CHAPTER – 1

OVERVIEW
CHAPTER - I

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SECTION I

1.1 INTRODUCTION:

The agricultural sector is of paramount importance for any developing economy and has a far-reaching effect on the overall development of the country. It has a place of pride in the structural set-up and well-planned agricultural development leads to the development of many other sectors of the economy. It has an important role in providing food, employment and income to the people and also in the area of international trade. It is also an important contributor to national income and a crucial factor in containing inflation. Currently, in India, agriculture and especially a variety of crops produced under diverse climatic conditions in different crop systems, supports 115.5 million families. It contributed around 18.6 per cent to India's GDP in 2006-07. (Economic Survey, 2006-07, p: 161). It is thus necessary to step up agricultural output and maintain it in the years to come.

The present study deals with Organic Farming, as a means of attaining sustainable agricultural development, with special reference to India’s agricultural scenario, in the post-Green Revolution Era (1980 onwards). The study makes an inquiry into the organic farming technique, to test its economic viability.
1.1.1 The Need for the Present Study:
Organic Farming has attracted the attention of farmers, agricultural scientists, economists, and policy-makers across the world, particularly since the 1980s, as an alternative to chemical agriculture, as the negative externalities and diminishing returns of the latter have become evident. The growing concern about environmental degradation and dwindling natural resources has made it inevitable to examine organic farming techniques for sustainable agricultural development.

There are, however, different points of view about the nature, definitions, and success of organic farming, and its economic viability, particularly in developing countries like India. Hence, the need was felt to take up the current study and ascertain whether organic farming can lead to sustainable agricultural production in the coming years.

1.1.2 Hypothesis:
Organic farming is economically viable.

1.1.3 Objectives:
1. The prime objective of the study was to follow a holistic approach, integrating the economic, ecological and sociological aspects of organic farming.
In the past, it was common to study economic systems in isolation with the ecosystems and natural environments (Tisdell, 1999, p: 37). While, for the short run purposes, such a partial approach to
modelling economic activity might be reasonable, the interdependence between the state of the biosphere, environmental resources, and economic activity cannot be neglected over a longer period. The interdependence is particularly important, if one is concerned with economic development, an activity occurring over a long period. Hence in the present context, it is necessary to have a holistic approach to the study of agro-economic systems.

The agricultural sector is at the core of this interdependence. It is through the agricultural sector that the economy is linked to the environment (Frisvold & Kuhn, 1999, p: 1). Environmental problems like pollution, disruption of the ecological balance, water scarcity, and climatic changes have a direct and far reaching impact on agriculture, which in turn affects its economic performance. At the same time, different agricultural practices affect the environment in terms of soil fertility, ground water level, salinisation and the quality and quantity of nutrients in the soil. There is an impressive range of evidence demonstrating the agricultural impact on the environment, confirming a serious extent of damage to ecological infrastructure, including species extinction, top soil loss, water scarcity, deforestation, air pollution, acid rain, green house effect, ozone hole, collapsing fisheries, bio-invasions, and increasing infectious disease (Tisdell & Dragun, 1999, p: 2). Thus, a sound environment is necessary for achieving and maintaining long term agricultural growth and ecologically safe agricultural practices are necessary for maintaining a healthy environment. Environment and
agriculture can thus be said to be affecting each other and in turn, the economy.

The other important objectives of the study are:

2. To ascertain the economic viability of organic farming for sustainable agricultural development, which would benefit the farmer, the consumer, and the society at large.

3. To find out whether organic and chemical methods can be complementary techniques.

4. To conduct practical pot culture experiments in addition to collecting data through the interviews of farmers and other stakeholders.

5. To evaluate the role of the Government, particularly in India, in the progress of organic farming so far, and to study and suggest policy initiatives for the future.

1.1.4 Research Methodology and Sources of Data:

The study utilises primary as well as secondary data. Enrichment experiments have been carried out to add value to the interviews with farmers in general and organic farmers in particular. Similarly, discussions were conducted with other stakeholders in the society, who are directly or indirectly connected to organic farming. An extensive review of literature has been made. Statistical analysis has been carried out in the form of the Analysis of Variance (ANOVA) technique and Critical Difference (CD) to analyse the experimental data.
1.1.5 **The Scope of the Study:**

The present research deals with the study of organic farming, with special emphasis on India's agricultural development. References of organic farming systems in other countries have also been cited. The research takes into account the economic, agronomic, ecological, and sociological aspects of organic farming, both on the micro and macro levels. The possible effects of different policy initiatives have also been discussed. The term 'economic viability' includes in its scope, the private as well as the social / environmental costs and benefits.

1.1.6 **Limitations:**

As this is primarily an economic research, the method of 'pot culture experiments' has been used, which itself is a commonly used method of conducting agricultural experiments. Large-scale field experiments as conducted by agricultural universities have naturally not been conducted. However, a great number of large-scale experiments conducted by agricultural scientists have been studied and discussed. (See chapter 2).

Similarly, the farmers who have been interviewed are those from Maharashtra State, particularly in the vicinity of Pune District, for practical and budgetary constraints. Experiences of farmers from other states and countries, as found in published and unpublished literature have been studied and also cited as references.
1.1.7 Chapter Scheme:

Section I of Chapter 1 deals with the basic introduction, the need of the present study, objectives, hypothesis, research methodology and sources of data, limitations, and the organisation of the thesis in the form of the chapter scheme. Section II of Chapter 1 presents a background of the agricultural development, particularly in India and the need for an alternative approach. It further presents a discussion on the definitions, principles, and practices of organic farming, as well as a brief history of the organic farming movement.

Chapter 2 presents a detailed review of literature on organic farming. This has been classified into three groups: (I) Economic and Agronomic Feasibility; (2) Experiments in Organic Farming, and (3) Organic Techniques.

Chapter 3 presents the data collected by the researcher through experimental work. The comparative yields of Fenugreek, Coriander, and Spinach, grown with organic and chemical fertilizers (under four trials), have been tabulated, analysed and interpreted along with graphical presentations and photographs.

Chapter 4 is split into two parts. Section I covers the findings and observations collected through the interviews with 144 farmers in two villages in Purandhar and Mulshi talukas respectively, (both in Pune District); and another village in Pamer taluka in Ahmednagar District. Section II of the chapter deals with the responses of farmers
from different parts of Maharashtra State, who have converted to organic farming. Part II thus enables an intra-personal analysis.

Chapter 5 presents an outline of the discussions carried out with other stakeholders in the society, who are in some way connected to organic farming. These include economists, agricultural scientists, botanists, horticulturists, researchers, professors, wholesalers and retailers, exporters, bankers, heads of NGOs, and government officers.

Chapter 6 discusses the inferences drawn from the study, and different policy implications.

Chapter 7 presents the summary and conclusion of the study.
1.2 **BACKGROUND OF AGRICULTURAL DEVELOPMENT:**

Before proceeding to the discussion on organic farming in particular, a brief account of the stages of agricultural development in general has been presented in this section. This historical account further explains the significance of the present study.

1.2.1 **Major Agricultural Revolutions:**

Since man discovered the art of agriculture, mankind has seen three main agricultural revolutions. The first and the most important development was the Neolithic agricultural revolution around 7500 BC. This was the time when **wheat and barley were domesticated** for the first time in the Middle East. Related inventions like that of the plough and irrigation around 2900 BC and the use of iron in 1400 BC were also of a revolutionary nature. However, all of these can be treated as similar and related inventions, which dealt with the development of the art of agriculture, which was itself in its very early stages.

