Final Report

On

Minor Research Project Entitled

"Cost-Benefit analysis of Use of Bio- fertilizers and Bio- pesticides in Udgir Tahasil (MS)"

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Chapter - I

Importance of Bio- fertilizers and Bio- pesticides

Introduction:

The green revolution of the 1960s and 1970s which resulted in dramatic yield increases is now showing signs of fatigue in productivity gains causing transformation of the green revolution into the 'greed' revolution. Excessive use of agrochemicals i.e. chemical fertilizers and pesticides are the main cause of damage to green revolution. More than 50% of crops, fruits and vegetables sold in market are contaminated with toxic residues of DDT (DichloroDiphenylTrichloroethane) like compounds. Intensive agriculture practiced without adherence to the scientific principles and ecological aspects has led to loss of soil health, depletion of freshwater resources and agro-biodiversity. Apart from good seeds, agricultural productivity depends on soil health, irrigation water quality and quantity, clean atmosphere of proper composition of carbon dioxide, nitrogen and oxygen, in addition to diverse micro-organisms, pollination insects, birds, earthworms, farm animals and other non-domesticated flora and fauna. Resources like farm yard manure, compost, biogas slurry, bio-fertilizers for the enhancement of soil are biological key to control pest or disease. Animal husbandry is needed to get continuous supply for the farm yard manure and compost. It forms the dark black humus that not only enriches the plant nutrient, improves bio-physico-chemical properties of soil like soil porosity, water holding capacity, biological activities of soil, and stabilizes the integrity of entire ecosystem enhancing overall productivity of agriculture. In addition to increase in the productivity of grains and the reduction in the cost to farmers, organic agriculture benefits enormously to the consumers who get healthy, pesticide free agriculture products. Agricultural sustainability brings the maintenance of the quantity, as well as the quality of agricultural produce over very long periods of time without signs of fatigue. Ecological foundations such as soil, fresh water, biodiversity, renewable energy and atmosphere remain intact, agricultural sustainability i.e. the quantity and quality or agricultural productivity over long periods of time won't get affected adversely and the ecological footprint will remain within the population supporting capacity of the planet Earth. Benefit in terms of

healthy environment along with the surrounding ecosystem to rise above from farmers to others, from current generation to future generation and from human to non-human transforming the green revolution into an evergreen revolution.

Benefits of Bio-fertilizers and Bio-pesticides:

Parameter	Potential benefits
Agriculture	Increased diversity, long-term soil fertility, high food quality, reduced pest/disease, self-reliant production system, stable production
Environment	Reduced pollution, reduced dependence on non-renewable resources, negligible soil erosion, wildlife protection, resilient agro-ecosystem, compatibility of production with environment
Social conditions	Improved health, better education, stronger community, reduced rural migration, gender equality, increase employment, good quality work
Economic conditions	Stronger local economy, self-reliant economy, income security, increase returns, reduced cash investment, low risk
Organizational/institutional	Cohesiveness, stability, democratic organizations, enhanced capacity

Source: Singh, 2009, Stoll, 2002, Crucefix, 1998

Bio-fertilizers:

It is said that the soil lives and breathes through its microbes. Large-scale use of chemicals and fertilizers has depleted the soil from its good microbial colonies and also cause pollution and deterioration of soil structure. Besides, there are losses of applied chemical fertilizers such as leaching, volatilization, denitrification and fixation of phosphorus. To compensate the losses caused by chemical fertilizers ,now a days biofertilizers are strongly recommended by the

agricultural scientists and experts. Experts argues that the use of biofertilizers increases the soil potency.

Bio-fertilizers are defined as preparations containing living cells or latent cells of efficient strains of microorganisms that help crop plants' uptake of nutrients by their interactions in the rhizosphere when it is applied through seed or soil. The microbial inoculants accelerate certain microbial processes in the soil which augment the extent of availability of nutrients in a form easily assimilated by plants. Bio-fertilizers add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances. Bio-fertilizers can be expected to reduce the use of chemical fertilizers and pesticides. Bio-fertilizers are eco-friendly organic agro-input and more cost effective than chemical fertilizers. Most of the time, microorganisms are not as efficient in natural surroundings as required to be and therefore artificially multiplied cultures of efficient selected microorganisms play a vital role in accelerating the microbial processes in soil. Therefore, application of bio-fertilizers is recommended by the agricultural scientists.

Some of the Common benefits of Bio-fertilizers are as below:

1. Microbial function is in long duration causing improvement of the soil fertility. It maintains the natural habitat of the soil.
2. It increases crop yield by 20-30%, replaces chemical nitrogen and phosphorus by 25%, and stimulates plant growth. Hence it is supplementary to chemical fertilizers.
3. It can also provide protection against drought and some soil-borne diseases.
4. Bio-fertilizers are cost effective relative to chemical fertilizers. They have lower manufacturing costs especially regarding nitrogen and phosphorus use.
5. It is environmentally friendly in that it not only prevents damaging the natural source but also helps to some extent cleanse the plant from precipitated chemical fertilizer.
6. Organic fertilizers have been known to improve biodiversity (soil life) and long-term productivity of soil, and may prove a large depository for excess carbon dioxide.
7. Organic nutrients increase the abundance of soil organisms such as fungal mycorrhiza, which aid plants in absorbing nutrients.
8. Secrete certain growth promoting substances.
9. Improve soil structure (porosity) and water holding capacity.

10. Enhance seed germination.
11. Increase soil fertility and fertilizer use efficiency and ultimately the yield of crops.

Some of the important bio-fertilizers and their properties are as below:

N-fixing Biofertilizers (NBF):

Rhizobium (Family: Rhizobiaceae)

Biofertilizers, particularly Rhizobium, could be a bridge between removals and additions to soil nutrients where farmers can scarcely afford costly inputs and that too in a risky environment. N fixation on land amounts to 135 million metric tons per annum average. In recent years use of Rhizobium culture has been routinely recommended as an input in pulse cultivation. In India about 30 million hectares of land is under pulses cultivation. They belong to family Rhizobiaceae, symbiotic in nature, fix nitrogen 50-100 kg/ ha
with legumes only.

