A REVIEW ON
ORGANIC FARMING
FOR
SUSTAINABLE AGRICULTURE

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Abstract

Organic farming seems to be more appropriate as it considered the important aspects like sustainable. Agriculture is the most important sector for ensuring food security, alleviating poverty and conserving the vital natural resources that the world's present and future generation will be entirely dependent upon for their survival and well being, in the name of development, the environmental resources have been beyond comprehension. Acid rain, deforestation, depletion, smog due to automobiles and discharge of industrial pollution, soil degradation, depletion of ozone layer and discharge of toxic wastage by industrial units into rivers and oceans are some environmental problematic issues. Intensive use of inorganic fertilizers and pesticides has been an important tool in the drive for increased crop production. In fact more fertilizers consumption is a good indication of agricultural productivity but depletion of soil fertility is commonly observed in soils. Due to heavy use of chemical herbicides, pesticides and intensification of agricultural production during the past few decades has led to other harmful effects like nitrate in the ground water, contamination of fooding materials, eutrophication, stratospheric changes etc. High agricultural inputs are unlikely to be sustainable for very long unless the inputs are correctly judged in terms of both their quality and quantity. To escape from these harmful effects, the concept of organic farming was emerged from the conference of Atlanta in 1981. Organic Farming seems to be more appropriate as it considered the important aspects like sustainable natural resources and environment. It is a production system, which favors maximum use of organic materials like crop residues, FYM, compost, green manure, oil cakes, bio-fertilizers, bio-gas slurry etc. to improve soil health from the different experiment, microbial fertilizers like Rhizomic, Azotobacter, Blue green algae, Azolla etc. have increased the yield and also played important role for minimizing the harmful effect of pesticides and herbicides. Organic farming is a practical proposition for sustainable agriculture if adequate attention is paid to this issue. There is urgent need to involve more and more scientist to identify the thrust area of research for the development of eco-friendly production technology.

1. Introduction

Agriculture remains the key sector for the economic development for most developing countries. It is critically important for ensuring food security, alleviating poverty and conserving the vital natural resources that the world's present and future generations will be entirely dependent upon for their survival and well-being. The world populations will inevitably double by the middle of the twenty first century, that we are soon to enter, that is in the space of just two generations. Over 90% of the developing nations, especially in Asia and to an ever greater extent will be in the urban areas (Rothschild, 1998).

In the kingdom of Nepal where the cultivable and cropped areas are 2.64 and 3.27 million hectares respectively suggesting a cropping intensity of 121%. The population of country is 19 million during 1991 census and increasing at the rate of 2.6% annually (Joshy, 1997). Over the period of 10 years from 1981-1991, the highest increase in the numbers of household and the total cultivation area are observed in the category of 0.5-1 ha., at 102% and 88.8% respectively (Yadav, 1991). On the other hand, agriculture is the main occupation of the people of

Nepal, as more than 90% of them are engaged in farming. The contribution of the agriculture to the national income and the foreign trade is 65% and 75% respectively. In the year 1990, agriculture has contributed 60.9% to the GDP (Joshy, 1997).
Moreover, Nepal is a country having many burning problems for the agriculture production. Soil erosion, mountain desertification, environmental degradation, declining of soil fertility and crop productivity, depletion of natural resources, increased compulsion of using dung as a fuel in rural areas etc. are the major problems. The need of the country is to be self sufficient for food, shelter and clothes. It is only possible, if efforts from all sides go jointly by applying all possible resources for the develpoment of soil fertility and productivity of the country.

There is widespread problem of unbalanced fertilizer use. In general, too much N fertilizer is being applied and too little phosphorus, potasium and micronutrients. It means that large amount P_2O_5 and K_2O are being removed in the straw and grain at harvest which results in increasing imbalance in the soil nutrient content.

In the process of attaining higher levels of food production for matching the demand of growing population during the past 4 decades, emphasis was laid on intensive agricultural practices. With the increase in crop yeilds from moden farming techniques reaching a plateau in most of the countries and the environmental problems due to excessive use of chemical fertilizers and pesticides becoming a matter of concern, the need for sustainable agriculture is increasingly being felt, the world over. In the view of resurgence of interest in alternate in a recent year, organic farming has been considered to be a sound and viable option in most of the countries. In this direction, the recommendations of the Atlanta Conference of 1981on “Organic Farming” have acted as catalysts in trigerring interest in the organic agricultural systems across the world (Dahama, 1997).

Organic farming seems to be more appropriate, it considers the important aspects like sustainability of natural resources and environment. It is a production system which favors maximum use of organic materials (crop residue, animal residue, legumes, on and off farm wastages, growth regulators, bio-pesticides) and discourages use of synthetically produced agro-inputs, for maintaining soil productivity and fertility and pest management under conditions of sustainable natural resources and healthy environment. In this paper, a review of literatures on organic farming is focussed as a alternate for sustainable crop production.

