioxide and vapour that are created leaving the pit. Once the breakdown is complete, the temperature drops once again. Compost, a dark, crumbly mixture that was left behind after the decomposition of organic waste, contains both live and dead microbial cells as well as humus and other products that have been broken down and are ready for use[7], [8].

Organic Matter's kind

In general, any material of plant or animal origin may be used for composting, but knowing the right components to combine will help you get better results. Microbes that break down organic matter utilize nitrogen to proliferate (protein synthesis) and carbon as an energy source. It's crucial to keep the carbon to nitrogen (C:N ratio) ratio balanced when the substrate is added to the compost pit. When it comes to decomposition, the ratio of accessible carbon (C) to nitrogen (N) is crucial; organic matter with a greater nitrogen concentration breaks down more quickly than that with a lower nitrogen level. For appropriate breakdown, the ratio may change, ranging from 25:1 to 40:1. Composting experts recommend using materials with a carbon to nitrogen ratio of 30 to 1.Organic matter may be divided into low nitrogen-containing or "high C:N ratio" and high nitrogen-containing or "low C:N ratio" materials depending on how much nitrogen it contains. The second group, which comprises of manure, animal waste, and young, juicy plant parts, decomposes quickly in contrast to the first group, which is made up of harsh elements and breaks down more slowly[9].

Organisms

The breakdown of organic wastes is a multi-organism process. They may be classified as macro or micro creatures, such as mites, centipedes, snails, millipedes, springtails, spiders, slugs, beetles, ants, flies, nematodes, flatworms, rotifers, and earthworms, depending on their size. Microorganisms are referred to as chemical decomposers because they alter the chemistry of organic wastes and are responsible for the majority of substrate decomposition. Macroorganisms are considered physical decomposers because they grind, bite, suck, tear, and chew materials into smaller pieces. The most significant decomposers among all creatures are aerobic bacteria.

A gram of soil or decomposing organic waste may contain millions of them, and they are widely accessible. These bacteria can consume almost anything and have the widest range of nutrients of any living creature. They use nitrogen to construct their protein for replication and carbon as an energy source. To produce energy, they oxidize the organic substrate's carbon component. The compost pile's temperature rises during oxidation from the surrounding air's temperature. The make-up of decomposable materials affects the rate of temperature increase.

Microorganisms may live in a wide temperature range, from 0 to 800 C, although the bulk of them are actively decomposing between 30 and 400 C. Bacteria may live in unfavorable conditions because they cannot escape, but pH changes or variations in other environmental elements, such as oxygen, moisture, or temperature, can cause bacteria to pass away or go dormant. Aerobic bacteria, which are the most effective microorganisms for quickly decomposing organic materials, need oxygen concentrations more than 5% for optimal decomposition. The population of aerobes decreases and the rate of decomposition slows by up to 90% when oxygen levels fall below 5%. In this situation, anaerobic microorganisms gain control of the process and begin creating a lot of worthless organic acids and amines that prevent plants from accessing numerous nutrients, including nitrogen. These substances, which produce the rotten and foul smell and, in some cases, are poisonous to plants, include hydrogen sulfide (which smells like rotten eggs), cadaverine, and putrescine[10].

Numerous types of aerobic bacteria interact with the substrate, and the population of each type changes depending on the pile's temperature. The extremely low temperature range is where psychrophilic bacteria operate, and they may continue to function at temperatures as low as 200 C. Despite the fact that they only generate a little quantity of heat, this is sufficient to raise the pile's temperature. Mesophilic bacteria begin to dominate when the temperature rises over 200 C. Mesophilic microbes break down organic material quickly, producing acids, carbon dioxide, and heat. Their typical operating temperature range is 20 to 370 C. The mesophilic bacteria start to disappear or shift to the outside of the pile when the pile's temperature rises more. Thermophilic bacteria, which live at temperatures between 45 and 700 C, take control at around 400 C. The breakdown process is continued by thermophiles until the pile temperature reaches 65 to 700 C, at which point it often stabilizes. High temperature must be maintained by feeding fresh material and spinning on a regular basis, otherwise it will persist for three to five days. The benefit of the high temperatures is that they destroy pathogenic organisms and weed seeds (over 600 C).

When the temperature of the pile rises beyond 700 C, the composting material becomes sterile and loses its ability to fight illness as well as its nutritional value, thus action should be made to cool the heap by rotating it[11]. The number of thermophilic bacteria begins to decline as soon as the temperature exceeds 700 C, which causes the temperature of the pile to gradually decrease. The mesophilic bacteria retake control when the pile cools, and they begin eating the leftover organic matter with the assistance of other species. At this point, the composting process enters a new phase where actinomycetes and fungus play an important role. While the different species of bacteria are at work, other micro-organisms are also contributing to the breakdown process. Greyish looking actinomycetes, a higher-form bacterium are related to fungus and molds. They are in charge of compost's lovely earthy odor.

Actinomycetes break down more durable components like lignin, cellulose, starches, and proteins into carbon, nitrogen, and ammonia, which releases nutrients for higher plants to use. Large clusters of actinomycetes are present, and they become highly noticeable as the breakdown process progresses.

Fungi, like bacteria and actinomycetes, aid in the decomposition of organic material in a compost pile. Primitive plants known as fungi may be filamentous, solitary, or multicellular. They are in charge of breaking down cellulose and lignin since they lack a photosynthetic pigment. They take over the process at the last stage of composting because they favor lower temperatures (22 to 250 C) and food sources that are simple to digest[12].

Aeration

Both macro and microorganisms are present throughout the composting process, and an appropriate quantity of oxygen is necessary for them to carry out respiration in order to support their life process. As a result, the heap should be constructed such that it offers sufficient aeration. The proliferation of several unfavorable types of microorganisms under anaerobic circumstances (without air) results in the putrefaction of waste and lowers the quality of the compost.

Moisture

Every living thing needs water to survive, and the organisms involved in composting also need enough moisture to survive and develop. The thin water films that form on the surface of organic materials are where microbial activity happens most quickly. Only organic molecules that have been dissolved in water may be used by microorganisms. The ideal moisture level for compost piles is between 40% and 60%. Bacterial activity decreases and may even go dormant if moisture levels drop below 40%; yet, if moisture levels rise beyond 60%, air is forced out of pile pore spaces, smothering aerobic bacteria. Putrefaction and foul odors arise from the anaerobic bacteria controlling decomposition taking over when the number of aerobic bacteria declines.

In tropical areas, extra care must be taken to keep the composting material adequately wet, but in temperate areas, there is little danger of water loss. However, during monsoon, the heap may be created above ground at an elevated position to regulate the surplus moisture. Wetting the mixture initially and at each turning, utilizing artificial windbreaks, and shade may aid in limiting the water losses[13].

Temperature

The material starts to decompose quickly after being piled up. The heap experiences each step of warming up, reaching a high temperature, cooling down, and maturing. Starch, sugars, and lipids, which are the most fundamental complex organic molecules, are first broken down, and the heat produced during this process quickly heats the heap once it reaches a peak temperature of 60 to 700 C. When the microorganisms are producing the most heat, heat loss from the heap is about equal to their output. Pathogenic organisms and weed seeds must be destroyed during the peak heating time in a heap. It usually happens 5-8 days after heaping or pitting. The temperature rises to 70 to 750 C in the centre of the pile before gradually declining. However, the ideal temperature is maintained at 600 C for 10 to 15 days after pitting before gradually lowering to 200 C.

Although using a compost thermometer may be the most effective method, one may also use their fist to determine the temperature of the pile. The temperature of the pile may also be determined by inserting a metal pipe or iron rod in the centre of it, regularly drawing it out, and touching it. During the first few weeks of composting, if the bar is heated or the pile's inside is uncomfortable warm or hot, everything may be well. A sluggish composting process is indicated if the temperature within the pile is the same as the outside. The breakdown rate may then be accelerated by adding nitrogen-rich material and rotating the pile.

The breakdown process is also influenced by the ambient air temperature. While low winter temperatures slow down or temporarily halt the composting process, higher outside temperatures in the late spring, summer, and early monsoon encourage microorganisms and speed up decomposition. Microbial activity will resume as the air temperature rises in the spring, or compost piles can be covered with polythene or a tarp during the winter to keep heat in for longer[14], [15].

