CHAPTER – 2

REVIEW OF LITERATURE
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2.1 INTRODUCTION:
This chapter presents an overview of the relevant studies conducted by various agricultural universities, researchers and scientists, as well as the organic techniques devised by different agriculturists, with special emphasis on studies dealing with the technical and economic feasibility of organic farming. The important articles, on the different aspects of organic farming, published in various newspapers from time to time, have also been covered. Thus, this chapter deals with the different points of view, involving the economic, agronomic, sociological and ecological aspects of organic farming. A brief review is given below. The review has been divided into 3 sub-titles:

- Economic and Technical Feasibility
- Experimental studies
- Organic Inputs / Techniques

2.2 ECONOMIC AND TECHNICAL FEASIBILITY:
According to Mishra (1994) sustainable growth of agricultural output is not possible without removing soil fertility constraints. He writes that the ill-effects of modern agricultural systems must be well-known by now. The negative impact of insecticides and fungicides on the environment is well documented. The pesticide
residues in the food chain have endangered the whole life-sustaining systems in many regions. The synthetic fertilizers have jeopardised the environment through nitrate poisoning by adversely altering the chemical and physical structures of the soil. He further writes that "technological advancement in India has created more problems than it has solved. India has been encouraging the use of chemical fertilizers, a costlier input, to feed its teeming millions. For this, it has been spending a lot of foreign exchange and financial resources in the form of subsidies, which has added fuel to the fire of adverse balance of payments and enlarging budget deficits....Increasing use of chemical fertilizers has been killing the natural fertilising potential of the soil, requiring persistently growing use of external nutrients which, in turn, has enormously raised the cost of farming, and led agriculture to become an unremunerative occupation. Secondly, excessive use of chemical fertilizers has increased the amount of alkalinity and salinity in the soil, causing long-term hazards to soil fertility and thirdly, the growing demand for fertilizers has increased its prices. All these hinder the sustainable growth of agriculture and pave the way to enquire the government role, played so far in it. The terms of trade are becoming persistently unfavourable to the agricultural sector. The prices of inputs, which the farmers have been using, have increased at a much faster rate than those of agricultural output, causing impoverishment in the real sense among them." (pp: 121-123)
He concludes that in these circumstances, the country has to switch over its dependence to locally self-produced organic manures from inorganic fertilizers, which is widely known as ecological or natural farming.

Save and Sanghvi (1995) write that the law of diminishing returns is clearly seen in chemical agriculture. "In the last 30 years and more, food production has only doubled, but the consumption of chemical fertilizers has gone up seven times" (p: 15). They state that economic savings can accrue from natural farming to both, the farmer and the nation, in terms of lesser foreign exchange spent on import of chemical fertilizers, pesticides, and hybrid seeds, lesser input costs, and increasingly higher yields. They give several examples of successful organic farms, and state that although organic farming has been successful wherever it has been adopted, it has not made the required headway. This, according to them, is due to the "vested interests of international giants, touting, promoting and pushing harmful chemicals". (p: 18)

Pretty (1999) discusses the profitability and productivity aspects of farming and states that the main challenge for sustainable agriculture is to make better use of available natural and social resources. This can be done by "minimising the use of external inputs, by utilising and regenerating internal resources more effectively, or by combinations of both. This ensures the efficient and effective use of what is available, and ensures that any dependencies on external systems are kept to a reasonable minimum." (p: 90).
further states that the best evidence of widespread redesign of farming systems towards sustainability goals comes from a wide range of countries in Africa, Asia and Latin America. "In these countries the major concern is to increase food production in areas where farming has been largely untouched by the modern packages of externally supplied technologies. In these lands, farming communities adopting regenerative technologies have substantially improved agricultural yields, often using few or no external inputs". (p: 91)

He mentions organic agriculture as a form of sustainable agriculture, in which maximum reliance is put on self-regulating agro-ecosystems, locally or farm-derived renewable resources, and the management of ecological and biological processes. He quotes Lampkin (1996) in this context, who states that in western Europe, there have been dramatic increases in organic agriculture in recent years, where the extent has increased ten fold from 1,20,000 hectares in 1985 to 1.2 million hectares in 1996. However, he feels that still relatively few farmers have taken the leap from modern high input farming to organic agriculture.

Pretty concludes that although it used to be believed that organic agriculture would mean reduction in crop yields, this generalisation no longer stands. He states that farmers can make some cuts in input use (at least 10 to 20 per cent) without negatively affecting gross margins. "By adopting better targetting and precision methods, there is less wastage and so the environment benefits. Yields may fall initially, but rise over time". (p :92)
Thus, it appears that according to Pretty, organic farming can be profitable over time.

Brumfield (2000) examined the economics of sustainable and conventional farming systems and observed that organic systems are more profitable than conventional systems with organic price premiums, but are not economically viable without price premiums. He also feels that the organic system is more profitable, if the cost of family labour is ignored, but less profitable if it is included, as organic farming is more labour intensive.

Mazzoncini et al. (2000) studied the agronomic and economic evaluation of conventional, low input and organic farming systems in Central Italy and observed that the net income of the whole rotation of crops was 55 per cent and 28 per cent higher under low input and organic systems respectively, compared with conventional systems. The increases were mainly associated with reduction in variable costs in the low input system and with greater proceeds of the organic system.

Siardos and Zervas (2001) studied the impact of organic agriculture on socio-economic structures and stated that the economic impacts concern high prices of organic products, low variable input costs, and higher or a least equal gross margin and farm incomes as compared to margins and farm incomes with those in conventional farming. In terms of social impacts, organic farming
tends to secure land tenure, contribute to rural employment and helps to keep small farms in business, support a community's self reliance, and encourage social participation.

Pietola and Lansink (2001) studied the farmers' response to policies promoting organic technologies in Finland, and observed that decreasing input prices and increasing direct subsidies trigger the switch to organic farming. The switch is also more likely on farms having large land areas and low yields. Intensive livestock production and labour-intensive production technique decreases the probability of switching to organic farming.

