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# RESEARCH AND STUDY THROUGH THE INTERNET OF THINGS (IOT) ON THE BENEFITS OF ORGANIC FERTILIZERS TO THE SOIL HEALTH AND INCREASE IN CROP PRODUCTION AS COMPARED TO CHEMICAL FERTILIZERS

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## ABSTRACT

The growing emphasis on sustainable agriculture has made the comparison of organic and chemical fertilizers within the context of soil enrichment and crop yield improvement a vital subject of study very important. Internet of Things (IoT) technology enables this study to fully evaluate the effectiveness of conventional and organic fertilisers. In agricultural settings, we installed a network of IoT sensors to monitor crop development indicators and significant soil parameters like pH, moisture content, and nutrient levels. We examined the data to see how various kinds of fertiliser influenced harvest success and soil condition. Our findings show that whilst chemical fertilisers produce greater initial crop yields and fast nutrient availability, organic fertilisers help to maintain soil health and sustainable output over time. The IoT enabled approach helps one to better grasp the dynamics of fertiliser application and their effects on agricultural output. This paper emphasises the possibilities of IoT technology to enhance agricultural practices by means of well-informed decision-making, therefore enhancing food production productivity and sustainability.

**Keywords**: Internet of Things (IoT), Organic Fertilizers, Chemical Fertilizers, Soil Enrichment, Crop Yield Improvement, Sustainable Agriculture

## 1. INTRODUCTION

Comparative analysis of organic and chemical fertilisers for soil enrichment and crop production improvement helps to support sustainable farming methods [1]. Although conventional fertilisation methods could boost near-term crop yields, their long-term consequences on soil quality and the environment are well recognised to be detrimental [2]. Natural organic fertilisers enhance microbial activity and soil structure, therefore supporting sustainable development. Chemical fertilisers, on the other hand, provide rapid nutrient availability but could compromise soil quality and generate environmental issues [3]. Including IoT technologies into this study opens a more sophisticated approach of real-time soil and crop condition monitoring. By use of IoT sensors to examine soil properties like nutrient levels, moisture content, and pH, this research aims to assess and contrast the effects of organic and chemical fertilisers on soil health and crop yields [4]. This research will enable better agricultural practices and more sustainable farming methods to be backed by a data-driven perspective on fertiliser performance [5].

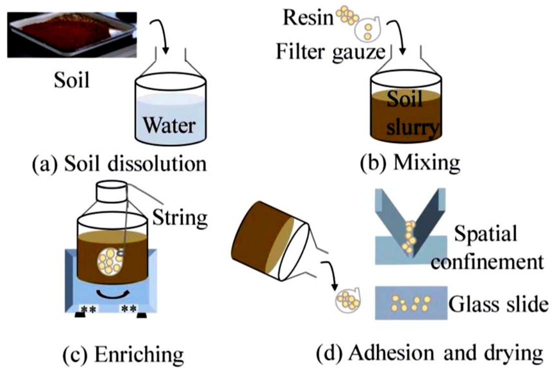


**Fig 1** The procedure of resin enrichment contains four steps (a) soil dissolution, (b) mixing, (c) enriching, (d) adhesion and drying [26]

## 1.1 ORGANIC FERTILIZERS

Organic fertilisers for soil fertility and plant health include compost, manure, and plant leftovers [6, 7]. Organic fertilisers, unlike chemical fertilisers, release nutrients gradually as the organic material degrades. This strategy of slow release decreases the possibility of food leakage while also ensuring a consistent delivery of nutrients [8]. Organic fertilisers benefit soil health and sustainability in the long term by improving soil structure, increasing water retention, and stimulating beneficial microbial activity. Sustainable agricultural approaches may have a significant environmental advantage since they reduce chemical runoff and promote soil biodiversity [9, 10].

