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## Promoting Organic Botanical Pesticides for Sustainable Agriculture: A Solution to Pesticide Misuse and Environmental Toxins

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Citation: Al Shamsi, M.A. Promoting Organic Botanical Pesticides for Sustainable Agriculture: A Solution to Pesticide Misuse and Environmental Toxins. *STJ*, 2024,1,10-23.

<https://doi.org/10.70957/uqu.edu.sa/s.toxicology.s/stj.2024.1.2>

Received: 16 November 2024

Accepted: 7 December 2024

Published: 18 December 2024



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**Abstract:**

The application of synthetic pesticides in agricultural activities is alarming with various implications to the health of human beings and the environment. Organic botanical pesticides are made from plants, making them the best option as compared to synthetic chemicals since they are environmentally friendly and have negligible toxic content. The purpose of this research is to assess the efficacy of organic botanical pesticides in the management of pests, especially on the nematodes and the mealybugs affecting the fig and mango trees using Abba organic pesticides oily extract of *Cymbopogon schoenanthus* (L.). It has also been observed that there has been a great success in the reduction of pest incidence as well as enhanced plant health from using organic pesticides hence underpinning its usefulness in an organic agriculture production system. However, some adoption barriers that the authors noted included higher costs, slower results, and poor awareness among farmers. The paper recommends changes in the policies, providing financial motivation, and increasing training concerning the application of organic botanical pesticides.

**Keywords:** Organic botanical pesticides, sustainable agriculture, pest control, environmental conservation, organic farming

### 1. Introduction

World agriculture now has a daunting task as the increasing abuse of synthetic pesticides threatens crop production, man's health, and the environment (2F6).

This is so even when there are regulations regarding the use of pesticides, their application often needs to be revised. This is primarily a result of low levels of training of employees in the

agriculture sector, low levels of awareness regarding the implications of the wrong use of pesticides, and the continuing high pressure towards productivity in agriculture. Such concerns are evident today, indicating that the future cannot depend on synthetic pesticides (20).

This has resulted in increased awareness of organic farming, which offers quality produce while promoting food conservation.

Organic agriculture has, therefore, stood out as a viable substitute – providing sustainable production solutions to our environment and enhancing human health. Applying organic botanical pesticides appears promising, as are all the strategies practiced within organic agriculture. Organic pesticides are pesticides whose raw materials are obtained from plant origin; they are practical methods of exterminating pests since they have the most minor side effects compared to synthetic ones (16).

Organic botanical pesticides differ from conventional chemical pesticides since they do not leave chemical residues on crops that pose potential dangers to consumers. In addition, they do not harm non-target organisms; hence, they are instrumental in conserving species diversity, unlike synthetic pesticides that harm non-target organisms when used (1).

Powdered botanical insecticides must be encouraged and developed as they do not pollute the environment, as do the synthetic chemicals, or cause death to humans and livestock when ingested (8).

It has been attributed that improper use of synthetic pesticides causes acute poisoning, chronic diseases, and long-term developing effects, for example, cancer. The Pesticide residues in the food products amplify these risks, mostly in developing countries with weak regulatory measures. Due to their natural composition and relatively low environmental toxicity, organic botanical pesticides can reduce such health hazards (28).

When these products are incorporated into standard farming practices, their use will be minimized, hence lowering the occurrence of pesticide-related health issues while at the same time producing healthy food (31).

Besides the health and environmental effects of organic botanical pesticides, they are also preferred in today's market, where people are more conscious about organically grown food (24).

Because people nowadays are getting more informed on the hazards that come with synthetic pesticides, people are more likely to go for the safer

option. This change in the demand system has contributed to the growth of the Organic food market, opening new avenues for farmers and producers who are willing to go organic naturally. It makes a lot of sense for farmers to explore organic botanical products to meet this demand while simultaneously continuing to produce competitive yields that can make their farming profitable. In field studies, it has been found that organic botanical pesticides are very effective against agricultural pests (28).

