Agri. Reviews, **33** (1) : 27 - 36, 2012

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
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ORGANIC FARMING AS A BASIS FOR SUSTAINABLE AGRICULTURE - A REVIEW

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Received:26-04-2011 Accepted:18-01-2012

ABSTRACT

Exhaustion of the natural potential, destruction of the agrosphere and environmental pollution resulting from increased manmade environmental modification expressed as climate change, has posed threat to existence of humankind. Therefore need for a new philosophy of sustainable development aroused. Parity of relations within the triad "human-economy-nature" is the basis for sustainable development. Organic farming unites all agricultural systems that maintain ecologically, socially and economically advisable agricultural production. For ensuring sustainable agriculture, organic farming aggregates following practices i.e. optimization of land use and crop structure; efficient use of available organic fertilizing resources; agro-technical methods to protect crops from weeds; crop rotation; soil-protecting technologies for planned chemical land reclamation; preservation of agricultural and biological diversity at farms and its efficient utilization; stabilization of agro-landscapes through uniform system of field-protecting forest belts; facilitation of proper use and preservation of water resources; usage of renewable resources; harmonious balance between crop and animal production through integrated farming and utilization of indigenous technical knowledge. In view of rising population and demand for food production, conventional farming systems cannot be abandoned but organic farming should be certified where it already exists and promoted to the newer areas to the extent possible because it seems safer bet for sustainable agriculture at a time when advanced technologies are still costly and have to be proved safe for long-term development.

Key words: Organic Farming, Sustainable, Conventional.

Global warming represents a major threat for food security, especially in tropical countries. It is expected that global warming will worsen the drought and the irregularity of rainfall in many countries. Meanwhile, intensive dependence of agriculture on agrochemicals and non-renewable fossil fuels has accounted for over 20 % of global anthropogenic greenhouse gas emissions (Scialabba, 2003). In Asia, this figure could be slightly higher as most of the fertilizers used in Asia are nitrogen-based (Stoll, 2002) and the industrial process of producing nitrogen fertilizer releases nitrogen dioxide, a strong greenhouse gas, into the atmosphere. While Green Revolution technologies will remain as the major production system in the world, there is growing evidence that the Green Revolution has, at its worst, increased inequality, worsened absolute poverty, and resulted in environmental degradation (IFPRI, 2002). Organic farming which avoids use of synthetic chemicals has huge potential to dilute these negative impacts on ecosystem. Therefore organic farming has been mentioned as a major thrust area for achievement of Millennium Development Goals (MDGs) and to secure sustainable development. Conversion to organic farming contributes to mitigate the contribution of agriculture to global warming. It therefore contributes to the stability of the food supply which is threatened by the climate change (Aubert, 2007).

According to IFOAM (2002) "Organic agriculture unites all agricultural systems that maintain ecologically, socially and economically advisable agricultural production. These systems

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make use of the natural potential of plants, animals, and landscapes and are aimed at the agricultural practice's harmonization with the environment. Organic farming significantly reduces the input of external production factors (resources) by putting a limit to usage of the chemically-obtained fertilizers, pesticides, and pharmaceutical preparations. Instead, in order to increase the yield and protect the crops, organic farming employs other agro technical methods and various natural factors. Organic agriculture adheres to the principles that have been formulated by the specific local, social, economic, climatic, historical, and cultural features". Organic Agriculture is based on four principles: Health, Ecology, Fairness and Care (Juma, 2007) and are key for sustainable agriculture. Organic production systems can make important contributions to food supply stability and farmer livelihoods by establishing soil fertility, providing diversity and, therefore, resilience to food production systems in light of the many uncertainties of climate change. In general, a local organic marketing initiative's set up and operating strategy should match its scope. The adopted choice will depend on the country, the location, nature and availability of product range, scale of intended operation and prevailing market/sector conditions (Wai, 2000). The impact of organic agriculture, compared to conventional agriculture, has not been extensively studied with inclusion of various social and economic aspects.

IMPACT OF INTENSIVE USE OF AGRO-CHEMICALS ON ENVIRONMENT: Intensive use of synthetic chemicals to boost production has proved harmful for sustainable resources of nature. When adverse use of agro chemicals takes place in modern farming by many developed and under developed countries, there are various adverse effect on soil, water, food and atmospheric environment which are reviewed below.

Pollution due to fertilizers: In the developed countries, there has been intensive use of fertilizers since more than four decades and it proliferated to developing countries especially with inception of green revolution. Many of the polluting effects of fertilizers are being observed now and amplified response can be expected in the near future. Some important problems associated in fertilizers pollution are summarized below.