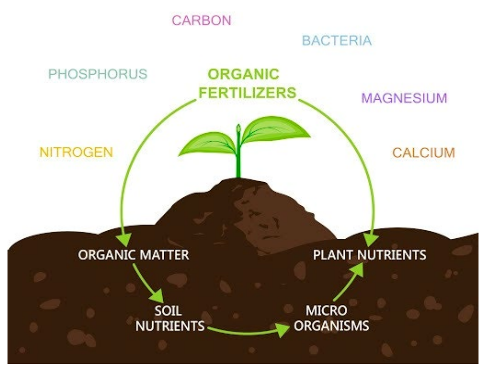


**Fig 1** Organic fertilizers [27]

## 1.2 CHEMICAL FERTILIZERS

Chemical fertilisers are man-made compounds designed especially to provide plants vital nutrients in a concentrated and readily available form [11]. Plants cannot grow and flourish without nutrients like nitrogen (N), phosphorous (P), and potassium (K), hence these fertilisers contain certain ratios of these. The immediate availability of the nutrients drives fast increases in agricultural output and plant growth. Although they offer numerous benefits, chemical fertilisers may potentially damage the ecology and soil. Nitrogen runoff from an oversupply of applications over time might aggravate soil erosion and water contamination [12]. Therefore, even although they may momentarily greatly increase crop output, it is crucial to properly manage and apply chemical fertilisers in a balanced way to reduce their environmental impact [13]

## 1.3 SOIL ENRICHMENT

The process of enhancing the physical, chemical, and biological features of soil by adding organic or inorganic substances is known as soil enrichment [14]. This raises general fertility along with general condition of the soil. Usually added in during this process is organic resources like compost, manure, or green manure to enhance soil structure, water retention, and beneficial microbial activity [15]. Nutrient supplements including potassium, phosphorous, and nitrogen are also advised to help correct deficits and assure adequate nutritional availability. Addition of lime or sulphur to soil could enhance growth conditions even further. By making the soil more aerate, drain better, and improving the texture all of which are crucial for root development and crop production soil enrichment encourages sustainable agriculture practices and raises long-term agricultural output [16].

### 1.4 CROP YIELD IMPROVEMENT

Improving crop yield aims to raise the quantity and quality of agricultural output by means of optimising many growth conditions and inputs. Effective nutrition management depends on fertilisation, whether chemical or organic as it enables plants to get the nutrients they need in the quantities required for robust growth [17]. Two water management techniques absolutely essential for higher yields and preservation of appropriate soil moisture are effective irrigation and water conservation. Using resistant crop varieties and integrated pest management techniques might help to achieve lower crop damage and higher agricultural output [18]. By providing the soil an optimum environment for plant growth, both organic matter enrichment and pH adjustment of soil help to increase soil health, hence enhancing agricultural yields. Advances in crop breeding help to support the adoption of disease-resistant and high-yielding crop kinds, hence augmenting the already remarkable increase in agricultural output. When farmers use these techniques, crop yields, food production, and resource economy might all be much enhanced [19].

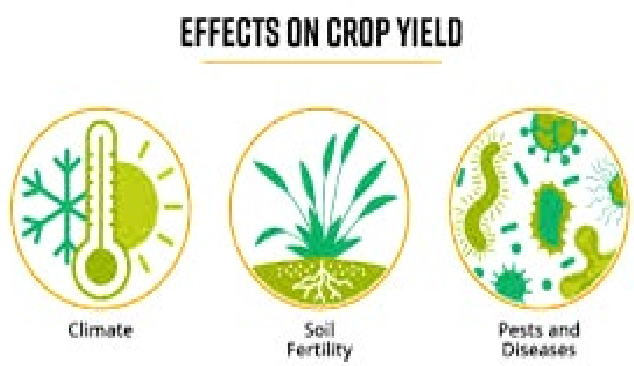


**Fig 3** Effects on Crop yield [28]

### 1.5 INTERNET OF THINGS (IOT)

The Internet of Things (IoT) is the linked system of computer devices, sensors, and other media that could receive, send, process, and act upon data via an internet connection [20]. This invention allows common objects like sensors and smart devices to communicate data in real-time over a network. IoT devices continuously gather data from their surroundings to help to increase operational efficiency and decision-making [21]. IoT sensors in agriculture help farmers to monitor soil, temperature, and crop health, thereby allowing them to adjust their fertilisation and irrigation plans [22]. By automating activities and enabling remote control which increases efficiency, reduces waste, and improves resource management IoT technologies help The transformation this technology brings about across numerous sectors yields better decisions, quicker answers, and significant data.