In these trials, the effectiveness of organic pesticides in controlling pests such as insects, fungi, and nematodes without adversely affecting crop quality or yield was displayed. For instance, applying organic herbicides has effectively controlled weeds, which remain a significant problem to organic production systems. Likewise, organic insecticides have also provided great solutions in pest management of crops, including fruits, vegetables, and grains. These trials provide evidence that organic botanical pesticides can be used as a substitute for synthetic chemicals used in the farming of foods; this can help ensure food production that is both sustainable and safe for human consumption (18)

However, the conversion to organic botanical pesticides comes with some difficulties. Thus, one significant challenge that produces high risks is more education and formal training among farmers and other agricultural industry personnel. Having reviewed the knowledge and experience of farmers, especially those in the developing world, this is likely an issue since many farmers need more understanding of applying what is necessary to obtain organic farming (39).

This involves information on the appropriate use of organic pesticides, signs portraying pest infestation, and the strategic implementation of integrated pest management, which minimizes chemical application. This forms the basis of this research covering the knowledge gap in using organic botanical pesticides. There is no better way to ensure this transition than through workshops, extension services, and demonstration projects that offer farmers training (22).

The other disadvantage needs to be more innovation in using organic botanical pesticides. Despite the encouraging results of the last few years, there is still a long way to go in understanding the full potential of these products (6).

This comprises the discovery of other plant-derived compounds with pesticidal value, improvement of the formulations of existing pesticides, and the effects of organic compounds on the fertility of the soil and the general balance in the ecosystem. There is a need to continue funding research and development activities to address the challenges of using organic botanical pesticides in meeting the increasing demand for botanical pest control (3).

Thus, the parts of policy and regulation that can advance organic botanical pesticides must be noticed. There is increasing recognition that governments and regulators are significant influencers of farmers and the practices that they engage in (11).

There is only a need for policies through which people are encouraged to use organic insecticides and repellants and, on the other hand, are discouraged from using synthetic chemicals through punishment based on the law. Such steps can be subventions for certified organic inputs, enhanced compliance with pesticide legislation, and the promotion of accreditation programs to incentivize farmers to use sustainable techniques in their farming enterprises (3).

In addition, cooperation with world conventions and the establishment of common standards can also give farmers the ability to export organic products and, hence, opportunities to expand to new markets and make organic practices more popular (9).

This paper recommends that to the extent of enhancing the use of organic botanical pesticides in the world's agricultural setting, focusing on the economic factors affecting the farmer's decisions is critical (13) From the following results, it can be deduced that switching from synthetic to organic pesticides has initial cost implications, which sometimes hinder smallholder farmers. These costs are the cost of organic inputs, the possibility of

purchasing new equipment for the transition, and the costs of training and education. There is a need to develop financial incentives and support structures to address such barriers (10).

This is especially important in the transition period and can be obtained through subsidies, grants, and low-interest credit for financing operations in organic farming. Besides, through cooperative purchasing, farmers can buy the inputs in bulk, improving the option of a cheaper source of organic inputs. Another factor that needs to be considered is how much organic botanical pesticides may be boosted (37).

Though these products have exhibited good efficacy in controlled field tests, their more realistic large-scale application needs more assessment regarding climatic zones and environmental factors. As has been emphasized earlier, there is a need to prove that the organic pesticides developed will be effective on different crops, other types of soils, and various pest attacks (38).

This will cover not only the geographical diversification of field trials but also the formulation of growth hormones specific to regions that farmers worldwide face. In addition, consumer attitudes and the demand for organic products are equally important in influencing the use of organic farming. Awareness creation by showing consumers that certified organic food, for instance, has no pesticide residues, has higher nutritional value than ordinarily grown food, and is grown through sustainable methods, among others, can create a market action where farmers opt to produce organic food (4).

They also have responsibilities, including sourcing organic ingredients to be used in the foods they sell, increasing the demand for organic foods.

## 2. Literature Review

### 2.1 Global Food Security

Agriculture and food security are interrelated globally, and the sector needs to evolve to feed the world's increasing population (23).

However, this essential sector suffers many problems because of the high and continuously growing usage of toxic pesticides and synthetic

pollutants. These chemicals were synthesized to control pest infestations and diseases affecting crops but have been causing so much concern in their reactivity to human and other animals' health and the environment. For example, while technology has embraced the use of pesticides, this has resulted in land degradation, soil erosion, and pollution of essential water resources, which form part of the sustainable agriculture system (15).