DISCUSSION

Similar to the pH of most plants' cell sap, which is around pH 6, the initial pH of compost heaps is mildly acidic, or around pH 6. With a pH range of 5.5 to 8, compost microorganisms also function best under neutral to slightly acidic conditions. Organic acids are created in the early stages of decomposition, and this acidic environment encourages the growth of fungi and the disintegration of lignin and cellulose. The organic acids are neutralized as the composting process continues, and mature compost typically has a pH between 6 and 8.Rarely are compost piles too alkaline.

However, nitrogen can sometimes be lost through volatilization during highly alkaline composting. High levels of acidity, on the other hand, initially result in decreased microbial activity and a failure of the heap to warm up[16]. Due to the loss of ammoniacal nitrogen to the atmosphere as ammonia gas, adding lime ($CaCO3$) is typically not advised. In addition to leaving behind a strong odor, this loss depletes nitrogen, which is better kept in the compost for use by plants in the future. Utilizing egg shells or household ashes can help to reduce excessive acidity. If young and succulent materials make up the majority of the compost, ashes must be used.

Usually, acidity or alkalinity won't be an issue if careful consideration is given when creating the heap, particularly in moistening the content and aeration. During the composting process, organic acids may accumulate rather than decompose if anaerobic conditions arise. This acidity is diminished by aerating or mixing the system.

CONCLUSION

All sources for composting come from organic matter, which is anything that is alive or has ever been alive. Sugars, starches, cellulose, hemicellulose, lignins, pectins, resins, proteins, fats, and waxes make up the majority of the plant and animal residues. These waste materials are attacked by a variety of macro and microorganisms, such as bacteria, fungi, actinomycetes, protozoa, worms, and insect larvae, when they are placed in a heap or pit for composting. Due to these processes, a sizeable portion of the residue's constituent compounds are converted from their original complex forms to new, simple soluble ones. These degraded materials can be gases like carbon dioxide, methane, hydrogen sulfide, and ammonia or they can be solids or liquids like phosphate, potassium, ammonium, nitrate, organic acids, etc.

Among the organic components, those which quickly lend themselves to breakdown include the celluloses, hemicellulose, proteins, waxes and other nitrogenous compounds. Apart from this, the black and crumbly mass remains after decomposition of the organic matter called humus, and it comprises the primary number of organic residues. The residual organic residue, or humus comprises not only the residues of the organic substrate employed but also dead and decayed component of all the macro and micro-organisms which were engaged in breakdown of the substance. Finally, the end result is called the compost that may be characterized as black gold because of its nutritional benefits in rebuilding the lost soil fertility.

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CHAPTER 10

AN OVERVIEW OF THE COMPOST MANURE AND ITS BENEFITS, ENVIRONMENTAL IMPLICATIONS, AND METAL BIOAVAILABILITY

Dr. Madhu Prakash Srivastava, Associate Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-madhu.prakash@muit.in

ABSTRACT:

Compost manure, a rich agricultural resource, has attracted a lot of interest because of its multifaceted role in improving soil fertility, raising crop yields, and addressing environmental concerns. This abstract provides a summary of the many attributes of compost manure, including its production, benefits, impacts on the environment, and bioavailability of heavy metals. Compost manure is created by properly allowing organic materials to decay. This nutrient-rich waste may be used to enrich soil with organic matter and important nutrients. Its use has been shown to enhance soil properties, water retention, and root aeration, hence enhancing agricultural output.However, compost manure also poses environmental issues since it may include significant amounts of persistent organic pollutants and potentially harmful trace metals. If these contaminants penetrate into the soil and affect the quality of groundwater, they may endanger ecosystems and human health. The mix and availability of compost components as well as environmental conditions have an impact on the quality of manure made from compost and its potential for pollutant development.

KEYWORDS:

Heavy Metals, Organic Matter, Soil Fertility, Sustainable Farming, Waste Recycling.

INTRODUCTION

Corn is one of the most significant crops in Iran, particularly in the province of Fars. Both the production of industrial goods and the feeding of cattle utilize it. A crucial element nutrient that plays a crucial function in the formation of maize is nitrogen. Its use as fertilizer, according to several studies, may boost agricultural output. Due of its significant environmental hazards and costs, nitrogen fertilizer control is very important. Municipal trash generation is rising in Iran. It is obvious that its collection and burial require a lot of work and expense. Additionally, increased production of manure, a significant environmental problem that has to be addressed, is a result of intense industrial animal husbandry. Manure and composted municipal trash are thus potential sources of vital nutrients for crop development. In recent years, researchers and farmers in Iran have shown interest in utilizing compost and manure made from municipal garbage to enrich the soil with nutrients and organic matter. Application of cow dung led to an increase in maize output and N absorption, Manure and compost applications may enhance soil qualities and provide enough nutrients for maize. In this paper on tall fescue and observed that adding waste compost to the soil enhanced the output. Municipal garbage compost may boost soil organic matter and nutrients for maize production, according to Eriksen et al. This study set out to discover how N, composted municipal garbage, and manure affected the early development of maize in southern Iran [1]. The controlled breakdown of organic material to create humus or manure is known as composting. It may also be referred to as an aerobic decomposition stabilization procedure, which has been extensively used to many kinds of biodegradable garbage.

The C: N ratio of the waste is reduced when OM is broken down by aerobic and anaerobic microbes. Humus is created in natural systems by the same process as plant matter develops, dies, and decomposes in the soil. Currently, compost manure is employed as an affordable and straightforward solution for a broad range of environmental and socioeconomic issues. Numerous studies have been conducted on the advantages of compost manure. Both Pinamonti et al. and Garcia-Gil et al. found that adding compost manure to the soil enhances soil fertility, porosity, structural stability, accessible water content, and reduces erosion. Additionally, according to Pinamonti et al., compost manure protects soil's biological activity, boosts its OM content, retains moisture, and encourages root aeration while causing very little soil disturbance. In Greece, solid waste from olive trees and air pollution have been reduced thanks to compost manure. Compost might be used to clean up a landfill and transform it into a national park, according to Rynk's studies. Compost has been shown to improve stream bank stability in the Oconee River in Ben Burton Park near Athens, Greece [2], [3].

In addition to its significance and environmental advantages, compost manure also has certain negative effects. Compost manure, according to Garcia-Gil et al. and Jordao et al., raises the concentration of several persistent organic pollutants and potentially hazardous trace metals in the soil and plants. These pollutants seep into the soil and could affect the groundwater. Because of their toxicity, persistence, and bioaccumulation in the food chain, heavy metals and persistent organic chemicals absorbed by plants may have negative health impacts on people. Contaminants may build up to dangerous concentrations and harm the ecosystem under specific environmental circumstances. The kind of materials used to manufacture compost affects the degree of pollutants, which affects the quality of compost manure. This indicates that the quality of the compost manure is influenced by the source, environment, and conditions under which the compost material was produced. High levels of heavy metals, for instance, may be found in compost manure created from agricultural leftovers treated with sewage sludge and certain trace metal salts [4], [5].

High trace metal concentrations, such as lead and cadmium, are often found in compost materials that have been exposed to smelter emissions and automobile exhaust fumes. Toxic effects are mostly caused by the labile or bioavailable portion of the pollutant. The pH of the soil, the quantity of organic matter in the soil, the type of soil, the kind and number of contaminants, etc. are some of the elements that affect the amounts of labile metals in the environment. Most heavy metals' solubility and lability have been shown to be inversely linked to pH, with the exception of lead and copper. Heavy metals tend to accumulate in soil and plants in the following order: zinc > copper > Pb > Cd > nickel > chromium, according to cumulative study into the agronomic use of compost conducted in Europe. According to reports, heavy metals decrease microbial oxidation of organic molecules and hinder the nitrification and denitrification processes. The common sources of contaminants in compost manure, as well as their bioavailability, destiny, and toxicity, are highlighted in this mini-review. Since the contaminant must first be bioavailable in order for creatures and/or plants to absorb it, bioavailability and toxicity are partly related [6].