It colonizes the roots of specific legumes to form tumour like growths called root nodules, which act
as factories of ammonia production. Rhizobium has the ability to fix atmospheric N- in symbiotic
association with legumes and certain non legumes like, Parasponia

Biological N fixation (BNF) occurs in the free living states, in association or in symbiosis with plants. From an ecological point of view, the most important N fixing systems are the symbiotic associations.

Rhizobium-a symbiotic Biofertilizers can be used for legumes crop and trees (e.g., leucerna) and is a crop specific inoculant, for example, *Rhizobium trifoli* for berseem; *Rhizobium melilotti* for leucerne, *Rhizobium phaseoli* for green gram, black gram, *Rhizobium japonicum* for soyabean; *Rhizobium leguminoserum* for pea, lentil; *Rhizobium lupini* for chickpea.

The appropriate strain can increase the crop yield up to 10-35% since N is fixed at 40-200 kg/ha which is able to meet up to 80-90% of N need of the crop. Also, residual N is beneficial for the next crops grown in the same field.

Azotobacter (Family: Azotobacteriaceae)

The Azotobacter colonizing the roots not only remains on the root surface but also a sizable proportion of it penetrates into the root tissues and lives in harmony with the plants, belongs to family Azotobacteriaceae, aerobic, free living, and heterotrophic in nature. Azotobacters are present in neutral or alkaline soils and *A. chroococcum* is the most commonly occurring species in arable soils.

These are non-symbiotic free living aerobic bacteria possessing highest respiratory rate and can fix N up to 25 kg/ha under optimum conditions and increase yield up to 50%. Alkaline phosphatase activity in the peach roots was highest with *Azotobacter chroococcum* + P fertilizer.

For sugarcane, *Azoto baacterindicum* is suitable in acidic sols in which it forms *rhizo bacteriocoenotic* association with roots and application in soil is economical but a large amount of organic C- and Mo is needed for stimulating nitrogenase enzyme activity during Nfixation (Mazid et al., 2012b; Khan et al., 2012a).

Azospirillium (Family: Spirillaceae)

It is also *Bacillus polymixa*. When applied to rhizosphere it fixes atmospheric N (free living state) and makes it available to crop plants. This is also N-fixing microorganism, beneficial for nonleguminous

plants, belongs to family Spirilaceae, heterotrophic and associative in nature. In addition to their N fixing ability of about 20-40 kg/ha, they also produce growth regulating substances.

Acetobacter

It is best adopted endo-phytically in sugarcane ecosystem and can tolerant high sucrose concentration. This bacterium can fix N- up to 15 kg/ha/year as plant secretes the growth promoting hormones IAA that enhance germination and root development and ultimately helps in absorption of plant nutrients.

Phosphate Solubilizing Microorganisms and Mycorrhizae

Most of the Indian soils are low to medium in Pstatus and the efficiency of phosphate fertilizers is

also allowed due to fixation of large fraction of applied P into sparingly soluble inorganic phosphates.

Some times PSM produce plant growth hormones (IAA, GA etc.). Such soluble phosphorus is taken up easily by plants resulting in 10- 20% increase in the yield of almost all the crops.

The PSB are life forms that can help in improving phosphate uptake of plants in different ways. The soil bacteria belonging to the genera Pseudomonas and Bacillus and Fungi are more common. The major microbiological means by which insoluble-P compounds are mobilized is by the production of organic acids, accompanied by acidification of the medium.

Bio-pesticides:

The use of synthetic chemical pesticides has been the widely used approach for reducing the estimated 45% gross crop loss due to pests and diseases, amounting to around Rs. 290 billion per annum. More and more quantities of chemicals are used for agricultural intensification to feed an ever growing population. In fact, the pest induced loss is on the rise despite increasing usage of pesticides. Fortunately, realization of the negative effects of these chemicals on nature and natural resources like pollution, pesticide residue, pesticide resistance etc, have forced many to shift focus on to more reliable, sustainable and environment friendly agents of pest control, the bio pesticides. In spite of the claimed efficacy, their use, however, has remained very low due to a number of socio-economic, technological and institutional constraints. Nonetheless, rise in income levels due to a growing economy coupled with increasing awareness of health related effects of chemical pesticides has increased the demand of organic food. In view of this demand and the government's efforts to mitigate climate change, bio pesticides are going to play an important role in future pest management programs.

The striking feature of bio-pesticides is environment friendliness and easy biodegradability, thereby resulting in lower pesticide residues and largely avoiding pollution problems associated with chemical pesticides. Further, use of bio-pesticides as a component of Integrated Pest Management (IPM) programs can greatly decrease the use of conventional (chemical) pesticides, while achieving almost the same level of crop yield. However, effective use of biopesticides demands understanding of a great deal about managing pests especially by the end users.In terms of production and commercialization, biopesticides have an edge over chemical pesticides like low research expenditure, faster rate of product development and flexible registration process.

Bio-pesticide market is growing rapidly. In 2010, it was accounted for about 5% of the total pesticide market, which was merely 2.5 % during 2005 and the market value is estimated to

reach more than US$ 1 billion (Source: BCC research). However, the overall growth rate is estimated to be about 10% per annum for the next 5 years.

The area under organic cultivation (crops) in India is estimated to be around 1,00,000 hectare. Besides, there are lakhs of hectare of forest area being certified as organic. Further, some states like Uttaranchal and Sikkim have declared their states as organic. Moreover, the area under organic crop cultivation is going to increase substantially because of the growing demand of organic food, a result of increasing health consciousness among the people. This indicates that there is huge scope for growth of the bio-pesticide sector in India. Analysts believe that due to rising cost of developing new effective molecules and the non-capability of most Indian companies associated with the pesticide industry to invest such huge amount, there would be a greater development in the bio-pesticides sector (Desai, 1997). Due to its rich biodiversity India offers plenty of scope in terms of sources for natural biological control organisms as well as natural plant based pesticides. The rich traditional knowledge base available with the highly diverse indigenous communities in India may provide valuable clues for developing newer and effective bio-pesticide. There exist opportunities for identification of novel sources of bio-pesticides; for instance, exploration and utilization of nanosilica as a potential agent of bio-pesticide. The supply chain management needs to be strengthened in order to increase the usage of bio-pesticides. In this regard, an efficient delivery system from the place of production (factory) to place of utilization (farm) of bio-pesticides is quite essential.