Pollution due to excessive nitrate: Application of nitrogen fertilizers such as urea and ammonium sulphate to soils produces acid by two processes. Firstly, the natural process of oxidation of ammonia ions to nitrate ions release acid. Part of acid produced is neutralized by alkaline ions released by plants during the subsequent uptake of the nitrate ions. Secondly, since nitrate ions are not strongly absorbed by the soil they are liable to leach or move down through the soil. The negatively charged nitrate ions carry positively charged basic cations such as Ca, K, Mg and Na in order to maintain the electric charge on the soil particles. A high nitrate concentration indicates likely presence of harmful bacteria as well. In condition, to high enrichment, oxides of **N** may produce as state known as methaemoglobinema (blue babies) which generally affects the infants under six months of age. Repeated heavy dose of nitrate on ingestion may likely to cause carcinogenic diseases. Apart from this, over use of N fertilizers leads to dwindling of earthworms from the particular area, earthworms have always been considered a farmers friends and their absence mean loss to the soil fertility.

Heavy metal accumulation in soil: Contamination of soil by heavy metal through fertilizers such as cadmium from phosphatic fertilizers is also getting increasing attention of environmentalists (Kostial, 1986). Fertilizers contain heavy metals as impurities. The application of rock phosphate or its produce to soil always implies the addition of significant amount of lead and cadmium into the soil. A combination of low analysis and straight fertilizers can add more lead and cadmium to soil than high analysis and mixed fertilizers (Arora *et al.,* 1995).

Eutrophication of water: It is the process of enrichment of surface water bodies like lakes, reservoirs and streams with nutrients. Nutrient enrichment of water bodies results in intense proliferation and accumulation of algae and higher aquatic plants in excessive quantities which can result in detrimental changes in water quality and can significantly interfere with the use of water resources. Severe eutrophication may leads to a

serious loss of marine life, blockage of aquatic passages.

Alterations in stratosphere: The stratospheres' ozone layer shields the biosphere from the harmful ultraviolet radiation and also influences the earth's temperature. Nitrogen loss to the atmosphere through denitrification may contribute to "green house gases" in the atmosphere thereby exacerbating the problems of the breaking down of ozone layer. Nitrogen losses can be particularly high from intensively cultivated and fertilized land whether the fertilizer is from organic or inorganic (Asmed, 1993).

Pollution due to pesticides: Use of different types of poisonous substances such as pesticides, contributes towards imbalances in the ecosystem and polluting the environment. Pesticides are now extensively used to control various pests which are harmful to the crops in conventional farming. Most of the chlorinated pesticides are non-biodegradable and leave residue which are detrimental human beings, animals and the environment.

Harmful effects of insecticides: During the 1900's, there was little information available on the bad impact of pesticides on soil and water quality. Organochlorine insecticides such as chlorine, dieldrin, DDT and heptachlor were widely used in agriculture to control insect/pests in different countries. Since 1960's, the organochlorine use was progressively restricted and finally banned now. Nevertheless, their residues still found in soil and continue to cause problems of food and food contamination. The presence of residues of insecticide in food commodities and other component of the environment is a matter of serious concern. Even small quantities of the residues ingested daily along with food can build up to high levels in body fat because of accumulation tendency of many pesticides. There is an increasing fear in society of being slowly poisoned by the intake of food contaminated with pesticide residues.

Pollution due to herbicide

Disturbance in soil ecosystem: The use of chemicals for controlling weeds started with the introduction of 2,4-D in 1940's. The usage of herbicide is higher than any agro-chemicals. Herbicides play major role in the disturbance of soil ecosystem. The herbicide can have direct effect upon decomposing micro-organisms, root pathogens and disease antagonists such as parasites and predators as well as organisms pathogenic to invertebrates. Herbicides are designed specifically to minimize plant diversity by controlling weeds thus promoting monoculture. So, they can also indirectly decrease populations and diversity of related soil organisms and lessens the natural input of organic matter into soil as well as have direct effect on soil organism. This may in turn increase the need for inorganic fertilizers and pesticides and magnify the inputs of agro-chemicals in soil ecosystem.

Adverse impact on farmer's health: The increased use of herbicides in recent years causes more concern about their effect on farmer's health. While herbicide technology has made remarkable progress in terms of developing sage herbicides that are less toxic to human beings, may farmers still suffer from chemical poisoning after applying herbicides. The extensive use of pesticides posses a more direct problem on farm workers.