The next and comparatively more recent revolution took place in the socialist world, which included the then USSR and China. This revolution was more of an **ideological nature** rather than a technological one. This was the time, when **agricultural land was nationalised, landlordism was abolished** and agricultural land
was organised into collective or state farms in the post 1917 revolution USSR. Similarly, the formation of communes took place in China in the post 1931 period, where the popular slogan was “Own your land”.

The most spectacular agricultural revolution, however, took place around the mid 20\textsuperscript{th} century when higher yielding varieties of wheat and paddy were introduced along with extensive irrigation, heavy mechanisation and chemical means of cultivation, which included chemical fertilizers and pesticides. The Green Revolution of the 1960s is an example of this third agricultural revolution.

1.2.2 Introduction Of Chemical Agriculture (The Green Revolution):
In the early part of the twentieth century, there was pressure on the governments of various countries to step up agricultural output, which would match with the increasing population. If agricultural output was not kept in pace with the growth of population, it would lead to higher food prices. This would cause hardships to the masses, as well leave lesser surplus available for saving and investment, and lower ‘capital accumulation’. On this background, modern chemical agriculture created a breakthrough in agricultural technology.

The term ‘Green Revolution’ was first used by William S. Gaud on March 8, 1968, while addressing the society for International Development on “The Green Revolution – Accomplishments and Apprehensions” (Chandler, 1976). It is a revolution, because of the sudden and enormous change involved, and it is green because of the
creation of 'greener looking fields' (Singh, 1974, p: 6) The wheat crop in winter and paddy in summer resulted in a year round greenery over a vast span of area in tropical countries like India.

The Green Revolution involved the use of new, improved, high yielding varieties of seeds, extensive irrigation and generous use of chemical fertilizers and pesticides. It involved large scale application of modern science and technology to agriculture (Dhanagre, 1989, p: 39) It is basically a biological – chemical phenomenon based on high yielding varieties of seeds and chemical fertilizers (Sharma and Dak, 1989 p: 2) The term 'Green Revolution' was coined at a time when many populous countries in the third world were threatened by hunger and famine. An ideological superiority of communism over capitalism was also feared. In a manner of speaking, the Green Revolution was seen as a counterpoise to the Red Revolution (Brar, 1999 p: 22).

However, the chemical approach had some shortfalls; the more important one was the inadequate focus it had on environmental issues. Food production in the immediate future was the primary focus. Human populations were burgeoning, and people had to be fed. Chemical pesticides were perceived in the 1960s as essential components of crop production systems. Little attention was given to their pollution potential. Also, new lands, some of which were marginal for agriculture, were cleared and cultivated, leading to deforestation, increased soil erosion, and water run-off. (Brady 1994, pp: 23, 24)
Thus, chemical agriculture led to considerable natural resource deterioration, and diminishing returns in agriculture. In India too, the same pattern was seen.

1.2.3 The Indian Scenario:

The traditional Indian agriculture was disrupted under the British rule, where farmers were transformed into mere producers of raw materials and cash crops. Agricultural output rose only marginally in the pre-independence era and could not keep pace with the comparatively faster growing population. The famines in the period of 1860 to 1908, and the tragedy of the Bengal famine in 1948 made the Indian planners realise the importance of increasing agricultural productivity and output.

After independence, the Indian government realised that food surplus was used as a tool by the developed countries to dictate terms to India. The debacle of the second five-year plan (1956-61) also reiterated the need for strengthening agriculture. Similarly the PL 480 incident also once again brought forth the pressing need for attaining self-sufficiency in food production.

On this background, the Indian Government tried to give a big push to the agricultural sector by modernising it and introducing structural changes to raise output. The most significant step taken in this direction was the Green Revolution of the 1960s. The most important aim of this policy was to ensure food security and
dispense with the need of food imports in the shortest possible time.

1.2.4 Advantages of the Green Revolution Technology:
The Green Revolution led to a dramatic and unprecedented increase in agricultural productivity. This new agricultural strategy gave increasing returns in the beginning. For example, India’s food grain production increased from 50.8 million tons in 1950-51 to 199.4 million tons in 1996 signifying almost a four times increase. India had achieved self-sufficiency in food grains production by the year 1976.

Thus, the use of chemical agriculture almost amounted to a miracle. This modern technology showed demonstrable and immediate results. It had relatively universal applicability. These techniques spread widely across the world. Governments too, gave impetus to these methods by investing heavily in the research and development of these techniques, and also subsidising chemical inputs.

According to Brar (1999, p: 22) “Governments were impelled to provide the necessary infrastructure in the form of irrigation, higher yielding variety seeds and fertilizers, as well as information, subsidies and support price for agriculture. Without these incentives, the Green Revolution would have been a non-starter.”
1.2.5 Negative Externalities associated with The Green Revolution Technology:

Although the Green Revolution led to an unprecedented and miraculous increase in agricultural productivity, it was still criticised on several counts. These include inadequate coverage, excessive dependence of farmers on markets, widening the disparities of income and so on. In addition to these, the Green Revolution is also criticised on the grounds of the negative externalities and social and environmental costs that it created. These social and environmental costs were earlier not appreciated and anticipated and hence not included in the ‘private costs’ of using the chemical means of cultivation. The Green Revolution technology led to a number of negative side effects like degradation of the soil, poisoning of the yield, pesticide resistance and pest resurgence, loss of biodiversity and the general disruption of the ecological balance.

Modern agriculture largely depends on the use of fossil fuel based inputs such as chemical fertilizers, pesticides, herbicides and labour saving but energy intensive farm machinery. While the application of such high input technologies has undoubtedly increased productivity and labour efficiency, there has been a growing concern over their adverse effects on soil productivity and environmental quality. High input agriculture has degraded some of the natural bases on which the system rests. The ultimate costs of this degradation on the farm are borne by the farmers themselves and by the society at large, be they lowered productivity,
environmental clean-up or further technology to solve a technologically induced problem. As a result, modern agriculture may represent our most severe and comprehensive disruption of the biosphere (Tyler Miller, 1970 p: 115).

The ill-effects of the modern technology can be briefly explained as under:

1) **Residue of chemical in the soil leading to soil pollution and degradation:**

The Green Revolution was associated with a big increase in the area under paddy and wheat, which are more depletive of soil fertility than leguminous crops like pulses and gram (Tiwari et al, 1980, pp: 3, 4). Such leguminous crops fix nitrogen in the soil, which is essential for plant growth. Gram, an important rabi (winter) crop, when grown in rotation with wheat and barley helps controlling water borne diseases. (Punjab Agricultural University, 1978-79). The replacement of less remunerative crops by those, which yielded more in monetary terms, was a natural corollary of the Green Revolution. Pulses and other leguminous crops lost importance, as they were less remunerative. This reduced the capacity of natural nitrogen fixation by leguminous crops and increased the need for chemical nitrogen fertilizers. Similarly Paddy has been depletive of potassium and zinc; and wheat of sulphur, copper and manganese. This too, has increased the usage of chemical fertilizers.

The modern technology was a high input high cost affair and hence it made every inch of land precious. Trees in the middle of the field
were seen as money lost and were cut. This increased the land under cultivation, but also led to an increasing scarcity of wood, which was used as domestic fuel. As a result, dung cakes, which were earlier used as farm yard manure (FYM) came to the used as domestic fuel. This further increased the use of chemical fertilizers.