Bio-pesticides represent only 2.89% (as on 2005) of the overall pesticide market in India and is expected to exhibit an annual growth rate of about 2.3% in the coming years (Thakore, 2006). In India, so far only 12 types of bio-pesticides have been registered under the Insecticide Act, 1968 (www.nicm.org.in/biopesticides/registered.htm). Neem based pesticides, *Bacillus thuringensis*, NPV and *Trichoderma* are the major bio-pesticides produced and used in India (http://coe.mse.ac.in/taxproj.asp). Whereas more than 190 synthetics are registered for use as chemical pesticides. Most of the bio-pesticides find use in public health, except a few that are used in agriculture. Besides, i) transgenic plants and ii) beneficial organisms called bio-agents: are used for pest management in India.

Consumption of bio-pesticides has increased from 219 metric tons in 1996-97 to 683 metric tons in 2000-01, and about 85% of the bio-pesticides used are neem based products. Consumption of

chemical pesticides has significantly fallen from 56,114 MT to 43,584 MT during the same period.

Growth of the agriculture sector is a prerequisite for economic development in general and rural development in particular. And this growth must be both pro-poor and environmentally sustainable to reduce poverty and improve the quality of life in rural areas. This growth can be accelerated in part through recognition and capitalization of the rich traditional knowledge base of India especially in areas like eco-friendly farm management. As many as 2,121 plant species are documented to possess pest management properties, 1,005 species of plants exhibiting insecticide properties, 384 with anti-feed ant properties, 297 with repellant properties, 27 with attractant properties and 31 with growth inhabiting properties have been identified. Some plants like *Azadirachta, Cymbopogon* have already been exploited for commercial production of biopesticides. Hundreds of such plants like *Mahua, Tagetes,* and *Chenopodium* etc. await serious attention.

Institutes like Centre for Indian Knowledge Systems, National Innovation Foundation and others are involved in exploring and promoting traditional pesticides. A lot more needs to be done for optimum utilization of the traditional wisdom for sustainable rural development. In this regard the recommendation suggested by the National Farmer Commission is praiseworthy. It says that the government should provide incentive/support measures for promoting the purchase of products developed through indigenous technologies especially in some areas including bio-pesticides. This is indeed a very concrete approach to boost rural livelihood and though the National Farmers Policy, 2007 recommended support and promotion of bio-pesticides as per with chemical pesticides, it did not spell out any specific mechanism of support like the one being mentioned here.

Another approach to promote bio-fertilizers and bio-pesticide use vis-à-vis rural development is to work out a mechanism to certify traditional bio-fertilizers and bio-pesticides in the line of Public Guarantee System (PGS) of organic products which is still under discussion. This certification system should be started and integrated with the Panchayat System for administrative control. The universities and research organizations can contribute to the certification process by providing empirical scientific efficacy of the traditional practices. Bio-fertilizers and Bio-pesticide has the potential to be developed into a rural industry like many

other sectors. For instance 'Natural dye' has successfully emerged as a rural household industry in the villages adopted by Gandhigram in Tamil Nadu. Likewise, the production of bio-fertilizers and biopesticides can be a decentralized activity under the Ministry of Rural development. But to create such an industry a lot of ground work needs to be done such as appropriate mechanism of production (including selection of products and processes, beneficiaries, technical know-how) and marketing and such others.

Objectives of the study:

Keeping in view of the discussion in the literature and the framework evolved, the researcher has set the following objectives for the present study.

1. To analyse the need of bio-fertilizers and bio-pesticides for sustainable development.
2. To do the cost- benefit analysis of bio-fertilizers and bio-pesticides in the Udgir Tashil Area.
3. To find out the problems involved in popularising the use of bio-fertilizers and bio-pesticides in the study area.
4. To give suggestions to overcome the constraints in the use of bio-fertilizers and bio-pesticides.

Limitations of the study

Since the study has covered only Udgir Tahasil area, the results cannot be generalized. But, the results and recommendations can be helpful in similar semi-arid drought prone regions of the country.

RESEARCH METHODOLOGY:

The researcher has taken primary survey in the study area. Primary survey is conducted and the study is based on the primary data, supplemented by the secondary data published by the various agencies of the state government.

Sampling Technique:

The study is primarily based on primary data. The data is collected through personal interviews from the selected farmers with the help of a specially designed questionnaire. The questionnaire covered information related to household resource base, input use pattern, cropping pattern, cost of sugarcane and soybean cultivation, prices fetched by these crops and problems faced by the framers. The duration of the study is from 2008-09 to 2010-11.

The bio-fertilizers and bio-pesticides are used by few farmers in the study area. Therefore, purposive sampling technique was applied for the selection of farmers. By considering the limitations only forty farmers sample is chosen and in it, twenty bio-fertilizers and bio-pesticides practicing farmers and twenty chemical farming practicing farmers were selected. In this also, twenty farmers were cultivating sugarcane and twenty were producing soybean.

Design of the Study

This introductory chapter is followed by chapter two that deals with the review of literature. The third topic gives the brief information about the study area. Forth topic is on cost-benefit analysis of bio-fertilizers and bio-pesticides. The last i.e. fifth topic is on results and recommendations of the study.

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Chapter No. II

REVIEV OF LITERATURE

Arunkumar(2001) studied the farmers from North Karnataka, Hubli, and concluded that they have switched to organic farming method and are easily selling their produce in local as well as in international markets through various organizations. Organic produce from this region is being exported to European markets (1).