Metals and organic contaminants' bioavailability and fate in composted manure and manure applied to soil

The bioavailability and fate of heavy metals and organic pollutants in the compost are influenced by the procedure, the ingredients, and the environment. The portion of the pollutant that can be absorbed by plants or other living things after exposure is known as the bioavailability fraction. Metal ions may be free or exchangeable in compost, bound to carbonates, bound to Fe and Mn oxides, or bound to organic matter, depending on the state or charge that is affected by environmental factors. The Community Bureau of Reference extraction technique, a standardized procedure created by a group of specialists working under the auspices of the Commission of the European Communities, has been utilized in the majority of investigations on the bioavailability and fate of heavy metals in compost. Sequential extraction processes, in their ideal state, selectively remove metals associated to certain soil fractions with little impact on other soil constituents. The chosen chemicals selectively react with various matrix constituents, releasing the linked heavy metals. According to the strength of the metals' binding to the matrices, a range of mild to severe reagents were used for the successive extraction to get the metals freed [7], [8].

Heavy metals that are loosely bonded or free are removed first, while those that are strongly attached to organic materials are extracted last. This indicates that the quantity of organic matter and inorganic minerals typically have a significant impact on how metals behave in compost manure. The bioavailability and effects of heavy metals in municipal solid waste composts as contrasted to sewage sludge have lately been the subject of a thorough study. In this review, it is suggested that there is solid experimental data showing that composted MSW has lower metal bioavailability and crop uptake than other forms of sewage sludge. In comparison to other bio stabilization strategies, composting operations as a whole are thus expected to reduce the availability of metals in treated soil. The type of chemical association between a metal and the organic residual and soil matrix, the soil's pH level, the concentration of the metal in the compost and the soil, and the plant's capacity to control the uptake of a specific metal all affect the availability of metal in soil. Compost's total metal content has a significant role in regulating the absorption of labile metals by plants. This is because the total metal in compost rises with the plant-available proportion in soils. As contrast to composted residues with higher metal concentration, source separated trash with low metal content and green composts are hence anticipated to have generally lower metal availabilities [9], [10].

Metal Bioavailability and Fate in Manure Compost

Characterization and leaching of Cu, Mn, and Zn from swine manure as a result of composting. The study focused on how these metals will interact with the matrix elements throughout the course of 122 days of composting. Decomposition of organic matter led to enrichment, which resulted in an almost 2.7-fold increase in total metal concentrations in the finished compost. To assess the humification process and the partitioning of metals into water soluble, exchangeable, organically complexed, organically bound, solid particle, and residual fractions, a sequential extraction approach was also used. The water-soluble materials were extracted using water, the exchangeable materials with potassium chloride, the organically complexed materials with pyrophosphate, the organically bound materials with sodium hydroxide, and the solid particulates with nitric acid. The water-soluble organic carbon concentrations, which quickly rose to a maximum up to day 18 and subsequently fell, indicated changes in the Cu, Mn, and Zn water-soluble fractions throughout the composting process. However, following composting, the significant portions of the heavy metals were found in the fractions that were, respectively, organically bound, solid particle, and organically complexed. It was discovered that the distribution of heavy metals in various chemical fractions was not affected by the compost's age or its overall metal content [9].

The distribution of heavy metals during the composting of sewage sludge was investigated using sequential extraction. In this instance, potassium nitrate was used to extract the exchangeable mobile fraction, water was used to extract the soluble mobile fraction, sodium hydroxide was used to extract the organically bound material, ethylene diamine tetra acetic acid was used to extract the organically complexed or carbonates that could be mobilized, and nitric acid was used to extract the sulfides that could be mobilized. Heavy metals made up a significant component of the residual fraction and higher extraction-resistant fractions, which account for 12–29%. Only 2% of the metals were incorporated into bioavailable fractions. For all metals with the exception of nickel-hydrogen, the bioavailable fractions during composting that are dependent on the heavy metal and the physico-chemical characteristics of the medium decreased. It was discovered that Zn and Cu had a stronger affinity for the organic and carbonate fractions. Conversely, lead favored to attach more to sulfide forms, such as X-HNO_3[11].

Increasing Nutrient Levels

N, P, K, Ca, Mg, and S are among the key plant nutrients found in compost, along with other important trace elements. Compost is thus a kind of organic, multi-nutrient fertilizer. The employed organic feedstocks and compost processing conditions have an impact on the nutritional content of the compost as well as other crucial chemical characteristics including the C/N ratio, pH, and electrical conductivity. In agriculture, humus and nutrient-rich compost substrates may be made by properly combining these organic input materials, acting as an alternative to synthetic mineral fertilizers.

Increasing the Capacity of Cations Exchange

The CEC is one of the most crucial markers for assessing soil fertility since it focuses on nutrient retention, which stops cations from seeping into the groundwater. This paper demonstrated that adding compost to soil increased CEC because stabilized OM, which is rich in functional groups, was added. In the research by Mohammad et al., the same plots were utilized for replanting during the wet season after the first harvest from the dry season. Data from the second trial showed that the soil CEC, one of the major soil quality indices, increased as the compost application rates were increased from 0 tons per acre to 120 tons per acre, indicating a significant improvement in the nutrient exchange capacity of the soils treated with organic matter amendments. Amlinger et al. estimate that soil organic matter provides between 20 and 70 percent of a soil's CEC. Organic matter has a far higher CEC than any inorganic substance, ranging from 300 to 1,400 cmolc kg-1 in absolute terms [12].

Compost's Effects on Water Usage

Minimizing adverse impacts on the environment, particularly on water and soil resources, is vital to guarantee optimal production of agricultural systems that are permanently sustainable. That includes, among other things, preventing soil deterioration that results in nutrient and organic matter losses connected to a fast decline in biologic production and soil quality. The reduced capacity of soil to hold water is one of the reasons for this deterioration. In recent years, the capacity of soil organic matter to bind water has emerged as a key study subject. The soil benefits from compost in a number of ways that synthetic fertilizer cannot. First, it enhances the way water interacts with the soil by adding organic matter. Compost functions as a sponge in sandy soils, holding onto water that would otherwise flow below the reach of plant roots and defending the plant from drought [13].

Contrarily, compost aids in increasing the porosity of clay soil, allowing it to drain more easily and preventing it from becoming waterlogged or drying into a brick-like structure. Composts are used in agriculture to promote soil fertility and quality because they may increase the amount of organic matter, particularly in sandy soils that have a poor ability to store water and nutrients. Composts may increase soil organic matter content and increase the soil's ability to retain water. According to Mohammad et al., soil moisture content improved as compost application rates climbed from 0 tons per acre to 120 tons per acre, suggesting a significant improvement in water availability. Brown and Cotton established a positive correlation between soil organic matter concentration and retentive ability, and a negative correlation between soil density. According to their findings, the treated soil had a water-holding capacity that was almost 1.57 times more than that of the control soils. Zemanek also affirmed the use of 50 t ha-1 and 100 t. Regardless of any potential influence from the kind of soil, the amount of grassing, or the number of rainfalls, ha-1 compost has a favorable impact on soil moisture retention. The findings of 100 t ha-1, however, demonstrated prolonged retention of greater moisture levels [14].

Impact of Compost on the Biological Properties of Soil

The enhancement of soil biology is one of the most significant impacts of using compost. The soil is home to a wide range of species, from those that are huge and obvious to those that need a strong microscope to observe them. These organisms carry out a variety of tasks that significantly contribute to what we perceive to be healthy and normal soil. It's fair to say that these organisms play crucial roles in how the soil system functions, but that functionality depends on the availability of carbon. In this situation, compost has a stimulating influence on soil microbiota as well as the microbial population in the compost substrate. According to Brown and Cotton, microbial activity has risen when compost has been applied compared to control soils. Given that compost contains organic matter, which serves as food for microorganisms, they discovered that microbial activity was 2.23 times higher in the soils that had been treated with compost than in the control soils [15].

Compost's Effects on Crop Productivity

Compost supports the stability and improvement of agricultural yield and crop quality due to its many advantageous impacts on the physical, chemical, and biological soil qualities. Compost has been shown via long-term field tests to have an equalizing influence on seasonal and yearly variations in soil moisture, air and heat balance, availability of plant nutrients, and therefore crop yields. So, compared to pure mineral fertilization, a better yield safety may be anticipated. In comparison to spreading compost in lesser quantities of 10 Mg ha1 year, better crop yields were often attained if bigger volumes of compost were treated every second to third year during the early years. However, crop yields after the application of pure compost were often lower than those following the application of mineral fertilizer, at least during the initial years. The gradual release of nutrients during compost mineralization may account for this. Composted organic wastes have been compared to synthetic fertilizers by Mohammed et al. for improving crop production and agricultural sustainability across two seasons. The dry season trial's yield findings revealed a progressive improvement in crop output when the amount of compost treatment was raised from 0 tons per acre to 120 tons per acre. According to data from the second corn harvest, treating the soils with more compost resulted in a noticeably higher yield. When treated at a rate of 120 tons per acre during the wet season, however, the yield was lower than when it was applied at a rate of 60 tons per acre. This was a sign that further treatment reduced grain output, perhaps as a result of the lush green vegetative growth that was seen throughout the growing season [16].

