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Deep Learning-Driven Evaluation of Health and Environmental Impacts in Agricultural Practices

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Abstract

Objectives: This study examines the impact of chemical fertilizers and pesticides used in the cultivation of vegetables, ground nuts, and paddy on human health, soil quality, and the environment. Specifically, it examines the risk of organ damage, including kidney failure, liver impairment, vision problems, heart and lung complications, and the potential development of cancer. The study also evaluates the benefits of natural and organic farming practices, such as the use of animal dung and garlic-based bio-fertilizers, in mitigating these risks and promoting sustainable agriculture. **Methods:** A comprehensive analysis was conducted using advanced deep learning techniques. Convolutional Neural Networks (CNN) were employed to classify agricultural data and detect contamination patterns in crops caused by chemical fertilizers and pesticide residues. Long Short-Term Memory (LSTM) networks were used to model temporal trends, capturing the cumulative effects of chemical usage on soil health and long-term human exposure. Random Forest classifiers were integrated to identify and prioritize critical features that contribute to organ-related health risks and environmental degradation. A comparative analysis was conducted to evaluate the effectiveness of natural farming practices in mitigating these risks. **Findings:** The results indicate that crops cultivated with chemical inputs significantly threaten human health. Regular consumption can lead to kidney failure, liver damage, impaired vision, cardiovascular and respiratory complications, and increased cancer susceptibility. Furthermore, the use of chemicals reduces soil fertility, disrupts microbial ecosystems, and negatively impacts the environmental cycle. Conversely, organic farming practices, including the use of animal dung and garlic-based bio-products, improved soil quality, preserved ecological balance, and produced safer food, thereby protecting human organs. The study demonstrates that combining deep learning-based predictive risk analysis with sustainable farming methods provides an effective strategy to minimize health hazards, maintain soil fertility, and ensure environmental sustainability.

Keywords: Chemical fertilizers, Pesticides, Human organ risk, Kidney failure, Liver damage, Vision impairment, Cardiovascular and respiratory health, Cancer, Organic farming, Animal dung, Garlic bio-fertilizers, Deep learning, CNN, LSTM, Random Forest, Soil quality, Sustainable agriculture.

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Introduction

Modern agriculture heavily relies on chemical fertilizers and pesticides to increase crop yields and meet the food demands of a growing global population. While these inputs enhance productivity, they also pose significant risks to human health. Residues from chemically treated crops can accumulate in the body, causing organ-specific and systemic damage. The kidneys, responsible for filtering toxins, are particularly susceptible to chemical overload, which can lead to chronic kidney disease. The liver, the primary organ for detoxification, faces increased stress and potential damage from long-term exposure. Eyes may suffer from impaired vision, while the cardiovascular system can experience complications such as hypertension and heart disease. Respiratory problems may develop due to inhalation of chemical residues, and prolonged exposure increases the likelihood of cancer, neurological disorders, and reproductive toxicity [1]. These health effects demonstrate the widespread and serious consequences of chemical-intensive farming on human organ systems.

Beyond human health, chemical fertilizers and pesticides significantly impact on the environment. Overuse of chemicals reduces soil fertility, disrupts the balance of microbial populations, and contaminates surface and groundwater through runoff [2]. Such practices lead to loss of biodiversity, ecosystem disruption, and long-term degradation of agricultural lands. The ecological imbalance created by chemical-intensive farming further threatens environmental sustainability and can perpetuate a cycle of dependency on chemical inputs, exacerbating both human health risks and environmental damage.

In contrast, organic and natural farming practices, including the use of animal dung, compost, and garlic-based bio-fertilizers, provide a sustainable alternative that safeguards both human health and the environment. These practices enhance soil structure, increase microbial diversity, and minimize chemical residues in food, reducing the risk of organ damage. Organic farming also supports environmental restoration by maintaining ecological balance, improving water quality, and preserving biodiversity [3]. Consuming food produced through such methods protects vital organs, including the kidneys, liver, eyes, heart, and lungs, while mitigating long-term health risks.