Karthikkumar reviewed that organic farming can fed the world and still have enough food left over. An extensive study carried out in nearly 50 countries, both developed and developing, by a group of eight eminent scientists from the University of Michigan and Michigan State University concluded that the available food production was more than sufficient for humankind. They estimated the calorific values of all food supply to be 2786kCals per capita per day, for the total volume of food supply available in 2001. They also went on to prove that, had the same land been farmed organically, the calorific value available in 2001 would have, in fact, been much higher i.e. 4380kCal per capita per day. The study showed that organic farming yield 1.312 times more grain products than non-organic farms. It is also significant that yield from organic farm in developing countries are higher compared to non-organic farms. The project also demonstrate that, for farmers, particularly those in marginal areas, who were not able to afford external inputs, an organic production management system offered a real and affordable means to break out poverty and obtain food security (2).

R Shivajirao (2008) reviewed that organic farming is safe for both the humans and environment. It is low budget form of farming, where one need not invest huge amount of money nor borrow from moneylenders or banks. Organic farming is low budget and farmer friendly. For example if a farmer is going to cultivate paddy in, say, about an acre, the cost of cultivation is about Rs.8500-10000 if used chemical fertilizers. If the same paddy is originally cultivated then the cost will be only Rs.3500-5000 which includes labor for weeding and harvesting. So if a farmer cultivate paddy using chemical fertilizer spending 10000 per acre, he gets about 18 bags (of 75 kg) and sells them for Rs.450 each, his total income will be around Rs.8000-8500 turning in to loss. But if he had restored to organic farming, the input cost, such as fertilizer and spray would have been much lower. There are different types of organic pesticides followed by farmers. Though the practice may differ according to region and crop, the basic input cow dung and cow

urine does not change. Organic farmer don't have to worry about having to face fertilizer shortage. They make their own fertilizer called manure. They make their own herbal extracts from easily available plants on roadside and control infestations. In short organic farm is a complete cycle where one thing is dependent on other (3).

S Radhakrishnan (2007) summarized that the demand for organic products such as vegetables has grown so much that over 2 tons of organic vegetables are now sold every month through the organic bazar and retail outlet. Organic vegetables such as spinach, beans, cucumber, and tapioca and fruits such as banana are among the favorites. However other products such as organic honey, wheat, and various kinds of pulses are sold (4).

G Srinivasan(2007) reviewed that on Aug 16, the commerce ministry has proposed a program to augment 40% more area under certified organic cultivation over and above the 1.10 lakh hectors in a bid to boost income of organic product growers and spare farm land from overdose of chemical fertilizers. APEDA had contacted the governments of Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra and Rajasthan and developed project proposals for assistance under the relevant schemes of the ministry of agriculture. The products covered for organic farming in these eight states encompass brinjal, banana, grapes, pomegranates, mango, chili, turmeric and vegetables, wheat and rice, soybean, sesame, arhar, basmati rice, onion, garlic, baby corn, pulses, ginger, coffee, vanilla, pepper, coriander and orange. Total expenditure for development of organic farming on a project mode in eight states would entail Rs.94.3 crore of which central assistance would be of Rs.51.71 crore from ministry of agriculture and Rs.8.82 crore from APEDA, Rs.3.42 crore from state government assistance and another Rs.30.35 crore from privet investment. Currently, 1.10 lakh hectors under certified organic cultivation is fetching export revenue of Rs.95 crore. It is estimated that the proposed area covering 400000 hectors might fetch and export revenue of about Rs.120 crore after a span of 3 years with the number of group growers in the eight states would be 160 with 20 groups in each state and the number of potential beneficiaries would be 80000 with 10000 farmers in each of the eight states (5).

GK Nair (2007) summarized that a large number of farmer groups, companies, NGOs, development agencies and government bodies promote organic farming in one way or the other. For many Indian farmers the organic approach might offer a new option for ensuring their

livelihood as they can reduce production costs and at the same time gain access to markets with better prices for their products. In 2000 an agricultural export promotion agency under the ministry of commerce has taken the lead in developing the national program for organic production farming national standards and certification guideline. Besides international certifiers such as IMO, SKAL, and Ecocert with offices in India and some Indian organic certification bodies have also been accredited under NPOP, the largest of them being INDOCERT. Meanwhile the ministry of agriculture has also come up with plans for a national project for organic farming. However, the progress has yet to pick up pace with the growing demand (6).

Swaminathan reviewed a new awareness of the beneficial influence of fresh fruits, vegetables and processed foods from cultivation through natural means are growing rapidly all over the US. As a result special farms have begun to appear in several states where organic has come to mean back nature. Organic practices involve a total departure from the use of artificial aids for boosting production and eradicating the insects and verming. Such a process if consistently pursued is believed to enable the retention of nearly 95% of the natural ingredients in every type of food products (7).

Sule SR (2001) reviewed an average productivity in groundnut was increased by 10% due to use of Rhizobium and phosphate solubilizing bacteria. In respect of brinjal and onion, the average productivity was increased by 11.73 and 10.59 % respectively due to use of biofertilizer like *Azospirillium*. In sugarcane, the average productivity was increased by 8.09% due to use of biofertilizer like *Azotobacer*. Per hector productivity of the field crops like groundnut, brinjal, onion and sugarcane was increased from 8-12% due to use of biofertilizers. Biofertilizer cannot totally replace conventional chemical fertilizers but for most of the crops and soil conditions up to 20% of the nitrogen requirement can be met through biofertilizers, which can be the best supplement for chemical fertilizers. It may help to reduce the cost on chemical fertilizer and avoid soil problems. The use of biofertilizers although not spread on wide scale for all crops it is dominantly responded in respect of groundnut, brinjal, onion and sugarcane. Many researchers have proved that there is an increase in yield of field crops by 17.86% due to use of biofertilisers. In view of the above facts and attempt of have been made here to study impact of summer/annual crops (8).