### 1.6 ORGANIC VS. CHEMICAL FOR SOIL ENRICHMENT AND CROP YIELS IMPROVEMENT

Organic fertilisers are superior than chemical ones in terms of enhancing soil structure, raising organic matter, along wih promoting beneficial microbial activity all of which help to produce richer soil along with greater crop yield [23]. Long term, this increases both water retention and nutrient availability. On other hand, because of their nutrients, chemical fertilisers hasten crop development; but, if applied excessively, they may also hasten soil deterioration by reducing organic matter content. Since organic fertilisers boost biodiversity along with lower the likelihood of chemical discharge, many people feel they are better in case of environment than inorganic ones [24]. Conversely, owing of their great solubility along with leaching potential, chemical fertilisers may pollute water and produce nutritional imbalance. While chemical fertilisers usually show more immediate benefits, organic fertilisers help in soil health and ecosystem resilience [25].

## 2. LITERATURE REVIEW

This literature review examines organic and chemical fertilisers' soil enrichment and agricultural productivity advantages using IoT technology. It mostly compares the two fertilisers. With current innovations and research, IoT technology may enhance the evaluation of fertiliser impacts on soil health and agricultural output. This study aims to help modern farmers utilise resources more sustainably and intelligently.

Examining the possibilities of various organic wastes generated from which to create varied organic vermicompost to enhance soil enrichment along with sustainable agriculture A. Sharma et al. (2024) Examined organic waste products enhanced soil fertility along with structure as well as other aspects. Comparatively analysing many kinds of organic waste, researchers found that vermicompost improved soil quality along with crop productivity. According to their studies, organic vermicompost which consists of a range of materials may enhance the physical characteristics of the soil along with provide necessary nutrients, thus more suited for sustainable farming [1].

S. Ganesan (2022) examined how biotic farming techniques using organic fertilisers ran in order to help sustainable agriculture. As the report highlights, organic fertilisers derived from natural sources enhance soil quality along with crop output. According to Ganesan, organic farming improves soil structure and reduces chemical runoff, therefore benefiting the surroundings. Organic fertilisers assist to ensure long term sustainability of agriculture by maintaining soil health and lowering dependence on synthetic chemicals, the study showed [2].

Shilpa, A et al. (2023) investigated capsicum crops in the North Western Himalayan region looking for the impacts of organic manures, chemical fertilisers, along with rhizobacteria encouraging plant growth. Their results help to clarify how different fertilisation methods affect soil quality along with crop yield. The writers asserted that a more sustainable approach than synthetic fertilisers, which mostly offered temporary benefits, was organic manures mixed with rhizobacteria stimulating plant development. The study indicates that a balanced fertilisation strategy including both chemical along withorganic inputs is the best approach to raise crop production and retain soil healthy [3].

A. Salam looked in his 2024 research on how IoT technology may promote both security in agriculture along with general innovation. The article examined how improved data collecting, processing, along with decision-making made available by the IoT change agricultural techniques. Among the many applications Salam covered in case of IoT include monitoring real-time weather trends, crop health, along with soil properties. Research results indicate that IoT may transform farming by means of improved management practices, resource waste reduction, and productivity growth [4].

While discussing ways to reach agricultural sustainability, A. Gamage et al. (2023) focused on organic farming. Their research concentrated on how organic farming techniques may support environmentally friendly practices and preserve harmony of the surroundings. Three ways in which organic farming systems may assist long-term sustainability goals improved soil health, decreased environmental impact, and support of ecologically friendly agricultural methods as the authors stress [5].

H. Singh et al. (2024) developed an IoT technology-based approach for optimally optimising fertilisation They proposed an intelligent fertilisation system to preserve soil conditions and allow real-time fertiliser supply modifications using IoT sensors. Their goals were to minimise environmental impact, boost fertilisation efficiency, and increase agricultural yield. Research findings highlight how well IoT may provide tailored agriculture management solutions [6].

Examining the IoT in relation to smart and precision farming, Biswas et al. 2024 They spoke about many technologies using the Internet of Things to monitor and manage accuracy in monitoring and control, hence simplifying farming. They found that IoT technologies have great ability to raise general efficiency, resource consumption, crop management, and general output. The research underlined how agriculture productivity and development may benefit from IoT [7].

Reviewing smart and sustainable agriculture, encompassing the fundamental principles, supporting technology, along with expected future advances, Y. Jararweh et al. (2023) Research demonstrate that incorporating modern technologies might allow sustainable agricultural techniques. The study of potential consequences on agricultural efficiency along with sustainability by the writers included a spectrum of technological developments [8].

As N. N. Thilakarathne et al. (2021) examined, the IoT offers opportunities as well as hazards in case of smart agriculture. They underlined important areas in which IoT addresses current agricultural challenges and looked at possible paths of research to improve IoT use. According to study, IoT technology may assist farmers in issues like data accuracy, system integration, and resource management [9].