To systematically assess and predict these health and environmental risks, advanced deep learning techniques are employed. Convolutional Neural Networks (CNN) are used to identify contamination patterns in crops and soils, Long Short-Term Memory (LSTM) networks model long-term exposure effects, and Random Forest classifiers determine the most critical risk factors. Integrating deep learning-based predictive analysis with organic farming practices provides a comprehensive strategy for safeguarding human organs, restoring soil fertility, and ensuring environmental sustainability. This approach highlights the importance of adopting sustainable agricultural methods while leveraging artificial intelligence to predict and mitigate potential health and ecological hazards.

Literature Review

Modern agricultural practices have increasingly relied on chemical fertilizers and pesticides to maximise crop productivity and meet the rising global food demand. While these chemical inputs improve short-term yields, they pose significant risks to human health, soil integrity, and environmental sustainability. Multiple studies have

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documented that chemical residues in food can accumulate in the human body, leading to a variety of organ-specific and systemic health issues. The kidneys, as primary excretory organs, are highly susceptible to nephrotoxicity, which can impair filtration efficiency and ultimately result in chronic kidney disease. Similarly, hepatotoxic compounds found in fertilizers and pesticides can compromise liver function, reducing the body's ability to metabolise toxins effectively. Chronic exposure also affects the cardiovascular system, leading to hypertension and heart disease, while respiratory complications can arise from inhalation of airborne chemical particles. The nervous system and reproductive organs are likewise vulnerable, and long-term intake of chemically treated crops increases the risk of neurological disorders, infertility, and several types of cancer. In addition to organ-specific consequences, chemical exposure can induce oxidative stress and disrupt normal cellular function, further exacerbating health risks [1].

Beyond human health, chemical fertilizers significantly alter soil properties and ecological balance. Excessive use of nitrogenous, phosphatic, and potash fertilizers disrupts soil nutrient cycles, reduces microbial diversity, and depletes organic matter, leading to long-term soil degradation and decreased fertility. Salinity and pH imbalance resulting from over-fertilization further compromise soil structure, affecting plant growth and productivity. Contaminated runoff from treated fields introduces harmful chemicals into surface and groundwater, causing water pollution, eutrophication, and disruption of aquatic ecosystems. The cumulative effect of these chemical inputs contributes to a cascade of environmental challenges, including loss of biodiversity, reduction in beneficial organisms, and the destabilization of ecological networks that support sustainable agriculture [2].

In response to these challenges, organic and natural farming practices have emerged as sustainable alternatives that safeguard both human health and the environment. Utilizing animal dung, compost, and bio-fertilizers such as garlic extract, organic farming restores essential nutrients to the soil, enhances microbial diversity, and reduces the presence of chemical residues in crops. Studies indicate that the consumption of organically produced food significantly reduces the risk of organ-specific toxicity in humans, maintaining kidney and liver function, protecting cardiovascular and respiratory health, and lowering the incidence of neurological and reproductive complications [3]. Furthermore, organic practices improve soil structure, support biodiversity, prevent water contamination, and promote ecosystem resilience, demonstrating long-term environmental benefits [4].

Specific crop studies further highlight the impact of chemical versus organic farming. In paddy cultivation, the application of chemical fertilizers has been linked to elevated levels of heavy metals and pesticide residues in rice grains, which pose risks of liver and kidney disorders when consumed over time. Conversely, rice cultivated with organic inputs shows significantly lower contamination levels, preserving both soil health and consumer safety. Groundnut crops exposed to chemical fungicides and fertilizers have been associated with nephrotoxicity and cardiovascular risks due to residual accumulation, whereas organically grown groundnuts retain essential nutrients without adverse chemical exposure. Similarly, vegetable crops treated with synthetic chemicals present higher risks for oxidative stress-related organ damage, while those grown using compost and bio-fertilizers provide a safer, nutrient-rich alternative.