According to Lampkin (2002), "In organic farming systems, crop yields are frequently higher than would be expected if the conventional farming text books were to be believed. One of the major factors which has limited the expansion of organic farming in the past is the belief that such systems are not financially viable. However, the cost price squeeze in agriculture has forced farmers to rethink their farming operations and look again at low external input options. Declining real prices have become a permanent feature of agriculture" (p: 491, 492) He cites several studies [MELU(1977), Vine and Bateman (1981), Steinmann (1983), Böckenhoff (1986), Schlütter (1987), Younie (1989), and Stanhill (1990)] which have proved that the yield under organic farming systems can be comparable, or marginally lower to the yield under conventional chemical farming systems. Lampkin feels that a reduction in yield tends to bring many farmers out into a
cold sweat, particularly in view of the pressure over the last few decades to produce ever greater quantities of food. In the current situation, where surpluses are the norm and the costs of maintaining surpluses are unacceptably high, less intensive methods of production with lower levels of output may be preferable to taking large areas of land out of agricultural production altogether. Whether this approach is financially acceptable will depend as much on government policy as on other factors” (p: 492) He further states that although yields tend to drop during the conversion period while the new system becomes established, the occurrence of low yields should not be taken as a guide to potential yield in an established organic system (p: 496). He feels that lower costs often compensate for reduced yields, even without the benefit of premium prices. “Variable input costs represent one of the chief differences between conventional and organic systems, and can play a major role in compensating for reduced yields, especially when premium prices are not obtainable”. (pp: 501-506). Thus, net returns are high under organic systems. He also writes that although labour costs may be higher, other fixed costs are likely to be similar or lower and the result is net farm incomes which are comparable to or somewhat lower than conventional systems (pp: 512) He also cites several examples where the net farm income was comparable under both farming systems. He also considers environmental externalities. Lampkin concludes that “such information as is available on the economics of organic farming would seem to indicate that changing over to such a system certainly need not spell financial
...For the farmer interested in changing over to an organic system, the question of what effect the changeover will have on his or her income can only be answered with reference to the current position on the farm” (p: 523).

Jawson (2002) reports that organic agriculture is the fastest growing sector in America’s agricultural economy. He states that America’s demand for organic food has grown at a remarkable rate of over 20 per cent annually for the past 10 years. In contrast to the scarcity of organic items about 20 years ago, and these only in specialty organic shops, today, organic items are easy to find in general supermarkets. In fact, mainstream stores altogether account for 49 per cent of organic retail sales, just exceeding the 48 per cent logged by natural food stores. Organic items are flourishing in other direct venues as well. In all, commerce from this array of diverse outlets, large and small, puts America in the first place internationally, in total organic sales. He also reports that registered organic land more than doubled in the United States in the 1990s, and the transition of conventional fields to strictly organic farmlands continues, thus making organic farming a highly sought after and viable farming option. (p: 2)

Dahama (2003) states that the economic value of an organic waste or residue to a farmer is the value of the increase in crop yield and crop quality that is derived from its use. Since crop yield responses to an organic amendment follow the law of diminishing returns, the average yield increase is always greater than the yield
increase attributable to the incremental unit of organic material. If the price of the farmer’s product is the same regardless of the quantity produced, then the revenue derived from the average unit of organic material will be greater than the incremental unit. Farmers can be expected to utilise organic materials to the point where the revenue from the incremental unit is equal to its price, assuming application is included in the price. They would certainly use no more than that quantity, since additional application of the organic material would yield a loss. Likewise, they would not wish to use less, since total profits would decline. Thus, an estimate of the value of the incremental waste is necessary by management agencies when analysing the marketability of a recycled product (i.e. organic manure derived out of waste, in this case) (p: 124). Thus, Dahama tries to explain the economic value of organic manure and its optimum use, explaining it in terms of the law of diminishing returns, and the equality between marginal revenue and price as a condition for optimality.

Regarding the current conventional chemical agriculture, he states that the “unleashed technology based on petrochemicals can reap abundance in the short run at considerable economic cost. Long run costs are also borne by these same resources and by future generations of mankind.” (p: 256) He categorically states that today’s chemical farming is not physically, economically, or socially viable in the long run. He thus believes that an alternative agricultural system needs to be developed. He also points out the challenges which such an alternative or sustainable agricultural system will have to face. According to him, it will have to
‘confront’ the urgencies of time as it also faces the question of how to help feed people profitably. He concludes that India is at present not in a position to do away with the use of synthetic agro-chemicals. However, phasing out the use of these agro-chemicals and synthetic fertilizers may prove beneficial. (p: 257)

According to A. K. Sharma (2004), organic farming is economically viable, as farmers can achieve more income as a result of price premiums, and the need of fewer inputs to maintain returns. However, as it is more ‘knowledge intensive’, it requires more design and management right from the beginning. He further states that absolute yield levels under organic management are increased over time, but at a slower rate than for conventional systems. However, according to him, yields increase over time, where increases up to even 400 per cent have been observed, where farmers adopt organic farming. The output-mix and output value are also higher for organic farming than in conventional agriculture. Labour is a dominant input. Other input costs are comparatively lower. He states that in family farm situations, the emphasis is on monetary outlays, and family labour is often not yet explicitly treated as a cost. Finally, he states that premium prices are important for the financial success of organic farms. Premium prices, according to him, are a consequence of demand exceeding supply, but the share the farmer receives, is also influenced by distribution and marketing costs. As the supply of organic products increases, prices to the consumers are likely to fall, but economies of scale in distribution and marketing
may mean that prices to producers can be maintained. As the market grows, short-term over supply may be encountered, leading to lower prices, until a critical mass of products is available to allow new traders and processors to enter the market and prices are restored. The sustainability of premium prices for organic producers seems secure in the medium to long-term. (p: 436-444)

Shiva, et al (2004) present a cost-benefit analysis of rice and wheat in organic and chemical farming practices, the results of a study undertaken in 2002. “The studies showed that net profits were higher in the organic farming system as compared to chemical farming.” (p:170). They have also presented a detailed break-up of the costs under both the methods. According to these figures, the net profit for rice per acre in Dehradun (Uttaranchal) is Rs. 8,140/- for the organic farm, while it is Rs. 6,300/- for the chemical farm. Similarly, the net profit for wheat per acre in Dehradun is reported as Rs. 7,980/- for the organic farm, whereas it is only Rs. 6,385/- for the chemical farm. In Lakhisarai, Bihar, the net profit per acre for wheat for the organic farm is as high as Rs. 11,950/- as against Rs. 7,945/- for the chemical farm. In Agra, U.P., the net profit per acre of wheat is Rs. 11,240 for the organic farm, while it is only Rs. 6,640/- for the chemical farm. In Moradabad, U.P., the net profit per acre for wheat is reported as Rs. 4,250/- for the organic farm, while it is Rs. 5,915/- for the chemical farm. Only in this case, the net profit is higher for the chemical farm, however, the net profit per acre for rice in Moradabad is Rs. 4,090/- for the
organic farm, as against Rs. 3,500/- for the chemical farm. (pp: 171-174)

They also quote a study by Roberts et al, (1979), who compared data from 15 organic farms in the western Corn Belt with USDA data on representative conventional farms in the same area, and concluded that in most cases, the net returns were greater on the organic farms (p: 170).

They conclude that organic farming is economically viable, and that ample data exist to conclude that it can complete economically with conventional farming (p: 170, 182).

