Pesticide Reduction through Organic Farming for Promoting Public Health Management and Food Security

Utkarsh Anand[1], Nitin Ranjan Rai[2]

[1]Associate Professor, Department of Management, Kalinga University, Raipur, India. Email: ku.utkarshanand@kalingauniversity.ac.in ORCID: 0009-0007-2124-6666
[2]Department of Management, Kalinga University, Raipur, India

KEYWORDS

Pesticide reduction, public health, Management, Food security, Agriculture, Sustainable food consumption, Food supply chain, Organic farming

ABSTRACT

There is a growing global interest in sustainable food consumption to ensure food security. One significant factor driving this demand is the belief that consuming organic food affects Public Health (PH). This research examines the historical context of sustainable agriculture. This article specifically examines the impact of sustainable agriculture on health-related substances, pesticide residues, and contaminants in crops. It also explores the connections between organic food and health indicators. In Organic Farming (OF), the use of pesticides is often restricted or non-existent, which is different from Traditional Farming (TF) methods that heavily depend on pesticides to preserve crops. The notable disparities in pesticide usage between the two agricultural systems profoundly affect the comparative nutritional exposure, hazards, and ecological impacts associated with pesticides. Pesticide Usage Monitoring (PUM) information has been used to compare pesticide usage across organically certified and adjacent traditional farms for tomato crops. This work suggested methods for PR by promoting the widespread use of organic agricultural techniques. Additionally, emphasis on many alternatives available within organic food supply chains to further minimize the usage of pesticides, contact, and adverse effects on workers has been proposed to provide food security.

1. Introduction

Several international organizations prioritize the development of resilient food systems as a crucial long-term objective [1]. Varying agricultural management techniques may influence the long-term viability of food supply chains by potentially impacting PH, animal welfare, food security, and environmental sustainability [18][13]. This research examines the existing data about the connections between agricultural systems (traditional and organic) and PH [10]. The potential benefits to PH, surroundings, and increasing consumer demand are the primary factors driving some governments to establish targets for promoting sustainable farming in their nations [2]. The food regulations, economic incentives, and enhanced revenue prospects for farmers contribute to the fast growth of sustainable farming, which has been implemented in over 165 countries [14]. In 2021, a significant rise of almost three times was seen in the amount of OF land, reaching 43 million hectares. This growth included 1.85 million farmers. However, despite this expansion, OF only accounts for 1.4% of the total agricultural acreage. Nevertheless, most European nations continue to see significant growth in expanding agricultural acreage for organic cultivation, increasing organic market shares, and average consumption. However, over 83% of organic suppliers are located in developing countries with the highest concentration of expanding marketplaces [4]. Sustainable development has been accomplished across various sectors, including farming and transportation [16]-[6]. The field of PH has mostly been associated with behavioral patterns, such as changes in nutrition and regular choice of food [7]. A growing issue in both emerging and wealthy nations is the often-seen shift in dietary habits leading to persistent Non-Communicable Diseases (NCDs) such as being overweight, cardiovascular illnesses, stroke, and diabetes [5]. As our lifestyle changes, the consumption of sugar and unnecessary fats grows, while the nutritional value of our daily meals is diminishing [12]. Adequate consumption of nutrients is crucial for an efficient existence and long lifespan. Malnutrition in nutrients is a significant issue in developing and wealthy countries. Over 3.5 billion individuals experience this nutritional deficiency [9]. In addition to the disorders mentioned above caused by a life of inactivity with excessive consumption of sugar and fat, a lack of essential nutrients in the diet also leads to reduced efficiency, learning difficulties, and higher death rates. Furthermore, efficient logistical assistance is imperative to construct a highly functional food distribution network [15]. Several recent research studies demonstrate the beneficial effects of consuming crop-based diets on PH [15]. The consumption of fresh produce has been identified as crucial in preventing cardiovascular illnesses and overweight. In addition to fruits, berries, and vegetables, other crop-based foods such as grains and legumes are also advantageous for PH [11]. Several factors may contribute to the effect on human health [8]. Crop-

based food is often low in sugar and fat, particularly processed varieties. However, these food items are also abundant in nutritionally advantageous elements such as micronutrients, antioxidants, and bioactive molecules [17].

PR through OF for promoting PH management and food security

OF greatly reduces pesticide use, which greatly improves PH management and food security. By not using pesticides, OF limits the dangerous chemicals people are exposed to. This lowers the number of health problems related to pesticides, such as cancer, hormone change, and neurological conditions. OF methods, like alternating crops, poly cultivation, and using natural enemies, also help keep the earth healthy and full of different plants and animals [3]. This makes food systems sturdier and more long-lasting. Less use of chemicals also helps keep the surroundings clean, protecting water sources from contamination and keeping beneficial pest populations alive. In the end, OF helps ensure food security by growing safe, healthy, and nutritious food, safeguarding the health of farmers and the public, and guaranteeing long-term agricultural output. This all-around method fits PH's objectives and will help build a better community and a more stable future.