Moreover, pesticides are equally responsible for killing non-targeted species, which are essential organisms for any ecosystem, such as beneficial insects, birds, and many aquatic life forms that regulate the balance of the ecosystem. It is also seen that the loss of biodiversity impacts the environment and weakens the adaptive capacity of the agricultural systems that are more vulnerable to future pest incursions and climate changes.

Even with regulations and guidelines to check pesticide use, its misuse is still rife, especially in developing countries where farmers have little or no knowledge of the risks posed by pesticide use. There is always unskilled labours needed to handle the pesticides (43).

Using pesticides also increases crop productivity, but most farmers do not know enough about the effects of abusing pesticides. One can point at this over-reliance on chemical solutions, indicating the need to embrace safer agriculture practices. These practices are essential for long-term sustainable food security for the world since they will reduce the use of dangerous chemicals to human health and the environment and embrace safer farming techniques (29).

## **2.2 Risks of Pesticide Misuse**

Pesticide abuse is seen to be a primary concern to people as well as the environment due to its dangerous impacts (Leoci & Ruberti, 2021).(19) The people at high risk of suffering the health effects of these toxic pesticides include agricultural workers. They include short-term effects like diseases affecting the respiratory system, skin and neurological diseases, and diseases that take a long time to manifest themselves, such as cancer and endocrine disorders (33).

For these reasons, many of these dangers are increased by inadequate training and insufficient personal protection equipment, especially in the developing world where legal compliance is frequently low.

Consumers are also in a vulnerable position, mainly because of the consumption of pesticide residues in foods. These residues are comparatively slow to metabolize and can build up in the system over time and a condition a chronic health state. Furthermore, pesticide residues in food lower consumer confidence in agricultural products, unaffected by the market force and the economic stability of farming areas (32).

Environmentally, the lousy use of pesticides can cause pollution of the soil and water; this, in a way, will cause pollution of water resources and pollination of non-target beneficial insects, fish, and other water organisms. Pollinators, for instance, bees, which are vital in pollination, will be extinct, making it difficult for crops to be pollinated (14).

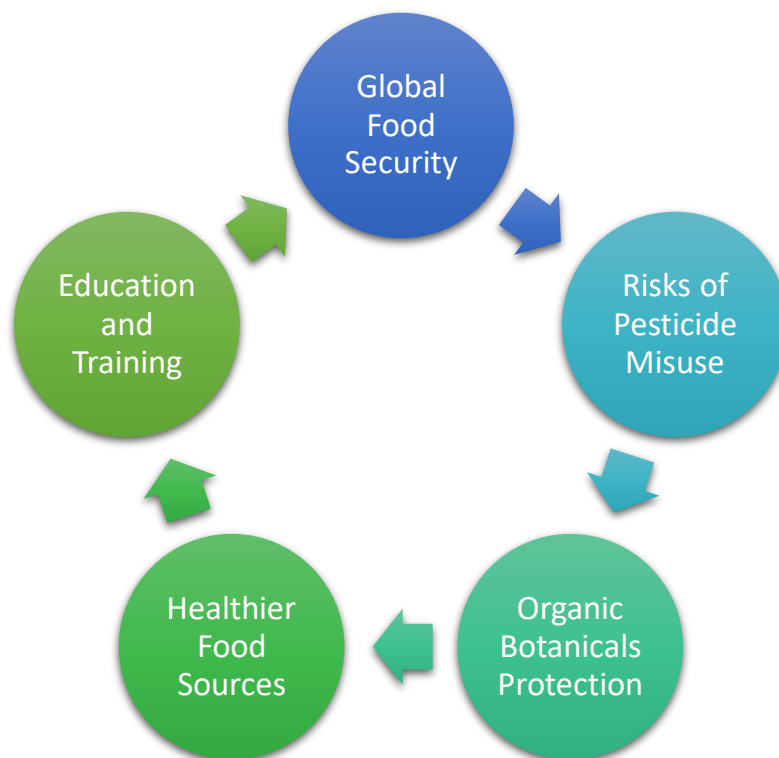
Moreover, the pesticides, when washed into the water sources, cause the accumulation of toxins in the water, affecting fisheries, fish, and algae, leading to fish mortalities, algal bloom, and food chain derailment. Using pesticides also fosters the buildup of pesticide-resistant pests, where high power and toxic chemical sprays are needed to achieve the same efficiency as in the beginning (42).