According to Wangikar (2005), the impact of the shift of the farmers from inorganic to organic farming is very slow and is only witnessed because of the detrimental effect of the different components of inorganic farming, emanated from their indiscriminate use for a fairly long period, which almost amounts to four decades. He believes that the bio-system of soil, water, air, environment, and human life in totality was endangered and to avoid these ill effects, only one resort is there, i.e., adherence to organic farming. “In the light of the havoc, the inorganic farming measures have played with the societies of human beings at large, in the present context and days to come; organic farming will certainly lead to an era of economic prosperity. The plethora of technologies of the inorganic farming system have lost their technological soundness in the light of the devastating effects on various factors of farm production, more so, the fiscal element involved is not within the reach of the common farmer, because of continuous hike in the
prices (of chemical inputs), their social palatability has also diminished to a significant extent, and the sustainability of flora and fauna is also at stake. The package in organic farming, on the contrary is economically beneficial, is claiming wider social acceptability and has proved its technological validity without any adverse effect on mankind. These social and economic virtues of organic farming are, therefore, popularising organic farming, not only in India, but throughout the world. (p: 161) He gives the example of the British Government, saying that it has encouraged organic farming in Britain, and has projected it for an 'economic advantage'. He believes that the measures of organic farming like organic fertilizers and herbal medicines (pesticides) possess relative advantage, as they are compatible with the social system, they are verifiable for testing their economisation, the result of their outcome is easily observable, they are easy to use, and involve less cost for their purchase. (pp: 161, 162) Thus, according to him, organic farming is technically and economically feasible.

Pawar (2005) has estimated that the total availability of organic wastes available in India is equal to 3,700 million metric tonnes, out of which 55 per cent is livestock and human wastes, 33 per cent is rural wastes, 11 per cent residue from principal crops, 1 per cent is urban wastes and agro processing. According to him, out of these, only 25 per cent are used for agriculture. (pp: 176 - 180) He quotes a study by the Indian Institute of Technology (IIT), Mumbai, that the cost of converting urban waste was Rs. 400 per ton and Rs. 200 per ton for rural wastes.
He further quotes a survey of 1,050 fields, conducted under the National Project on Development and Use of Bio-fertilizers in different parts of India. The increase in the use of bio-fertilizers in India, according to this survey was 4 per cent for plantation crops, 7 per cent for fruit crops, 9 per cent for wheat and sugarcane, 10 per cent for millet and vegetables, 11 per cent for fiber, condiments and spice, 13 per cent for rice and pulses, 14 per cent for oilseeds and herbs, and 15 per cent for tobacco.

He goes on to quote the benefit : cost ratio of an experiment conducted by 10 organic farmers in Karnataka. The B : C ratio was 4.5 for paddy and ragi, 3.0 for sugarcane, 7.5 for fruit crops (sapota and guava), 5.0 for areca nut, 6.0 for coconut, 4.0 for spices.

Thus, from these B:C ratios, it can be concluded that organic farming is economically viable. However, he has not mentioned which costs were taken into account, whether they were only private costs, or social and opportunity costs, is not mentioned. Similarly, the term ‘benefit’ also has not been defined.

Magar (2005) discusses the advantages and limitations of organic farming in India. According to him, 100 per cent conversion to organic farming would be suicidal. He believes that although the advantages of organic farming are well-known and widely accepted, the process of international certification and guidelines is very complicated, and beyond the reach of the common farmer (the producer) and the common man (the consumer).

He states that the ‘organic management plan’ which comprises the ‘manurial policy’ and ‘plant protection’ must be documented and
certified by an objective third party, based on inspection, made by an experienced inspector. According to him, while the ‘economically stable’ farmer could plan for some fodder or vermi-compost, optimum number of animals for manure, green manuring and legume-based crop rotation; small land holders and marginal farmers have to struggle for biomass from outside. At the same time, organic sources from cities are out of the question, due to industrialisation, and heavy metal and industrial pollution.

However, it is true that huge quantities of sugarcane trash, wheat straw, paddy straw, etc. are being burnt every year. He feels that soil scientists should direct their research towards bringing ‘precision in integrated nutrient management’, because cost of cultivation is increasing day by day, as compared to the slow growth in food prices. (p: 158)

Shinde and Kharche (2005) state that the Green Revolution with high input use has reached a plateau and is now sustained with diminishing returns. However, they believe that although total organic farming may be the most desirable proposition, it is not feasible due to the inadequacy of organic manures, slow nutrient releasing capacity, and it cannot sustain at high levels of production in prevailing semi-arid or tropical climatic conditions. They believe that total organic farming would be possible only under subsistence farming practised a few decades ago on soils that were already at a high level of fertility in our country. It might be possible for horticultural farming, where consumers are ready to pay extra premium for ‘green products’, to
compensate for their low productivity. They feel that scientific explanation of organic produce, consumers' awareness, standards for input certification of farm produce and processing is required to make organic farming successful (p: 20).

They further list the practices that small and marginal farmers over the centuries have experimented, innovated, adapted, and standardised, to suit their agro-climatic regions and socio economic conditions. They state that the beneficial effects of organic farming on soil fertility by recycling residues and improving nutrient availability are well-known and established. Thus, they feel that there is in reality, no loss of productivity by its adoption. Contrary to this, it gives better production under protected cultivation practices. It improves the quality of the produce. It is cheaper, labour intensive, and provides opportunities to increase rural employment. The diversity of crops and livestock gives the farmer flexibility and a diverse income. The energy consumption is less than that of conventional farming. Moreover, energy efficiency is high. The higher level of organic stability provides a distinct advantage in the initial reclamation of marginal soils, because it imparts a beneficial long-term improvement of soil physical properties. (pp: 21, 22)

Shinde and Kharche thus conclude that the labour intensive nature of organic farming is a benefit of the organic system and it should be treated as a means of increasing rural employment. However, the increase in labour cost as a result of using this method is not discussed, but other economic benefits like low energy consumption and high energy efficiency have been included.
Similarly, long-term benefits, as a result of better quality of soil, have also been discussed.

Ismail (2005) states that it is a universally accepted fact that chemical fertilizers act exactly in the same way, as nutrients from organic sources in the soil, as they are chemically the same. It is also true, that the quality of the agricultural produce, particularly horticultural produce like flower, vegetables and fruits improves when the nutrients are supplied through organic manures than in the form of chemical fertilizers. This is because all the growth principles like enzymes, hormones, growth regulators, besides all the essential plant nutrients, are supplied by organic manures. As a result, the metabolic functions in the plant get regulated more effectively, resulting in the better synthesis of proximate constituents and constituent improvement in the quality of the produce. He quotes Krishnaswamy (2002) in this context, who also states that chemical fertilizers would supply one or two nutrients only, and not the growth regulators. He also quotes Sankaran (1996), who feels that organic manures are superior in comparison to inorganic fertilizers and are more beneficial, because of nutrient dynamics, the soil structure build up and stability, optimum air-water relationship, retention and release of nutrients and regulators. This creates a balanced supply of nutrients to all metabolic functions in plants. (p: 171)

Ismail explores the agronomic implications of using organic manures as compared to chemical fertilizers. However, little reference is made to the economic aspect.
Chhonkar (2005) presents a different point of view and states that while organic farming is a philosophy that has been well tested in some of the western countries, it is not suitable for a country like India with a huge population to feed. According to him, "Due to its lower productivity and high cost of production, organic farming would leave many more people hungry in the country."