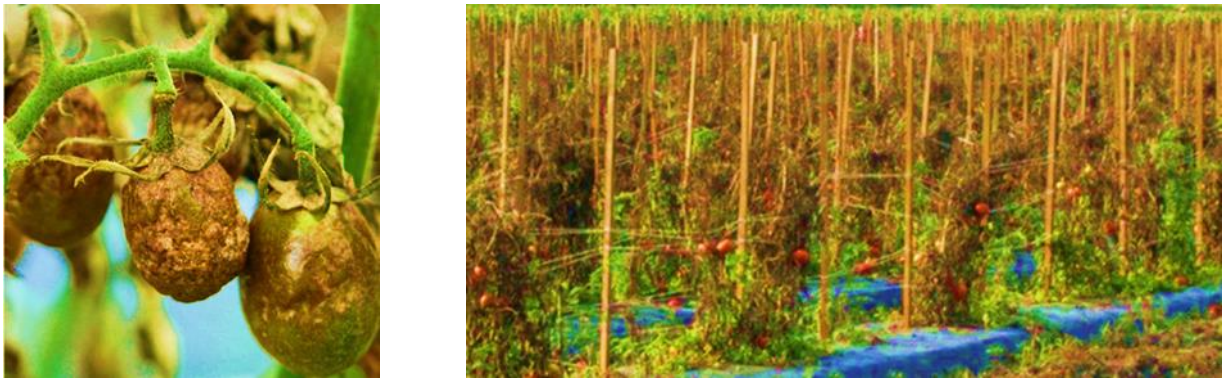

Fig. 1 (a) Late blight disease in tomato. (b) A plot of land, spanning 25 acres is dedicated to cultivating organic tomatoes

Pest control issues decrease in frequency and become easier to identify and conquer on sustainable farms that are properly managed. Occasionally, new issues emerge that need system modifications and creativity to regain a satisfactory degree of control. However, flexible and assertive management can often solve these obstacles without relying heavily on pesticide use or returning to traditional cultivation methods. At times, particular sections on organic vegetable and fruit fields have complete crop failures, as seen in Fig. 1, which depicts an organic tomato crop affected by late blight disease shortly before harvesting. A 25-acre plot of organic tomatoes, with a value exceeding fifty million US dollars, was completely destroyed by late blight only just a few days before the scheduled harvest. Notwithstanding this setback, this multifaceted enterprise yielded robust revenues from the roughly 20 other crops cultivated on the site.

PR-driven consumer choices

Consumer studies indicate that the biggest motivation for individuals to convert to organic foods is the intention to decrease their exposure to pesticides in their diet. The Sustainability Working Group's "Dirty Dozen" and "Clean 15" lists have increased awareness about residues in different foods. These lists have assisted customers in recognizing that certain fruits and vegetables usually have no traces of pesticides. In contrast, others have four or more residues, and a few have ten or more. The analyses and hazards leftovers pose often vary between locally grown and imported commodities. Opting for organically produced food is the most effective way to reduce pesticides and associated risks significantly in our food.

Advancements in medical studies, toxicology, and epidemiology are now being made to determine how pesticide residues lead to negative health effects. Four health problems need more organized and targeted study, and they are likely to increase customers' motivation to choose organic brands:

• Effects on human reproduction and offspring growth, particularly on the neurological,

immunological, and reproductive organs.
• Pesticide concentrations have been linked to an increased risk of cancer, particularly blood and brain malignancies in youngsters.
• The potential effects of long-term pesticide exposure on the structure and functioning of an individual's gastrointestinal microbiome.
• The degree to which early pregnancy pesticide exposure may cause inherited genetic changes that raise the likelihood of adult-onset diseases, sexual anomalies, or other PH issues.