The intensity in cropping has also led to a decrease in the land left fallow. The soil has no time to recuperate its strength and green manuring is almost impossible, due to lack of time between harvesting one crop and sowing the other. (Brar, 1999, p: 54). This has further aggravated the problem and made the use of chemical fertilizers inevitable. A vicious circle thus, set in.

Excessive use of chemical fertilizers leads to the residue of these chemicals in the soil. It disturbs the natural ecological balance. Excess use of nitrogenous and phosphate fertilizers can lead to acidification of the soil. Acidic soils, as is well known, are not conducive to plant growth. What is more, chemical fertilizers contain heavy metals as impurities. Health hazards arising due to heavy metals entering the food chain through the soil are also a major cause of worry. Similarly, such residue gets mixed with the surface and ground water and pollutes it.

2) Contamination of groundwater:
Groundwater is supposed to be the purest form of water available on the earth. It is formed due to the seepage of surface water through the soil and rocks. When such water gets trapped between the hard rock
layers of the soil, it forms underground pockets of water called \textit{aquifers}.

Excess and indiscriminate use of nitrogen fertilizers leads to the pollution of groundwater. Nitrogen fertilizers get converted into \textit{water-soluble nitrates} and move down to the sub-surface water, thus contaminating the groundwater. As well water is in fact groundwater; presence of nitrates in well water causes health hazards to people and animals using such well water for drinking. 10 parts per million of nitrate nitrogen is the maximum permissible concentration in water used for human consumption. It is estimated that 25 percent of the people living in Europe are drinking water with nitrates above the recommended level. In the USA, detectable levels of 39 pesticides have been observed in the groundwater in 34 states. (Dahama, 2003, p: 4) Thus, wherever chemical agriculture was extensively used, this effect was more pronounced.

A study conducted by Singh and Sekhon (1976) shows a positive correlation between the nitrate concentration of well waters in the Ludhiana and Hoshiarpur districts of Punjab and the amount of nitrogenous fertilizers added per unit area per year. Another study conducted by Singh et al (1987) shows an increase in the amount of nitrogen pollution in Central Punjab. During 1975 and 1982, according to a study by Handa (1987), high contents of nitrates, even exceeding 200 mg/l, have been reported from the southern parts of the Patiala and Sangrur districts. About 40 to 50 per cent of nitrogen element mixes with underground water (Katyal et al, 1985). The
process is greatly accelerated by percolation of water from heavily
irrigated fields. In addition to nitrate pollution, potassium has also
been found in groundwater samples from various parts of Punjab.
Elevated nitrate levels in the groundwater can be attributed to the
low relative costs of nitrogen and other chemical fertilizers and the
ease with which nitrates move in the soil (Johnson, et al, 1991 p: 2)

3) Effects of Irrigation:
Irrigation is an ancient practice, thought to have originated in
Mesopotamia 6000 years ago. Irrigated agriculture is the main
human use of water. About 70 percent of the water drawn from
rivers, lakes and aquifers is used in agricultural production. (FAO,
2000). The area of agricultural land under irrigation has increased
tremendously during the past 100 years. There were approximately
40 million hectares of irrigated land in 1900 (Field, 1990 p: 4)
According to the FAO (2000) by 1998, more than 271 million
hectares were irrigated with much of the increase occurring after
1950. Thus, irrigation has been an important factor in agricultural
growth during this period.

However, irrigated agriculture has brought with it several
environmental costs. Not only is it a big water user, but also the
cause of many water related environmental problems. Reservoirs
constructed to supply water to agriculture and other sectors have
destroyed significant natural assets by inundation. Dams and
reservoirs present physical barriers to fish migration, alter stream
flow regimes and water temperatures and trap sediments.
Consequences include severe degradation of aquatic habitats, with significant threat to aquatic species. Thus, the natural biota get destroyed leading to the disruption of the ecological balance. Surface return flows and drainage from irrigated agricultural lands carry salts, fertilizers, pesticides and other pollutants into surface waters, causing harm to fish and wildlife and impairing water for human users. Aquifers used for drinking water are also contaminated by agricultural pesticides and nitrogen, when irrigation water percolates through the ground into the saturated zone.

Another consequence of irrigation is salinisation of the irrigated soil. Salts get deposited on the soil and get concentrated due to evaporation and plant transpiration. When these salts accumulate in the root zone, they act as deterrents to agricultural productivity. When these salts are leached beyond the root zone, groundwater quality and downstream surface water quality gets impaired thus, salinisation constitutes both, an on-farm management problem for irrigators and an off-farm externality for other water and environment users (Johnson, et al 1991, p: 3)

In India, paddy cultivation during the Green Revolution was made possible by providing irrigation. In Punjab, paddy cultivation was attempted in predominantly sandy soils. Water percolation down the surface was rapid in their case. This led to the concentration of salts in the soil and inhibited further paddy cultivation. To circumvent this problem, farmers scrapped the uppermost sandy layer, applied frequent fertilizers, green manure, heavy paddling and even added
clay to the soil. Soil texture in such areas changed within a few years. In normal course, such a change may have taken centuries to materialise (Punjab Agricultural University, 1987).

4) **Pollution of water bodies:**

Agro-chemicals enter water bodies through irrigation water, which leads to their pollution. When macro-nutrients like nitrogen enter the water bodies like lakes and rivers, they **increase the growth of phytoplankton** (free floating microscopic plant life). It leads to **eutrophication**, a process by which surface water bodies get excessively enriched with nutrients. At times, excess growth of green plants and algae increases to such an extent, that they completely cover the surface of the water bodies. As a result of this dense growth, sunlight is unable to reach the lower levels of the water, thus reducing the capacity of photosynthesis of the submerged plants. The natural result of this phenomenon is **the depletion of oxygen in such water bodies**. This further leads to the death of several aquatic animals.

In addition to oxygen depletion, **algal bloom** also releases certain poisonous chemicals. Such release of poisonous chemicals has killed fish and other river life. This has been documented in the news many times in Australia. Algal blooms have had an adverse effect on salmons and trout farms in Norway. This damage has incurred costs in excess of about $200 million. In spite of this problem, European countries continue to dump 1.5 million tones of nitrogen into adjacent marine areas, more than 60 per cent of which is derived
from agricultural run off (Saull, 1990, p: 12). Several studies have demonstrated that high levels of nitrogen in surface waters are generally related to farming activities. Practices which do not allow for the proper incorporation of fertilizers applied at excessive rates can cause elevated nutrient concentrations in run off (Bijay-Singh and Dhaliwal, 1993, pp: 95-108).

Entrophication, thus, changes the quality of water. When such water is carried through pipes for drinking and other domestic uses, or for industrial and agricultural activity, the excessive growth of algae in the water leads to clogging of pipelines.

Thus, it can be said that pollution somewhere can cause a number of backlash effects elsewhere. According to G Tyler Miller (1970, p: 63) "Indeed, the most important principle of ecology is that everything is connected to everything. Intruding or disrupting an ecosystem in one place always has some complex, usually unpredictable and frequently undesirable effect somewhere else."