However, he does agree that policy initiatives should be taken to boost the practice of (a) composting techniques (b) recycling of on-farm and off-farm organic residues, (c) biogas technology, and (d) green leaf manuring.

However, he vehemently opposes the view that agricultural policy should be directed towards gradually reducing the use of chemical fertilizers and pesticides. On the contrary he feels "policy initiatives directed at reducing or eliminating the use of chemical fertilizers will in the long run prove disastrous for Indian agriculture". (p: 40)

Thus, as most literature on organic farming supports the system in terms of its ecological, agricultural and economic benefits, some scientists also present an opposite viewpoint.

P. D. Sharma (2005) feels that organic farming is economically viable as a result of decrease in the cost of cultivation, due to no use of chemical fertilizers, insecticides, and pesticides. There is recession in the yields of crops during the initial phase of transition from conventional to organic agriculture. Accordingly, there is a deficit in the net income under organic farming compared to
conventional farming up to the third year. Yields generally recover in 2-3 years. In most cases yields increase progressively under organic farming by the sixth year. In this context, he quotes a long-term study undertaken to test the financial viability and risk analysis for organic farming at the Central Institute for Cotton Research, Nagpur, for Cotton in the Yavatmal district of Maharashtra. “The farmers’ yield and production costs showed that the same trend was followed. As input cost was lower under organic farming, and the produce fetched a premium of about 20 per cent; the net income increased progressively, fourth year onwards under organic farming, as compared to conventional farming. The appreciation in net income was over 80 per cent under organic farming in comparison with conventional farming. He states, that in addition to these benefits, organic farming shows a distinct improvement in the physico-chemical and biological properties of soils, determining soil quality. (pp: 25-27)

Thus, according to Sharma, organic farming is both, economically and ecologically desirable.

Sarkate (2005) writes about the need to use biological pest control. This aspect of organic farming is generally neglected in most of the literature on the subject. Greater importance is given to organic manures and nutrient management, rather than pest control. This might be due of the fact that greater knowledge is available about organic manures than organic pesticides. Sarkate gives a valuable account of the different methods of ‘biological suppression of crop pests in India’. According to him, ‘indiscriminate use of pesticides
for the last forty years has brought about problems like pollution of
the environment, killing of wildlife, toxic residues in food,
development of pesticide resistance and resurgence posing health
hazards to users and consumers, and eliminating natural enemies of
pests from many crop ecosystems. **Less than 1 per cent of the
pesticides applied to the crop reach the target pests, while 99 per
cent reaches non-target sectors.** Biological control in organic
farming plays an important role, especially in crops like tea,
vegetables, and fruits, where commodities having nil insecticidal
residues fetch a premium price’. (p: 149) He also presents a list of
different biological control methods being used in India for crops
like sugarcane, paddy, cotton, pulses, oil-seeds, coconut, fruits, and
vegetables; as also a list of the potential bio-control agents, which
can be used in India.

M. S. Swaminathan (2006) (The Hindu, p:10) writes, “Punjab,
Haryana, and Western Uttar Pradesh, which constitute the
heartland of the Green Revolution, are in a state of economic
and ecological distress. Economically, indebtedness is growing
and ecologically, this region has been mining its soil and
groundwater resources. In the rice-wheat areas, the water table is
going down by 2 to 2.5 feet annually...India will not be able to
maintain a stable food security system, if the ‘fertile crescent’
(Punjab, Haryana, and Western Uttar Pradesh) is not saved through
adequate support for conservation farming and green agriculture’.
He makes a distinction between ‘organic farming’ and ‘green
agriculture’, in the context of conservation farming. According to
him, "Green agricultural practices involve the adoption of Integrated Pest Management and Integrated Nutrient Supply Systems. While in organic farming, the use of mineral fertilizers, chemical pesticides and genetically modified varieties are avoided, green agriculture involves the minimum essential use of fertilizers, safe pesticides and the cultivation of the most appropriate variety."

He concludes that in all regions, the principles of conservation farming, particularly with reference to land and water, need to be integrated with farming practices.

In another article, M. S. Swaminathan (2007, The Hindu, p: 10) states that organic manures should receive the same subsidy or support as mineral fertilizers since soil organic matter content is often low. He states, "Spread of appropriate technologies and the inputs needed for applying those technologies are essential for good harvests. Market linked farming systems, diversification, and value addition will involve concurrent attention to livestock, fisheries, and fodder and feed production. Crop-livestock integration helps to increase income as well as nutrition security. It facilitates organic farming." He feels that the smaller the farm, the greater is the need for a marketable surplus. "For a population rich but land hungry country like ours an integrated system of conservation farming and green agriculture is the pathway to sustainable food security."

According to MOFF (2007) cotton is profitable only if grown organically. The total cost of organic production is Rs. 4,200/- per ha. Adding Azotobactor, PSB, and Trichoderma at Rs. 500/- each (total Rs. 1,500/-) is useful to avoid productivity loss even in the first
year of conversion. This additional expense stops after 2-3 years, after the soil is enriched with microbes. Inter-cropping is necessary for increasing profitability. Cotton income is the profit, while intermittent income of inter-crops meets the farm expenses. Multicultural farming also reduces pest incidence, thus reducing the pesticide cost. Chemical farming, or the other hand is unviable as the fertilizers cost Rs. 2,500/-, pesticides Rs. 4,000/-, and labour Rs. 1,000/-, totaling to Rs. 7,500/- per ha in the rain fed farms. Electricity costs another Rs. 4,500/- per ha/year. The profits are thus reduced to Rs. 10,000/- even if it yields as high as 10 quintals earning Rs. 20,000/- Organic cotton, on the other hand, earns Rs. 20,000/- for 10 quintals, implying a project of around Rs. 16,000/- Intercrops provide 50-80/- bonus income and fodder (pp: 4, 5).

Selvaraj, et al (2007) present a case study of the Nilgiris in South India, which has intensive chemical farming and mono-cropping of tea. They state that, "the high cost of chemical inputs, erratic rainfall, and fluctuation in the market price of vegetables, have made agriculture a big gamble, especially in the Nilgiris. Besides, mono-cropping of tea has weakened the economic status of the farmers due to the low prices fixed for fresh green leaves, and the high costs incurred for chemical pesticides and synthetic fertilizers. It has been estimated that the farmers of the Nilgiris are indebted to an unimaginable Rs. 35 crores to around 135 pesticide outlets in the district alone" (p: 19)

They report the findings of several research experiments conducted by the Horticultural Research Station, Tamil Nadu Agricultural
University, Ooty, on the organic farming techniques, on the growth parameters, crop protection, and yield of various hill crops. Results have shown that the organic techniques were effective in improving the yield of crops besides improving soil fertility and protecting the environment from chemical pollution". (p: 21) The results were as under:

- In Potato, the adoption of integrated bio-dynamic organic farming systems resulted in a total yield of 30.6 t/ha, while the conventional system recorded a total yield of 28.8 t/ha.