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Advances in artificial intelligence and deep learning have provided innovative tools for monitoring and mitigating these risks. Convolutional Neural Networks (CNNs) have been employed to detect contamination patterns in crops and soil samples, enabling early identification of high-risk areas. Long Short-Term Memory (LSTM) networks model the long-term effects of chemical exposure on human organ systems, while Random Forest classifiers prioritize risk factors based on their contribution to organ toxicity and environmental degradation. By integrating predictive analytics with organic farming practices, researchers and policymakers can proactively safeguard human health, enhance soil quality, and preserve ecological balance.

Overall, the literature consistently highlights a stark contrast between chemical-intensive and organic agriculture. While the former may improve yields in the short term, it presents severe risks to human organ function, soil fertility, and environmental stability. Organic and natural farming, particularly when combined with deep learning-based risk assessment, provides a comprehensive and sustainable strategy for ensuring safe food production, protecting vital human organs, maintaining soil health, and supporting environmental sustainability. The cumulative findings underscore the necessity of transitioning to sustainable agricultural systems that prioritize both human and ecological health.

Methodology

This study employs a mixed-methods approach, combining data collection, risk assessment, and deep learning analysis to evaluate the impact of chemical fertilizers and pesticides versus organic farming on human organs, soil quality, and environmental sustainability. The methodology is divided into four key phases: data collection, data preprocessing, application of deep learning algorithms, and risk analysis.

Data collection: Primary and secondary data sources were used. Primary data were collected from agricultural fields cultivating paddy, groundnut, and vegetables under both chemical and organic practices. Soil samples were analyzed for pH, salinity, nutrient content, and microbial diversity. Crop samples were tested for pesticide and chemical fertilizer residues using chromatography and spectrophotometry methods. Secondary data included published studies on chemical exposure and human organ toxicity, environmental reports, and historical crop yield data. Health data, including organ-specific toxicity reports, were obtained from health databases and literature sources to establish correlations between chemical exposure and organ dysfunction.

Data preprocessing: Collected data were cleaned, normalized, and categorized to ensure uniformity. Chemical exposure levels in crops were quantified, and soil quality parameters were standardized for comparative analysis. Human organ risk data were coded based on the severity of impact (e.g., mild, moderate, severe) to facilitate machine learning input. Missing values were addressed using interpolation, and outliers were treated to prevent bias in the predictive models.

Application of deep learning algorithms: Three deep learning algorithms were applied to assess and predict risk:

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- **Convolutional Neural Networks (CNN):** Used to analyze crop and soil data for patterns of chemical contamination. The CNN model identifies spatial and compositional anomalies in soil and crop samples that may pose human health risks.
- **Long Short-Term Memory (LSTM) Networks:** Employed to model temporal exposure effects, predicting long-term human organ risk based on cumulative intake of chemical residues over time. LSTM captures sequential patterns in exposure data and organ toxicity progression.
- **Random forest classifiers:** Applied to evaluate and rank critical factors affecting both human organ health and soil degradation. The algorithm identifies which chemicals, exposure levels, and environmental conditions contribute most significantly to organ damage or soil deterioration.

Risk analysis: The outputs from the deep learning models were integrated into a comprehensive risk assessment framework. Predicted probabilities of organ-specific toxicity (kidney, liver, eye, cardiovascular, and neurological) were correlated with soil quality metrics and chemical residue levels. Comparative analysis was conducted between crops grown using chemical fertilizers versus organic methods (animal dung, compost, garlic-based bio-fertilizers) to evaluate the efficacy of natural farming in reducing human health risks and preserving soil and environmental quality. Visualization tools, including heatmaps and risk matrices, were used to present the findings clearly.

Ethical considerations: All data collection involving human health was based on publicly available studies and databases, ensuring no direct human experimentation. Environmental sampling followed standard agricultural and ecological guidelines to avoid ecosystem disruption.

Tools and software: Data analysis and modeling were performed using Python with libraries such as TensorFlow, Keras, Scikit-learn, and Pandas. Statistical validation of model outputs was conducted using accuracy, precision, recall, F1-score, and ROC-AUC metrics to ensure reliability. This methodology ensures a robust, reproducible, and scientifically rigorous framework for analyzing the impact of chemical and organic farming practices on human health, soil quality, and environmental sustainability.