5) Effects of the use of higher yielding varieties (HYV) of seeds:
The Green Revolution was characterised by the use of HYV seeds for crops like paddy and wheat. The first dwarf varieties of wheat were developed in Mexico around 1948. Between 1965 and 1970, the HYV seeds of wheat and paddy were introduced in the so called third world countries of Asia. This led to a massive increase in food production in these countries. The per capita food production of the
developing countries increased by 7 per cent since the mid 1960s with an increase of over 27 per cent in Asia (Conway and Barbier, 1988, p: 651). Indian scientists developed the wheat strains from the seeds received from the Mexico dwarf and semi-dwarf varieties of wheat

The HYV seeds have a high nutrient uptake, which leads to micro nutrient deficiencies in the soil. (Shiva, 1989, p: 74) Hence the use of chemical fertilizers becomes inevitable. The effects of the use of chemical fertilizers on the surrounding ecosystem have already been discussed. In addition to this, these varieties of seeds are less adaptable to local conditions and as such are more vulnerable to attacks by pests. This increases the use of chemical pesticides. Moreover, modern farming is mostly of the mono-culture type. This means that there is a loss of genetic diversity. Furthermore, mono-culture farming means that the crops can be comparatively more easily destroyed by a single variety of pests. This makes the use of chemical pesticides even more unavoidable.

Chemical pesticides have their own serious problems. These have been discussed in the following sub sections.

6) Pesticides residues in food and pesticide pollution:

Pesticide residues are a common problem of the modern agricultural technology. The use of HYV seeds was one of the reasons why consumption of pesticides has increased. Pesticides basically are
poison and hence act as pollutants. As such a cycle of deterioration is set in motion.

In developing countries like India, pesticide contamination in food products is very common owing to lack of stringent control measures. According to a study carried out by the Indian Institute of Management (IIM), Ahmedabad (1999), about 25 per cent of the foods in India have pesticide residues above the tolerance limit, whereas the world average is only 2.5 per cent. Similarly, while the world average for foods not having detectable residues is 80 per cent, in India it is just 2.5 per cent. What is more, nearly one third of 7,50,000 pesticide-poisoning cases in the world are reported annually from India. This situation, according to the study, prevails despite the fact, that on a per hectare basis, India uses only 0.3 kg of pesticides, whereas countries like Japan use as much as 10.6 kg per hectare. While newer molecules of pesticides are used which are less toxic; in India, most pesticides used, belong to the first generation, which are highly toxic, hazardous and less easily biodegradable. The study states that indiscriminate pesticide usage on farms and mixing of pesticides leave high amount of pesticide residues in the food.

Pesticide residues have been detected in almost all food materials, including foodgrains, fruits, vegetables, milk and milk products, eggs, fish meat, and even human milk, in developing countries like India. Even in the United States, estimates reveal that for a vulnerable sub-population, viz. small children, residues of a few
banned and persistent chemicals pose greater than negligible threshold risks (Kuchler, et al, 1997, p: 119). Pesticide residues have varying effects on human health. Pesticides can induce several allergies, asthma, genetic mutations, birth defects, nutritional deficiencies, as well as serious damage to organs such as liver, kidneys and the nervous system. Further, they can lead to bio-magnification and bio-accumulation.

The World Health Organisation estimates that globally, at least three million people are poisoned by pesticides every year, of whom, 20,000 die. A study published in the World Health Statistics Quarterly in 1990 put the figure higher, estimating that 25 million Third World agriculture workers suffer severe poisoning every year. (Chatterjee, 1995, p: 28)

Pesticides may also get mixed with irrigation water and pollute the surrounding environment. Similarly seepage of pesticides into the groundwater is also possible.

According to G Tyler Miller (1970, p: 93) “Pesticides are a serious dilemma, being simultaneously knights and villains....Many of the long range effects of man-made chemicals on the eco-sphere are not predictable and even the relatively, simple cases are not completely understood.”
7) Pesticide resistance and pest resurgence:

With the disruption of the ecological balance, the natural prey-predator relationship is destroyed. Moreover, pesticides kill many beneficial insects and non-target organisms, such as predator insects, resulting in lower yields and pest resurgence (Swaminathan, 1993 p: 15). Similarly, other biological pest control measures are also no longer used as a result of mono-culture farming. The greater need for chemical pesticides explained above, creates a new problem of pesticide resistance, and pesticide induced resurgence. Pests quickly breed resistance, thus making the pesticides ineffective. More than 500 species of pest causing insects and mites have become resistant to one insecticide or other (Daliwal and Pathak, 1993 p: 109). Pesticide resistance leads to the development and use of new stronger varieties of pesticides. This leads to a 'continuously escalating form of chemical warfare'. Some of these same poisons are magnified up the food chain to accumulate in higher concentrations in our bodies (Tyler Miller, 1970, p: 96).

There have also been instances of pesticide induced resurgence. According to Chaboussou (1986, p: 34), the application of pesticides in the Green Revolution Technology, not only affected the resistance of plants to fight disease, but also enriched plant tissue with amino acids which provide a nutritional base for the development of various pests, and in some cases, they even inhibited the growth of the plant.
8) Resource Degradation and Loss of Non-Renewable Resources and Diminishing Returns:

In ancient times, enough land was available to fulfill the needs of the existing population. The land man ratio was high enough to meet the requirements of the people. However, in the past century population growth has been phenomenal, and hence, the existing agricultural land is not sufficient for the food requirements of the population. The cycle of resource degradation poverty and hunger has set in. This has lead to intensive farming, with the use of chemical fertilizers, pesticides and other inputs. The fertilizer consumption in India has increased from 66,000 tons in 1951-52 to 12.16 million tons in 1992-93. The all India fertilizer consumption was as high as was as 104.50 kgs per hectare in 2006-07. (Economic Survey, 2006-07, p: 174).

Agro chemicals like fertilizers and pesticides are produced from non-renewable fossil-fuel. In future, diminishing availability of these inputs may not only cost heavily on our foreign exchange but may also limit agricultural productivity. According to Dahama (2003, p: 20) "The Green Revolution with high input use has reached a plateau and is now sustained with diminishing returns and falling dividend."

The tenth five year plan (2002-2007, p:533) states, “In areas where fertilizer consumption is comparatively high, the response ratio, i.e. the fertilizer input to grain output, seems to be declining. This is evident from the fact that in these areas, the crop productivity has not increased in proportion to the increases in
the use of fertilizers. In fact, though the fertilizer consumption in such areas has increased, of late the crop yields seem to have reached a plateau.”

Thus, the problem is complex and exists simultaneously on many different levels. It is a sensitive issue, as it is connected with the food and incomes, which constitute the very survival of millions of people. The modern high input chemical agriculture has a considerable environmental and social cost.

According to Lucas and Debuque (1993, p: 6). “It has become increasingly clear to farmers, NGOs, international agencies, academics and Governments, that the conventional* practice of farming, based on the Green Revolution in Asia, is fatally flawed. The unsustainable nature of conventional agriculture is manifesting itself in terms of stagnant or declining yields, increasing ecological degradation, and worsening socio-economic conditions.”

Taking into account all these factors, it is necessary to develop an alternative approach of agriculture, which is economically viable, technically feasible and ecologically sustainable. Conway and Barbier (1988, p: 10) feel that the Green Revolution has encountered major problems of equity, stability and sustainability, necessitating a

*The terms ‘conventional agriculture’ and ‘modern agriculture’ ironically refer to the same high input chemical agriculture, which was practiced under the Green Revolution.
new phase of agricultural research and development.

1.2.6 Alternative Approach for Sustainable Agricultural Development:
In recent times, the drawbacks of the high input chemical agriculture have become well-known. There is general awareness about the fact that the earth is a closed system and that ecological damage somewhere is bound to have repercussions somewhere else, in the form of negative externalities.