Such a phenomenon increases not only the cost of farming but also contributes to the degradation of the environment and adverse effects on the health of the public. To effectively counter these challenges, several measures include increased vigor in enforcing the existing laws against users of pesticides, enhancement of awareness and knowledge among farmers, and implementation of integrated pest management measures.

## **2.3 Organic Botanicals Protection**

Organic botanical protection is a sustainable solution to the problems arising from using synthetic pesticides and industrial pollutants (28).

Unlike ordinary chemical pesticides, organic botanicals are biological plant products safe for



**Figure 1: Global Food Security and Agricultural Challenges (Source: Author).**

cultivated crops and livestock. These products stimulate or, in some way, support the plant's body to handle a disease or pests without harming the surrounding environment. The use of organic botanicals as practices in agriculture is necessary towards the need to avoid the use of toxic chemicals (25).

They are environmentally friendly since they help control pests using agents that are safe for the environment. Besides being harmless to the environment, they are biodegradable and will not pollute the environment. Furthermore, botanicals derived from organic plants, which are safe for humans, contribute to the health of insects that are helpful to plants, especially pollinators and natural enemies to pest species, hence, stability in the ecological environment (5).

Another advantage of using organic botanical protection is protecting livestock health. Organic products from plants available in the marketplace can prevent diseases and parasites affecting animals without chemical agents in foods consumed by humans. This not only enhances the quality and productivity of animals but also rids them of ailments, and animal products like meat, milk, and eggs are disease-free from bacteria. In addition, cost-related constituents such as organic

botanicals are also helpful in maintaining soil health (44).

In contrast to synthetic pesticides, which negatively impact the aggregate of the soil through negative regulation of erosiveness, organic pest products help enrich soil fertility by promoting the growth of favorable microbes and cycling nutrients. As is well known, healthy soil is a prerequisite for healthy crops and, therefore, for sustainable agricultural practices as it allows for better water control and chemical fertilizers. The widespread use of organic botanical protection is needed to shift toward a new, more sustainable agricultural system (37).

Farmers can save their crops and stock by minimizing synthetic chemicals without polluting natural resources and ensuring future generations. This aligns with the fundamental idea of organic agriculture, which seeks to practice environmentally friendly agriculture to produce safe foods.

### 3. Methodology

#### 3.1 Study Design

This study used a qualitative research approach to understand the attitudes, encounters, and information of the farmers and agriculturalists on

applying organic botanical pesticides. This qualitative study aimed to examine the following research questions: What are the perceived advantages and disadvantages of using organic pesticides based on individual experiences and perceived threats and opportunities inherent in the use of organic pesticides to health and the environment?

### **3.2 Study Area and Participant Selection**

The study was performed in areas of agricultural production that employ the use of organic (Abba organic pesticides oily extract of *Cymbopogon schoenanthus*) as well as synthetic pesticides. The primary respondents in the survey were farmers who used both types of pesticides, and the other respondents were agricultural workers and extension officers. Consequently, purposive sampling was used to recruit clients with adequate knowledge of applying organic botanical pesticides. Altogether, 20 participants were interviewed for the current study, and an attempt was made to select participants with different types of farming practices, crops, and geographical locations to have a broad perspective on the topic.

### **3.3 Data Collection**

Both interviews and field observations that are non-standardized or structured interviews were used in the study. The interviews were structured in a way that asked the participants to provide complete descriptions of their encounters with organic botanical pesticides; areas of discussion included efficiency, ease of application, risks to the environment, and health risks. Specific questions encouraged participants to respond more spontaneously because they offered a structure that enabled the researcher to examine themes that may have emerged during the discussion. These interviews were face-to-face during a visit to the participant's farm or through telephone interviews, depending on the possibility.