The objective of this paper is to review the impact of modern agricultural technology and to promote the organic farming for sustainable crop production.

2. METHODOLOGY

During the preparation of this paper, a number of sources were used to collect the information. Some of the consulted materials are Annual reports, proceedings, Agriculture Journals, FAO soil bulletins, FFTC Extension and

Technical Bulletins, Workshop Papers, Statistical Year of Nepal, monthly bulletins of Haryana farming Indian farming and different books. Some of the sources were also used with personal communication, peer group discussion and the author's experiences.

This section provides various effects of agro chemicals on soil, water, food, environment and health and need of organic farming for sustainable development which are discussed under the following headings and sub headings.

3. ORGANIC FARMING AND SUSTAINABLE DEVELOPMENT

3.1. Adverese effect of agro-chemicals on soil, water, food and atmospheric environment

When adverse use of agro chemicals takes place in modern farming by many developed and under develpoed countries, there are various adverse effest on soil, water, food and atmospheric environment which are reviewed below.

3.1.1. Fertilizer Pollution

In the developed countries, there has been intensive fertilizer use for the last four decades. If the polluting effects of fertilizers are being observed now, similar problems in developing countries should be expected in the near future. Some important problems associated in fertilizers pollution are summarized below.

3.1.1.1 Nitrate Pollution

Application of N_2 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 bateria as well. In condition, to high enrichment, NO_3 may produce as state known as methamoglobinema (blue babics) which generally affects the infants under six months of age. Repeated heavy dose of nitrate on ingestion may likely to cause carcinogenic diseases. Consumption of high dose of NO_3 may develop symptoms of dizziness, abdominal cramps, vomitting, weakness, convulsion, mental inpairment and even nitrosamine which causes stomach cancer. Apart from this, over use of N_2 fertilizers leads to swindling of earthworms from the particular area, earthworms have always been considered a farmers friends and their absence mean loss to the soil fertility.

3.1.1.2 Accumulation of Heavy Metals

Contamination of soil by heavy metal through fertilizers such as cadmium from phosphatic fertilizers is also getting increasing attention of environmentalists (Kostial, 1986). Health hazards associated with heavy metals entering the food chain through soil is demanding attention. 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. Analysis of several commercial fertilizers commonly used revealed that a combination of low analysis and straight fertilzers can add more lead and cadmium to soil than high analysis and mixed fertilizers (Arora et al. 1995, Bijaya Singh and Sekhon, 1977).

3.1.1.3 Eutrophication of Water

It is the process of enrichment of surface water bodies like lakes, reserviors and dreams with nutrients. Nutrient enrichment of water bodies results in intense proliferation and accumulation of algae and higher aquatic platns in excessive quantities which can result in detrimental changes in water quality and can significantly interfere with the use of water resources.

The excessive accumulation of dissolve nutrients such as phosphorus, nitrogen, silicon and other element in water leads to an excess production of algal biomass. This requires a corresponding increased supply of oxygen for decomposition of organic materials when the algae and their remnants sink to bottom, reduced O_2 content and eventually anaerobic condition may prevail. This is syptomatic a severe eutrophication and may leads to a serious loss of marine life, blockage and aquatic passages and a major reduction in real estate value of the affected areas. The normal N:P ratio in water is around 20:1. Algal growth increase when this ratio drops to around 7:1 (Asmed, 1993).

In the developed countries like USA due to heavy use of fertilizers, more than 50% of the community and rural wells are contaminated with nitrate nitrogen (NO_3N). The contamination has exceeded the standard (10mgNO_3/lit.) of drinking water by 2% (Dahama, 1997).

3.1.1.4 Stratospheric Changes

Many research studies involved in the atmosphere may increase the rate of reaction in the stratosphere that to be the distraction of ozone layer. The stratophere ozone layer shields the biosphere from the harmful ultraviolet radiation and also influences the earth's temperature (Dahama, 1997). 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 fertlilzer is from organice or inorganic (Aluned, 1993).

3.1.2 Pesticide Pollution

By the use of different types of poisonous subtances as pesticide as pesticide, it contributes towards imbalances in the ecosystem and polluting the environment. Pesticides are now extremely used to control various pests which are harmful to the crops raised by man for food, feed and fibre production. However, most of the chlorinated pesticides are non-biodegradable and leave residue which are detrimental human beings, animals and the environment.

3.1.2.1 Insecticide Pollution

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 (Dhaliwal and Singh, 1993). There is therefore a contant fear that society is being slowly poisoned by the intake of food contaminated with pesticide residues.