- A total yield of 30.5 t/ha was obtained upon adoption of integrated bio-dynamic farming systems in carrot, while the conventional system recorded 26.4 t/ha. Moreover, nutrient analysis revealed an increase in the contents of major nutrients in the carrots produced by the integrated systems.

- In cabbage, the integrated organic systems recorded a higher yield of 56.8 t/ha as compared to the conventional yield of 49 t/ha.

- Similarly, in French beans, the integrated systems recorded a yield of 21.9 t/ha, while the conventional system recorded 17.7 t/ha. They have also presented similar results for garlic, carnation, rosemary, cauliflower tea, and gerbera.
2.1 **EXPERIMENTAL STUDIES:**

Taxler et al (1995) write about the Old Rotation Experiment at Auburn University, Alabama, USA, set up in 1896. This is the oldest continuous cotton experiment in the US (and possibly the world), the third longest running continuous field crop experiment in the US (1896-1992) and the first experiment to demonstrate the benefits of rotating cotton with other crops, and the additions of organic amendments to increase yield. The organic plot experienced a 40-year period (1920-60) during which the yield increased five-fold, but declined later on; the output on the chemical plot also peaked in the early 1960s and gradually declined in 1990. Thus, the trends shown by the organically and chemically treated plots were similar, showing similar productivity impacts. The system which had no treatment at all, was less productive than both these systems.

Cassman and Pingali (1995) present productivity trends with reference to rice systems in Asia. They state that for Asia as a whole, growth rates in yield have declined sharply in the 1980s. Yield increases in the 1980s were slowest in South Asia (excluding India) and substantial declines in yield growth also occurred in China and South-East Asia. In Indonesia, from 1976-86, total rice production increased by 70 per cent, mostly due to the increase in yield, whereas estimates of nitrogen (N) fertilizer use on rice increased by 440 per cent. **Diminishing returns from higher rates of N application, and favourable subsidies that may have encouraged inefficient use of fertilizer** were likely contributors to the decline in N factor
productivity. However, the magnitude of decline in N fertilizer productivity raises the question whether degradation of the paddy resource base due to the imposition of continuous irrigated rice mono-cropping has also contributed to declining N output/input efficiency. In the Philippines, grain yield per unit of applied N declined markedly from 1966 to the early 1970s; then remained relatively constant at about 50 kg grain per kg N input. A steady decline in productivity from applied N is also apparent in the Indian districts since the mid-1970s.

They further present an account of long-term continuous cropping experiments with rice systems established by the International Rice Research Institute from 1964-1966, in the Philippines, and in 1972-73 at two sites in India as a part of a project on Long Term Fertilizer Experiment initiated by scientists from the Indian Agricultural Research Institute. They state that it was not until the early 1980s, that declining yield trends were recognised at several sites. "Yield growth at regional levels, total factor productivity at national, district, and farm levels, and partial factor productivity from nutrient inputs in long term experiments are decreasing, where rice is cultivated continuously with irrigation.....Based on the district, farm, and experimental data, we have examined, it appears that declining partial factor productivity for fertilizer N, and possibly fertilizer nutrients more generally, provide a focal point that deserves closer scrutiny......The soil resource base has degraded.....We have not considered the potential negative externalities associated with intensification of rice systems in our analysis...when these costs are explicitly accounted for in the estimation of total social factor
productivity, then the declining trends in total social factor productivity based on the farm monitoring data and long term experiments discussed here are more dramatic (pp: 83,84).

Duff, et al (1995) present the observations of a long-term experiment conducted by the Columbia Basin Agricultural Research Centre, Pendleton, USA, with reference to wheat. The objective of the experiment was to evaluate the long-term effects of fertilizer amendments and residue management on grain yield and soil quality. They state that in the residue management experiment, the organic manure treatment has consistently produced the highest yield, which rose steadily from 2.96 t/ha in the 1930s to 4.87 t/ha in the 1980s. The chemical treatment yielded about 5 per cent less than the manure treatment, but “a direct comparison is not possible, since organic manure supplies more N, and also other elements (P, S, K, Zn, etc).” (p: 90) They state further, that while the input prices of wheat have risen steadily, long-term wheat prices have increased only slightly, since 1970. They conclude that the development of higher yielding varieties appears to be unable to overcome the decline in biological sustainability in the semi-arid Pacific North-West, wherever there is a declining the soil resource base. Economic sustainability is presently declining under all wheat-fallow system practices, because production costs are rising faster than wheat prices or yield increases. They believe that the most viable option lies in the development of technologies and management systems which reduce production costs, while using land, water, and other systems resources more efficiently.
"The ability to grow crops with less fertilizers, pest and disease controlling chemicals, and to use machinery more efficiently might lower costs, and increase economic sustainability. An added benefit of these developments would be a decline in environment and other externality costs." (p: 109)

Bhiday (1995) gives an account of an experiment conducted in the INORA farm near Pune. The same variety of rice was planted side-by-side, one with organic vermi-compost, and the other with the usual dose of chemicals. He writes that the results were remarkably different. The organic rice plants were standing erect even with the unusual excessive rains. The chemical rice plants, although taller, were flat on the ground, and had to be taken out before full maturity. There was no smell on the chemical rice plant, while the organic plant gave a characteristic good smell. "The seeds and water used were the same, but the output of the organically grown rice was distinctly superior in quality and quantity, than the chemically grown rice. Earthworms remained in the soil after the organic rice was taken out, and the soil was soft, moist, and granular. The chemical farm soil was immediately dry, cracking with large clods, and not useful for further cropping". (pp: 5, 6)

He further throws light on the symbiotic nature of organic farming, and the practice of inter-cropping. "Various species of crops and animals are grown under different farming technologies; such as rice-fish culture technique, jointly with vermi-composting technology.....There is an inter-factional relationship in organic farming. Some of the produce from the farm is used to feed the fish,
and the fish pond provides water and slime, which is thick liquid mud. The earthworms under the rice fields provide the compost to the soil, and make the soil porous. (p: 6)

Although Bhiday has focused primarily on the agronomic aspect, rather than the economic one, he has given an estimate of the agricultural waste that a given farmer can produce and the sale value of the vermi-compost created out of the waste. According to him, if the farmer has 5 large animals, 10 poultry birds, and a family of 6 persons; he produces an entire agricultural biomass and waste output of about 30 tonnes per year. The entire waste produced in 6 months, i.e., about 15 tonnes, would be consumed by the earthworms in 6 months. The vermi-compost produced, would be about 15 tonnes per year having a sale value of about Rs. 45,000/- per year. The farmer requires 10 to 12 tonnes per year for a farm of 2 ha and he could sell the balance to earn more money.