Besides interviews, field observation was conducted to capture the application of organic botanical pesticides in practice. Assessments comprised the method adopted by farmers in spraying pesticides on their crops, the conditions of the crops, and indications of pest control or plant

health. Field observations were also made to complement the interview data, and photographs and notes were recorded during the observations.

### **3.4 Data Analysis**

The interviews and the observations made in the study were transcribed and analyzed in terms of themes. Therefore, the data was coded to determine the patterns of using organic botanical pesticides with the help of the grounded theory. The first coding step occurred at the super-ordinate level, where responses were sorted into broad domains like 'perceived benefits, 'barriers to adoption,' and 'environmental effects.' The next step was fine-grained coding, where attempts were made to differentiate among responses to the participant's perceived experiences.

In categorizing and analyzing the data, the researchers relied on qualitative data, which allows systematic comparisons between different participant responses and groups of participants. The study also qualified contextual factors, including region or crop type, that were useful in explaining the effect of such contextual factors on the participant's exposure to OBP.

### **3.5 Ethical Considerations**

The study was a cross-sectional descriptive survey; informed consent was sought from the participants, and ethical clearance was sought from the institutional review board before the study was conducted. Consent was sought from all the participants before the interviews and observations, which explained the aim and purpose of the study and their rights as subjects. Security and protection of participants' identities were observed by using pseudonyms for the participants' names and other identifying information in the transcripts and reports. Participants were also made aware of their rights to opt out of the study at any time with no reasons asked of them.

### **3.6 Trustworthiness**

The following analytical techniques were used to minimize the source of error and enhance the study's credibility. Cross-validation was done in line with the triangulation in which different data sources, which include interviews and field observations, were used to substantiate the



**Figure 2: Nematode infestation in fig roots - the following results can be observed after treatment with the Abba (Source: Author)**

findings. Another method used was member checking, in which the participants were given summaries of their interviews to ensure that what they said was understood correctly. Further, peer debriefing was conducted with other researchers to validate the research findings of the present study and establish the credibility of the data analysis phase.

## 4. Results

### 4.1 The effectiveness of the organic herbicide on agricultural pests in trees, fields, environmental plants, and gardens

Abba organic herbicide is quite effective on agricultural pests such as those on trees and infested fields, ecological plants, and gardens, mainly where root nematodes in fig tree infestations occur. From the observations made between 29/06 and 21/06, the plant's health has been rising, illustrating the herbicide's effects. Figs roots had also, in an equal manner, improved their health by June 21, when the infestation of the nematodes was proven to have reduced significantly. This recovery was coupled with quite a marked improvement in plant growth and vigor, demonstrating a second aspect of the herbicidal action – plant growth stimulation. These findings prove that organic herbicides are capable substitutes for synthetic products that can

effectively target pests and, at the same time, promote eco-friendly farming systems.

### 4.2 Before Spraying the Organic Botanical Pesticide (Abba Botanical Pesticide)

Mealybugs were found to have affected the mango tree, most probably by 80% of the leaves, which showed a lot of infestation symptoms. The level of infestation was severe by a large conglomeration of the Mealybugs on the leaves. Other indications were that the tree's foliage turned yellow and wilted, which compromised the tree's ability to perform photosynthesis. Furthermore, abnormal growths in honeydew, which are sticky, were observed on the leaves and tender branches, and it affected the overall health of the tree. The effect was the curling of the leaves, decoloration, and premature leaf drop, which led to stressed tree growth and decreased fruiting.

### 4.3 After Spraying the Organic Botanical Pesticide (Abba Botanical Pesticide)

As indicated in the observation, after using Abba botanical pesticide to control the Mealybugs, the infestation level on the mango tree has reduced drastically. Mealybug colonies decreased significantly, and in most cases, there could be less than five leaves affected by Mealybug infestation. In the case of treatment efficacy, the symptoms of yellowing and wilting were reduced, and very little honeydew was covering the plant. As a result, the



**Figure 3: Severe Mealybug infestation on leaves of the perennial mango tree (Source: Author)**



**Figure 4: After Spraying the Organic Botanical Pesticide (Source: Author)**

condition of the leaves became less wizened and decolorized. Thus, the improvement in the health state of the tree was noticeable due to its increased growth with a tendency toward the frequency rates of fruiting.