During the 1900's, there was little information available on he bad impose of pesticide 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 like Nepal. Since 1960's, the organochlorine use was progressively restricted and finally banded now. Nevertheless, their residues still found in soil and continue to cause problems of food and food contamination. The metabolite of DDT still occur in the top 150 mm of the soil profile Centerbury region in Switzerland (Bould, 1994).

3.1.2.2 Herbicide Pollution

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. Farming has now realized the importance of herbicide usage for harvesting higher crop yields.

3.1.2.2.1 Bad Effect in Farmer's Health

Herbicide plays an important role for the disturbance of soil eosystem when soil micro-flora and fauna lies in the breaking down of organic matter, incorporating it into the soil and releasing nutrients for plant growth. The herbicide can have direct effect upon decomposing micro-organisms, rhizosphere 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 this 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.

3.1.2.2.2 Bad Effect in 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. Epistemologies data shows that workers who handle pesticides more than 20 days a year have an increased risk of developing certain type of cancer (Dahama, 1997).

3.1.2.2.3 Soil Water and Environment Effect

We can probably assume that herbicides applied over many years are almost always going to have some adverse impact on the environment. They do not affect only 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 resistant to all possible options and choose those that maximize profit is currently accepted as a key strategy in modern pest control.

4. Principles of Organic Farming

The major widely used term **"organic farming"** describes two major aspects of alternative agriculture.

A. The substitution of manure and other oranic matter as organic fertilizers.
B. The use of biological pest control instead of chemical pest control.

Organic farmers emphasize using only organic fertlilzers for fertility maintenance. In many aspects, inorganic farming is a way of life as it is a method of farming. The profitability of organic farms depends on the higher prices that their products demand in the market place. To stimulate inorganic farming, some government have passed laws that create a demand for organic foods, for example, in some states of USA, poor people who receive food aid get coupon only redeemable at organic markets. Cities have created farmers market, where inorganic producer can sell their goods (Dahama, 1997).

Organic agriculture is not based exclusively on short term economics, but also considers ecological concepts. It utilizes appropriate technology and appropriate traditional farming methods. This form of farming can also be called sustainable form of farming or sustainable agriculture. The principles of this method are:

- Organize the production of crops and livestock and the management of farm resources so that they harmonize rather than conflict with natural sysem.

- Use and develop appropriate technologies based upon an understanding of biological systems.
- Achieve and maintain soil fertility for optimum production by relying primarily on renewable resources.
- Use diversification to pursue optimum production.
- Aim for optimum nutritional value of staple food.
- Use decentralized structures for processing, distributing and marketing of products.
- Strive for equitable relationship between those who work and live on the land.
- Maintain and preserve wildlife and their habitats.

5. Components of Organic Farming

There are assumtions throughout the organic literature of differences between organic and conventional systems with respect to their effects on soil physical properties, soil insect fauna and nurient flow within the soil, crop health and nutritional value of the harvested crop. Different components of organic farming are as follows:

5.1 Crop and Soil Management

Organic farming system encourages the use of rotations and measures to maintain soil fertility. Carefully managed soil with a high production of humus offer essential advantages with respect to water retention ion exchange, soil erosion and animal life in the soil. Green manuring and inter-cropping of legumes is another important aspect for biological farming systems not only in regard to weed control but also in reducing the leaching of nutrients and in reducing soil erosion. A green cover throuthout most of the year is one of the main goals of such farming methods. Depending on the green manure mixture or the legumes used for under sowing, there may be an increased soil organice matter and soil N_2 as well as in other nutrients.

5.2 On-farm Waste Recycling

Increase price of chemical fertilizers have enables 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.

5.3 Non-chemical Weed Management

Weed management is one of the main concern in organic agriculture. Generally, all aspeects of arable crop production play an important role in a system approach to problems. The elements to consider in preventing weed problems

are crop rotation, green manuring, manure management and tillage. Mulching on a large scale by using manure spreaders may also be useful in weed control.

5.4 Domestic and Industrial Waste Recycling

Sewage and sludge use for crop production can form an important component of organic farming if treatment and application methods are improved further.

5.5 Energy Use

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.

5.6 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.

5.7 Ecological Agriculture

The growing concern about environmental degradation, dwindling natural resources and urgency to meet the food needs of the increasing population are nompelling farm scientist and policy makers to seriously examine alternative to chemical agriculture. As reported by Vankataramani (1995) case studies shows that when chemical farm incurred about 11.250 towards the cost of cultivation of rice. An organic farm spend rupees 10,590 to produce 5625 kg paddy and 8 tonnes of straw/ha. The net returns from the ecological farming system at the current cost of rupees 3.34/kg paddy is rupees 8,197.50. In chemical farming, the net profit is rupees 7500. If one gets a premium price for the poison force, organically grown rice, the economic returns from the ecological farming system will highly encouraging.