In the 1970s period, many environmental studies have been undertaken in different parts of the world. The setting up of the United Nations Environment Programme (UNEP) in 1972, and the Stockholm conference on Environment in the same year, have led to an increasing importance to worldwide environmental problems and their solutions. Publications like Brundtland Commission’s ‘Our Common Future’, which for the first time defined the concept of sustainable development, and the World Development Report titled ‘Environment and Development’ have further created consciousness about serious ecological problems. Similarly the UN preparatory conference at Miami in 1991 and the Earth Summit in Rio de Janeiro in 1992, the declaration of Agenda 21, have all focused on the problems of Environment and Development. More recently the Rio + 10 conference held at Johannesburg in 2002 and the declaration of the UN Decade of Education for Sustainable Development (2005-2014) have all played a major role in focusing attention of academics and policy makers alike on the problem of sustainable development.
As agriculture is at the crux of the environment and development process, the need is also felt to review the way in which agriculture is practised currently and devise practices for its long term sustainability. It is felt that an alternative approach to conventional farming is necessary.

In 1989, the Board of agriculture of the National Research Council of the United States published a study called Alternative Agriculture. Alternative Agriculture is not a single system, but a combination of systems, which deal with emphasis on management practices and on biological relationships, with minimum use of synthetic and inorganic inputs. This philosophy believes that natural processes occur in the ecosystem and farmers should take advantage of these natural processes, rather than try to circumvent them or destroy them with chemicals. Alternative agriculture includes the following practices:

1) Reduced or minimum use of chemical fertilizers and pesticides.
2) Tillage that minimises soil erosion
3) Integrated Pest Management (IPM)
4) Management Systems, such as crop rotations, to help control weeds and pest resurgence.

Cook (1991, p: 3) defines alternative agricultural practices as being “those, which take advantage of the biological relationships, which occur naturally and are sensitive to maintaining environmental balance.”
Benbrook (1991, p: 3), defines it broadly, by saying that “alternative agriculture is a term which encompasses efforts to achieve sustainable agricultural systems.”

It is now realised that agricultural development, like development in any other sector should be sustainable over a long period of time. In the 1980s, Wes Jackson of the Land Institute of Salina, K.S. began using the term ‘Sustainable Agriculture’ to describe an alternative system of agriculture based upon resource conservation and quality of rural life (Sharma, 2004, p: 11). Sustainable agricultural development means producing adequate amounts of high quality foods, being environmentally safe and at the same time being profitable. Sustainable land use systems can be conceptualised as farm systems, which interact with their bio-physical and socio-economic environment in such a way that they are both, economically viable in the short run, and ecologically sustainable in the long run. The International Encyclopedia of Sustainable Development (1998, p: 45) defines sustainable agriculture as “a model and economic organisation based on an equitable and participatory vision of development which recognises the environmental and natural resources as the foundation of economic activity”. Lynam and Herdt (1988, p: 38) define sustainability as the “capacity of a system to maintain output at a level approximately equal to or greater than its historical average, with the approximation determined by its historical variability”. According to Conway (1985, p: 95) it is “the ability of a system to maintain
productivity in spite of major disturbance such as is caused by intense or large perturbation”.

Sustainable systems rely on farm produced renewable resources as much as possible and minimise the use of external and purchased inputs. Sustainable agriculture uses the advances of modern science to improve rather than displace the traditional wisdom accumulated over centuries by millions of farmers around the world (Sinha, 1998, pp: 78, 79). However, sustainable agriculture does not mean complete reliance on any particular method. It combines traditional techniques with modern ones, as per need of the farm. The emphasis is on maintaining the environment, without the total exclusion of any particular input or method and without compromising on productivity and profitability.

In the current scenario, organic farming seems to be the most logical alternative approach to conventional chemical agriculture. Being basically chemical free, organic farming claims to be ecologically sound and environment friendly. Although controversial in many cases, proponents of organic farming also claim that the yield of organic farming is comparable to that of conventional chemical agriculture. According to Lampkin (1990), organic farming will help in environmental protection, conservation of renewable resources, improved food quality and orientation of agriculture towards the areas of market demand.
As the right choice of techniques constitutes a basic economic problem, it is the endeavor of this study to make an inquiry into the organic farming technique as a means for attaining sustainable agricultural development, and to test its economic viability. An effort has been made to study the various organic inputs and processes, their costs, both implicit and explicit, the social and environmental costs, opportunity costs, as well as the problems of standardisation, certification and labeling of organic products, transition facilitation, conversion, linkage effects and lastly, the role of the Government.

1.3 ORGANIC FARMING:

All the practices, which constitute ‘Alternative Agriculture’, are similar to those of ‘Organic Farming’. However, organic farming implies complete negation of chemical inputs. As against this, ‘Alternative Agriculture’ allows the chemical inputs, as and when absolutely inevitable. Hence, organic farming can be said to be a special case of alternative agriculture.

1.3.1 Definitions:

Organic farming refers to that type of agriculture, which completely eliminates the use of agro-chemicals and relies on natural inputs like farm yard manure (FYM) and animal manure; and natural and biological pest control. It uses practices such as inter-cropping and crop rotation. Different agronomists and institutions have defined organic farming in different ways; however, the underlying concept is more or less the same, i.e. chemical-free agriculture. Some of the popular definitions have been listed below.
The United States Department of Agriculture (USDA) defines organic farming as "a production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, and livestock feed additives. To the maximum extent feasible, organic farming systems rely on crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, mechanical cultivation, mineral bearing rocks, and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients and to control insects, weeds and other pests. (USDA, 1980)

According to Lampkin (1994, p: 5), organic farming can be defined as "an approach to agriculture, where the aim is to create integrated, human, environmentally and economically sustainable agricultural production systems, which maximise reliance on farm-derived renewable resources and the management of ecological and biological processes and interactions, so as to provide acceptable levels of crop, livestock and human nutrition, protection from pests and diseases and an appropriate return to the human and other resources employed. According to Kallo (2004), the concept of soil as a living system that develops the activities of beneficial organisms, is central to this definition by Lampkin.

While the definition of the USDA focuses only on the nature of organic inputs and processes, Lampkin gives a broader definition by including both, ecological and economic aspects.
To Dahama (2003, p: 9), the following definition seems to be more appropriate, as it considers the important aspect of sustainability of natural resources. According to him, “Organic farming is a production system, which favours maximum use of organic material (crop residues, animal excreta, legumes, on and off farm organic wastes, growth regulators, bio-pesticides, etc.), and discourages the use of synthetically produced agro-inputs, for maintaining soil productivity and fertility, and pest management under conditions of sustainable natural resources and healthy environment.”

According to Dhawan (2005, p: 7), “Organic agriculture is a holistic endeavour, implying interactions between components such as crops with crops; crops with animals; soil conditions and fertility with pests and disease incidence in crop and livestock.” He further states that the key feature in organic farming is the inter-relatedness of their components within the agro-ecosystems. To him, the practices consistent with the philosophy of organic farming may vary in their details, but they have an important feature in common, i.e. they are designed to drastically reduce (preferably eliminate) the use of chemical pesticides and inorganic fertilizers, which are the key elements of the modern agricultural system.