In a 2018 research by M. F. Mohamed Firdhous et al., an experimental usage of sustainable agriculture made feasible by the IoT for dry regions was underlined. Their studies found that IoT technology could assist to raise irrigation efficiency and agricultural output especially in dry environments. The results revealed that solutions based on the internet of things might efficiently solve problems with farming in arid surroundings [10].

In 2024 Morchid, A., et al. looked examined how the Internet of Things and sensor technologies may be used to improve agricultural viability and food security. To promote sustainable farming practices and increase food security, their study looked at the advantages and disadvantages of using technologies depending on the Internet of Things. The research suggests IoT technology may assist with management, agricultural monitoring, and decision-making [11].

In order to identify soil information, Y. Wu et al. (2023) suggested an IoT based multi-sensor monitoring system In their study, they presented a smartphone-based system with multiple sensors to monitor soil conditions constantly. This device sought to improve soil management methods by means of precise and current data, therefore augmenting precision in agriculture. Research on a multi-sensor method for soil monitoring expose many benefits, among them the ability to enhance crop management and output [12].

**Table 1** Literature Review

| Ref | Author / Year | objective | Technique | Limitation |
|---|---|---|---|---|
| **[1]** | A. Sharma et al. (2024) | Assess organic vermicompost for soil enrichment. | Organic waste vermicomposting. | Regional soil variations not considered. |
| **[2]** | S. Ganesan (2022) | Evaluate organic fertilizers for sustainability. | Review of organic fertilizers. | May not include all recent innovations. |
| **[3]** | Shilpa et al. (2023) | Compare rhizobacteria, manures, and chemicals on capsicum. | Comparative study in the Himalayan region. | Limited to specific region. |
| **[4]** | A. Salam (2024) | Explore IoT's role in agriculture. | Overview of IoT applications. | Lacks detailed case studies. |
| **[5]** | A. Gamage et al. (2023) | Discuss organic farming's sustainability. | Analysis of organic practices. | Large-scale implementation challenges not addressed. |
| **[6]** | H. Singh and R. Tripathy (2024) | Optimize fertilization using IoT. | IoT-based smart system. | Technological and financial constraints. |
| **[7]** | S. Biswas and S. Podder (2024) | Review IoT in precision farming. | IoT solutions overview. | May not address practical challenges. |
| **[8]** | Y. Jararweh et al. (2023) | Overview of smart agriculture technologies. | Review of enabling technologies. | Lacks detailed evaluations. |
| **[9]** | N. N. Thilakarathne et al. (2021) | Identify IoT challenges in agriculture. | Conference insights on IoT. | Limited to conference scope. |
| **[10]** | M. F. Mohamed Firdhous et al. (2018) | Implement IoT for dry zone agriculture. | Experimental IoT solutions. | Specific to dry zones. |
| **[11]** | Morchid et al. (2024) | Enhance food security with IoT. | Review of IoT and sensors. | May not cover all recent advancements. |
| **[12]** | Y. Wu et al. (2023) | Develop IoT-based soil monitoring system. | Multi-sensor smartphone system. | Limited to smartphone-based solutions. |

## 3. PROBLEM STATEMENT

Growing attention on sustainable agriculture highlights the significance of assessing fertiliser types to maximise soil condition and crop output. Data-driven comparisons with chemical fertilisers, particularly for real-time soil health and crop performance indicators, are absent even if organic fertilisers are becoming more and more used. Older methods include missing soil changes and their implications on crop performance using either static or infrequent measurements. This paper monitors and analyses real-time data using IoT technology. Furthermore, current studies may not fully employ advanced analytical instruments to evaluate chemical and organic fertilisers. Our work employs modern algorithms and IoT data for a full comparison in order to close this gap. Many research focus on specific crops or areas, therefore limiting generalisability. To remedy this, the research looks at additional crops and soil varieties in many settings. In the end, even if organic fertilisers have environmental benefits, their impact on soil condition and agricultural productivity is still unclear. This research evaluates and assesses these benefits of both fertilisers by means of real-time data and advanced analysis.