5.8 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 (Venkataramani, 1996).

6. Value of Oranic Farming

The value of organic materials as fertilizers and soil conditions is often misunderstood and has been the source of some controversy. The simplest and

the most common means of estimating the value of organic amendments is by assigning the market value of the potentially available plant nutrients, they contain nitrogen-phosphorus-potash (NPK) and other micro-organisms.

Benefits of Soil Organic Matter

- It serves as a slow release of nitrogen, phosphorus and sulphur for plant nutrition and microbial growth
- It posses considerable water holding capacity and thereby helps to maintain the water regime of the soil.
- It acts as a buffer against in pH of the soil.
- Its dark color contributes to absorption of energy from the sun and heating of the soil
- It acts as "cement" for holding clay and silt particles together, thus contributing to the crumb structure of the soil and resistance against soil erosion
- It binds micro-nutrients metal ion in the soil that otherwise might be leached out of the surface soil
- Organic contituents in the humic substances may act as plant growth stimulants

7. Use of Traditional Additives for Organic Farming

Most countries have traditionally utilized various kinds of organic materials to maintain or improve the tilth, fertility and productivity of their agricultural soils. Hoever, 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 utilization of organic materials such as agricultural residue and urban wastes to protect agricultural soils from wind and water erosion and to prevent nutrient losses through run-off and leaching. Traditional additives are classified into two groups which are given below:

7.1 Bulky Organic Manure

FYM, farm compost, night soil, sludge and green manure are bulky in nature and supply large quantities of organic matter but small quantities of plant nutrients in comparison to the inorganic fertilizers. Their average nutrient content of bulky manure is given in **table 1**.

Table 1: Average nutrient content of bulky manure

Manure	Percent Content		
	N_2	P_2O_5	K_2O
1. Animal Refuse:			
Cattle dung, fresh	0.3-0.4	0.1-0.2	0.1-0.3
Horse dung, fresh	0.4-0.5	0.3-0.4	0.3-0.4
Sheep dung, fresh	0.5-0.7	0.4-0.6	0.3-1.0
Night soil, fresh	1.0-1.6	0.8-1.2	0.2-0.6
Poultry manure, fresh	1.0-1.8	1.4-1.8	0.8-0.9
2. Wood Ashes:			
Ash, household	0.5-1.9	1.6-4.2	2.3-12.0
Ash, wood	0.1-0.2	0.8-5.9	1.5-36.0
3. Farm Factory and Habitation:			
Rural compost, dry	0.5-1.0	0.4-0.8	0.8-1.2
Urban compost, dry	0.7-2.0	0.9-3.0	1.0-2.0
FYM, dry	0.4-1.5	0.3-0.9	0.3-1.9
4. Plant Residues:			
Rice hulls	0.3-3.5	0.2-0.5	0.3-0.5
Groundnut husks	1.6-1.8	0.3-0.5	1.1-1.7
straw and stalks: Banana, dry	0.61	0.12	1.0
Maize	0.42	1.57	1.65
Paddy	0.36	0.08	0.71
Wheat	0.53	0.10	1.10
5. Green Manure, fresh			
Cowpea	0.71	0.15	0.58
Green gram	0.72	0.18	0.53
Sunhemp	0.75	0.12	0.51

7.2 Concentrated Organic Manure

Concentrated organic manures are those materials that are organic in nature and contain higher percentage of essential plant nutrients such as nitrogen, phosphorus and potash as compared to bulky organic manure. The concentrated manures are made from raw materials of animal or plant origin. The concentrated organic manure commonly used are oil-cakes, blood meal, fish meal, meat meal and horn and hoof meal. Their average nutrient content is given in the **table 2**.

Table 2: Average nutrient content of major oil cakes and slaughter house wastes:

Manure	Percent Content (%)		
	N_2	P_2O_5	K_2O
1. Oil Cake:			
a. Non-edible type:			
Castor Cake	4.3	1.8	1.3
Cotton Seed Cake	3.9	1.8	1.6

Mahua Cake	2.5	0.8	1.8
b. Edible Oil Cakes:			
Coconut Cake	3.0	1.9	1.8
Groundnut Cake	7.3	1.5	1.3
Cotton Seed Cake	6.4	2.9	2.2
Rape Seed Cake	5.2	1.8	1.2
Sesame Cake	6.2	2.0	1.2
2. Slaughter House Wastes:			
Meat Meal	10.5	2.5	-
Blood Meal	1.0-12.0	1.0-2.0	-
Fish Meal	4.0-10.0	3.0-9.0	0.3-1.5

8. Use of Non-Traditional Additives for 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 micro-organisms in soil
- Soil conditioners that claim to created favorable soil physical and chemical conditions that result in increased growth and yield of crops
- Vermmi-compost which help in improving soil health and fertility.