Soil water pollution: Herbicides applied over years are going to have some adverse impact on the environment. They not only affect many species of plants and animals in and around farmland but also cause pollution of underground as well as surface water. The new ecotypes of weed which are resistant to herbicides have developed. Some species even have multiple resistances to all possible options.

ROLE OF ORGANIC FARMING IN USTAINABLE AGRICULTURE: In India, about 528,171 hectare area is under organic farming (this includes certified and area under organic conversion) with 44,926 number of certified organic farms. This accounts for about 0.3% of total agricultural land (Ramesh *et al.,* 2010). The locally available resources are used mostly by the majority of small farmers in India. As such, in many marginal areas of India, organic farming is present not by choice but by the default.

Organic animal husbandry: In organic animal husbandry, integration of more than one livestock species and livestock with cropping can be the basis of a balanced and sustainable farming system, allowing nutrient recycling and effective resource use (Subrahmanyeswari and Chander, 2008). Prospects for organic livestock farming appear to be bright in comparison to intensive livestock production especially in dryland areas of India (Chander *et al.,*

2007). In rainfed areas, livestock mostly local ones is mainstay of millions of Indian small scale farmers. Crops may fail but livestock sustain the life of poor farmers. The maintenance cost of these livestock is very low in comparison to the crossbreds. This type of mixed farming system is widely prevalent in India. The farmers are not aware with the scientific as well as systematic approach for organic agriculture management of farm (Tewari and Tewari, 2007). Hence it is necessary to provide in-puts to the organic farmers in the form of technical know-how so as to enable their livestock systems to modify to be certified which is mandatory in organic production systems (Subrahmanyeswari and Chander, 2008).

Principles of organic farming are reflective of sustainable agriculture. These principles of organic agriculture as described by IFOAM (2005) are as following:

Principle of Health: Organic agriculture is intended to sustain and enhance the health of soil, plant, animal and human beings as one and indivisible. In view of this, it constrains the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Principle of Ecology: Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help to sustain them. Organic agriculture should attain ecological balance by means of utilizing locally available resources.

Principle of Fairness: Organic agriculture should build on the relationships that ensure fairness with regard to the common environment and life opportunities. Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and their relations to other beings.

Principle of Care: Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the cost/risk of jeopardizing health and well-being.

Certification for organic farming is issued by several national or international certification agencies to organic farmers. A few agencies with the assistance of international bodies have entered the field of inspection and certification (Narayanan, 2005). Some of the important certification centers include APOF Organic Certification Agency (AOCA), Control Union Certifications, ECOCERT India Private Limited, Indian Organic Certification Agency (Indocert), ISCOP (Indian Society for Certification of Organic products), Vedic Organic certification Agency etc (EC No:1235/2008, 2011). According to the official standpoint of IFOAM Basic Standards (2002) production and processing of organic produce is based on many motives, among which it is impossible to single out the priority ones, because all of them are equally important. They are as following:

- Production of high-quality foodstuffs, raw materials and other goods in sufficient quantities;
- Harmonization of the work to be performed within a production system with the soil's natural cycles and live systems and plant and animal worlds;
- Acknowledgement of a wider social and ecological impact beyond and within the organic production and processing system;
- Preservation and improvement of soils' fertility and biological activity with the assistance of local cultural, biological, and mechanical methods, instead of employment of external production factors (resources);
- Preservation of agricultural and biological diversity at farms and the surrounding areas through introduction of a stable production system and wild-life protection;
- Facilitation of proper use and preservation of water resources with all their live organisms;
- Usage of renewable resources in the production and processing systems to the maximal extent and prevention of their losses and pollution;
- Facilitation of local and regional production and movement of goods to consumers;
- Achievement of a harmonious balance between crop production and animal production;
- Ensuring of conditions in animal husbandry under which domestic animals exhibit natural behavior;
- Usage of packaging materials those are subject to recycling or can decompose in a biological way;
- Making sure that each person engaged in organic farming and processing enjoys the living conditions that satisfy the requirements of a healthy and safe environment;

• Creation of a socially-oriented chain 'production-processing-sale', which would comply with the ecological requirements;
• Recognition of the fact that it is important and necessary to study the local experience and traditional forms of farming;
• Independence of agriculture from industrial chemicals, reduced energy consumption in agricultural production, substantially curtailed production expenditures and dependence on external financing and
• Development of local, national, and international markets for organic produce, and fair international trade.

Various components of organic farming which help in sustainable development have been elaborately discussed below.