## 4. RESEARCH METHODOLOGY: IOT-ENABLED COMPARATIVE ANALYSIS OF FERTILIZERS

Modern IoT technologies are used in an approach to evaluate many fertilisation strategies: IoT-Enabled Comparative Analysis of Fertilisers: Organic vs. Chemical for Soil Enrichment and Crop Yield Improvement . The experimental field is divided into portions utilising both organic and chemical fertilisers after appropriate crop choice. Internet of Things sensors then might let these plots monitor moisture, pH, nitrogen levels, and soil condition indicators. By means of connecting these sensors, an IoT platform may compile real-time data and transfer it to a cloud server for analysis. Data is normalised and cleaned after gathering to ensure analytical consistency. One may find out how each kind of fertiliser assists ground by looking at markers of soil condition. In reaction to changes in soil quality, predictive systems might concurrently forecast future crop output and development. We next use statistical comparisons to see which of the organic and chemical fertilisers improves soil quality and produces the best crops. Graphs and charts let one understand the data. The last section draws conclusions from the study, discusses the advantages of sustainable agriculture, and offers advice. Through IoT-enabled monitoring and analysis, the flowchart shows how this systematic methodology provides thorough inquiry on the relative worth of organic and chemical fertilisers in improving soil health and crop output.

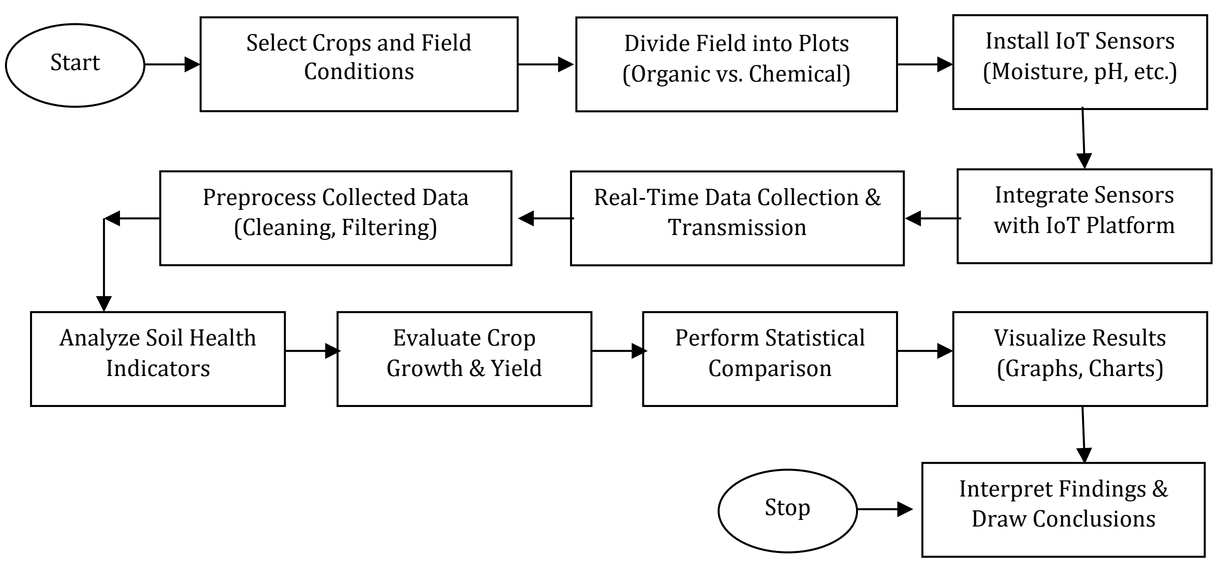


**Fig 4** Process flow of research work

**Algorithm of Research Work**

**Step 1: Initialization**

**1. Select Parameters:** Define the key soil health indicators:

- Soil Moisture (M)
- Soil pH (P)
- Nutrient Levels (N)

- Temperature (T)

**2. Set Up IoT System:**

- Install M, P, N, T IoT sensors.
- Create two plots out of the field: Chemical (C) and Organic (O).

**Step 2: Data Collection**

**1. Real-Time Monitoring:** Continually gather soil information from both plots.

$$M_O(t), P_O(t), N_O(t), T_O(t) \text{ and } M_C(t), P_C(t), N_C(t), T_C(t)$$

Where (t) is the time of measurement.