Thakur DS (2005) summarized that the IFS over the years burns the soil organic matter and soil microbes rendering soil lifeless and infertile spoiling the soil structure and soil health, depleting soil of the micronutrients and its natural fertility this has resulted in stagnant and declining yield, production and income of crops. The chemical inputs used in IFS are costly and lead to contamination and pollution of soil, water, air, atmosphere, plants and crops. The damaged caused through agrochemical pollution to environment and human health, directly and through the human food chain and sustainable agriculture and food security is irreparably. In many cases, over 90% of the inorganic produce of vegetables, food grain, fruits, milk, etc. produced under IFS contains poisonous agro chemical residues harmful and unsuitable for consumption (9).

Shrisagar (08) studied the impact of organic farming on economics of sugarcane cultivation in Maharashtra. The study was based on primary data collected from two district covering 142 farmers, 72 growing organic sugarcane and 70 growing inorganic sugarcane. The result concluded that organic sugarcane cultivation enhances human labor employment by 16.9% and its cost of cultivation is reduced by 14.2% than inorganic sugarcane farming. Although the yield from organic sugarcane farming was 6.79% lower than the inorganic sugarcane it is more than compensated by the price premium received and yield stability observed on organic sugarcane farms. Overall the organic sugarcane farming gives 15.63% higher profits than inorganic sugarcane farming (10).

Lampkin (94) summarized various studies conducted on economics of organic farming in different crops in south and west of England and parts of Scotland and Wales. They concluded that the organic farming systems were more divers in terms of enterprise mix; have lower yield and higher labor cost which were not compensated for fully by reduced input costs. Higher premium price are essential if organic farmers are to achieve similar incomes to their conventional counterparts (11).

Padel and Uli (94) reviewed several studies on cost and returns of organic farming in various crops in Germany. Their study revealed that the organic farming under German condition was equally profitable with conventional farming. Lower yields for arable crops were compensated by reduced costs of inputs and premium prices for most of the crops. Many farmers explain that financial stability was the main reason for converting to organic farming. Introduction of support

schemes for conversion and continuing organic farming also made a significant impact on the profitability (12).

Dubgaard (94) studied the economic analysis of organic farming in Denmark. His results showed the yield differences were most noticeable for intensive crops such as wheat and potatoes with organic yields around half the conventional averages. The organic farms used about twice as much labor per hectare as the conventional farms. The study also concluded that the substantial price premium on output and public support are essential for the economic viability of organic farming in Denmark (13).

John (94) reviewed the various field experiments conducted on organic farming in Canada. Many sample farms recorded yield that were the same or slightly below conventional farms. Even though some market regularity problems exists in case of organic products, the price for them were higher (about 30%) than the conventional farming products. Overall the study concluded that 72% of farmers strongly conceived that organic farming is as profitable as conventional (14).

Anderson (94) examined different research studies conducted on organic farming in USA. They concluded that the lower yield on organic farms contrasted with conventional farms were balanced by lower cost production. The noted difference between economic performances of organic and other farms may be due to farm size rather than farming system. During the study period the organic farmers did not received any benefit from the environment advantages except to the extent that consumer willing to support by paying a premium (15).

Wynen (94) carried out a review study on organic farming in Australia. He concluded that the wheat yield were almost similar between organic and conventional farms. The study also indicated that the variability of wheat yield on organic farms was lower than the conventional farming. The financial results of two groups of farms per hectare were remarkably similar (16).

Biswas (10) made an attempt to assess economics and efficiency of organic farming in India in different crops and states. The crop economic showed a mixed response. The result concluded that the unit cost of production is lower in organic farming in case of cotton (in Gujarat and Punjab) and sugarcane (in UP and Maharashtra) crop were as the same is lower in conventional farming for paddy and wheat (in Punjab and UP) crops. The result concluded that there is ample

scope for increasing the efficiency under organic farming. Exposure to more training and increase in technical guidance would enhance the productivity and efficiency of organic farms in India (17).

P Dahiya (2002) studied that investment in Ber orchid has a payback period of 7 years, starts yielding net return of Rs.709 per hectare from the fourth year which rises to Rs.13748 in seventh year there after it remain same. However it is intensive with an IRR of 22.5%. The NPV and BCR at a discount rate of 14% is Rs.26346and 1:1.22 respectively

Huchhappalvar (2002) studied that average yield of paddy and sugarcane was higher on organic farms as compared to inorganic farms. Organic farms gained 21.93% higher grain yield and 14.17% higher straw yield of paddy over the inorganic farms. In sugarcane also organic farms gained 18.10% higher yield over inorganic farms. This was due to the fact that organic farmers practiced organic farming for last five years and as a result there was a good buildup of soil fertility on their farms. They also used small quantity of chemical fertilizers to maintain the yield levels. Long term application of organic compounds increases the soil fertility and also the yield levels. Whereas continuous application of chemical fertilizers decreases the soil fertility and ultimately it leads to decrease in the yield levels (18).

Sule SR (2001) studied the factors that influence the pattern and use of biofertilizers and was observed that the use of biofertilizers increases with an increase in the size of holding. The study was based on primary data collected from 180 farmers. On the basis of multiple regression analysis, the size of holding had significant impact on the use of biofertilizers on sample farms. Further, quantity of chemical fertilizers used by biofertilizer users was found to be significant in boosting the use of biofertilizers. However the gross family income has turned out to be non-significant (19).

Birthal PS, Sharma OP and S Kumar (2000) reviewed that IPM appears to be effective to chemical pest control. IPM package as implemented on farmer field was bio intensive in nature with bio-control agents and cultural controls as major components. This could reduce the pesticide use almost to nil and without having any adverse effect on crop yield. Pest killing efficiency of IPM was higher. So was its potential to conserve natural enemies of insect pest. The per hectare crop yield was higher by 24% on IPM farms. The use of some inputs was higher on

IPM farms, but this did not make any significant difference in the average cost of cultivation between IPM and non IPM farms. However the unit cost of production was 19% less on IPM farms. The gross return on IPM farms was 24% higher to which IPM contributed about 6%. The share of inputs like fertilizers, draught power and seed did not contribute significantly much to the observed difference. Human labor however contributed substantially to the additional gains. As such the intensity of human labor use was more on IPM farms on account of activities such as hand picking of insect larvae, manual weeding and harvesting of additional output (20).