#### **4.4 Positive Effects of Organic Pesticides on Fruit Protection**

The following pictures show organic pesticides protecting fruits from hazards such as spiders, aphids, fungal attacks, and insects. More particularly, one of these can be described as treating a single papaya plant that produced no fruits before. However, when treated with Abba botanical pesticide, the plant began to look healthy throughout the study. Two weeks after pesticide application on this plant, the papaya plant developed the formation of flowers and fruits, even as the fruits of this plant developed on the plant. This satisfactory result shows that organic

pesticides play a role in increasing fruit yield and plant health by controlling pests and infections.

#### **4.5 Successful Treatment of Scabies in Livestock Using Organic Insecticide**

This research shows how an abiotic insecticide of microbial origin from the environment efficiently treats a zoonotic skin ailment and scabies in sheep and camels. This disease caused by parasitic mites is known to cause considerable discomfort, skin lesions, and significant loss of livestock. The problem of such infestation has been tackled well by applying a specially formulated agricultural/animal pesticide made from natural products, which has been realized to be quite effective and cheap. The treatment led to the disappearance of the scabies condition, making all the affected animals healthy again at almost negligible charges. This is an environmental solution and proves the effectiveness of





**Figure 5: Positive Impact of Abba Botanical Pesticide on Papaya Plant (Source: Author).**

observation for organic insecticides in sustainable livestock management.

#### **4.6 Rapid Response of Chronic Skin Infection in Camel to Abba Organic Pesticide**

A case with chronic skin sickness with major ulcers in the skin of a female camel was effectively treated with Abba organic agricultural and animal pesticide. Aim and facts reveal that the chemical substance relieving a chronic disease, including deep-seated skin ulcers, diminished the growth of theaceous infectious bacteria by using the natural based pesticide, which is known to be effective in eradicating such infections. The following pictures depict the progress of the disease with traceable healing of ulcers, and overall, the skin condition of the camel has been significantly enhanced. This outcome shows the effectiveness of Abba organic pesticide in treating severe skin diseases in livestock and emphasizes organic solutions.

### **5. Discussion**

The findings give insights into organic botanical pesticides' performance, perception, and implementation issues. This research, which adopts interviews and observations, has found that although organic pesticides have numerous environmental and health benefits over synthetic ones, adoption barriers persist in the agricultural sector (7).

This paper shows that organic botanical pesticides are efficient against agricultural pests (18). Another response shown by agriculturists who used the Abba organic botanical pesticide in their

plantations and farmlands was better plant health and better pest infestation status. For instance, samples from fig plantations revealed a remarkable decline in the prevalence of nematodes and significant improvement in plant roots after a few weeks of the treatment. Likewise, the mango trees that showed signs of severe mealybug infestation had their foliage in much better health and less pest activity after applying the organic pesticide. These findings agree with prior field practices where it was shown that organic botanical pesticides are efficient for pest control without affecting crop quality or quantity (17).

However, it should be noted that, on the results obtained, the authors also emphasized the negative aspect. There are cases when the efficacy of organic botanical pesticides is slower and less efficient than synthetic counterparts (27).

Although the pest population was controlled, their elimination was not achieved in several cases. For example, even though mealy bug quantities were drastically reduced on mango trees, they could never be wholly eradicated. Consequently, these studies show that though there is a practical application of organic pesticides with efficiency in pest control, it is true that such pesticides may offer little results and may take longer to work than their synthetic counterpart. However, they might be highly effective but may need multiple uses compared to synthetic pesticides (Damalas & Koutroubas, 2020). (6).

This tally with the statements of some of the farmers who complained that, even though many



**Figure 6: Efficacy of Organic Insecticide in Treating Scabies in Livestock (Source: Author)**



**Figure 7: Effectiveness of Abba Organic Pesticide on Chronic Skin Infection in a Camel (Source: Author)**

agreed with the environmental impact of organic pesticides, they are less effective than synthetic chemicals, especially when combating numerous pests. An essential learning revealed in this research is that applying organic pesticides leads to adverse environmental impacts, which are significantly reduced, and the soil condition is enhanced (35).