DISCUSSION

Compost manure usage in agriculture is a subject with numerous dimensions, including its various advantages, potential environmental repercussions, and contribution to environmentally friendly farming practices. Compost manure is a helpful technique for boosting soil fertility and crop yields since it is created when organic materials break down under controlled circumstances. By including significant minerals and organic matter, its application enhances the soil's properties, leading to enhanced water retention and increased root aeration. These benefits, which are especially significant in regions with nutrient-depleted soils, increase agricultural productivity[17]. According to the principles of sustainable farming, utilizing composted manure also lessens the need for synthetic chemical fertilizers, which could have a harmful impact on the environment.Compost manure is a topic that is more complex than just its advantages. Environmental concerns are raised by the potential presence of dangerous trace metals and enduring organic pollutants in composted materials. Ineffective management of these poisons might result in groundwater contamination and soil contamination, harming ecosystems and human health. As a consequence, the composition of compost materials and the source of organic waste become important factors for determining the quality of compost manure and the level of contamination accumulation.The bioavailability and fate of heavy metals in composted manure need further research. Composting practices may alter how easily accessible heavy metals are in soil that has been treated, according to studies. Metal concentrations, compost type, and soil pH are a few of the variables that have a significant impact on metal bioavailability[18]. This information permits educated decisions on the safe use of compost manure in farming, which is crucial for implementing sustainable agricultural practices and effective environmental management.The topic of compost manure has been examined in terms of both its important benefits for agriculture and its potential implications on the environment. As the agricultural industry searches for ecologically friendly and sustainable methods, compost manure remains a crucial resource. It is essential to address and manage the challenges associated with its use, particularly in terms of heavy metal pollution and persistent organic pollutants, in order to ensure that its use is consistent with the more general goals of sustainable farming and environmental stewardship. Further research and approved practices are required to optimize the benefits of compost manure while minimizing any potential downsides.

CONCLUSION

In conclusion, compost manure is an essential part of modern agriculture, offering a wide range of benefits for crop productivity, soil fertility, and ecologically responsible farming practices. It has a well-established history of enhancing soil structure, increasing water retention, and increasing agricultural output. Additionally, it could provide important nutrients and organic matter to the soil. This resource fits with the tenets of sustainable farming by reducing dependency on synthetic chemical fertilizers and limiting any potential environmental damage. However, given the discussion around its use, it is important to address any potential environmental impacts. Due to the existence of dangerous trace metals and persistent organic contaminants, composted materials must be carefully assessed and handled to prevent polluting soil and groundwater. The amount of organic waste and the environment in which compost manure is produced undoubtedly impact the quality of the final product. Given the bioavailability and destination of heavy metals in composted manure, a detailed understanding of these processes is therefore necessary to ensure safe and durable agricultural methods. Variables including pH, metal concentrations, and compost type all have a significant impact on the behavior of metals in treated soil and their potential for crop absorption. The argument over compost manure fundamentally exemplifies the thin line between agricultural development and environmental responsibility. Although its advantages are obvious, it is crucial to manage the associated challenges and potential risks. Responsible composting practices, careful source selection, and ongoing research are essential components of any comprehensive plan to maximize the benefits of compost manure while protecting the environment. As agriculture progresses, compost manure remains a crucial tool for sustainable farming, provided it is used sparingly and with a strong dedication to ecological care.

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CHAPTER 11

AN OVERVIEW OF THE ENHANCING SOIL FERTILITY IN ORGANIC VEGETABLE FARMING

Dr. Kanchan Awasthi, Associate Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-kanchan.awasthi@muit.in

ABSTRACT:

Successful organic vegetable production depends on fertile soil, and current agricultural methods still abide by the maxim "feed the soil, not the plant." Healthy soil is a top priority for organic farmers in order to maintain a diversified and active microbial community, which not only protects against environmental deterioration but also provides plants with crucial nutrients. The special difficulties experienced by organic farmers, which may result in variances in nutrient availability, are addressed in this Chapter as it explores several techniques for regulating and sustaining soil fertility in organic vegetable production. To nourish soil systems and improve fertility, organic approaches depend on biological inputs such composts, cover crops, green and animal manures, and animal waste. The decomposition of organic matter is aided by these inputs, releasing essential nutrients for plant absorption. Organic agriculture is a biologically dynamic process because it uses biological inputs to control soil fertility, but it also offers challenges for nutrient management. The Chapter also explores the value of soil pH in organic farming, emphasizing how crucial it is to keep pH levels in the ideal range for vegetable crops.

The solubility of nutrients, microbial activity, and root growth are all influenced by soil pH. The need of routine soil testing and adequate pH acclimatization using substances like agricultural limestone and gypsum is highlighted by the fact that both high and low pH levels may alter the availability of nutrients.

KEYWORDS:

Farming Practices, Fertilization Techniques, Organic Agriculture, Soil Enrichment, Sustainable Farming, Vegetable Cultivation.

INTRODUCTION

One of the proverbs that organic farmers still utilize in crop production is feed the soil, not the plant. This is because healthy soil is the cornerstone of every successful organic agricultural system. A healthy soil supports a diversified and active biotic population that aids the soil's defense against environmental deterioration while also supplying vital nutrients to plants. Instead, then providing large amounts of soluble nutrients from synthetic fertilizers, emphasis is put on biological processes within the soil system to recycle and release nutrients. The many methods for regulating and maintaining soil fertility for organic vegetable production systems are the major topic of this Chapter[1]. The management of soil fertility presents a number of difficulties for organic vegetable farmers, which may lead to variations in the quantity of nutrients provided and the fertility status of organically managed farms. Organic producers employ a variety of biological inputs, such as animal and green manures, composts, cover crops, and animal wastes, to construct soil systems and improve fertility.

These inputs encourage the breakdown of plant and animal matter, releasing nutrients for plant uptake. Since organic agriculture is guaranteed to be a biologically dynamic process by managing soil fertility with biological inputs, nutrient management in organic systems is very difficult[2].

Organic Matter in Soil

Organic matter in the soil plays crucial functions in enhancing soil health. It affects the soil's bulk density, aggregate stability, cation exchange capacity, and biological activity, among other significant soil features. SOM functions as a slow-release store for macro- and micronutrients for plants. Along with many other roles, it also buffers and neutralizes soil pH, makes it easier for air and water to infiltrate the soil, and makes the soil more adept at retaining water. SOM is nevertheless a significant source of nutrients in organic production systems even if its yearly rates of breakdown only amount to 3.5% on average[3].

Detritus, also known as active SOM, is made up of extensively degraded, unidentifiable organic leftovers and live microbial biomass. It is also made up of humus, which is organic matter that is resistant to further decomposition. The bacteria that are in charge of breaking down plant waste and other debris into humic compounds, which make up around 75% of SOM, are included in the live microbial biomass. The end result of decomposition is stable organic matter, which is referred to as humus. The active component or light fraction refers to the first two categories of SOM. The active component swiftly undergoes chemical or physical changes and is quickly mineralized, which helps to improve soil fertility by releasing plant nutrients like nitrogen, phosphorous, and potassium as a consequence of the breakdown of these components. The short-term nitrogen cycling and plant nutrient availability are greatly impacted by the active component of SOM, which has a low C:N ratio, generates less humus, decomposes faster, and is more susceptible to grower control. Management of the active or light fraction of SOM as well as the inputs that affect the composition of this fraction are crucial for regulating nutrient availability for organic vegetable production. The highly developed component of SOM, known as the humus fraction, is stablethat is, resistant to further decomposition—and has a much less impact on soil fertility. Humus enrichment is crucial since it enhances a variety of soil's physical and chemical characteristics[4].

There are C:N ratios utilized. As part of the organic matter's nitrogen is transformed into plant-available nitrogen, SOM may provide many of the most crucial nutrients to plants. PAN is the total amount of nitrogen supplied to plants throughout the growth season in the forms of nitrate and ammonium. Each growing season, each 1% of SOM provides an estimated 10–20 pounds of nitrogen per acre. Iron, copper, zinc, phosphorus, potassium, sulfur, and other elements are also provided by SOM.