Maintenance of soil fertility: Preservation and improvement of soil fertility is the key issue during introduction of organic farming technology. Studies show that organic farming conserves soil fertility and improves system stability better than conventional farming (Stolze *et al.*, 2000; Shepherd *et al.*, 2003). A study of cotton production under organic conditions in India found yield levels similar to a modern cultivation technique, but soil quality, as indicated by soil organic matter, water stable aggregates and mean weight diameter, showed advantages for the organic system (Blaise, 2006). Soil fertility under organic farming is maintained by several measures (Partap, 2010) which includes optimization of agricultural crop within each farm; efficient use of available organic fertilizing resources (humus, turf, turf-and-humus composts, putrid mud, organic wastes of agricultural production and others); taking the advantages of diversification of farming by increasing areas under perennial grasses, application of bacterial substances and expansion of areas under green fodder; recommencement of planned chemical land reclamation, which would make use of local deposits of limestone, chalk and marl; usage of local raw material resources for improvement of fertility of soil (sapropels, phosphorites, zeolites, glauconites, phosphate slag, defecate and others); cessation of unadvised expansion of areas under harmful crops, which can further deteriorate the phytosanitary state of the soil; overall introduction of minimal-tillage regimes, wide-cut tillage methods and direct sowing technology; application of contour structural arrangement of the territory in land use, which presumes optimization of the state of natural environment within the territory of watersheds or ravine and gully systems; optimization of water-protecting and field-protecting measures; overall restoration and support of a uniform system of field-protecting forest belts, as the most important method for stabilization of agro landscapes and fixation of field boundaries; application of soil-protecting technologies, while the soil is tilled for all crops at the sowing bed depth (up to 5 cm), whereas the surface of the soil is mulched with stubble. The technical support of soil-protecting technologies is based on usage of wide-cut heavy disk harrows, wide-cut heavy cultivators, disk-crowfoot rollers and grain packer drills or sowing machines of direct sowing and protection of crops from weeds by agro-technical methods. The role of soil organisms, found abundantly in organic systems, is central to soil processes and fertility since they render available the elements in plant residues and organic debris entering the soil (Alfoldi *et al.,* 2002).

Ecological benefits: The growing concern about environmental degradation, dwindling natural resources and urgency to meet the food needs of the increasing population are compelling farm scientist and policy makers to seriously examine alternative to chemical agriculture. Nemecek *et al.* (2005) found greenhouse warming potential in organic systems 29 to 32 percent lower on per ha basis than in a mineral fertilizer system and 35 to 37 percent lower than in the conventional manure-based system. If one gets a premium price for the organically grown rice, the economic returns from the ecological farming system are really appreciable. The declines in productivity or no effect on yields is over turned by better prices farmers get for their organic produce (Rao *et al.,* 2006). Various studies have confirmed that organic agriculture is productive and sustainable (Mader *et al.,* 2002)

Efficient energy utilization: In the energy requirement for production measured per rupees of produce for organic farms is only one third of what it is for their conventional counterparts. Because N-fertilizer and pesticides are not used by biological farmers, the comparison of total energy input/ha with total energy output favors biological farming systems.

In one study, soil organic matter was higher in organically managed soil than in conventional soil despite relatively similar totals of organic carbon (Marinari *et al.,* 2007). Reduction in nitrate leaching can only be obtained by carefully designed crop rotations including catch and cover crops (Thorup-Kristensens *et al.,* 2003). Meanwhile, a twelve year study by Hoeppner *et al.* (2006) on the impact of organic versus conventional management on energy use, energy output and energy-use efficiency reports that: 1) energy use was 50% lower with organic than with conventional management; 2) energy output was 30% lower with organic than with conventional management; and 3) energy efficiency (output energy/input energy) was highest in the organic management.

Superior food quality: Food quality is one of the main issues, which concerns both scientists and consumers. Nitrates in water and farm produce, desirable components, pesticides residues, keeping quality and physiological imbalances are some of the important aspects of food quality. It is an often overlooked fact that, by applying holistic methods, differences resulting from cultivation methods are mostly in favor of the organic variants (Velimirov, 2006). Synthetic pollutants are dramatically reduced, if not even completely avoided, in organic foods (Baker *et al.,* 2002; Mahnke-Plesker, 2005). People of higher as well as middle economic status are more concerned about quality of food items and therefore are ready to purchase organic food products at premium prices.