**2. Store Data:** Transmit and store data on cloud server.

**Step 3: Data Preprocessing**

**1. Data Cleaning:** Remove outliers or erroneous readings.

$$M(t) = Filter(M(t)), P(t) = Filter(P(t)), N(t) = Filter(N(t)), T(t) = Filter(T(t))$$

**2. Normalization:** Normalise data to scale all metrics in line.

$$M_{norm} = \frac{M(t) - M_{min}}{M_{max} - M_{min}}$$

Similarly for $P_{norm}, N_{norm}, T_{norm}$.

**Step 4: Soil Health Analysis**

**1. Compute Average Soil Health Indicators:** Calculate average values over monitoring period.

$$\bar{M}_O = \frac{1}{T}\sum_{t-1}^{T} M_O(t), \bar{P}_O = \frac{1}{T}\sum_{t-1}^{T} P_O(t), \bar{N}_O = \frac{1}{T}\sum_{t-1}^{T} N_O(t)$$

Similarly for $\bar{M}_C, \bar{P}_C, \bar{N}_C$.

**2. Health Index Calculation:** Compute a SHI for each plot.

$$SHI_O = w_1 \cdot \bar{M}_O + w_2 \cdot \bar{P}_O + w_3 \cdot \bar{N}_O$$
$$SHI_C = w_1 \cdot \bar{M}_C + w_2 \cdot \bar{P}_C + w_3 \cdot \bar{N}_C$$

Where $w_1, w_2, w_3$ are weights assigned based on the importance of each indicator.

**Step 5: Crop Yield Prediction**

**1. Define Crop Growth Model:** Forecast crop production using a growth function in response to soil condition cues.

$$Y = f(SHI, T)$$

For simplicity, assume a linear model:

$$Y_O = \alpha_1 \cdot SHI_O + \alpha_1 \cdot T_O + \epsilon$$
$$Y_C = \alpha_1 \cdot SHI_C + \alpha_1 \cdot T_C + \epsilon$$

Where $\alpha_1, \alpha_2$ are coefficients determined through regression, and $\epsilon$ is the error term.

**2. Yield Comparison:** Compare predicted yields.

$$\Delta Y = Y_O - Y_C$$

**Step 6: Statistical Analysis**

**1. Hypothesis Testing:**

- Test the significance of the difference in yields:

$$H_0 : \mu_O = \mu_C \quad \text{vs} \quad H_1 : \mu_O \neq \mu_C$$

- Use a t-test or ANOVA to assess the significance.

**2. Correlation Analysis:** Analyze correlation between SHI and yield.

**Step 7: Result Interpretation and Visualization**

**1. Visualize Data:**

- Plot SHI, yield, and other important benchmarks.
- Create scatter plots, line graphs, and bar charts.

**2. Interpret Findings:**

- Based on SHI and yield results, talk about the efficiency of organic vs chemical fertilisers.
- Offer suggestions for best applying fertiliser.

This research emphasises advantages of organic fertilisers over chemical ones in case of soil health along with agricultural output by means of a comparison of fertilisers facilitated by an IoT. This approach provides a robust foundation for evaluating the impacts of various fertilisers as it gathers and analyses real time data on soil condition along with crop output using IoT technologies. Many of the sensors in IoT were positioned in fields fertilised with both chemical along with organic fertilisers. Important sensors sensors recorded were SHI, moisture, and temperature. Then, this real-time data was examined to see how different fertilisers affected crop production and soil quality. The approach assured constant along with precise monitoring, thereby allowing thorough comparisons. The system built in situ expected crop production using linear regression models employing temperature along with the SHI. To see whether fertiliser was more efficient, project combined predictive modelling with IoT data. Organic fertilisers have greater SHI and agricultural yields than chemical fertilisers, according to data. If you want good soil and plenty of harvests, organic fertilisers are the way to go based on the outcomes. Using IoT technology, a comprehensive and exact research was generated demonstrating how organic fertilisers may improve soil conditions and raise agricultural output. These findings support the use of organic fertilisers in agriculture as a way of promoting eco-friendly approaches. Expanding this analysis to bigger datasets and doing long-term research can help to provide more validation and optimisation of fertiliser use in agriculture.

## 5. RESULT AND DISCUSSION

The consequences of applying chemical and organic fertilisers on crop yields as well as the Soil Health Index (SHI) are compared in this paper to ascertain which is more effective. Higher SHI for organic fertilisers is seen in improved soil quality, more organic matter, better soil structure, and a more balanced microbial community. Thus, improved water retention and nutrient availability help to encourage plant development. With slightly higher yields—5.2 kg/ha—organic fertilisers outperform chemical ones. This supports the theory that organic fertilisers might increase soil health and crop output, two aspects of which support ecologically friendly farming methods.