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Chapter III

About Udgir Tahasil Area (Study region)

Udgir is a histrorical city in the Balaghat Range of hills and border taluka in Maharashtra state of India, adjoining Karnantaka, Aandra Pradesh states of India. In 1956 the Marathwada region of the Nizam state was transferred to Mumbai state and the Osmananbad was made the district capital of the city. On 16thAugust 1982 a new district was created as Latur district and Udgir became one of the important taluka place in Latur District of Maharashtra.

Udgir is one of the leading taluka in the district and famous for trade, education, health facilities.

Location of the study area:

Geographically the taluka is on the south east side of the Maharashtra state with 18 15 North and 18 37 North latitude and 76 56 East and 77 21 longitude. As per the 2001 census the geographical area of the taluka is 779.22 square kilometer and population is 261449. Out of this population 91933 is urban and 169516 is rural. The population density of the taluka was 223 per square kilometer. The taluka has 97 villages and five revenue circles called Udgir, Wadhwana, Devarjan, Mogha and Her. The udgir city has a class Municipal council.

Geomorphology of the area:

The region is made of post crateshes and pre eosina period basaltic lava rocks which is also called Deccan Trap. The taluka is made of basaltic rock and Tiru, Lendi are the rivers who have deposited silt on these rocks in the river basin which has maximum 10 meters.

Balaghat platu and river basins are two distinct geomorphologic types are found in the taluka.

1. Balaghat platu: The southern part of the taluka is occupied by this platue. The height of the platue increases as we move from east to west. The average sea level height of the platue is 610 meters. Reddish brown soil covers the platue and only Kharip crops are taken, but if irrigation facility is provided the rabbi crops also can be grown.

2. River basins: The Lendi river flows from the west to east on the east side of the taluka. Lendi is subsidery of Tiru river which merges with Manjra river. Most part of the taluka comes under Lendi river basin , specially the southern part of the taluka. The soil is medium black and rabbi crops are grown in this region. One medium irrigation project has been undertaken on Tiru river at Wadhvana and 2348 hector area has brought under irrigation.

   Climate:

   Except rainy days the climate of the taluka is dry. The monthly weather of the taluka is collected at veterinary college, Udgir. The details of 2010 are as follows:

Sr. No	Month	Maximum Rainfall (in mm)	Minimum Rainfall (in mm)
1	January	28.71	11.47
2	February	33.42	14.75
3	March	37.99	19.66
4	April	40.57	22.67
5	May	41.16	23.55
6	June	34.19	20.00
7	July	29.21	17.90
8	August	29.00	17.67
9	September	29.61	17.29
10	October	30.49	16.43
11	November	29.70	18.90
12	December	27.79	14.21
	Average	32.65	17.87

(Veterinary college, Udgir 2010)

As per the data in the month of November the temperature falls sharply and December is coldest month of the year as maximum temperature is 29^0C and minimum 13.5^0C. Sometime the temperature falls up to 8^0C. May is the hottest month of the year.

Rainfall:

The average rainfall of the taluka is 800 to 900 mm. and the taluka receives rainfall mainly from south west monsoon as 85% of the rainfall is in July and August months. It begins in the mid June, July and august are the rainy months.

Average rainfall (in mm)

2005	2006	2007	2008	2009	2010	2011
976.20	857.90	701.80	726.60	629.70	1375.20	786.75

(Veterinary college, Udgir 2011)

Humidity:

In rainy days the relative humidity of taluka is 80-85 per cent. In summer the relative humidity is 30 %.

Soil:

The common soil in the taluka is black soil with 1 to 5 meters thick. The northern side of the taluka is hilly and brownish soil is found.

Vegetation:

The total area under reserve forest in the district is only 3 square kilometer and 37 square kilometer is unclassified forest. Only 102.5 hector (1.02 Square km) area in the taluka is under forest which comes around 0.13 % of the total area.

Land use:

Near about 88.18 % of the total area is under cultivation.

Sr. No	Circle	% of geographical area	% of area under cultivation	% of Fallow land	% of forest land	Total area %
1	Udgir	32.00	81.10	18.57	0.33	100
2	Wadhwana	21.30	89.98	10.02	-	100
3	Devarjan	16.70	86.18	13.82	-	100
4	Mogha	13.80	90.51	9.49	0.19	100
5	Her	16.20	93.15	6.85	-	100
	Taluka total	100	88.18	11.33	0.52	100

(Mr. Nagargoje sir, research scholar in Geography)

Sex ratio:

As per the 2001 census the Maharashtra had sex ratio of 922 women behind 1000 men. In the taluka it was 938 women behind per 1000 men.

Literacy:

As per the 2001 census the state literacy rate was 76.90 % and district had 71.54% rate. In Udgir taluka literacy rate is 59.53 %.

Transport and communication:

Roads: (in 2004)

Sr. No	Type of road	Length in K.M.
1	State Road	123.10
2	District Road	130.20
3	Other rural roads	155.65
	Total	562.18

Railways:

The taluka has one broad gage which connects Vikarabad to Parli Vaijinath Junction. Near about 32km railway route is in the taluka.

Communication:

The city and the taluka is well connected by post, telephone and other means of communication. The taluka has 41 post offices and 05 telephone exchanges.

Chapter IV

Cost-Benefit Analysis of the Bio-Fertilizers and Bio-Pesticides

The study is primarily based on primary data. The data is collected through personal interviews from the selected farmers with the help of a specially designed questionnaire. The questionnaire covered information related to household resource base, input use pattern, cropping pattern, cost of sugarcane and soybean cultivation, prices fetched by these crops and problems faced by the framers. The duration of the study is from 2008-09 to 2010-11. Secondary data has been collected from various government publications to supplement the study.

The bio-fertilizers and bio-pesticides are used by few farmers in the study area. The farmers use bio-fertilizers and bio-pesticides as supplement to the chemical fertilizers and pesticides. Therefore, purposive sampling technique was applied for the selection of farmers. By considering the limitations only forty farmers sample is chosen and in it, twenty bio-fertilizers and bio-pesticides practicing farmers and twenty chemical farming practicing farmers were selected. In this also, twenty farmers were cultivating sugarcane and twenty were producing soybean.