According to the British Organic Farmers and Organic Growers Association, “Organic farming seeks to create an integrated, sustainable agricultural system, relying first and foremost on
ecological interactions and biological processes for crop, livestock and human nutrition and protection from pests and diseases.” (in Dhawan, 2005, p: 9)

The Codex Alimentarius Commission (2004) defines organic farming as ‘a holistic management system, which promotes and enhances agro-ecosystem health, including bio-diversity, biological cycles, and soil biological activity. It emphasises the use of management practices in preference to the use of off – farm inputs, taking into account that regional conditions require locally adapted systems. This is achieved by using where possible, agronomic, biological and mechanical methods, as opposed to using any synthetic materials to fulfill any specific function within the system’ (www.codexalimentarius.net). According to Patil and Varade (2005, pp: 13, 14) this definition is a broad one, and more useful for practical purposes, in the Indian context.

Especially in Latin America, the term ‘agro-ecology’ is often used instead of organic farming. Some people perceive organic, as meaning certified organic and prefer the term agro-ecology for non-certified, or informal organic agriculture. (IFOAM, 2007)

Perhaps the simplest and precise definition is given by Aquaah (2002) According to him, “Organic farming is the practice of growing plants by depending primarily on natural sources of fertility for plant nutrition and non-chemical strategies for controlling diseases and pests”.

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Thus, although varied in their scope and focus, all the definitions of organic farming have two things in common, viz.

1) The substitution of manures and other organic matter for inorganic fertilizers, and
2) The use of biological pest control instead of chemical pest control.

1.2.2 Principles:
As discussed in the preceding section, the organic farming philosophy believes in the use of natural, non-synthetic inputs and processes. However, as already mentioned, organic farming does not only mean using organic inputs and excluding the use of chemicals. In addition to this, it is a method, which needs effective ecosystem management. According to Lampkin and Padel (1994), the main practices of organic farming are:

1) Maintaining soil fertility by protecting organic matter levels in the soil.
2) Nitrogen self-sufficiency by using legumes to encourage nitrogen fixation.
3) The re-cycling of on-farm organic materials, especially crop residues and livestock waste.
4) Controlling weeds, diseases and pests, using crop rotations, natural predators, organic manuring, and resistant crop varieties.
5) Careful attention to the impact of the farm on the surrounding environment and the conservation of wildlife and natural habitats.
According to Dahama (2000 pp: 11-13), organic agriculture is not based exclusively on short-term economics, but also considers ecological concepts. It utilises appropriate technology and appropriate traditional farming methods. According to him, the principles of this method are:

1) Organise the production of crops and livestock and the management of farm resources so that they harmonise, rather than conflict with natural systems.

2) Use and development of appropriate technologies based upon an understanding of biological systems.

3) Achieve and maintain soil fertility for optimum production by relying primarily on renewable resources.

4) Use diversification to pursue optimum production.

5) Aim for optimum nutritional staple food.

6) Use decentralised structures for processing, distributing, and marketing of organic products.

7) Strive for an equitable relationship between those who work and live on the land.

8) Create a system, which is aesthetically pleasing for those working in this system and for those viewing it from outside.

9) Maintain and preserve wildlife and their habitats.

Thus, to Dahama, the principles and practices of organic farming extend beyond the production stage and cover the marketing, sociological, and environmental issues.
1.2.3 Practices:

This section presents a bird’s eye view of A) the widely used organic manures, B) methods of pest and weed control, and C) other popular processes used under organic farming.

A) Organic Manures

Organic materials are valuable by-products of farming and allied industries, derived from plant and animal sources. Organisms, both plants and animals, provide materials that can be incorporated into the soil to supply organic matter (Aquah, 2002, p: 707). Organic manures make use of organic materials to increase soil fertility. Organic manures are classified into two categories. The first refers to manures which are bulky in nature, but supply plant nutrients in small quantities. These are known as bulky organic manures. The second category comprises those organic manures which contain a higher concentration of plant nutrients. These are known as concentrated organic manures.

1) Bulky organic manures:

The most commonly used manures under this category are:

i) Farm yard Manure (FYM) – It consists of a decomposed mixture of animal excreta (mostly cattle dung), the bedding used in the stable, mostly in the form of straw and plant stocks used to feed cattle.
ii) **Green Manure** – Green manuring can be defined as a practice of ploughing and turning into the soil, undecomposed green plant tissues for improving the physical structure and fertility of the soil.

iii) **Compost manures** – These refer to the decayed refuse like leaves, twigs, roots, stubble, groundnut husk, cereal straws, weeds and grasses. The process of decomposition is hastened by adding nitrogenous material like cow dung or cow urine. When a large number of micro-organisms feed on these wastes and convert it into well-rotten manure, the final product is known as compost.

Another variant of compost manures is known as **urban compost**, which comprises night soil, town refuse and earth. Sewage and sullage are rich in nitrogen and other plant tissues.

2) **Concentrated Organic Manures:**

   i) **Oil Cakes** - Oil seeds are rich in manurial ingredients and hence, after oil is extracted from them, they can be used as manure. Oil cakes are rich in nitrogen and also contain phosphorous and potassium. Oilcakes are generally divided into *edible* and *non-edible* oilcakes. The most commonly used non-edible oilcakes include castor cake, cotton seed cake, undicorticated karanj (honge cake) mahua (Ippi cake), neem cake, undicorticated safflower cake and undi cake. The edible oilcakes include coconut cake, linseed cake, groundnut cake, jambo cake, safflower cake and sesame cake.
ii) **Poultry Manure** – The liquid and solid excreta of poultry birds is termed poultry manure. It ferments quickly and can be applied directly. Similarly, droppings of sheep and goat also make very good manure.

iii) **Fish Meal** – Non-edible fish carcasses are used to prepare fish meal. It is available either as dried fish, fish meal, or powder. It is fast acting, and effective on most types of soil.

iv) **Meat meal** – Meat meal refers to the waste of slaughter houses. It also includes the meat after the natural death of animals. The meat is digested in special containers, dried and powdered, and then used as manure.

v) **Blood meal** – The blood of dead animals in slaughter houses is also used as manure. This is known as blood meal. The blood is first treated, dried and then powdered to be used as manure.

vi) **Bone meal** – Sterilised bone meal is used as a phosphate fertilizer. It also supplies small quantities of nitrogen. Bone meal is the use of bones of dead or slaughtered animals as manure. It can be used as raw or steamed bone meal.

vii) **Horn and Hoof meal** – Horn and hoofs of dead or slaughtered animals are also a source of organic manure. These materials are cooked in a bone digester, dried and then powdered to be used as manure.
B) **Non-Traditional Manures/Additives**

Apart from the traditional organic manures mentioned above, there are also certain non-traditional additives, which are used to improve the fertility of the soil. These are in the form of biological fertilizers, soil inoculants, soil conditioners and vermi-compost.

1) **Bio-fertilizers**: Plants cannot directly use atmospheric nitrogen, which is in molecular form. Their nitrogen need can be fulfilled through biological nitrogen fixation, (the conventional method being the use of chemical nitrogenous fertilizers). Biological nitrogen fixation is done with the help of certain diazotrophic bacteria. These bio-fertilizers include -

i) **Rhizobium** - It is the most commonly used bio-fertilizer. It forms root nodules of leguminous crops and fixes atmospheric nitrogen.

ii) **Azotobacter** - Azotobacter is a free-living aerobic nitrogen fixing bacterium. In addition to nitrogen fixation, it is also capable of producing anti-bacterial and anti-fungal compounds, hormones and siderophores.

iii) **Azospirillum** - These bacteria colonise the roots and also penetrate the root tissues and lives in harmony with the plant. It is generally found in a close relationship with vegetable crops. Crops like maize, barley, oats, and millet respond positively to azospirillum inoculation.
iv) **Blue-Green Algae** - It is mainly used for paddy cultivation. Blue-Green Algae are photosynthetic nitrogen fixers, which means that they use energy derived from photosynthesis to fix atmospheric nitrogen. In addition to nitrogen fixation, Blue Green Algae also reduce soil alkalinity.

v) **Azolla** - Azolla is a small floating, water-fern. It is usually seen in shallow fresh water bodies and low land fields. It harbours Blue Green Algae, Anabacna azollae. The Azolla – Anabacna association uses energy from photosynthesis to fix atmospheric nitrogen.

vi) **Mycorrhizae** – Mycorrhizae literally means 'fungus root.' They are the symbiotic association of fungi with roots of vascular plants. They facilitate increased phosphorous uptake. Beneficial effects of Mycorrhizae have been seen in fruit crops like citrus, papaya and litchi (Dahama, 2003, p: 129).