Utilization of waste: Increased prices of chemical fertilizers have enabled organic wastes to regain an important role in the fertilizer practices on the farm. Good manure management means improved fertilizers value of manure and slurry and less nutrient losses. Composting of all organic wastes in general and of Farm Yard Manure (FYM) or feedlot manure in particular is important in organic farming. The nitrogen self-reliance of organic systems is a major advantage in times of fossil energy shortage (Cormack, 2000). Sewage and sludge use for crop production can form an important component of organic farming if treatment and application methods are improved further. Lotter *et al.* (2003) found that water capture in organic plots was approximately 100 percent higher than in conventional plots during torrential rains.

Use of traditional knowledge: Most countries have traditionally utilized various kinds of organic materials to maintain or improve the fertility and productivity of their agricultural soils. However, several decades ago, organic recycling practices in some countries were largely replaced with chemical fertilizer which were applied to high yielding cereal crops that responded to a high level of fertility and adequate moisture, including irrigation. Consequently, the importance of organic matter to crop production received less emphasis and its proper use in soil management sometimes neglected or even forgotten. With these changes and the failure to implement effective soil conservation practices, agricultural soils in a number of developed and developing countries have undergone serious degradation and decline in productivity because of excessive soil erosion and nutrient run-off and decreased soil organic matter levels. To achieve sufficiency in utilization of organic materials such as agricultural residues and urban wastes to protect agricultural soils from wind and water erosion and to prevent nutrient losses through run-off and leaching, organic farming has again been considered as reliable method of agricultural production.

Intensive use of resources or Integrated Intensive Farming System (IIFS): IIFS involves intensive use of farm resources. To be ecologically sustainable, such intensification should be based on techniques which are knowledge intensive and which replace to the extent possible, market purchased chemical inputs with farm grown biological inputs. Organic agriculture has been shown to promote more species and have more abundance of organism groups than conventional farming (Bengtsson *et al.,* 2005) which ensures better utilization of wide variety of resources. Pretty *et al.* (2006) outlined several ways to improve water use efficiency in organic agriculture, including reducing evaporation through minimum tillage, using more water-efficient varieties and inducing microclimatic changes to reduce crop water requirements.

Economic Benefits: Recent market study in India (Partap, 2006) highlights the fact that there are a sufficient number of people now who will be ready to spend extra on safe food supplies from organic market. Some key findings from research on yields (Wynen, 1994; Stonehouse *et al.,* 2001; Mendoza,

2002) suggest that yields equivalent to or better than conventional agriculture can be achieved under organic systems, although often they are not and yields decrease during conversion period but then improve afterwards. The evaluations by the International Fund for Agricultural Development (IFAD) (Giovannucci, 2005) and Partap and Vaidya (2009) reported that the income of participating small farmers can increase substantially.

Biodiversity conservation: In organic grasslands, the number of species is more than that in conventional grasslands, leading to plant communities richer in species and structure (Frieben, 1997). In Europe, researchers have found greater diversity and abundance of soil and surface-living arthropods, such as spiders, beetles, parasitic flies and wasps, as well as non-pest butterflies and many other invertebrate species, in organic farming systems compared to conventional farming systems (Feber *et al.,* 1997; Stolze *et al.,* 2000; Tybrik *et al.,* 2004). Organic farming systems are an appropriate tool for planners to balance conservation and production (Hole *et al.,* 2005). Therefore many schemes and projects worldwide working to conserve seed banks and indigenous varieties are linked to organic agriculture projects (Stolton, 2002).

Scope for modified/modern techniques in organic farming: A number of products are now available that are generally referred to as soil and plant additives of non-traditional nature. These products include:

• Microbial fertilizers and soil inoculate which are reported to contain unique and beneficial strains of soil micro-organisms;

• Microbial activators that supposedly contains special chemical formulations for increasing the numbers and activity of beneficial microorganisms in soil;

• Soil conditioners that claim to created favorable soil physical and chemical conditions that result in increased growth and yield of crops and

• Vermicompost which help in improving soil health and fertility.

Microbial fertilizers or Bio-fertilizers: Bio-fertilizers are the biological active product called microbial inoculates containing active strain of selective micro-organisms like bacteria, fungi, algae or in combination. Common types of Bio-fertilizers are *Rhizobium, Azotobacter, Azospirillum,* Blue Green Algae (BGA)*, Azolla*, *Mycorrhizae* etc. The bio-fertilizers containing biological nitrogen fixing organisms are of utmost importance in agriculture in the view of the following advantages:

Advantages of Bio-fertilizers

• Enhance bio-mass production and grain yield by 10-20%.