8.1 Microbial Fertilizers or Boi-fertilizer as a Non-traditional Additive for Organic Farming

Bio-fertilizers are the biological active product called microbial inoculates containing active strain of selective micro-organisms like bacteria, fungi, algae or in combination. The bio-fertilizers containing biological nitrogen fixing organisms are of upmost importance in agriculture in the view of the following advantages.

8.2 Advantages of Bio-fertilizers

- They enhance bio-mass production and grain yield by 10-20%
- They are cheap and can help to reduce the consumption of chemical fertilizer
- They make available nitrogn directly to the plant
- They solubilize phosphorus and increase phosphorus uptake to the plants
- They enhance plant growth due to release of hormones, vitamins, auxins etc.
- They improve the soil properties and sustain the soil fertility
- They control and suppress soil borne diseases
- They are suitable in organic farming

8.3 Types of Bio-fertilizers

8.3.1 *Rhizobium*

The most widely used bio-fertilizer is *Rhizobium* which colonizes the roots of specific legumes to form tumor like growth, called root nodules. These nodules act as factories of ammonia production. The *Rhizobium* legume association can fix upto 100-300 kgN/ha. in one crop season and in certain situation can leave behind substantial nitrogen for following crops (Dahama, 1997). The range of N fixed/ha. is given in the Table 3.

Table 3: The range of N fixed/ha. by Different Legumes

S.N.	Crop	Nitrogen fixed (kg/ha.)
1	Clover	100-150
2	Cowpea	80-85
3	Alfalfa	100-300
4	Faba Bean	240-320
5	Lentil	90-100
6	Lupins	150-200
7	Groundnut	50-60
8	Soybean	60-80
9	Mungbean	50-55
10	Pasture Legumes	100-400

Soruce: Dahama, 1997

8.3.2 *Azotobacter*

The beneficial effects of *Azotobacter* bio-fertilizers on cereals, millets, vegetables, cotton and sugarcane under both irrigated and rainfed field condition have been subestimated and documented (Pandey and Sushil, 1989). Application of *Azotobacter* has been found to increase the yield of wheat, rice, maize, pearlmillet and sorghum by 0-30% over control. Apart from N, these organisms are also capable of producing antibacterial and anti-fungal compounds, hormones and siderophones (Dahama, 1997). Research done in Nepal shows that the amount of nitrogen to be applied to wheat can be cut down to 15% of inoculation with effective strain of *Azotobacter* is practiced (Karki and Baral, 1997).

8.3.3 *Azospirillum*

A very important bacterium discovered by Brazilian Scientists in 1970's. The crops which respond to *Azospirillum* inoculation are maize, barley, sorghum, pealmillet and forage crops. Its application increase grain productivity of cereals by 5-20% and of fodders by over 50%.

8.3.4 Blue Green Algae (BGA)

The utilization of BGA as a bio-fertilizer for rice is very promising. BGA have contributed greatly to the enrichment maintenance of soil fertility in rice fields. On farm level, the algae can contribute to about 25-30kgN/ha. Recent researches have shown that algae also help to reduce soil alkalinity and this opens up possibilities for bio-reclamation of such inhabitalbe environment.

8.3.5 Azolla

A small floating water fern, azolla is commonly seen in low land fields and shallow fresh water bodies. This fern harbors a blue green algae and anabaena azolla. This azolla-anabaena association is a live floating nitrogen factory using energy from photosynthesis to fix atmospheric nitrogen amounting to 100-150kgN/ha. nitrogen from about 40-60 tonnes of biomass (Singh, 1983).

Effects of Azolla on Soil Fertility

Patel et al. (1980) have reported while summerizing the responses of rice to azolla inoculation in Model Agronomic Trials conducted at four locations, the rice yields obtained from azolla inoculated plots are comparable to that of 60 kgN/ha. as given in **table 4**.