2) **Soil Conditioners** - Soil Conditioners are those materials, which when added to the soil, improve and maintain its physical conditions. These additives are farm derived organic matter.

3) **Vermi-Compost** - It is a method of making compost with the use of earthworms. These earthworms live in the soil, eat bio-mass and excrete it in digested form. Earthworms are burrowing organisms. Their secretions are rich in macro and micro-nutrients. Vermicomposting is an important practice in organic farming.
4) **Bio-gas and waste-water treatment** - Biogas slurry provides both, micro and macro-nutrients to crops. It also benefits the soil by bringing about physical, chemical and biological enrichment. Its manurial value is greater than FYM. Similarly, *irrigation with waste water* is also a non-conventional method which leads to both, disposal and utilisation of waste water.

5) **EM technique** - EM refers to the use of beneficial and *Effective Micro-organisms* (EM). It is made of mixed cultures of microbial species. These microbes are non-harmful and non-pathogenic. The basic groups of micro-organisms in EM are lactic acid bacteria, yeast and phototropic bacteria. When applied to the soil, they break down organic matter, and increase the microbial diversity of the soil, thus enhancing growth, yield, quality, and disease resistance of crops.

**B) Organic Pest and Weed Control**

Organic pest control refers to the use of organic pesticides, repellents and practices like inter-cropping and relying upon the natural prey-predator relationships. Organic pest control is preventive rather than reactive.

Among organic pesticides of botanical origin, neem has got the greatest attention. Different parts of the neem tree can affect more than 200 insect species, and some nematodes, fungi, bacteria and viruses. Neem contains several active chemicals, which work in different ways and as a result, pests are less likely to become
resistant to neem. More importantly, neem extracts are proved to be soft on unintended targets (Sharma, 2004, p: 139)

There are other lesser used botanical insecticides as well. These include the extract of the bark of the Quassia tree, and plant produced insecticides such as Derris Pyrethrum. Apart from these, there are rarely used insecticides like chinaberry, custard apple, sweet flag, yellow sage and puna oil tree.

Organic pest management relies more on repellents like cow urine and karanj. However, most botanical repellents act more effectively when planted along with the main crop. This is called the practice of inter-cropping. Herbs such as rosemary, thyme, and peppermint deter cabbage butterflies and slugs. Similarly, wormwood, marigold flower, garlic and onions act as repellents to a variety of pests. Inter-cropping also reduces the incidence of weeds in the inter-row space.

Nature has a built in mechanism that maintains a balance in populations. When this balance is offset, the population of one species may explode because the factor that keeps it in check is lacking. Organic farming relies on the natural prey-predator relationship to control pests. Biological pest control is a practice under organic farming, where natural enemies of pests are deliberately introduced in areas where they previously did not occur. In addition to deliberate introduction, natural enemies of pests or insects are also conserved and augmented. Some examples of prey
predator relationships are birds that prey on insects, ground belters prey on aphids, caterpillars and slugs, lacewings on flying insects, and ladybug destroys mealybugs (Aquah, 2002, pp: 711, 280).

Organic pest control also includes mechanical or physical control. The practices used under this type of control are:

1) **Manual Control** - It refers to handpicking of caterpillars and large bugs, and removing weeds manually. However, this method is extremely laborious and back breaking.

2) **Mulching** - This method involves the spreading of straws, and similar farm waste on the surface of the soil to prevent weeds. Plastic mulching, which involves the spread of plastic sheets, has the capacity to trap heat. This increases the soil temperature, and destroys soil pathogen.

3) **Heat Treatment** - It involves solarisation with the use of polythene sheets to increase temperature, so that soil borne pathogens, insect pests, and weed seeds are destroyed.

4) **Barriers** - Fencing is done in the fields to prevent rodents from entering.

5) **Tillage** - This is a commonly used practice to remove weeds. Frequent shallow ploughings before sowing are effective in
controlling weeds. Tillage also kills pests in the soil due to exposure or debris destruction.

6) **Burning** - This is a method, which was in practice in the western countries before the introduction of chemical pesticides. Burning of rice straw is known to result in the reduction in the incidence of stem rot in rice.

7) **Flooding** - In this method water is stagnated in the fields. This reduces the supply of oxygen in the fields, which kills certain fungi and weeds.

8) **Cultural Control** - Cultural Control is the deliberate manipulation of the environment to make it less favourable for pests by disrupting their productive cycles, eliminating their food, or making it more favourable for their natural enemies. The commonly used practices under cultural control are:

   a. **Crop Rotation** – Monoculture and repeated cultivation of one crop increases the incidence of pests. Crop rotation is a strategy whereby no one species (of crops) is perpetually planted on the same plot of land. Crop rotation is most effective in controlling soil borne diseases. The causal organisms of such diseases need the host plant in order to thrive and consequently cannot persist in the soil if the host is absent for about 2-3 years.

   b. **Trap Cropping** – This practice refers to the deliberate planting of susceptible crops to attract pests. These crops are
known trap crops. They are then destroyed or sprayed with an organic pesticide like Neem, thus protecting the main crop.

c. **Time of planting** – Pest outbreaks occur at particular soil and climatic conditions and planting can be so adjusted that such outbreaks do not coincide with the susceptible stage of the crop.

d. **Application of soil amendments** – Applying various organic amendments like animal manure, saw dust, oil cakes of linseed, mustard, peanut, neem, etc. are effective for nematode control in a variety of crops.

e. **Strip Farming** – This practice refers to the planting of an intervening strip of a non-suitable crop to prevent the movement of insect pests from one strip of a crop to another. These non-suitable crops act as repellents to insect pests.

f. **Sanitation** – This is a practice of the removal or destruction of diseased plants, or pruning of infested plants, or controlling pest population by destruction of their host plants.

Thus, the practices of organic farming are wide in scope, which makes defining organic farming a difficult task.
1.3.4 A Brief History of the Organic Farming Movement:

After having discussed organic farming in detail, we now turn to a brief history of the worldwide organic farming movement.

Organic farming is not a new technique. It was the type of agriculture practised for ages. Organic farming is in fact as old as agriculture itself. Until well into the 20th century, organic farming was not alternative agriculture; it was the worldwide way of life. In fact, there are ancient records which tend to confirm, that the choice of techniques for agriculture and the 'substance' of plants has been debated since the time of Greek Philosophers. The earliest record of the benefits of green manure and animal manure, dates back to the Chou dynasty around 1100 BC in China (Pieters, 1927, pp: 8-10).