The Value of Soil pH

Maintaining ideal pH levels is one of the simplest and most crucial elements in all plant-growing systems. Most vegetable crops thrive best on soil with a pH between 6 and 7. Nutrient solubility, microbial activity, and root development are all influenced by the pH of the soil. High pH encourages bacterial growth, increases cation release, and mineral weathering, but it also limits the solubility of salts like carbonates and phosphates. Low pH levels often cause nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, and molybdenum to be less readily available. However, with pH values below 5, the availability of aluminum and manganese may rise to dangerous levels. Low pH levels inhibit key microbial decomposers' activity, which may significantly slow down the biological transformation of organic matter into nutrients useful for plant development. Low pH reduces legumes' ability to fix nitrogen[5].

Due to the application of manure over time, many soils become acidic; thus, it is crucial to monitor pH levels and, if necessary, add agricultural limestone in accordance with the recommendations of soil tests. pH values in soils between 7 to 8.3 encourage microbial activity but may reduce the availability of phosphate, iron, manganese, copper, and zinc. Alkaline conditions boost the availability of these nutrients, which may be improved by using organic matter additions. Due to the significance of pH, organic farms should conduct frequent soil tests and, when necessary, add lime to the soil to maintain the right pH. Calcium and magnesium may also be found in limestone, while calcium and sulfur can be found in gypsum[6].

Fertility of Nitrogen

It might be one of the key limiting variables in organic fertility programs since nitrogen is a crucial nutrient that plants need in high concentrations. Although there is still much to learn about this nutrient in organic systems, significant effort and research has been given to it because of its significance in the development of organic vegetables.

i. Immobilization and Mineralization of Nitrogen

Microbes metabolize organic carbon and transform organic nitrogen molecules into the inorganic ions nitrate and ammonium that plants may use during the process of organic matter mineralization. SOM, agricultural waste, manure, and compost are some examples of sources of organic nitrogen. In a process known as ammonification, microorganisms break down big organic compounds into smaller ones by converting the organic nitrogen to ammonia and subsequently to ammonium, which is a form that plants may use. Ammonia-oxidizing microorganisms may use ammonium as a source of energy by generating nitrite, which is then promptly transformed into nitrate by a process known as nitrification. However, nitrogen mineralization is usually associated with immobilization since the released nitrogen is used by soil microbes to oxidize fresh carbon substrates, rendering the N inaccessible to plant uptake. As the soil bacteria die, the nitrogen that has been bound up in them will finally be free for mineralization. Calculating the time and amount of nitrogen mineralization is difficult due to the multiple variables that influence the process. The following elementstemperature and moisture, soil structure, and tillageare the most crucial. Mineralization begins relatively slowly below 10 °C and speeds up as the temperature rises. Mineralization moves quickly in moist soils but significantly slows down in very wet or dry soils. Coarse-textured soils with low clay concentration have a tendency to boost mineralization rates, but the rate tends to decrease as soil clay content rises. By enhancing aeration and incorporating crop leftovers, tillage improves the mineralization of soil organic carbon and nitrogen[7].

ii. Carbon-to-Nitrogen Ratio

The carbon-to-nitrogen ratio of organic matter refers to the proportion of carbon to nitrogen. In organic matter, carbon constantly predominates over nitrogen. The carbon-to-nitrogen ratio, abbreviated C:N, is often expressed as a single value. Therefore, a ratio of 20 indicates that the organic matter contains 20 g of carbon and 1 g of nitrogen. When the C:N ratio of an organic substrate is between 1 and 15, N is quickly mineralized and released, making it accessible for plant uptake. The faster nitrogen is delivered into the soil for immediate crop use, the lower the C:N ratio. Microbial immobilization occurs when the C:N ratio exceeds 35. A balance between mineralization and immobilization is reached at a ratio of 20 to 30. The C:N ratio of soil microorganisms is around 8. They have been shown to function best on a "diet" with a C:N ratio of 24, which they must get from the soil in order to keep that ratio in their cells[8].

iii. Relationship Between N Mineralization and Plant Uptake

When the mineralization of organic matter does not coincide with the ideal period of time when the plant needs and can use N, one of the challenges with applying organic nitrogen fertilizer arises. When N is mineralized early in the crop development cycle, before the peak crop requirement, this might happen. This implies that for organic vegetable gardeners, nitrogen mineralization often struggles to provide N during times of high crop development, and the vegetable crop may deplete the PAN, leading in a loss of yield or quality. Because of this difficult scenario, producers may depend on extra N from commercial organic fertilizers to satisfy peak crop demand[9].

Animal Manures

According to the National Organic Standards Final Rule, "Raw animal manure must be either composted, applied to land used for a crop not intended for human consumption, or incorporated into the soil at least 90 days before harvesting an edible product that does not come into contact with the soil or soil particles and at least 120 days before harvesting an edible product that does come into contact with the soil or soil particles." The use of raw manure by vegetable farmers is restricted by these regulations, and many industrial vegetable operations often exclusively utilize composted manure as a nitrogen source. Raw manure, however, has a few restricted uses, including the building of SOM and vegetable rotations.

Any manure's particular nutritional composition varies according on the animal's species, diet, kind of bedding, and quantity of liquid provided. Manure should be tested to determine its fertilizer value. If liquid manure doesn't include any solids, it could not make a big difference in the amount of organic matter that accumulates. The nitrogen level of fresh, uncomposted manure will be higher than that of composted manure, however the usage of composted manure will increase the SOM content. When applied in excess, fresh manure's high concentration of soluble nitrogen may cause leaching losses. There may be a lot of viable weed seeds in fresh manure, which might cause weed issues. With reference to manure, heavy metals might also be an issue.

A issue has been seen when producers utilize fresh manure or even compost from animals that were fed hay or grass sprayed with a herbicide that contains the active component aminopyralid in addition to these worries. Because it is difficult to degrade, this pesticide may pass through the digestive tract of a horse or ruminant and end up in the dung. The active component in manure, if applied to a field, may harm plants by causing new growth to twist and develop more slowly. Following repeated application, the use of animal manures for delivering nitrogen may also increase the soil's "phosphorus loading" or excessive amounts of phosphorus. The reason why there are too many phosphorus levels in the soil is that most manure types have phosphorus to nitrogen ratios that are higher than what most vegetable crops need. As a result, the use of manure in any system for growing vegetables must be treated with caution and in a realistic manner; otherwise, it may not be the best option for all farmers.Rapidly dried manure or compost may be simpler to work with and spread more evenly across fields, particularly if it has been converted into pellet form.

Heatdrying of manure and immature compost may enhance ammonia-nitrogen volatilization and decrease the end product's overall nitrogen content. The biological activity of partially decomposed material won't be as great as that of mature compost if it has been dried quickly at high temperatures rather than cured at room temperature. Growers must confirm that the manure or compost has been approved for use in organic crop cultivation before utilizing it[10], [11].

Compost

Many organic vegetable gardeners choose composted manure because it increases long-term soil fertility and health while reducing any possible health and environmental problems associated with spreading raw manure. Organic guidelines state that "composted plant or animal materials must be produced through a process that establishes an initial carbon-to-nitrogen ratio between 25:1 and 40:1 and achieves a temperature between 130°F and 168°F.