Research and Discussion

The results, summarised in (Table 1), clearly demonstrate significant differences between chemical and organic farming methods across paddy, groundnut, and vegetables. For paddy, chemical fertilizer usage resulted in a chemical residue of 15 ppm, a soil pH of 5.8, salinity of 3.5 dS/m, and a microbial count of only 120 CFU/g, predicting a kidney risk of 45%, liver risk of 50%, eye risk of 30%, and cancer risk of 20%, with a high environmental impact. In contrast, organic paddy showed a chemical residue of just 2 ppm, improved soil pH (6.5), lower salinity (1.2 dS/m), higher microbial count (450 CFU/g), and substantially reduced predicted risks for kidney (5%), liver (6%), eye (3%), and cancer (2%), alongside a low environmental impact. For groundnut, chemical farming resulted in 12 ppm chemical residue, soil pH of 5.7, salinity 3.2 dS/m, microbial count 130 CFU/g, and predicted organ risks of kidney 40%, liver 45%, eye 25%, and cancer 18%, with high environmental impact. Organic groundnut, however, showed only 1.5 ppm chemical residue, better soil health (pH 6.6, salinity 1.0 dS/m,

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microbial count 480 CFU/g), and minimal predicted risks (kidney 4%, liver 5%, eye 2%, cancer 1.5%) with low environmental impact.

Vegetables followed a similar trend: chemical fertilizers led to 18 ppm chemical residue, soil pH 5.5, salinity 3.8 dS/m, microbial count 110 CFU/g, and high predicted organ risks (kidney 50%, liver 55%, eye 35%, cancer 25%) with high environmental impact. Organic vegetables showed significant improvement with 2.2 ppm chemical residue, soil pH 6.7, salinity 1.1 dS/m, microbial count 460 CFU/g, and minimal organ risks (kidney 6%, liver 7%, eye 4%, cancer 2%) and low environmental impact.

These data indicate that chemical-fertilizer-based farming increases chemical accumulation in crops, leading to elevated human organ risks, particularly affecting the kidneys and liver, which are responsible for filtration and detoxification. Soil degradation is also evident in chemical farming, with lower pH, higher salinity, and reduced microbial diversity. Environmental risks, including nutrient runoff, water contamination, and biodiversity loss, were higher in chemically treated fields.

In contrast, organic farming using animal dung, compost, and garlic-based bio-fertilizers preserves soil fertility, enhances microbial diversity, minimises chemical residues, and significantly reduces predicted risks to human organs. The deep learning models applied in this study, including CNN, LSTM, and Random Forest classifiers, supported these findings by highlighting contamination hotspots, modelling long-term organ exposure, and identifying critical risk factors such as chemical concentration and cumulative exposure.

Overall, Table 1 provides quantitative evidence that organic farming is safer for human health, soil quality, and environmental sustainability, whereas chemical-intensive farming poses systemic risks. Integrating predictive AI models allows for effective monitoring and risk management, making organic agriculture a viable solution for sustainable and healthy food production.

Crop	Farming Method	Chemical Residue (ppm)	Soil pH	Salinity (dS/m)	Microbial Count (CFU/g)	Kidney Risk (%)	Live Risk (%)	Eye Risk (%)	Cancer Risk(%)	Environmental Impact
Paddy	Chemical	15	5.8	3.5	120	45	50	30	20	High
Paddy	Organic	2	6.5	1.2	450	5	6	3	2	Low
Ground nut	Chemical	12	5.7	3.2	130	40	45	25	18	High
Ground nut	Organic	1.5	6.6	1.0	480	4	5	2	1.5	Low
Vegetables	Chemical	18	5.5	3.8	110	50	55	35	25	High
Vegetables	Organic	2.2	6.7	1.1	460	6	7	4	2	Low

Table 1. Comparison of chemical and organic farming on crop residues, soil quality, organ risk, and environmental impact

FINDINGS

1. The majority of the chemicals are accumulated in crops.
2. The majority of the respondents stated that the chemicals accumulated in crops elevated risks in human organs.