The researcher has taken soybean and sugarcane crops from the region for the study because of the following rational.

Soybean:

Soybean, the 'Golden Bean' is an important oilseed and pulse crop containing about 20% edible oil and 40% protein.

Maharashtra is a major soybean producing state with higher productivity.Among the major oilseeds satisfying domestic demand for edible oil, soybean has emerged as one of the important crops. Popularly known as an oilseed crop rather than a legume, there was a marked increase in the area as well as production of this crop. Today soybean or the ‘miracle bean’ has come to occupy an important position in the study region. Shorter duration of the crop (i.e. 3 to 3.5 months- from July to August) allows the cultivators to take the second crop on the same piece of

land and add to their income/profits, which is not possible for a kharif crop like cotton or Tur. Being a purely commercial crop, it is not retained for home consumption. Similarly, it is not retained for the purpose of expulsion also as the processing requires a large operation unit and sophisticated technology. One time harvest of the crop makes the harvesting operation comparatively easier. Easy cultivation of the crop and benefits in terms of improvement in fertility also prompted farmers to undertake soybean cultivation. Soybean crop has been found to be very profitable as compared to other kharif crops (Kajale,2002).

Soybean is one of the important crop grown in the region's rain fed area as it requires 700mm to 1000 mm water. Moreover, the area under the soybean crop in Latur district has grown exponentially by 11665.38 per cent from 1993-94 to 2009-10. No other crop area has not grown at this speed. Hence, the soybean crop has been chosen.

Ten soybean growing farmers, who were using bio-fertilizers and bio-pesticides and ten farmers using chemical fertilizers and pesticides were chosen for the study purpose.

Table: 01 Net Changes in Absolute and Relative terms for Major Commercial crops in the Latur district : TE 1993-94 and TE 2009-10

Crops	Absolute change in 00ha	Relative change in percentage
Groundnut	-203.67	-81.14
R&M	-2.00	-27.27
Sesame	-105	-67.02
Soybean	2022	11665.38
Total Oilseeds	1402.67	95.83
Cotton	-227.67	-89.87
Sugarcane	379	349.84
GCA	949	14.78

Source: Calculated from District wise Statistical Information relating to agriculture, GOM, Season and
Crop Reports, GOM various issues and data obtained from Office of the Commissioner of Agriculture, Pune.

Sugarcane:

Sugarcane is water and capital intensive crop in the semi-aridic region, under the study. Sugarcane is also most important cash crop grown in irrigated area of the study region as one can observe from the above table. Sugarcane is the second most important cash crop covering less than three per cent of the total cropped area of the Maharashtra state but it utilizes more than 60 per cent of the total water available for irrigation in the state. The demand of water for sugarcane irrigation has led to an increase in number of wells and had resulted into the decrease of water table by more than four meters over the past decade in several districts of Maharashtra (World Bank 2003). The study region is also no exception to this. The average water productivity of sugarcane in Maharashtra comes to 0.403 T/ha/month/'000 m^3 water, compared to 1.11 for UP**.** Maharashtra is inefficient by 175.43 per cent when productivity per unit of water consumption is considered (CACP). The CACP report further calculates that in Maharashtra every kilogram of sugar needs 2068 liters of water, where as in UP the requirement is almost half, at 1044 liters. The nutrient requirement of sugarcane crop is very high. An estimated N requirement of sugarcane is about 150kg N ha. Ten sugarcane growing farmers, who were using bio-fertilizers and bio-pesticides and ten farmers using chemical fertilizers and pesticides were chosen for the study purpose. Some of the important features of land use pattern and related data is as follows:

(A) Land under various crops in the study area (Udgir Tahasil) :

Table no.02 (Numbers are in Hq)

	Cropped area	Irrigated area
Total Cropped Area	73400	7800
Area under food crops	57779.23	7779.23
Area under double cropping	17000	700
Net cropped area	56700	7100

(Reference: Socio-Economic Review of Latur District Year-2009-10)

(B) Land Use for the study crops(Udgir Tahasil):

Table No.03

Crop	Land utilization for the crop (in Hector)	Irrigation (in Hector)	Per cent of total cropped area (in per cent)
Sugarcane	4400	4400	5.99
Soybean	19800	Nil	26.98

(Reference: Socio-Economic Review of Latur District Year-2009-10)

The above table clearly shows that the soybean is taken on dry land and it is not under irrigation and sugarcane is totally irrigated crop.

(C) Use of Chemical fertilizers in the study area (Udgir Tahasil):

Table No.04

Regulated Institutions	2600 MT
Private Institutions	11834MT
Total	14434MT

(Reference: Socio-Economic Review of Latur District Year-2009-10)

(D) Production of the sample crops in the Study area(Udgir Tahasil):

Table No.05

Crop	Production in MT	Production per Hector
Sugarcane	335.00	90 Tonnes
Soybean	224	1400kg

(Reference: Socio-Economic Review of Latur District Year-2010-11)

(E) Important features of the sample farmers:

(Table No. 06)

Characteristics	Farmers Using Bio-Fertilizers and Bio-Pesticides	Farmers Using Chemical-Fertilizers and Chemical Pesticides
Family Size(No.)	05	06.5
Age of the Family Head (years)	37	42
Education of family head (Education year)	10.30	09.5
Size of Land Holding(Hq)	3	2.2
Livestock (No./Household)	6.5	4
Machinery (No./Household)	5.21	3.21
Major Crop Grown		
Sugarcane		
Soyabean		
Tur (Adhar)		
Frout crop		
Jawar		

It is evident that the farmers who are experimenting on their farm are relatively better off, with larger family size, land holding and resource base.