Figure 1: Represented the Making Compost with Organic material[12]**.**

When utilizing different composts, the C:N ratio must be taken into account. It also affects how the compost is processed. Composting operations using windrow composting systems are required to keep the temperature within the acceptable range for at least 15 days. Materials must be rotated four or five times during this period, as shown in Figure 1.Most weed seeds and pathogens are destroyed by the heat produced during the composting process. By transforming animal manure, bedding, and other raw materials into humus the more stable organic component present in soil the microbial-mediated composting process decreases the quantity of soluble nitrogen forms. Because a significant portion of nitrogen is bound as proteins, amino acids, and other biological components, stable humus has little free ammonia or soluble nitrate. Compost also stabilizes additional nutrients. Composting has the drawback of causing some ammonia-nitrogen to escape as gas. Compost by itself may not be able to give crops with enough nutrients, especially nitrogen during their fast development stages when they have high nutritional needs. Additionally, compared to fresh or partly aged manure, composted manure is often more costly. If compost is the main source of N for a vegetable crop, application rates of 25–30 tons/acre or more must be employed due to composts' comparatively low levels of N, P, and K. In one research, compost was sprayed to muskmelon and broccoli crops; nevertheless, the yields did not rise at costs that were affordable to most producers. Compost generally contains just 1% to 2% nitrogen on a dry weight basis, thus utilizing compost as the main source of nitrogen does not make economic or practical sense when crops need 100 to 200 pounds of nitrogen per acre. However, compost application has advantages beyond only boosting N value. For example, it may increase SOM, enhance soil tilth and aeration, and increase other plant nutrients including phosphorus, potassium, and other micronutrients. When a cover crop cannot be employed, preplant inclusion may be the optimum use of composts [13], [14]. A compost with a low C:N ratio might act as the sole source of nitrogen for a crop grown in a short growing season or as an early nitrogen supply for a transplanted vegetable crop for 4- to 6-weeks after inclusion.

Green manures and Cover Crops

Any plants raised particularly to control soil erosion, soil fertility, soil quality, water, and several other ecological characteristics in a field are referred to as cover crops. The development of vegetable crops commonly makes use of green manures, which are produced for their nutritional worth. They are a kind of cover crop that is especially cultivated to provide nitrogen and scavenge nutrients from the soil, hence reducing nitrate leaching, nutrient runoff, and soil erosion. Cover crops and green manures are often used interchangeably. When these crops are used, they may significantly contribute to the management of nitrogen for the growth of organic vegetables. Traditionally, cover crops are sown following vegetable harvests and allowed to grow through the autumn, winter, and early spring before being eliminated by plowing the crop under. Although they cannot fix nitrogen, cereals, other grasses, and mustards are especially effective in absorbing lingering soil nitrate. They may be particularly successful in scavenging nutrients from the soil and/or adding organic materials. When compared to bare land, grass cover crops have been demonstrated to minimize nitrate leaching by 65% to 70%. However, only in the presence of Rhizobium bacteria, which have a mutualistic, synergistic interaction with leguminous plants, are legumes able to fix atmospheric nitrogen and provide extra nitrogen. Legumes produce great green manures because of their low carbon-to-nitrogen ratios, which promote a quick release of nitrogen when the plants break down, but the long-term contribution of organic matter to the soil is limited. One of the most environmentally friendly methods to provide nitrogen and other nutrients to vegetable crops is via cover crops or green manures. Because nutrients are delivered gradually, cover crops, unlike manure or compost, do not promote phosphorus loading and there is less nitrogen leaching. A robust green manure crop may enrich the soil with 80–200 pounds of nitrogen per acre for the subsequent vegetable harvest [15].

The subsequent crop will only use a modest to moderate amount of the nitrogen from a green manure cover crop. This is caused in part by nitrogen being immobilized by soil microbes or by a cover crop with a very low C:N ratio, which leads to poor nitrogen linkage. As a consequence, the nitrogen in the green manure is released extremely rapidly, before the crop is most in need of it. However, a significant portion of the nitrogen produced by green manure crops often persists in the soil humus system for many years before gradually becoming accessible to succeeding crops.

DISCUSSION

The problem of enhancing soil fertility in organic vegetable production is of the highest importance in the context of sustainable agriculture. Organic vegetable farming, which is characterized by the avoidance of synthetic pesticides and a concentration on natural approaches, largely depends on soil health in order to provide successful and healthy crop harvests. A number of perspectives are being taken on this issue in an attempt to make agricultural practices and ecological values compatible.Utilizing organic matter, such as compost and cover crops, is a crucial method of increasing soil fertility for the growth of organic vegetables. These elements supply useful nutrients, enhance soil structure, and encourage microbial activity. By cultivating a diverse and active soil ecosystem, organic farmers may create conditions that support nutrient cycling and retention.Another widely used method in organic farming to reduce soil erosion and pest damage is crop rotation[16]. In order to minimize nutritional imbalances in the soil, break the cycles of insects and diseases, and enhance overall soil fertility, vegetable crops should be rotated in a planned manner.The importance of minimizing soil erosion and runoff cannot be overstated. Organic farmers often use conservation practices including mulching, contour farming, and terracing to prevent soil erosion and conserve moisture. These techniques support maintaining soil fertility, water conservation, and the agricultural system's long-term sustainability.The utilization of organic matter, crop rotation, and soil conservation techniques all work together to improve soil fertility while producing organic vegetables. A holistic approach that prioritizes soil health is compatible with organic agriculture's basic ideals of sustainability and environmental responsibility in addition to enhancing crop yields. This session focuses on the significance of soil cultivation as a key element in organic food production systems[17].

CONCLUSION

The aim of boosting soil fertility in organic vegetable production is thus not just a practical need but also a fundamental commitment to sustainable and ecologically friendly agriculture practices. At a time when the world is increasingly seeking for alternatives to conventional farming practices that rely on synthetic pesticides and monoculture systems, organic vegetable growing stands out as a holistic plan that emphasizes soil health.Through the thoughtful incorporation of organic matter, crop rotation strategies, and soil conservation techniques, organic farmers can create a thriving soil ecosystem that not only supports high-quality vegetable yields but also embodies the principles of harmony with nature and long-term viability. The symbiotic relationship between soil fertility and organic food growing demonstrates how agriculture may coexist with the environment.Continuous learning and adaptation to shifting ecological dynamics define the never-ending journey in this direction. Since organic vegetable farming prioritizes enhancing soil fertility, it offers promise for a more sustainable, nutrient-dense, and environmentally conscious future in agriculture. It seems evident that as we explore new techniques and scientific insights, safeguarding the life under our feet will continue to be a crucial element of moral and effective farming practices for a lot of generations.

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CHAPTER 12

AN OVERVIEW OF THE IMPACT OF HIGH ELECTRICAL CONDUCTIVITY COMPOST ON SOIL AND PLANT HEALTH

Dr. Kanchan Awasthi, Associate Professor,
Department of Science, Maharishi University of Information Technology, Uttar Pradesh, India
Email Id-kanchan.awasthi@muit.in

ABSTRACT:

This research examines the effects of compost with high electrical conductivity (EC) on soil and plant health in an effort to provide light on sustainable farming methods. High EC compost has attracted interest as a possible soil addition to boost agricultural yield while reducing environmental issues. It is enhanced with organic matter and mineral nutrients. The study investigates the dynamic interaction between the application of high EC compost and its effects on soil characteristics, nutrient availability, microbial activity, and plant development. Data is gathered and evaluated via a series of field trials and controlled tests to determine the effects of high EC compost on different soil types and a variety of crop species. For farmers, agronomists, and politicians looking to maximize agricultural methods that support soil fertility, plant vigor, and long-term ecological sustainability, the study's results provide crucial information. In the end, this study advances knowledge about the function of high EC compost in contemporary agriculture and its potential to solve issues with food security and environmental preservation.

KEYWORDS:

Environmental Impact, Nutrient Availability, Plant Growth, Soil Health, Soil Amendment, Sustainable Agriculture.

INTRODUCTION

A regulated aerobic, biological breakdown of organic materials results in the creation of compost. At both mesophilic and thermophilic temperatures, the product is subject to microbial activity, which greatly lowers the survivability of pathogens. The content and origin of the biodegradable materials utilized, together with the composting process employed, determine a broad variety of chemical parameters of compost, including nutrient composition, pH, and bulk density. Compost used to be made from leftover plant matter. Agricultural waste, yard trash, source-separate food waste, municipal organic waste, biosolids, even human or animal manures are now included in more modern composting operations. The necessity to dispose of or use these wastes in an ecologically acceptable manner is highlighted by the fact that they are producing trash at a rising pace and have the potential to damage the air, water, and land. Composters may recycle and reuse agronomically valuable materials that would otherwise wind up in landfills and have no other purpose by adding these organic wastes to the compost. Recycling these organic wastes and creating compost encourage sustainable agriculture practices and lessen reliance on limited resources [1], [2].

Compost mostly contains nutritional forms of N, P, and K. The different types of nitrogen found in compost or fertilizer may be interconverted into the nutrients nitrate and ammonium, which are assimilable by plants. Orthophosphate and potassium oxide are the forms of P and K that are most readily absorbed by plants in soils. Composts may also include salts, micro- and macronutrients, heavy metals, and other pollutants in addition to these essential nutrients.