He finally states that the results from the earlier studies tend to confirm, that “organic farming systems can be technically feasible, even highly successful in terms of yield, and cash returns; and that they have a positive contribution to the environment, health of the soil, products, and humans”. (p: 11)

A study conducted by Sule et al (2002) states that an average increase in productivity by 10 per cent was shown due to the use of Rhizobium and Phosphate solubilising bacteria. In respect of brinjal and onion, the average productivity increased by 11.73 per cent and 10.59 per cent respectively, due to the use of bio-
fertilizers like Azospirillium. In sugarcane, the average productivity increased by 8.09 per cent due to the use of bio-fertilizers like Azotobacter. The per hectare productivity of field crops like groundnut, brinjal, onion, and sugarcane increased from 8 per cent to 12 per cent due to the use of bio-fertilizers.

In addition to this, they also collected secondary data of 6 villages from the Haveli Taluka of Pune district, selected on the basis of maximum use of bio-fertilizers in the agricultural year 1996-1997. The results of this study showed, that the yield (in tonnes) was higher for bio-fertilizer users, than for non-users. The difference was 0.17 tonnes for groundnut, 3.68 tonnes for brinjal, 1.92 tonnes for onion, and 6.71 tonnes for sugarcane. The percentage difference was 10 per cent in groundnut, 11.73 per cent in brinjal, 10.59 per cent in onion and 8.09 per cent in sugarcane, implying a substantial increase in productivity due to the use of bio-fertilizers.

The study concludes that although the use of bio-fertilizers brings about a marked increase in agricultural productivity. Bio-fertilizers cannot totally replace conventional chemical fertilizers. However, for most of the crops, and soil conditions, up to 20 per cent of the nitrogen requirements can be met through bio-fertilizers, which can be the best substitute for chemical fertilizers. It may help to reduce the high cost of cultivation due to chemical fertilizers, and avoid soil problems.

Sule, et al believe, that although the use of bio-fertilizers has not spread on a wide scale for all plants, specific plants like groundnut, brinjal, onion, and sugarcane have responded very positively to the use of bio-fertilizers. Based on other related studies, they state
that there is an average increase in the yield of field crops by 7 to 7.86 per cent due to the use of bio-fertilizers.

Awasaraiol and Katare (2005) present the results of several experiments carried out in different parts of the country in their paper entitled, 'Experiences in Organic Farming under Long Term Cropping Experiments'. They state that "the world has accepted that organic farming is eco-friendly, and keeps the soils healthy, and does not pollute the environment. Long term studies all over the country indicate that sustained yield and soil productivity can be accomplished with balanced nutrient addition using animal manures, and / or commercial fertilizers" (p: 129).

According to them, inorganic fertilizers should be supplemented with the use of organic manures. This would not only progressively reduce the use of chemical fertilizers, but also increase yield and improve soil quality. On the basis of earlier studies [Swaroop and Wanjari (2000) and Dhyan Singh (2003)], they state that it is proved beyond doubt that on a long term basis, conjoint application of inorganic fertilizers along with fertilizers from various organic sources, is capable of sustaining higher crop productivity, improving soil quality and soil productivity. They have presented the results of an "All India Co-ordinate Research Project" on Cropping Systems, under which long term cropping experiments were conducted since 1983 at various locations in twenty states all over India. They state that the results of these experiments upto 2001-2002 are encouraging as regards
organic farming. The data on inorganic fertilizers along with the supplementation of organic sources showed a good performance in respect of crop productivity, nutrient uptake of the plant, and fertility status of the soil.

The treatments for these experiments varied in terms of the proportion of the recommended NPK dose. It was 50 per cent NPK through chemical fertilizers and the remaining 50 per cent through organic manure and in one treatment; 75 per cent NPK through chemical fertilizers and 25 per cent through organic manure, and so on. Some of the results were as such:

- Highest yield of Kharif rice (4.95 tones / hectares) was recorded under 50 per cent dose of NPK through chemical fertilizers and 50 per cent N through green manuring in Rajendranagar.

- Highest yield of Kharif rice (4.38 tonnes / hectares) was recorded under 50 per cent of NPK (Chemical) and 50 per cent of N through FYM in Chiplima.

- Highest yield of Kharif rice (5.06 tonnes / hectares) was recorded under 75 per cent NPK (chemical) and 25 per cent N through green manuring in Bhubaneshwar. Highest yield of rabbit rice (5.84 tonnes / hectares) was recorded under 50 per cent recommended NPK (chemical) and 50 per cent N through FYM.

- Highest grain yields of pearl millet and wheat (4.6 tonnes/hectares) were recorded in the conventional treatment, however without any potash fertilizers. The situation was altogether different when potash was applied irrespective of treatments. The application of potash fertilizer had a detrimental effect on crop yield irrespective of seasons in Junagadh. (pp: 132-135).
As it is not possible to list all the results of these experiments, only a representative four have been listed. However, the conclusion derived by Awasarmol and Katare is that at present “estimates show that about 25 to 30 per cent of the nutrient needs of Indian agriculture can be met by utilizing various organic sources”. (p: 135) They suggest that organic farming should aim at mobilising nutrients from organic sources, and Integrated Nutrient Management (INM) holds the key to the future.

Thus, these experiments prove that the use of NPK through chemical fertilizers can be reduced to the extent of 25 to 30 per cent, thus reducing their ecological footprint. However, no reference has been made to the cost of production.

Parchure (2005) quotes the results of a twenty-one years’ trial at the Rodale Institute, Pennsylvania. “The economic comparison made during 1991-2001 (without price premium for organic) for organic corn-soybean rotation, and conventional corn soybean system revealed that the net returns for both systems were similar. The annual return for the conventional system averaged about $184 per ha, while the organic system averaged $ 176 per ha.

The annual costs per ha for the conventional and organic rotations respectively were $ 354 and $281. The organic system requires 35 per cent more labour, but because it is spread out over the growing season, the hired labour costs per ha are almost equal between the two systems. Over the ten year period, organic corn (without price premium was 25 per cent more profitable than conventional corn ($ 221 per ha versus $ 178 per ha

84
respectively). This was possible because organic corn yields were only 3 per cent less than the conventional yields (5843 kg/ha versus 6011 kg/ha) while costs were 15 per cent less ($351 per ha versus $412 per ha). (pp: 50, 51)

Rathod (2006) studied the effect of organic and inorganic fertilizers on yield and juice quality of tomato, through a series of experiments carried out at the Horticulture Section, College of Agriculture, Pune, during the period of September 2004 to May 2005. He reports that the combination of organic and inorganic fertilizers responds well to the growth parameters of tomato i.e., average weight of fruit and number of fruits per plant. Only organic manure alone cannot satisfy the nutrient requirement of tomato. However, organic manure through vermi-compost and inorganic fertilizers both in combination were equally effective in increasing the yield. “Organic manures respond better in colour retention than the inorganic fertilizer during storage of tomato juice”. He concludes that the application of organic manure in combination with inorganic fertilizers, increases the yield and juice quality in tomato.