Table 4: Effect of Azolla on Rice Yields in Model Agronomy Trials in India

Treatments	Cuttack	Bhubaneshwor	Kharagpur	Titabar	Mean
Uninoculated (control)	2.75	2.94	2.48	2.92	2.77
Azolla (10t/ha) Basal	3.29	4.00	3.75	3.63	3.67
Azolla dual cropping	3.08	3.60	3.05	3.12	3.21
Fertilizer (30kg/ha)	3.05	3.38	3.74	3.00	3.29
Fertilizer (60kg/ha)	3.25	4.20	4.20	3.25	3.27

Source: Patel et al., 1980

8.3.6 Mycorrhizae

Mycorrhiza is the symbiotic association of roots with roots of vascular plants. The main advantages of mycorrhiza to the host plants lies in the extension of the penetration zone of the root fungus system in the soil, facilitating an increased phosphorus uptake. Mycorrhizal fungi assist the uptake of phosphorus (Tinker, 1980) and trace metals and possibly influence water and nutrients via hormonal influences is not in doubt.

8.4 Cost Effectiveness and Economics of Bio-fertilizers

8.4.1 Cost Effectiveness

Production of chemical fertilizer, especially that of nitrogen is high energy budgeted process based on fossil fuels with one unit of nitrogen requiring two units of fuel. In terms of crop productivity, for 3 legumes, chick pea, lentil and

soyben alone, rhizobial inoculation can generate an additional gain of approximately Rs. 11,800 million from the entire cropped area, for which the inoculant cost will be only around Rs. 35-40 million. If rural production is encouraged by the use of algae, it has a potential of generating an additional income to the farmers of about Rs. 1000-1500 from half an acre of land through the sale of the produce (Dahama, 1997).

8.4.2 Economics of Bio-fertilizers

Mani Ram and Megh Singh (1994), reported that following are the economics of bio-fertilizers in agriculture

- Saving 20-50 kg inorganic nitrogen per hectare
- One tonne Rhizobium inoculant is equivalent to 100 tonnes nitrogen considering minimum fixation of 50 kg/ha. application dose
- One tonne of Azotobacter and Azospirillum each equivalent to 40 tonnes of nitrogen considering minimum fixation of 20 kgN/ha. from 0.5 kg/ha. application dosse
- One tonne of BGA is equivalent to two tonnes of nitrogen considering minimum fixation of 20 kg/ha from 10 kg BGA/ha. application dose

9. Utilization of Green Manuring Crops in Organic Farming

9.1 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 et al., 1997). The process of green manure is of two types:

9.1.1 Green Manuring In-situ

A practice of ploughing or turning into the soil of undecomposed green manure crop in the same field where the crop is grown eg. Sunhemp, sesbania etc.

9.1.2 Green Leaf Manuring

This refers to turning of green leaves and tender green twigs collected from shrubs and trees grown on bunds, waste lands and hereby forest areas. The common shrubs and trees useful for this purpose are glyricidia, sesbabia etc.

Advantages of Green Manuring

- It adds organic matter to the soil
- The green manure crop return to the upper top soil, plant nutrients taken up by the crop from deeper layers
- It improves the structure of soil and other physical properties
- It facilitates penetration of rain water, thus decreasing run-off and erosion
- The green manuring crops hold plant nutrient that would otherwise be lost by leaching

- Leguminous plants add nitrogen to the soil
- It increases the availability of certain plant nutrients like phosphorus, calcium, potassium, magnesium and iron

The farmers in many parts of the hills of Nepal are also using wild plants such as Titepati (*Artemisia vulgaris*), Siris (*Albizzia lebbeck*), (Khatri Chhetri, 1991). Others are legume crops like Daincha, sun-hemp, berseem, cowpea, lentil etc. The use composition of some wild plants is given in the table 5.

Table 5: Wild Plants Used for Green Manuring and Their Nutrient Content

Plants	Nutrient Conten (%)		
	N_2	P_2O_5	K_2O
Titepati (*Artemisia vulgaris*)	2.40	0.42	4.90
Asuro (*Adhatoda vasica*)	4.30	0.88	4.49
Taramandal (*Helianthus annus*)	4.90	0.87	5.23
Banmara (*Eupatorium Adenophorum*)	2.35	0.71	-

Source: Maskey and Bhattarai, 1984

Joshi et al. (1992) conducted an experiment at Khumltar farm in 1989-91 on rice by using some of the indigenous plant materials including dhaincha, mungbean, water hyacinth and azolla. They reported that *S. canabena* produced the highest yield of rice as compared to others (**in table 6**) when incorporated in the soil.

Table 6: Different sources of green manures and their effect on the yield of rice at Khumaltar

Treatment	Biomass incorporated (t/ha)		N (%) dry wt. basis	Moisture (%)	Grain yield (Kg/ha.)		
	1989/90	1990/91			1989/90	1990/91	Mean
Control	-	-	-	-	4195	1927	3061
S. canabaena	23.6	23.6	5.6	77.6	6190	3606	4898
S. rostrata	21.6	21.6	4.1	75.4	6175	2246	4210
Mungbean	11.8	11.8	4.8	73.5	6511	2518	4514
Azolla	10.0	10.0	4.0	90.0	5156	2259	3768
Water hyacinth straw	10.0	10.0	0.6	89.0	4457	1831	3144
Compost	10.0	10.0	2.6	50.0	5869	2586	4228

10. 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 sametime 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 (Khatri-Chhetri, 1991).