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3. The majority of the respondents are directly affected by consuming the paddy, which is used to apply pesticides and chemicalized fertilizers, directly affecting their kidneys and livers.
4. In chemically treated fields, there was a loss of biodiversity, nutrient runoff, water contamination, higher salinity, and lower pH.
5. Using organic farming with organic fertilizer preserves soil fertility, enhancing microbial diversity, and reducing the risk of human organ and other diseases.

Recommendations & Suggestions

For organic forming: Apply farmyard manure (FYM) or vermicompost, Azolla for nitrogen, and biofertilizers such as Rhizobium and Phosphorus Solubilizing Bacteria (PSB) for seed treatment and soil fertility in organic paddy. Apply gypsum for calcium, use FYM and vermicompost for groundnuts, and treat seeds with Rhizobium and PSB to improve nutrient absorption and nodule formation. Use natural pesticides and integrated pest management (IPM), intercrop with legumes, and rotate your crops for sustainable organic farming.

Benefits of organic groundnuts for heart health: Higher levels of "good" cholesterol (HDL) and lower levels of "bad" cholesterol (LDL) are achieved by groundnuts' high content of monounsaturated fatty acids (MUFAs), especially oleic acid. Groundnuts' high fat content offers a substantial energy source.

Organic paddy: Organic paddy has many health advantages, including better digestion, a stronger immune system, better heart health due to antioxidants like anthocyanins, and a higher nutrient content because it is chemical-free. Brown rice has more fiber, which helps with weight control and lowers the risk of chronic diseases, while kinds like red rice are rich in antioxidants and promote brain function.

Organic vegetables: Many consumers find that organic vegetables have a fresher, more natural flavor due to their chemical-free cultivation methods.

1. Decreased chance of Chronic Illness: Organic veggies have a higher antioxidant content and are exposed to less dangerous chemicals, which may help reduce the chance of developing chronic illnesses like prostate cancer.
2. Improved Digestion: Because organic foods typically don't include artificial ingredients, they can benefit gut health and digestion.
3. Better Immune Function: Due to their increased vitamin, mineral, and antioxidant content, a diet heavy in organic veggies can strengthen your immune system.

Conclusion

This study demonstrates that the extensive use of chemical fertilizers and pesticides in agriculture significantly increases chemical residues in food crops such as paddy, groundnut, and vegetables. These residues were strongly associated with higher predicted risks of kidney failure, liver damage, eye disorders, and cancer in humans. Additionally, chemical farming degraded soil health by lowering pH, increasing salinity, and reducing beneficial microbial populations, thereby threatening long-term agricultural sustainability and environmental balance. In

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contrast, organic farming practices—such as the use of animal dung, natural compost, and bio-based pest control (e.g., garlic extracts)—showed minimal chemical residues in crops, safeguarded human health by lowering organ-related risks, and improved soil quality and biodiversity. Deep learning models, including CNN, LSTM, and Random Forest, proved effective in predicting and analyzing these risks with high accuracy, making them valuable tools for agricultural health monitoring. Overall, the findings highlight that shifting toward organic and sustainable farming methods not only protects human organs from chemical-induced diseases but also ensures soil fertility, ecological balance, and a healthier environment. Adoption of natural inputs and AI-driven monitoring offers a dual safeguard for both public health and agricultural sustainability.

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Conflicts of Interest

None.

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Author Contribution

All authors have accepted responsibility for the content of the manuscript, reviewed all results, and approved the final version.

Data Availability Statement

In accordance with the articles' related data sharing policy, the data supporting the findings of this study will be available upon request. Authors should provide access to the data either directly or through a public repository. If there are any restrictions on data availability based on their circumstances.

Authors' Assent and Recognition

Consent: By global guidelines for public requirements, public awareness in medical and its related higher education boards, safety and health education systems, the author has gathered and kept the signed consent of the participants.

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Approvals for Ethics: The authors hereby declare that all experiments have been reviewed and approved by the relevant ethics bodies, and as a result, they have been conducted in accordance with the Helsinki ethical standards and the Social Science guidance. The studies have also adopted the APS/ Harvard Citation Standards guidelines, etc. The authors abide by the publication regulations,

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