DHI to ensure food security and PH

The pesticide residue was generated using the Dietary Hazard Indicator (DHI) approach. The DHI value is a ratio that represents the amount of pesticide found in one serving of food compared to the maximum permissible level set by the US Environmental Protection Agency (EPA). The maximum permitted level is the highest amount of pesticide found in the food without causing problems with prolonged exposure. The DHI system utilizes residual pesticide data from the US Pesticide Monitoring Initiative to determine the average residue content for a specific combination of food and pesticide. This calculation is based on the average residue levels of every specimen with reported residues (average of the positives; $\%P$). The average residue levels (Avg_Res) are used in conjunction with the mass of one portion of food (Por) and an individual's body mass (BM) to compute three DHI values:

$$Positive\ Sample\ Average\ (DHI - Avg) = (Avg\_Res \times Por)/(LRD \times BM) \quad (1)$$

$$Food\ Supply\ (FS) - DRI = (Avg\_Res \times Por)/(LRD \times BM) \times \%P = DHI - Avg \times \%P \quad (2)$$

$$Individual\ Sample\ DHI = (Pesticide\ level \times Por)/(LRD \times BM) \quad (3)$$

Within these equations, the term Lasting Reference Dose (LRD) might be substituted by Lasting Population Adjusted Dose (LPAD) or other Acceptable Daily Intake (ADI), depending on the context. The DHI readings are dimensionless since they represent the ratio between the weights of two pesticides. The DHI can monitor and analyze residues and risk levels in food based on several factors, such as the kind of pesticide used, whether the food is produced organically or conventionally, whether it is locally grown or imported, and any combination of these selection criteria.

2. Results and discussion

We used the PUM information to compare pesticide usage across organically certified farms and adjacent traditional farms for tomato crops. We assessed the quantity of Treated Hectares (THa), the amount of the vital component used, and the usage rates in both kilograms per THa and kilograms per Planted Hectare (PHa). We assessed the proportion of THa relative to the total PHa during a single crop generation period. The tomato database included 100 organically grown fields with a mean area of 25.4 hectares and 480 traditional fields with a mean area of 28.1 hectares.

Fig. 2 shows the pesticide usage on tomato crops. In TF, 0.19 kg/ha of insecticides are used, but 0.56 kg/ha are used in OF, which is much more. In contrast, 0.58 kg/ha of fungicides are used in TF, but only 0.04 kg/ha are used in OF. Herbicides are only used in TF at a rate of 1.19 kg/ha. No herbicides are used in OF. Crop Growth Regulators (CGR) are also used at 0.72 kg/ha in TF and 0.02 kg/ha in OF, as shown in Fig. 2(a). These numbers show that even though OF might use fewer pesticides, like fungicides and herbicides, it might use more of others, like insecticides, to compensate for the lack of chemicals. This method improves food security and sustainability while protecting PH by lowering the total amount of chemicals in the environment and food supply.

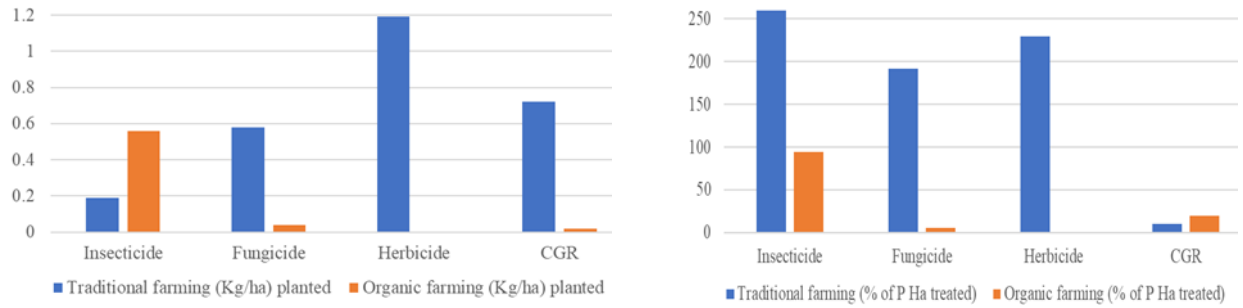

Fig. 2 Pesticide usage on tomato crop. (a) Application rate per PHa (b) % of PHa treated

TF used herbicides in 260% of the grown fields, but OF only used them in 94%. Regarding fungicides, TF covered 192% of the fields, but OF only covered 5%. 230% of traditional farmers used herbicides, but none of the farmers who carried out OF did. CGR, on the other hand, had a 20% treatment rate in OF compared to 10% in TF, as shown in Fig. 2(b). This information shows that using OF methods significantly lowers the use of pesticides, especially fungicides and herbicides. This can help improve PH and have a smaller negative effect on the environment.

3. Conclusion and future scope

This study analyzes the historical background of sustainable agriculture, the notable chemicals that affect PH due to PR initiatives, and the variations in PH-related components present in crops. Moreover, this paper especially investigates the influence of sustainable agriculture on health-related compounds, pesticide residues, and toxins in crops. This study proposed strategies for PR by advocating for the broad adoption of organic agriculture practices. The findings indicate that although OF may reduce the usage of some pesticides, such as fungicides and herbicides, it may compensate for this by using more insecticides to compensate for the absence of synthetic chemicals. This approach enhances food security and sustainability by reducing the overall quantity of chemicals in the environment and food chain, safeguarding PH.