10.1 Agronomic Importance of Bio-gas Slurry

A field experimental was conducted by Kuppuswamy et al. (1993) to study the effect of bio-gas slurry and gypsum riched bio-gas slurry on rice-blackgram. Bio-gas slurry at 10 tonnes/ha. enriched with gypsum @250kg/ha. gave an additional grain yield of 1.8 tonnes/ha. compare to control. The residual effect of FYM on succeeding blackgram was comparatively better than that of biomass slurry (**Table 7**).

Table 7: Direct and Residual Effect of Bio-digested slurry on Ric and Blackgram

Treatments	Rice yield (ton/ha.)	Blackgram (kg/ha.)
Wet bio-digested slurry @10 ton/ha.	7.46	422
Dried bio-digested slurry @ 10 ton/ha	7.80	393
Wet bio-digested slurry @ 10 ton/ha with gypsum 250 kg/ha	8.41	402
FYM @ 10 ton/ha	7.33	463
FYM @ 10 ton/ha with gypsum 250 kg/ha.	8.00	431
Gypsum 250 kg/ha	6.78	294
Control	6.61	292
CD (P = 0.05)	0.19	51

Source: Kuppuswamy et al., 1993

12. Methods for Minimizing the Adverse Effect of Pesticides

12.1 Biological Pest Control

In Korea, by using inorganically method of pest control in the rice is becoming popular nowadays. Current biological control research is mainly concerned with the brown plant hopper (BPH) on rice. Biological control of the BPH is best by the spider and fungal pathogens. A numbero of leaf hopper and BPH are controlled by using different types of spiders in kores was reported by Choi and Lee (1990) and their research report is tabulated in Table 8.

Table 8: Number of leaf hopper and plant hopper preyed per spider per day

Pests	*Pitrata subpiraticus*			*Pachygnatha clerki*			*Ghathonarium dentatum*		
	Male	Female	Mean	Male	Female	Mean	Male	Female	Mean
Nilaparvata lugens	6.8	3.7	5.3	2.2	1.7	2.0	1.2	1.0	1.1
Sogatella fercifera	3.8	4.0	4.0	2.8	1.9	2.4	1.2	0.9	1.1
Laodephax striatella	11.9	6.5	6.5	2.1	1.8	2.0	2.6	0.9	1.3
Nephotellix cinticeps	5.8	3.1	3.1	2.6	2.1	2.4	2.5	1.9	2.2

Source: Choi and Lee, 1990

12.2 Biological 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 eg. the tadpole, ducks etc. are used for weed control in Japan, as in the grass carp in Indonesia and the apple snails in Taiwan.

12.3 Bio-pesticides for Insect-pest and Disease Management

The growing public awareness of the chemical insecticides used to control insect-pests has urgent the scientists to develop new bio-pesticides as an alternative. Bio-pesticides are destinguished from conventional chemical pesticides by their non-toxic action. They include the following:

12.3.1 Microbial Pesticides

Microbial pesticides are naturally occuring organisms which include bacteria, fungi, protozoa or viruses eg. BT (Bacillus thuringiensis), Baculoviruses 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 FIIou, 1980)

Baculoviruses are promising agent for the control of insects of order Lepidoptera (Butterflieds and moths), Hymenoptera (Sawflies) and Coleoptera (Beetles).

12.3.2 Biochemical Pesticides

Biochemical pesticides from insect and plants which can be used to modify insects' behavior and physiology and even affect insect control. These include semio-chemicals, hormones, natural plant regulators, enzymes etc. Sex pheromones are one kind of semio-chemicals that attract the pests and controlled by mechanical damage. About 1000 insect pheromones have been isolate and identified and synthesized in Taiwan (Kao, 1999). Among them, botanical pesticides investigated, neem has justifistically 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 livelihood of pest resistance
- Environmentally safe

- The are selective, biodegradable, ecological and renewable alternative for the use of Integrated Pest Management (IPM) programs

12.3.2 Integrated Pest Management (IPM) Programmes for Sustainable Agriculture

IPM is a procedure to manage pest populations by harmonizing control methods such as natural enemies, pesticides and cultural practices. The purpose of IPM is not eradication or removal of the pest, but management of pest populations so that economic damage and harmful environmental side effects are minimized.