A cross-section of the participants and observation made it clear that using organic pesticides did not produce toxic residues on the crops or the environment (34).

The soil samples collected before and after using organic pesticides showed no contamination, and the microflora was found safe and sound. This contrasts with synthetic pesticides, which have been reported in the study to reduce the quality of

soils and negatively affect non-target organisms based on participants' past usage of chemical pesticides. Such results can be parallel with other research works that prove a lesser environmental toxicity of organic pesticides (41).

The study also establishes that crop quality and yields are improved after using organic botanical pesticides (2).

Participants observed enhanced health status of the plants, better foliage, fewer stress signs, and more fruits, especially papaya and mango. For example, one of the advantages was established by using the organic pesticide that helped a papaya plant, which had not previously yielded fruits or flowers, to do so after applying the organic pesticide. This concurs with the general findings by other authors that organic-based pesticides enhance plant growth and yield quality by improving the ecological balance (36).

However, the study's findings also present several issues related to using organic botanical pesticides. The first discovered barrier was the cost of organic pesticides compared to synthetic ones (40).

Most participants commented that they were ready to adopt the new organic farm-ing practices, but this has been greatly hampered by the fact that organic pesticides are very expensive and require frequent application. This is especially true with smallholder farmers who operate on thin profit margins and cannot easily absorb such incremental costs into their new producing models (21).

Based on the presented results, a theoretical targeted impulse – financial incentives or subsidies- has been provided to the farmer during the transition to organic production, given the accessibility and availability of synthetic pesticides.

## 6. Implications

These considerations of the findings concern the influence of the research on organic botanical pesticides in various fields, including sustainable agriculture, environmental conservation, and public health (30).

Organic pesticides are another example of environmentally friendly farming strategies since

they limit the level of negative impacts the synthetic chemicals have on soil, water, and biodiversity. In contrast to synthetic chemical pesticides, organic botanically derived pesticides are eco-friendly and safe for consumption, environmentally compatible, non-contaminating to water sources, and nontoxic to beneficial forms of insects like bee pollinators and useful insects. This, in turn, results in a convenient balance that would favor biological diversity and equally inhibits the cases of pesticide-susceptible pests. In the economic implication, the usage of organic botanical pesticides leads to the creation of a new market for organic fresh produce since most consumers are now more conscious of their health, thus avoiding foods containing chemicals (28).

Synthetic pesticides used in crop production have been associated with negative implications for the health of consumers, and as consumers become more informed about the hazard, there is a growing demand for organically produced products, which means that farmers can be able to tap into the premium markets. However, this means that several challenges with regard to cost aspects have to be met since organic pesticides often have to be applied more frequently and potentially are more costly than synthetic substances (9).

Agricultural subsidies may force farmers to implement these sustainable practices, cooperative purchasing may include recommendations for ecologically friendly farming techniques, and low-interest farmer loans enable farmers to invest in the application of such technologies.

In the light of policies, governments help support the use of organic pesticides through the formulation of policies that approve the use of organic farming inputs, setting standards for organic farming, and encouraging farmers to engage in sustainable practices. Policymakers must, therefore, put in place measures to ensure farmers attend training sessions and extension services so that they are well informed on the merits, applications, and uses of organic pesticides (12). Moreover, international cooperation could enhance these standards and make sources of

organic farming competitive in the world market with reference to worldwide food security.

## 7. Conclusion

The implications of the present research are far-reaching, especially in the applicability of organic botanical pesticides as safer alternatives to chemical-based pesticides. Although the long-term advantages are seen in their consideration of the environmental and health impact of foods produced by farmers, constraints pertaining to the usage of these techniques include cost, time taken in yield production, and poor knowledge among farmers. Thus, for these hurdles to be surmounted, a complex solution is required which entails economic and educational frameworks. The government and other relevant global organizations should use cash offers, which include subsidies and grants that would help farmers adopt organic farming techniques.

Moreover, extension education and other educational programs play an important role in providing the farmers with organic pesticides in a proper way, and in turn, the farmers need to know about the advantages of using organic pesticides in the long run.

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