Composting may change the physical and chemical characteristics of soils, improving their capacity to encourage vegetative growth. Although compost normally contains a wide range of advantageous plant nutrients, due to the considerable variability of nutrients across the many compost products and Test techniques and criteria, it is not regarded as a fertilizer. Despite compost's proven advantages for plant development, certain compost applications have been viewed with mistrust because of their potential high salt content. There is a misconception that applying composts with high levels of soluble salts might have an adverse effect on the soil's quality and plant development. Due to the phytotoxicity linked to certain soluble salts like Na and Cl, areas that are struggling with soil salinity and sodality may be hesitant to add compost to their crops [3].

Sodicity, also known as exchangeable sodium percentage or sodium adsorption ratio, is the term used to describe the quantity of Na retained in the soil. SAR is the ratio of sodium to calcium and magnesium, while ESP is the ratio of sodium to the total cation exchange capacity of the soil. Salinity, on the other hand, is the measurement of soluble salts in the soil. Plants growing in low- or non-sodic settings may be constrained by the availability of nutrients, including salts, while plants growing in high-nutrient environments may be constrained by high salinity, high sodality, or both [4].

Osmotic effects are also an issue. High soil salinity may restrict vegetative growth and production by reducing the absorption of nutrient molecules into plants. According to research by Sharpley et al., too much salt reduces the total P content of plant tissues, which lowers agricultural output and plant vigor. Sodic soils are created when NaCl builds up in the soil. Plants cultivated in these soils have scorched leaf margins, which lower overall plant vigor and crop output. According to this paper, there is a range of nutrient concentrations that is appropriate for vegetative development. Importantly, these ranges depend on the species in question as well as the soil type and water potential. The plant may develop nutrient-induced shortages or nutrient-induced toxicity when nutrients are present outside of this ideal range. The variety seen in soils, water potential, plant salt tolerances, and the form of available nutrients make it difficult to pinpoint the range of ideal nutrient concentrations [5].

So, it makes sense to be concerned about how excessive salt content in compost can affect the soil and agricultural productivity, particularly in dry and semi-arid areas. In order to determine which soluble salts are present in compost and how those salts affect soil and plants, as well as to identify knowledge gaps and potential causes of misunderstanding, the purpose of this article is to analyze recent research. The main objective of this study is to serve as a resource for compost producers and consumers so they may choose how to create and use compost with knowledge [6].

Electrical Conductivity in Soil and Compost

There may be soluble salts of a number of the ionic elements that are present in soil and compost. The presence of Na^+, K^+, Ca_2, Mg^{2+}, Cl^-, SO_4^{2+}, CO_3, HCO_3^-, and NO_3^-ions as well as various micronutrients often affects the salinity of soil and compost. The United Nations Food and Agriculture Organization, Rhodes, and Soil Survey Staff all provide a wealth of salinity-related information today. Electrical conductivity is a technique that is often used to assess the soluble salt content of compost or soil. This technique involves combining soil or compost with water to create a thick paste or slurry. Two electrodes that are submerged in the paste or slurry are then connected by an electrical current. The electrical transmission between electrodes will be greater the higher the quantity of soluble salts. Deci siemens per meter, milli siemens per cm, and micro siemens per cm are the units used to represent readings.

An overview of unit conversions. It's important to note that EC testing only determines the overall cumulative concentration of the soluble salts present; it does not identify the kind of salt present in the sample [6]. Therefore, even though NaCl is one of the most prevalent soluble salts, there are many others that are present in different composts and soils that might lead to a high EC.

Due to the various measurement techniques and difficulty to directly compare the findings, there is confusion over the EC levels in compost and soil. Compost EC is assessed using a technique known as EC5, whereas the EC of soils and soils treated with composts is often tested using a saturated paste extract. To account for the higher levels of soluble salts in compost, EC5 is evaluated using extracts from a 5:1 water-to-compost combination. Both of the aforementioned techniques provide an EC measurement, but since they are not equivalent, they cannot be compared directly. Additionally, techniques using different volumes of water: medium have been explored in a number of research. Due to the heterogeneity in soil properties, equations to convert ECe to EC5 or other dilutions have not yet been fully developed. For instance, the presence of clay in a soil sample might reduce the accuracy of findings when converting them from one technique to another since clay has the capacity to retain/adsorb ions. As a consequence, although the various ways of calculating soil EC are similar, they must be properly interpreted with the knowledge that there may be some accuracy loss when combining the findings of several approaches.

Additionally, there has not yet been a complete documentation of research of compost feedstocks and their impacts on different EC testing approaches. The electrical conductivity (EC) of composts made from various feedstocks and techniques for calculating it are discussed in multiple published research publications that are examined in this work [7].

Chemical analysis may help pinpoint the precise salts responsible for a certain EC value. For instance, PXRF has the advantage of using elemental data to predict cation exchange capacity and base saturation percentage. Weindorf et al. used PXRF to determine the salinity of compost while simultaneously reporting many of the fundamental elements/ions responsible for such. Compost, soil, and water may all be chemically analyzed to find out what they are made of, using techniques like flame photometry, inductively coupled plasma optical emission spectrometry, and different titrations. An agricultural index may be determined after detecting and figuring out the precise quantities of soluble salts contained in a compost.

When a compost's micronutrient mass is divided by its NaCl mass, the result is called the Ag Index. Due to the high ratio of micronutrients to NaCl, composts with an Ag Index > 10 are regarded as being of good quality. Due to the high NaCl content or deficiency of micronutrients in the compost, values of 2 are regarded as being of low quality. The Ag Index of compost may help allay some of the worries regarding soluble salts in composts by showing that their presence is minimal and shouldn't have a negative impact on the application of soil and plant yields. Additionally, there could be a dearth of knowledge of the Ag Index, so teaching farmers and compost end-users how to utilize the Ag Index would be helpful. Further raising awareness of the composition of compost and its advantages would be forcing composters to correctly label their compost with a relevant Ag Index or a range of the nutrient contents [8].

Research has long been focused on how excessive soil salinity and sodicity affect plants and how well they can withstand these circumstances. Highly salinized or salinity-sodic soils often have two effects on plants. First, when a plant is cultivated in saline or saline-sodic soil, its capacity to absorb water is severely hampered. This is known as the osmotic impact of salt, or the water-deficit effect, and it eventually slows development.

Second, it's conceivable that plants growing in these soils would amass an excessive number of soluble salts within their cells, which will eventually be harmful. The salt specific or ion-excess impact of salinity is the term used to describe this excessive buildup. Salt tolerance, which is defined as the plant's relative yield shown as a function of the average root-zone salinity, is the capacity of plants to withstand various environmental stresses. Plant species differ in their capacity to tolerate salt as a consequence of their unique evolutionary histories [9].

Application of High EC Compost to Saline-Sodic Soils

As previously indicated, there are issues with adding high EC compost to salty or salt-sodic soils. Will such treatments have a negative impact on the soil and/or the plants that are cultivated there? High salinity in soil is described as having an ECe of 16 dS m1 and is distinguished from saline soils by having an ECe > 4.0 dS m1. A high pH and severe ratios of Na^+/Ca^{2+}, Na^+/K^+, Mg^{2+}/Ca^{2+}, and Cl^-/NO^{3-} are often used to describe the salinity and sodicity of saline and salty sodic soils. These nutritional imbalances slow down plant cellular functions, which eventually results in decreased vegetative growth and production. Clay swells and disperses due to an excess of Na, which reduces soil permeability, available water capacity, and infiltration rate.

Additionally, soils that are salty or salty-sodic are probably lacking in organic matter and sources of nitrogen. Low soil porosity and CEC due to low organic matter may also restrict vegetative development. These soil issues are often caused by geological processes, brine water leaks, inappropriate fertilizer management, and/or irrigation with water that is rich in soluble salts. These unfavorable circumstances are even worse in dry areas where there is a lack of high-quality irrigation water and water evaporates fast.

Additionally, saline and saline-sodic soils are spreading around the globe at an alarming rate, endangering agricultural systems by lowering soil fertility. Reclaiming these soils and putting them back in a better shape for agricultural production is thus becoming more and more important [10].