Gwawali et al. (1996) reported that indigenous knowldege on plant protection have been used by farmers. They have taken study on Makwanpur, Chitwan and Mukundapur, Nawalpur districts to assessment of indigenous knowledge in plant protection for possible integration into IPM. They reported that farmers of Mangalpur (76%), Chitwan and Mukundapur (72%) were traditionally following integrated approach of chemical, cultural/mechanical and indigenous methods of plant protection for the control of a range of of crop pests. For the control of rice stem borers, summer ploughing, puddling and levelling of fields, burying of tobacco leaves and stems in puddled field, removing of the tips of seedlings at the time of transplanting and trapping of adult insects in the fields by using light traps etc. practices were followed.

13. Constraints on Popularity of Bio and Organic Fertilizers

a. Though the usefulness of bio and organic fertilizers has been demonstrated, beyond doubly, the farmer's acceptance of this practice has been far from satisfactory in spite of low cost of these inputs. Being biological materials, they are subject to various environmental stress once introduces into the soil.
b. Moisture regime level of available nitrogen, phosphorus and molybdenum salinity and alkalinity. These influence the response of legumes to bio-fertilizers.
c. Non-availability of quality inoculants is another constraint in the culture with low shelf life and commonly are often being marketed.
d. Lack of suitable transport and storage facilities, optimum temperatures and humidity conditions are often not maintained.
e. Farmers are not aware of advantage of non-traditional organic manures such as poultry manures, urban wastes etc. The use of bio-fertilizers and organic manures can be improved substantially.

14. Packages for the Development of Organic Farming in Nepal

The following priorities areas for research and development under organic farming as a package in Nepal are given below:

- Research priorities for formulating organic farming practices should be framed by NARC (National Agriculture Research Council) and other agencies.

- Establishment of national centre for organic farming will be useful in undertaking and co-ordinating basic research on organic farming systmes.
- Development of pesticides of plant origin (eg. neem) and use of bio-agents especially under IPM systems need to be promoted.
- Linkages between the Ministry of Agriculture, Government of Nepal, NARC and IAAS (Institute of Agriculture and Animal Science), Rampur Chitwan need strengthening in respect of developing organic farming systems.
- NARC and IAAS institutes should be restructured their courses on organic farming.
- Incentives for production of good quality organic manure, bio-pesticides, bio-fertilizers and green manuring crops may be considered.
- Encourage the visit of farmers to model organic farms, organic seminars, workshops, conferences and lectures to create awareness regarding the improvement component of organic farming.
- The indiscriminate use of inorganic fertilizers and pesticides nedd to be discouraged.
- Steps are needed to avoid hazardous chemical residues in feeds, fodder, food products and milk.
- Develop marketing infrastructure for organically produced commodities.
- Financial marketing can come forward to provide appropriate support.

15. Conclusion

Agriculture remains the key sector for the economic development of most developing countries, because for the development of any country should be self sufficient for food shelter and cotton. To make self sufficiency of the country, there has been intensive fertilizer used for the last four decades, which created several problems linking excessive fertilizer used with environment have been identified. Increased amount of nitrate in drinking water is due to excessive and improper use of nitrogen fertilizers, which is most important fertilizer related pollution issues. Nutrient enrichment, eutriphication of lakes and deterioration of surface water quality due to transportation of nutrients applied through fertilizer via leaching and/or runoff and sediment erosion are other problems. Contamination of soil by heavy matal through fertilizer such cadmium from phosphatic fertilizer which has been found to carcinogenic is also getting increasing attention of environments. The significance of fertilizers in polluting the air is being viewed with concern after the course that nitrous oxide originating from agricultural soil can damaged the ozone layer in the stratosphere.

Pesticide contamination of agro-chemical and horticultural crops have also been reported. Due to heavy use of pesticides, different problems like soil, water, environment pollution and food contamination also takes place.

Agriculture is not sustainable if its resource base declines, or if it has an adverse impact on the environment or if it leads to economic hardship for farmers especially for farmers with limited resources and landless tenant cultivators. To

overcome such problems, organic farming receives the top priority in sustainable agriculture. There is a considerable scope for supplementing of renewable rsources such as bio-fertilizer and organic wastes for improving crop productivity and crop health. The use of FYM, compost is in practice but the use of bio-fertilizers, green manures and other waste has yet to become popular as a cost effective and eco-friendly nutrient supply. Experiments conducted on different legume crops grown under varying agro-ecological conditions proved the potentiality of bio-fertilizer and organic wastes as important source of plant nutrients.

So, from the different reviewed paper, it is clear that organic farming is practical proposition for sustainable agriculture if adequate attention is paid to this issue. There is urgent need to involve more and more scientists to identify the thrusst area of research for the development of eco-friendly production technology.

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