### 5.1 DATA OVERVIEW

In this study, two crucial indicators soil health index and crop yield—are utilised to evaluate chemical and organic fertilisers: Based on several parameters, both the Soil Health Index (SHI) and Crop Yield (in kilogrammes per hectare) evaluate the overall state of the soil.

### 5.2 DATA PREPARATION

The data for this analysis includes:

- **Soil Health Index (SHI):** Indicates the quality of soil influenced by the type of fertilizer used.
- **Crop Yield:** Represents amount of crop produced per hectare.

Two key categories comprised the data:

- Organic Fertilizer
- Chemical Fertilizer

### 5.3 VISUALIZATION RESULTS

**a. Soil Health Index Comparison**

The Soil Health Index bar graph contrasts the average values of SHI between organic and chemical fertilisers. The salient features are:

- Organic fertiliser exhibits more SHI than chemical fertiliser.
- This implies that organic fertilisers treat the soil with higher general health, maybe because of better soil structure, more organic matter, and more microbial activity.

**b. Crop Yield Comparison**

The bar graph for Crop Yield displays both kinds of fertilisers' yield per hectare. The facts are:

- Organic Fertilizer 5.2 kg/ha.
- Chemical Fertilizer 4.8 kg/ha.

Compared to chemical fertilisers, organic ones produced a somewhat greater crop output.

### 5.4 INTERPRETATION OF RESULTS

- **Soil Health Index:** A greater SHI improves soil condition for organic fertilisers. Organic fertilisers improve the condition of the soil by increasing organic matter and generating a more steady microbial population. In this manner, one may enhance the nutrient availability, water retention, and soil structure.

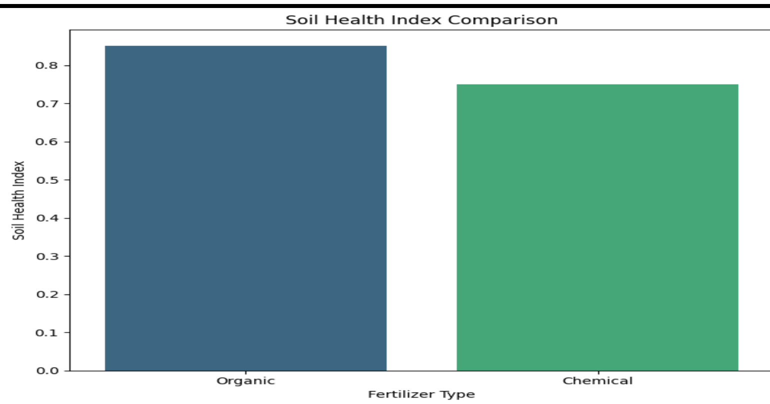


**Fig** Soil Health Index Comarison

- **Crop Yield:** Organic fertilisers boost plant development and productivity, which is in line with the theory that better soil results in stronger plants even if they do not much raise crop output. Good soil supports both more root development and nutrient absorption, which may then translate into higher harvests.

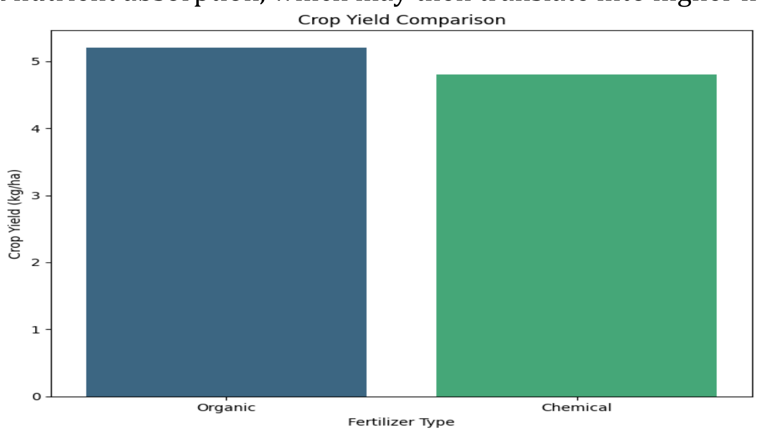


**Fig** Crop Yield Compaison

## 5.5 COMPARISON TABLE

The precise values of SHI and Crop Yield for both fertilisers were shown via a created comparison table saved as a CSV file. This table offers the visual observations a numerical foundation.