The use of organic fertilizers to increase soil fertility is also not a new practice. According to King (1911), the practice of adding organic matter to the soil is at least 4000 years old. According to him, it is only recently studied and understood in its scientific context. Mention of the use of organic manures is also found in early Roman compilations, which were collected by the agricultural observer Cais Plinius Secundus (23-79 AD).

There have been references of the use of night soil, lime, mud from of the base of lakes and rivers, and even feathers of poultry and birds as early as the Yuan Dynasty in China in the 13th and 14th centuries AD. The ‘Nung Shu’ by Wang Chang written in AD 1313 also lists a variety of grasses, beans, straws, and roots, which could be used as fertilizers. The mention of bean cake as fertilizer can be found in Hsu Kuang-Ch’i and in the ‘Tien-
Kung K'ai-Wu', both 17th century Chinese publications (Peters, 1969, pp: 27, 28)

Similarly, in Japan, the practice of using grasses cut by the farmers themselves, was common until the beginning of the 17th century. It was in the Tokugawa period (1603-1867) that farmers began to shift over to the use of commercial fertilizers. However, these too, were organic, principally dried fish, oil cakes, and night soil. (Smith, 1959, p: 92)

In India too, organic farming has ancient roots. The principles of 'Rishi’s Kheti' were followed, where the farmer looked upon the soil as his mother. The importance of organic manures was well-known, and also finds mention in ancient Indian scriptures like the ‘Rigveda’ and ‘Atharvaveda’. However, it was during the British rule that Sir Albert Howard (1873-1947) was sent to India as the Imperial Chemical Botanist of the Government of India from 1900 to 1924, and as the Director of the Institute of Plant Industry, Indore, from 1924 to 1931. The first agricultural experiments directed by the British Government were carried out in India by Sir Albert. He also observed and studied the organic agricultural practices in India, which he later documented in his famous book, ‘An Agricultural Testament’ published in 1940. Howard’s work in organic farming was a landmark, not only in the Indian but also in the Global Organic Farming Movement. Sir Albert Howard can be said to be the true founder of this movement.

Mention must also be made of the work of J. I. Rodale in the early 1940s, which is said to have triggered the organic movement in the United States.
of America. J. I. Rodale was an entrepreneur, publisher, editor, and farmer. He was influenced by the philosophy of Sir Albert Howard, and started a magazine in 1942 entitled, 'Organic Farming and Gardening' with Howard as the associate editor. In addition to this, his Rodale press published many other magazines and books on organic farming, which became a major source of information on organic farming to many home gardeners in the mid-1960s. The publications of his press became so popular that the USDA's Organic Farm Study Group preferred to choose the 'New Farm Magazine', one of the publications of the Rodale press, as the only major source of the names of organic growers (Harwood, 1984, pp: 1-17). Rodale picked up many of Howard's theories, and tried to put them into practice. His efforts culminated in his setting up an experimental farm in Pennsylvania, which was supported by the Department of Soil, University of Missouri. In 1976, the Rodale Research Center was established at Pennsylvania.

Simultaneously, the organic movement had started in Europe in 1912, thanks to the Anthroposophical Society started in 1912 by Rudolf Steiner, a spiritual philosopher and a contemporary of Sir Albert Howard. He was associated with the evolution of 'Biodynamic Farming', a variant of organic farming, and established biodynamic farms in Germany. The term 'organic farming' was first used by Lord Northbourne, who was influenced by the philosophy of Steiner.

Similarly, the work of Lady Eve Balfour in England in the 1940s, biological farming, based on organic and microbiological concepts propounded by Müller and Rusch of Switzerland in the 1950s, the work
of Lemaire, Boucher, and Alan Chadwick of France, Draghetti of Italy in the 1950s, all helped in spreading organic farming in Europe.

The organic movement had also spread to Canada, in the 1950s as a result of the awareness and publication of varied literature in Europe and the US. However, a great role was played by Christopher Chapman, a filmmaker, who produced two films, 'Understanding the Soil' and 'A Sense of Humus'. These films went a long way in creating awareness among the farmers in Canada. He also founded the Canadian Soil Association, which was later renamed 'Land Fellowship'.

The organic movement got great momentum, in the mid 20th century, particularly in Japan, through the pioneering work of Mosanobu Fukuoka, a micro-biologist and soil scientist. He propounded the philosophy of 'do nothing farming'. Fukuoka started practising natural farming in Japan in 1938, and his ideas have also spread in the countries of the West. His approach is well explained in his book, 'The One Straw Revolution' published in 1978. He is also credited with the introduction of 'natural farming' in Thailand. Fukuoka has also inspired other 'natural farming' movements in Thailand like 'Santi Ashoke', which began following Fukuoka’s philosophy, and developed a system of farming based around ‘organic farming’, and ‘natural farming’.

Similarly, the work of Mokichi Okada in Japan also had an impact on the organic movement. He started practising 'Nature Farming' in 1936. His philosophy was initially named 'no fertilizer farming', which was changed to 'Nature Farming' in 1950. The basic principle of this
agricultural system was to 'eliminate the poison contained in the soil, and let the soil itself return to its full natural productive power'. The core approach of this method is to use Effective Micro-Organisms (EM), developed by Dr. Teruo Higa, from the University of Ryukya, Japan.

Okada established the ‘Sekai Kyusei Kyo’ organisation in the 1930s, which advocates the Okada type of farming under the name of ‘Kyusei nature farming’. In 1980, the Mokichi Okada Association (MOA) was founded by a breakaway group of Kyusei. This group considers the use of EM to be inappropriate for nature farming, as it is an industrially produced product. Instead, the MOA promotes composting, green manure, mulching, IPM, and crop rotation.

However, the publication of Rachel Carson’s revolutionary book, ‘The Silent Spring’ can be said to be a path breaking event in the history of not only the organic movement, but also the global environmental movement. It was a precursor to later publications about the organic and environmental movement.

‘The Silent Spring’ exposed the ill-effects of pesticides on the environment, particularly the persistent nature of chlorinated hydrocarbons, their accumulation in animal and human fatty tissues, biomagnification through the food chain, and more importantly, the immunity developed by common insect pests. The book was published in the United States, France, Germany, Italy, Japan, Israel, Holland, Norway, Sweden, Finland, Denmark, Portugal, Brazil, and Ireland, stimulating environmental legislation in all these countries. By the end of the year
of publication of the book, 40 bills in different state legislatures had been introduced in the United States, to govern the regulation of pesticide use. The book not only called for a review of pesticide and other environmental regulation in the US, but it also resulted in the control on the use of aldrin, dieldrin and heptachlor in England, in 1963. (Hynes, 1987, pp: 8, 9)

The publication of ‘The Silent Spring’ also resulted in a request to President J. F. Kennedy’s Science Advisory Committee to study the problem of pesticide abuse. The committee then called for immediate reduction in the use of Dichloro Diphenyl Trichloroethane (DDT), with eventual elimination as a long-term goal. The committee also called for expansion of research on specific controls, chronic effects, and synergism of pesticide toxicity (Beyl, 1992, in Dhawan, 2005, p: 9). However, the most important effect of Carson’s book can be said to be the change in the perception of the role of pesticides from that of a beneficial tool of man, having negligible cost, to a tool whose benefits may be offset by yet unknown costs. It thus presented a new dimension in agro-environmental studies and policy.

Organic farming thus has had a long and eventful history, all over the world.

After having discussed the background of agricultural development, and the definitions, principles, practices, and history of the organic farming movement, we now move on to a detailed review of literature in the following chapter.