• Cheap and can help to reduce the consumption of chemical fertilizer.

• Make available nitrogen directly to the plant.

• Solublize phosphorus and increase phosphorus uptake to the plants.

• Enhance plant growth due to release of hormones, vitamins etc.

• Improve the soil properties and sustain the soil fertility.

• Control and suppress soil borne diseases.

• Suitable in organic farming.

Green manuring: Green manuring is a practice of ploughing or turning undecomposed green plant materials into the soil for improving the physical condition of soil or for adding nitrogen where the green manure crop is legume (Cheema, 1997).

Bio-gas slurry as manure: The dung and the farm wastages are increasing being burned instead of being returned to the soil as manure. Technology is available for the conversion of the dung to fuel and at the same time retain fertilizer value of the material. The gas produced from cow dung and water as a result of anaerobic fermentation is called bio-gas. Bio-gas contains methane gas (50-65%) as most useful component and the remaining part mostly being CO_2 with small amount of other gas. Community biogas plant mission has huge potential to utilize animal waste at large scale in rural corners of India.

Biological weed control: Weed management is one of the main concerns in organic agriculture. Generally, all aspects of arable crop production play an important role in a system approach to problems. The traditional elements for preventing weed problems were crop rotation, green manuring, manure management and tillage. Mulching on a large scale by using manure spreaders may also be useful in weed control. One aspect of biological control of weeds is direct use of natural enemies to reduce weed populations. They are usually plant

pathogens but may be insects or various herbicides, for e.g. tadpole, ducks etc. are used for weed control in Japan, as in the grass carp in Indonesia and the apple snails in Taiwan.

Bio-pesticides for insect-pest and disease management: The growing public awareness of the chemical insecticides used to control insect-pests has urged the scientists to develop new bio-pesticides as an alternative. Bio-pesticides are distinguished from conventional chemical pesticides by their non-toxic action. Positive effects of organic farming using biodiversity on pest prevention have been proven (Pfiffner *et al.,* 2003; Wyss *et al.,* 2005; Zehnder *et al.,* 2007). Microbial pesticides are naturally occurring organisms which include bacteria, fungi, protozoa or viruses e.g. BT (*Bacillus thuringiensis*), *Baculo* viruses etc.

Some of the successful examples to control crop pests are as follows:

a. Entomogenus fungi eg. *Netarhizium anisopliae* and *Isaria sinclavii* were tested and applied to control sugarcane grass cicada.

b. Verticillum lecani was infective to corn aphids.

c. Entimophthora spp. were reported to be highly pathogenic to the tiger moth, *Creatonotos gangis* and the green leaf hopper (Roger, 1987).

d. Baculo viruses are promising agent for the control of insects of order *Lepidoptera* (Butterflies and moths), *Hymenoptera* (Sawflies) and *Coleoptera* (Beetles).

Biochemical pesticides: Biochemical pesticides from insect and plants which can be used to modify insects' behavior and physiology. These include hormones, natural plant regulators, enzymes etc. Sex pheromones attract the pests and controlled by mechanical damage. About 1000 insect pheromones have been isolated, identified and synthesized in Taiwan alone. Among botanical pesticides investigated, *neem* (*Azadirachta indica*) has justifiably received the maximum attention during the last two decades. More than 300 species of insects have been reported to be affected by the *neem* components (Singh, 1993).

Advantages of Bio-pesticides

- Lack of residues and pollutants in the soil.
- High level of safety to human and non-target organisms.
- Low likelihood of pest resistance.
- Environmentally safe.
- They are selective, biodegradable, ecological and renewable alternative for the use of Integrated Pest Management (IPM) programs.

CONCLUSION

A higher conviction and motivation is necessary to ensure farmers' diligence in the implementation of the guidelines of organic farming and it should be accompanied by a proper communication of the costs and benefits incurred in organic certification. It is recommended that Governments should develop appropriate policies for widespread adoption of organic agriculture by millions of individual farmer households. Specifically, Governments should encourage farmers to establish effective organizations to promote organic agriculture. Furthermore, they should support the development of alternatives to chemical pest control and chemical fertilizers. Meanwhile, local NGOs and all other related sectors should facilitate farmers to reduce chemicals use in farming practice. Actions should be taken to increase consumers' awareness of organic consumption. For this massive extension works and support from state government for capacity building of local NGO's are needed. More research need to be conducted on markets for organic products and operational mechanism for risk insurance should be secured through financial support during the conversion period and provision of incentives or subsidies for organic agricultural production.

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