Reference

[1] Wezel, A., Herren, B. G., Kerr, R. B., Barrios, E., Gonçalves, A. L. R., & Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agronomy for Sustainable Development*, *40*, 1-13.

[2] De Schutter, O., Jacobs, N., & Clément, C. (2020). A 'Common Food Policy'for Europe: How governance reforms can spark a shift to healthy diets and sustainable food systems. *Food Policy*, *96*, 101849.

[3] Srinivasa Rao, M., Praveen Kumar, S., & Srinivasa Rao, K. (2023). Classification of Medical Plants Based on Hybridization of Machine Learning Algorithms. Indian Journal of Information Sources and Services, 13(2), 14–21.

[4] Durham, T. C., & Mizik, T. (2021). Comparative economics of conventional, organic, and alternative agricultural production systems. *Economies*, *9*(2), 64.

[5] Alamer, L., Alqahtani, I. M., & Shadadi, E. (2023). Intelligent Health Risk and Disease Prediction Using Optimized Naive Bayes Classifier. Journal of Internet Services and Information Security, 13(1), 01-10.

[6] Raman, A., Suhartanto, D., & Shaharun, M.H.B. Delightful Customer Experience: An Antecedent for Profitability and Sustainable Growth of Airline Businesses. Preprints (2023), 2023121838. https://doi.org/10.20944/preprints202312.1838.v1

[7] Cena, H., & Calder, P. C. (2020). Defining a healthy diet: evidence for the role of contemporary dietary patterns in health and disease. *Nutrients*, *12*(2), 334.

[8] Sofiene, M., Souhir, C., Yousef, A., & Abdulrahman, A. (2023). Blockchain Technology in Enhancing Health Care Ecosystem for Sustainable Development. Journal of Wireless Mobile Networks, Ubiquitous Computing, and

Dependable Applications, 14(3), 240-252.

[9] Adeyeye, S. A. O., Ashaolu, T. J., Bolaji, O. T., Abegunde, T. A., & Omoyajowo, A. O. (2023). Africa and the Nexus of poverty, malnutrition and diseases. *Critical Reviews in Food Science and Nutrition*, *63*(5), 641-656.

[10] Thooyamani K.P., et.al Deploying site-to-site VPN connectivity: MPLS Vs IPSec, World Applied Sciences Journal, V-29, I-14, PP:6-10, 2014.

[11] Johansson, E., Hussain, A., Kuktaite, R., Andersson, S. C., & Olsson, M. E. (2014). Contribution of organically grown crops to human health. *International Journal of Environmental Research and Public Health*, *11*(4), 3870-3893.

[12] Willer, H., Trávníček, J., & Schlatter, S. (2024). The World of Organic Agriculture. Statistics and Emerging Trends 2024.

[13] Radmanović, S., Đorđević, A., & Nikolić, N. (2018). Humus Composition of Rendzina Soils in Different Environmental Conditions of Serbia. Archives for Technical Sciences, 2(19), 57–64.

[14] EFSA Panel on Nutrition, Novel Foods and Food Allergens (NDA), Turck, D., Bohn, T., Castenmiller, J., de Henauw, S., Hirsch-Ernst, K. I., ... & Vinceti, M. (2022). Tolerable upper intake level for dietary sugars. *EFSA Journal*, *20*(2), e07074.

[15] Prashanth, B. Arasu, R. & Karunanithy, D. (2024). Perceptual Study on Higher Level Digitilization Among Managers in the Logistics Industry. The Journal of Distribution Science, 22(1), 25-36, https://doi.org/10.15722/jds.22.01.202401.25.

[16] Raman, A. & Ramachandaran, S. D. (2023). Factor Influencing Consumer's Adoption of Electric Car in Malaysia. TEM Journal. Volume 12, Issue 4, pp 2603-2612, ISSN 2217-8309, DOI: 10.18421/TEM124-50.

[17] Demirci, B., & Demirhan, S. A. (2022). Food composition and dietary overlap of the lionfish species in Iskenderun Bay. Natural and Engineering Sciences, 7(3), 228-239.

[18] Ristono, A., & Bud, P. (2019). Design of Reliable and Efficient Manchester Carry Chain Adder Based 8-Bit Alu for High Speed Applications. Journal of VLSI Circuits and Systems, 1(1), 1-4.