Rupela, et al (2007) present the results of an ongoing long-term experiment carried out at Patancheru, India, which was designed to compare and evaluate crop production systems, based on locally available biological inputs. They state that in economic terms, the low-input strategy is proving to be much more profitable. These low inputs included locally available, low-cost and eco-friendly materials such as biomass and compost, along with beneficial
micro-organisms. These low inputs, they state, have been able to produce yields that match those from the purchased inputs systems which rely on chemical fertilizers and pesticides. However, labour was a major input in the low-input organic treatment. "While this has opportunity costs for small and marginal farmers, these producers have relatively more access to labour than to cash, so their binding constraint is land and capital, rather than labour." (p:222). Similarly farm waste was "assumed to be available with little or no opportunity cost." (p:217).

2.4 ORGANIC INPUTS / TECHNIQUES:
A host of unique and innovative organic techniques have been developed by farmers for thousands of years, and have also been put into practice. These techniques are generally localised, and applied on a small scale in individual farms, and seldom make it to the research institutes for further analysis, verification, and testing, or to agricultural journals and other publications. Many of these techniques do not even get documented. In this section, some important and commonly used techniques, devised by certain agriculturists, which have been documented and published are presented.

An important technique which dates back to the 1920s, is that of ‘biodynamic farming’, a variant of organic farming, which was popularised by Rudolf Steiner in Europe. Biodynamic farming treats farms as unified and individual organisms, emphasising
balancing the holistic development and inter-relationship of the soil, plants, and animals, as a closed self-nourishing system. A unique feature of this system is the use of 8 specific preparations derived from cow manure, silica, and herbal extracts to treat compost pits, soils, and crops. These preparations are:

- Biodynamic preparation 500 (Cow Horn Manure)
- 501 (Horn Silica)
- 502 (Yarrow Flower)
- 503 (Chamomile Flower)
- 504 (Stinging Nettle)
- 505 (Oak Bark)
- 506 (Bandelion Flower)
- 507 (Valerian Flower)

These preparations are easy to formulate, and can done by farmers on their own farms. It has been proved in several experiments carried out in Germany, America, Sweden, and New Zealand, that biodynamic preparations help in increasing yield and quality parameters, the soil exhibits better physical, biological, and chemical properties, and are just as financially viable as their counterparts. However, the claims need to be verified under Indian conditions. (Ghonsikar, et al, 2005, pp: 136-140)

One of the early scientific publications in the 20th century was that of Howard (1929, 1931, 1940) He opens his book, 'An Agricultural Testament' (Howard, 1940, p: 1) with the statement that, "The maintenance of the fertility of the soil is the first condition of any
permanent system of agriculture. In the ordinary processes of
crop production, fertility is steadily lost, its continuous restoration
by means of manuring and soil management is, therefore, imperative". He writes that the practices like mixed cropping, crop
rotation, growing legumes with cereals, are common in India, and
that the peasants in the orient have anticipated and acted upon
some of the problems that Western Science is only just beginning
to recognise. In chapter IV of his book, he explains in detail, his
'Indore process' of composting, which is based on the premise, that
"loss of soil fertility is the root cause of all problems related to
plant health and diseases. Improved varieties, themselves could
be relied upon to give an increased yield of 10 per cent; improved
varieties plus better soil conditions were found to produce an
increment up to 100 per cent or even more. The real problem was
not the improvement of the variety, but how simultaneously to make
the variety and the soil more efficient" (pp: 39, 40)
The Indore process is based on 2 principles:

1) The admixture of vegetable and animal wastes with a base for
neutralising acidity, and

2) The management of the mass, so that micro-organisms which do
the work can function in the most effective manner. (p:40).
The raw materials required are vegetable wastes and animal residues;
cow urine is particularly important. Chalk, limestone, wood ashes,
then provide a convenient base for maintaining the general reaction
with the optimum range of pH needed by micro-organisms which
break down cellulose. Water is needed during the whole process,
along with abundant aeration in the early stages. Howard then
proceeds to give the exact size of the pits, the specific layers and the order in which they should be made, the exact amount of cow urine to be put on the layers and the precise time of turning the compost.

Pioneering work in the preparation of manure in pits was carried out by Acharya (1939), particularly on the utilisation of town residues and night soil. This process is known as the ‘Bangalore method’ or the hot fermentation method of manure production. In this method, the compost production depot is located on the outskirts of the city to transport refuse and night soil to the pits. After filling the pit with refuse and night soil in alternate layers, the pit is filled up to 15 cms above the ground level with a final layer of refuse of 15 cms on the top. This is covered with red soil or mud to prevent moisture loss or breeding of flies. Sludge water can also be emptied on it. As the process involves no turning or watering, it is suitable for areas having low water availability or scarce labour. It also provides a method for the disposal of wastes. (Kachhave and Waikar, 2005, pp: 75, 76)

Fukuoka (1978) explains that ‘natural farming’ is best suited for maintaining environmental balance and a high level of yields. His ‘natural farming’ philosophy is an extreme variant of organic farming, as it does not allow certain practices of organic farming; and is based on principles like no prepared compost, no weeding by tillage or herbicides, no dependence on chemicals, and so on. Fukuoka writes about several novel techniques, which he himself has prepared, like the use of ducks to supply manure, which
will at the same time help control weeds. **However the most important technique in his natural farming is the use of straw.** Fukuoka states, “It is fundamental to my method of growing rice and winter grain. It is connected with everything; with fertility, with germination, with weeds, with keeping away sparrows, with water management” (p: 47) **He further states that if farmers stop using “weak, improved varieties, stop adding too much nitrogen to the soil, and reduce the amount of irrigation water so that strong roots could develop, these diseases would all but disappear, and chemical sprays would become unnecessary. Rice can be grown very well without chemicals, as can citrus, and it is not difficult to grow vegetables that way either.”** (pp: 70, 81)

He feels that his type of farming has evolved according to the natural conditions of the Japanese islands, but it could be applied in other areas, and to the raising of indigenous crops.