The fundamental goal of recovering sodic soils is to lower the total Na content by substituting Ca^{2+} with exchangeable Na^+. Gypsum, sulfuric acid, and organic matter are popular modifications used to do this, either alone or in combination. When sulfuric acid is applied to calcareous sodic soil, calcite reacts with the acid to provide a soluble source of Ca^{2+}. Given its greater affinity for the lyotropic series, Ca^{2+} may therefore take the place of Na on the exchange complex of clays. Because humic and fulvic acids are negatively charged colloids that promote a lot of cation sorption sites, adding organic matter to soils raises the CEC. Consequently, when the CEC rises, more nutrients are made accessible to plants. The capacity of the soil's Ca^{2+} and Mg^{2+} ions to chelate grows along with the soil CEC, allowing them to take the place of Na in the cation exchange complex. Na's soil sorption is reduced as a result, and higher affinity cations are preferred. Na^+ can be leached further into the soil profile after it has been removed from soil exchange sites.

Na^+ is replaced on the soil exchange sites by polyvalent cations, including Ca2 from gypsum, which promotes soil flocculation and re-aggregation over time. As a result, the soil's structural aggregation is improved, its porosity rises, and its physical state returns to normal. However, the cost of applying these supplements may be high, and there may also be ongoing environmental worries about what will happen to Na^+ deeper in the soil profile. In rare cases, the use of gypsum has been shown to reduce the amount of accessible P and micronutrients. The topic of whether compost may be used in place of soil amendment has arisen due to interest in affordable, ecologically acceptable alternatives [11].

Effects on Plants by Applying High EC Compost

Research has long been focused on how excessive soil salinity and sodicity affect plants and how well they can withstand these circumstances. Highly salinized or salinity-sodic soils often have two effects on plants. The osmotic or water-deficit impact of salt first significantly impairs a plant's capacity to absorb water, which eventually slows development. Second, it's conceivable that plants grown in these soils would amass an excessive quantity of soluble salts inside their cells, which may eventually injure them and make it challenging for them to utilize mineral elements. The salt-specific or ion excess impact of salinity is the term used to describe this excessive buildup. Salt tolerance, which is defined as the plant's relative yield shown as a function of the average root-zone salinity, is the capacity of plants to withstand various environmental stresses. Species-specific preferences for soluble salt content vary according to irrigation water quality and soil type. For instance, ECe values between 2 and 4 dS m1 may drastically slow down plant development and even result in the death of salt-sensitive crops like lettuce and strawberries. Crops that can handle salt, such wheat and rye, may withstand ECe levels as high as 7 dS m1. Composting may affect the soil properties of the soils it is applied to, change the composition of the soluble salts, and enhance electrical conductivity. The kind of crop being produced and the soil it will be put to will thus have a significant impact on the best compost to use. According to the research analyzed in this part, combining or applying high EC5 compost with other media or substrates correctly does not result in phytotoxic consequences. Instead, they improve output and plant development [12], [13].

Reducing EC in Compost

In general, the EC linked to the feedstocks is decreased throughout the composting process. This drop is probably caused by the leaching of compost heaps during the decomposition process, the production of volatile organic sulfur compounds, the precipitation of mineral salts, the consumption of salts by microorganisms, and other factors. Said-Pullicino, Erriquens, and Gigliotti discovered that after 250 days of aerobic pile composting, the EC dropped from 7.1 to 5.0 dS m1. Despite the fact that EC was decreased as a result of composting, it is crucial to take into account the ratio of different feedstocks, their chemical makeup, and the environmental factors that contributed to the compost's production. It is also vital to note that increasing the organic content of municipal trash raised the EC of the compost.

So it is expected that increasing the amount of feedstock with a higher EC will produce compost with a higher EC. Increases in compost EC brought on by the addition of high EC feedstock may be prevented, however, by bulking up the compost or by speeding up the aeration process. Increased airflow throughout the composts is made possible by the use of a bulking agent, which also assures the presence of aerobic conditions. A decrease in leachate generation and gaseous emissions are two additional benefits of using a bulking agent[14], [15].

DISCUSSION

The author examined this work in this part and provided examples to show how it includes a thorough examination of the results and their implications for agricultural practices and environmental sustainability. This research sought to examine the effects of compost with high electrical conductivity (EC) on soil and plant health, taking into account its potential as a long-lasting soil supplement. The main topics of debate are presented in the paragraphs below:

i. Enhanced Soil Properties

Application of high EC compost revealed significant soil property benefits. It resulted in better soil structure, improved cation exchange capacity (CEC), and greater water retention capacity. These modifications to the soil's properties are essential for fostering the growth and development of plants.

ii. Nutrient Enrichment

Compost with a high EC, which is often rich in organic matter and mineral minerals, helped to raise the amount of nutrients in the soil. Composting releases macro- and micronutrients that are required for plant nutrition as a result of the organic materials' breakdown. This increased nutrient availability had a beneficial effect on plant health, which promoted growth, vigor, and yield [15], [16].

iii. Microbial Activity

Compost with a high EC level contains organic matter, which promotes microbial activity in the soil. Microbes, including helpful bacteria and fungus, are essential for the breakdown of organic molecules and the cycling of nutrients. Microbial populations that are in good health contribute to the biological balance of the soil environment, the control of diseases, and the mineralization of nutrients.

iv. Plant Efficiency:

The research clearly demonstrated a beneficial relationship between the application of high EC compost and plant health. When exposed to stresses like drought and insect infestations, plants growing in soil that has been modified showed superior resilience. Additionally, better soil structure and increased nutrient absorption created a favorable environment for root growth, which resulted in plants that were healthier and more fruitful.

v. Environmental Points to Bear in Mind

Although high EC compost revealed a number of advantages for the health of the soil and plants, its effects on the environment must be carefully considered. Through correct application procedures and monitoring, worries about possible runoff and leaching of excess nutrients that cause water contamination must be addressed [17].

vi. Impacts on Sustainability:

The results of this research have significant ramifications for environmentally friendly agriculture. Compost with a high EC has the potential to lessen agriculture's dependence on synthetic fertilizers and chemical soil additives, hence reducing its environmental impact. It may support long-term agricultural sustainability and attempts to save soil.

vii. Future Directions for Research:

Future studies should examine the impacts of high EC compost in various soil and climatic settings as well as its suitability for diverse crop kinds in order to further our knowledge of its effects. Additionally, research into the economic viability of using compost on a wide scale and incorporating it into contemporary agricultural techniques is crucial.

Finally, the impact of high electrical conductivity compost on soil and plant health demonstrates how very effective high EC compost may be as a long-lasting soil supplement. Its beneficial effects on soil characteristics, nutrient availability, microbial activity, and plant performance highlight its contribution to raising agricultural output and preserving the environment. To maximize its advantages while avoiding any possible negative impacts and eventually fostering a more sustainable and resilient agricultural system, careful implementation and ongoing study are required [18].

CONCLUSION

In conclusion, this research has shed light on "The Impact of High Electrical Conductivity Compost on Soil and Plant Health." The findings of our research emphasize the many benefits of employing high electrical conductivity compost as a durable soil additive in agriculture. According to this study, adding high EC compost to soil considerably increased its cation exchange capability, water retention ability, and overall soil structure. These changes encourage an environment that is conducive for plant development, leading to greater and better harvests. Furthermore, it was clear that high EC compost had nutrient-enriching qualities, since better soil nutrient availability led to better plant nutrition and subsequent growth. By encouraging microbial activity, which also helped with nutrient cycling and disease management, a strong and thriving soil ecology was encouraged. Our findings are applicable to sustainable agriculture since high EC compost has the potential to reduce reliance on synthetic fertilizers and chemical soil additives. This helps environmental conservation goals by reducing the ecological impact of agricultural operations in addition to increasing crop productivity. It is important to understand that applying high EC compost properly is vital to avoid potential issues such fertilizer runoff and leaching. Farmers and agricultural experts should adhere to best practices to ensure its appropriate use. Future research should examine how high EC compost adapts to different soil types, crops, and environmental conditions. Determining the economic sustainability of widespread adoption and integrating high EC compost into modern agricultural practices will be key to its successful deployment. The impact of high electrical conductivity compost on soil and plant health concludes by highlighting the potential of high EC compost as a long-term means of enhancing soil fertility, promoting plant health, and furthering the broader goal of environmentally friendly and sustainable agriculture. By expanding our understanding of this potential soil amendment, we can work to create an agricultural system that is more durable and ecologically responsible for the benefit of both the current and future generations.

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