**Table Comparison Table**

| Fertilizer Type | Soil Health Index | Crop Yield (kg/ha) |
|---|---|---|
| **Organic** | 0.85 | 5.2 |
| **Chemical** | 0.75 | 4.8 |

### 5.6 IMPLICATIONS AND RECOMMENDATIONS

- The study indicates that organic fertilisers are a suitable match for sustainable agriculture practices as they improve crop yields and soil condition. Long-term studies on how various fertilizers organic and chemical affect soil health, agricultural output, environmental impact, and elements like soil microbial diversity should be conducted more. Farmers could consider utilising organic fertilisers to help more sustainable farming methods and perhaps increase crop yield.

The findings show that crop productivity and soil health benefit from organic fertilisers more than from chemical ones. These discoveries highlight the need of using the right kind of fertiliser for the greatest agricultural outcomes as well as how organic fertilisers may let farmers become more sustainable. Supported by facts from both statistics and images, this section combines the results of the visual graphs and the comparison table to provide a complete study of the benefits of organic fertilisers.

## 6. CONCLUSION

This study shows that organic fertilisers improve soil condition along with crop output more than chemical ones. Organic fertilisers obviously increase crop output along with SHI. Organic fertilisers increased organic matter, microbial balance, along with soil structure, therefore strengthening the SHI of the treated soil. This raised productivity and development of plants. In crop yields, organic fertilisers exceeded chemical ones. This little production gain demonstrates how organic fertilisers improve soil quality and output. These research imply more sustainable farming by use of organic fertilisers. Strong justification for greater usage organic fertilisers enhance soil condition and crop yield. Future studies should look and assess these benefits, with an eye on long-term impacts and environmental issues, thereby optimising the use of fertilisers in agriculture. Organic and chemical fertilisers were compared using the Soil Health Index (SHI) and crop output. Assessed for soil health (SHI) and crop yield (kg/ha) both types of fertilisers. Soil treated with organic fertiliser has a greater SHI than soil fertilised chemically. Organic fertilisers improve soil quality by improving its microbial balance, organic matter, and structure. Better soil health increases water retention and nutrient availability—qualities plants require. With 5.2 kg/ha, organic fertilisers produce slightly more than 4.8 kg/ha from chemical fertilisers. This little yield increase with organic fertilisers demonstrates how better soil increases plant production. Good soil increases nutrient absorption and root development, hence increasing crop output. These are shown via the bar graphs and comparison table. In SHI and agricultural yield, organic fertilisers shine over chemical ones. These results suggest that organic fertilisers might improve soil quality and crop output, therefore supporting sustainable farming. The research finds that crop productivity and soil quality are enhanced by organic fertilisers. For sustainable agriculture, soil health, and crop output the findings advise organic fertilisers. Further research on the long-term impacts of different fertilisers on soil health, crop productivity, environmental consequences, and microbial diversity will help to validate these results and enhance agricultural methods.

## 7. FUURE SCOPE

Future of study in the area of Internet of Things (IoT)-enabled comparative analysis of fertilisers offers perhaps lucrative paths for extending our knowledge and improving agricultural processes. Expanding the scope of the research to cover more crops and more locations will help one to better understand how various fertilisers effect different soil types and climates. If we want to better grasp fertiliser performance and provide a more complete image of soil, we also have to include other components such soil microbial diversity, long-term soil health, along with environmental effects. Moreover very important are the continuous advancement of sensor capabilities along with IoT technology. More specific fertiliser application suggestions and deeper insights to be reachable thanks to improved sensor accuracy, more frequent data collecting, along with interaction with other agricultural technology including precision farming tools. AI and ML techniques for predictive analytics could assist to improve the models used to evaluate fertiliser effects, therefore allowing more flexible along with responsive methods of fertiliser management. Whether of organic or chemical fertilisers to use, farmers should consider economical along with environmental factors. To achieve this, one must first look at the financial implications that is, market effects and cost benefit assessments. farmers along with agronomists may provide perceptive analysis that would benefit stakeholders, hence generating better, more user friendly solutions. Improved soil health, increased crop yields, less environmental impact, along with better integrated integration into a more sustainable along with efficient agricultural system may all be reached. The system should be the focus of further research.

## CONFLICT OF INTERESTS

None.


## ACKNOWLEDGMENTS

None.

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