Fukuoka’s natural farming was not much developed as a commercial enterprise and had little market orientation. However, Fukuoka makes mention of the economic aspect of natural farming and states, “Since natural food can be produced with the least expense and effort, I reason that it should be sold at the cheapest price” (p: 89) He also gives an example of his fruit being the cheapest in the market, and according to shopkeepers, it was also the most delicious. However, according to him, “Until natural farming can be distributed locally, the average farmer will worry about not having a market in which to sell his produce. As **for the consumer, the common belief has been that natural food should be expensive. If it is not expensive, people suspect that it is not natural food**”. (pp: 90, 91)
He also quotes the remark of a retailer who said that nobody would buy natural produce unless it is priced high. Fukuoka writes, "If a high price is charged for natural food, it means that the retailer is taking excessive profit. If natural food is to become widely popular, it must be available locally, at a reasonable price. If the consumer will only adjust to the idea that low prices do not mean that the food is not natural, then everyone will start thinking in the right direction." (p: 91) He also mentions government policies and says, "Although natural farming can be pursued successfully, as long as the Government continues to endorse the use of chemicals, no one else would give natural farming a try. If the people from the Ministry of Agriculture and Forestry, and the Government at large had suggested that farmers throughout the country should try growing rice without chemicals, sweeping changes in agriculture could have been made. However, if crops were to be grown without agricultural chemicals, fertilizers, or machinery, the giant chemical companies would become unnecessary and the Government’s Agricultural Co-operative Agency would collapse." (pp: 81, 82)

About Fukuoka’s natural farming, Lucas and Debuque (1993) feel that it will allow the farmer to provide both, food for his family, and a surplus for sale, and that it has been adapted by farmers into a sustainable, and commercially viable system. However Kokate (1995) is not in favour of blindly following Fukuoka’s method and writes, “We cannot apply a whole sole method of natural farming everywhere, irrespective of the soil structure and nature” (p:14). However, she does feel that chemical farming gives heavy
production in the start, but very less and even “no production” later on. “By now, one thing we need to realise is that the very pre-supposition of chemical farming was unnatural. Externally, one cannot maintain the natural balance. We need to realise the inner structure of nature, and understand its phenomenon” (pp: 13, 14)

Senior (1995) believes that to combat with the problem of the ecological, environmental, and social backlashes of chemical fertilizers, it is necessary to develop an alternative method of supplying natural nutrients to plants. He estimates that a compost pit of 240 x 180 x 90 cms containing green manure crops in any field is sufficient to produce the basic requirement of manure for an acre. Both legumes and non-legumes are used as green manure crops in India. He states that bio-fertilizers like blue-green algae and azotobacter are also very effective. Cultivation of blue-green algae (algalisation) in rice fields is also a commonly practiced method in China, USSR, Egypt, and also in India. He states that the benefit from algalisation is about 30 kg N/ha per cropping season. He also mentions the use of Azolla (aquatic fern) as biofertilizer and states that different studies have revealed that growing of Azolla in rice fields increases the yield equivalent to that obtained from 30 kgs N/ha as urea or ammonium phosphate. He concludes that the use of bio-fertilizers by small and marginal landholders can solve the problem of high cost of chemical fertilizers, thus making bio-fertilizers a viable option. (p: 19)
Deshpande (1996, 2003) has formulated a technique of ‘Angara’ and ‘Amrit Pani’. Angara is the rhizospheric soil (soil surrounding the roots) of the Banyan tree in which cocoons of earthworms are present. According to him, such soil is biologically rich, as it has the excreta of birds, fallen leaves, (and the Banyan tree has adventitious roots which have hormones and enzymes for reproduction). This soil should be added to the farm at the rate of 15 Kgs to 1 acre of land, before sowing the crop. His second technique is that of Amrit Pani which is a solution prepared by mixing 250 grams ghee (prepared from the milk of an indigenous cow) in 10 kg cow dung. Then 500 grams of honey is mixed to it, and added to 200 litres of water. This solution, according to him can be used as seed treatment (seeds or the roots of saplings are to be dipped in Amrit Pani, before sowing). It can also be sprinkled on moist soil to increase its fertility, or mixed with irrigation water.

He also recommends the use of a paste prepared by mixing ‘Angara’ and ‘Amrit Pani’ as seed treatment.

As for pest control, he claims that if his ‘Rishi-Krishi’ technique (the use of Angara and Amrit Pani) is used, there will not be any pest attack in the first place. Even if there is an attack by pests or inspects, it can be tackled with the use of cow’s urine as a pest repellent. For this purpose, he recommends mixing of 100-150 ml of cow urine in a 15 liter water-pump and spraying it in the same way as pesticides are sprayed.

Regarding the cost aspect of his technique Deshpande (2003) writes that there are no actual costs, as there are no purchased inputs. According to his estimate, the cost of Amrit Pani for one acre if land
(for any crop) is at the most Rs. 100 for one year. He also states that different researchers have proved that earthworm-cultured soil is 5 times more rich in nitrogen, 7 times more in phosphorous, and 11 times more in potassium, as compared to the original soil. He also writes about an experimental study conducted at the Padegaon sugarcane research centre between 1957-60, which stated that the yield of the sugarcane cultivated with the use of vermi-culture was 29.83 per cent greater than that of the chemically cultivated one. Similarly, the organically grown sugarcane had a higher sucrose extract, which was 8.53 per cent more than the chemically grown sugarcane.

Palekar (2001) criticises the Rishi-Krishi technique, and states that ‘Amrit Pani’ will give diminishing returns in the consecutive years. He opposes the use of honey and ghee, as he feels it is not environmentally and socially justified. He also opposes the use of ‘Angara’ as he feels that taking away the rhizospheric soil of the banyan tree would disturb its ecosystem. This technique, according to him, cannot be used on a large scale. He believes that the beneficial results of Amrit Pani can also be obtained from cow dung, urine, and jaggery. He recommends the use of a solution, which is prepared by mixing 10-30 kg cow dung into 100 l of water. 10 l of cow urine is then added to the mixture, and then 2 kg jaggery and 2 kg flour of any leguminous crop is added. Finally, 100 l of water is added to it. This solution is then fermented for 2 to 7 days. He calls this technique ‘Jeev Amrit’. He recommends
the sprinkling of this solution on the soil, before sowing; and later on to be sprayed every 15 days. It can also be mixed in irrigation water.

Takara (2005) presents an economic overview of the use of EM Nature Farming. He feels that the use of EM in agriculture has its agronomic as well as economic benefits. “It promotes growth in plants, enhances their photosynthetic capacity, increases the efficacy of organic matter as fertilizers, develops resistance of plants to pests and diseases, and suppresses soil borne pathogens and pests. Due to these benefits, EM enhances crop yields in organic systems in most environments”. (p: 142) As a result of this, EM has certain economic benefits to the user, as the requirement of EM declines with time; the use of EM reduces labour requirement; the soil requires lower tillage and weeding; the use of agro-chemicals, which are expensive in most countries, is eliminated; and EM ensures faster growth and better yield.

Takara also discusses the method of preparing EM solution and EM compost, and the bacteria required for it.

After discussing the different points of view and opinions about the yield, profitability, and environmental benefits of organic farming, its techniques, and studies conducted under it, we now turn to the results of the experimental trials, conducted by the researcher, using organic and inorganic techniques. The proceeding chapter presents, discusses, and analyses the data collected through these experimental trials.