Soybean production Cost: Benefit Analysis (Per Hq) in Rupees

Table No. 7

Particulars	Farmers using bio-fertilizers and Farmers using bio-fertilizers and bio-pesticides (A_1)	Cost in per cent	Farmers using Chemical fertilizers Farmers using Chemical fertilizers and pesticides (A_2)	Cost in per cent
seeds	2600	12.95	2600	12.26
Farm yard manure	700	03.49	500	02.36
Bio fertilizers	400	1.99	----	---
Bio pesticides	200	01	----	---
Chemical fertilizer	2800	13.95	4000	18.87
Plant protection chemicals	400	1.99	800	3.77
Human labour	5200	25.91	5500	25.94
Bullock labour	2000	09.96	2000	09.43
Machine labour	5000	24.91	5000	23.58
Irrigation charges	--		--	---
Interest on working capital	772	3.85	800	3.77
Total operational cost per ha.	20072	100	21200	100
Cost of Production/q	1254.50		1367.74	
Average Yield per ha.(in 00)	16		15.5	
Price of the produce sold	2100		2100	
Total value of production	33600		32550	
Gross returns	33600		32550	
Net returns	13528		11350	
Benefit cost ratio	1.67		1.53	

(Data: Primary Survey)

Yield Levels on bio-fertilizer and bio-pesticides using and chemical fertilizer and pesticides using farms:

It is deducted from the results presented in the table no 07 that, the average yield of soybean was higher on the farm using bio-fertilizers and bio-pesticides as supplementary input by 16.10 per cent. This was mainly due to the combination of savings in chemical fertilizers and pesticides crop and higher yield. It is important to note that, the farmers were practicing the use of bio-fertilizer and bio-pesticides since last four to five years.

Costs and returns in soybean production:

It is shown in the table no.07 that , the cost of soybean cultivation on bio-fertilzers and bio-pesticides using farm (Rs.1254.50) was slightly less when compared to that on non using farm (1367.74) which is 08.28 per cent. This marginal differences was due to the higher cost incurred on chemical fertilizers by the farmers who were not using bio-fertilizers and bio-pesticides. The per hector operational cost in soybean cultivation of bio-fertilizers and bio-pesticides using farms (Rs.20072)was slight lower as compared to non using farms (Rs. 21200) because most of the organic compounds were cheaper and relatively available at village level as compared to chemical fertilizers.

The cost on total human labour was also slightly lower on the farms applying bio-fertilizers and bio-pesticides (Rs. 5200) compared to non using farm (Rs.5500). This may be because of the average family size of the farmers using bio-fertilizers and bio-pesticides were bigger and family labour is always bit efficient on farm. Bullock labour is same in both the cases. There was no difference in cost of seeds between both types of farming as farmers purchase seed from the same market. The cost on plant protection chemicals was low in the farm using bio-pesticides (Rs.600) compared to non bio-pesticide user farm (Rs.800) because bio-pesticides like neemoil, nimbicidine are used. Some of the microbial extracts were prepared at home only. The asset of farmers using bio-fertilizers and bio-pesticides were high. Consequently, the yield of soybean was also high from these farms (1600kg) than the light asset based farmers using chemical fertilizers and pesticides (1550kg). The net return of the farmers using bio-fertilizers and bio-pesticides was higher (Rs.13528) than the non user farmers (Rs11350). The return per rupee of investment was found to be higher on bio-fertilizers and bio-pesticides using farms (1.67)

compared to non using farms (1.53). This was because of high gross returns obtained under the bio-fertilizers and bio-pesticides using farms.

Sugarcane Cultivation Cost:Benefit Analysis in Rupees per hector (Table No.08)

Particulars	Farmers using bio-fertilizers and bio-pesticides (B_1)	Cost in per cent	Farmers using Chemical fertilizers and pesticides (B_2)	Cost in per cent
seeds	14000	18.93	14000	17.88
Farm yard manure	4000	5.40	2500	3.19
Bio fertilizers	2900	3.92	---	--
Bio pesticides	2000	2.70	----	---
Chemical fertilizer	8500	11.48	13900	17.76
Plant protection chemicals	1000	1.35	4000	5.11
Human labour	24000	32.43	25000	31.94
Bullock labour	500	0.68	500	0.64
Machine labour	7400	10.00	7500	9.58
Irrigation charges	7000	9.46	8000	10.22
Interest on working capital	2712	3.66	2884	3.68
Total operational cost per ha.	74012	100	78284	100
Cost of Production/t	740.12		798.81	
Average Yield per ha.(in tone)	100		98	
Price of the produce sold per tone	1600		1600	
Total value of production	1,60,000		1,56,800	
Gross returns	160000		156800	
Net returns	85988		78516	
Benefit cost ratio	2.16		2.00	

(Source: Primary Survey)

Yield Levels on bio-fertilizer and bio-pesticides using and chemical fertilizer and pesticides using farms:

It is deducted from the results presented in the table no 08 that, the average yield of sugarcane was higher on the farm using bio-fertilizers and bio-pesticides as supplementary input by two tonnes. This was mainly due to the combination of savings in chemical fertilizers and pesticides crop and higher yield. It is important to note that, the farmers who were practicing the use of bio-fertilizer and bio-pesticides were relatively better off and in a good economic situation to take risk in farm practice. It is to be noted that there is no considerable difference in sugarcane yield of farmers using bio-fertilizers and bio-pesticides and non users (only 02 per cent more in bio-fertilizers and bio-pesticides using farmers). But, the cost difference is 05.77 per cent which leads to difference of 0.16 in benefit-cost ratio.

Costs and returns in sugarcane production:

It is evident from the results presented in the table no 08 that, the total cost of sugarcane cultivation on bio-fertilizers and bio-pesticides user farms (Rs74012) was less when compared to that of non user farms(Rs78284). This was because of higher cost incurred on human labour, fertilizers and pesticides by non users.

The cost of human labour, seed, bio-fertilizers and bio-pesticides were item of cost with major share in the variable cost of bio-fertilizers and bio-pesticides using farmers. Planting, manuring and harvesting operations in the cultivation of sugarcane consumed lot of human and machine laobur. The farmers also applied farm yard manure to enhance the yield.

The cost of human labour was lower on bio-fertilizer and bio-pesticide user farmers (Rs 24000) than the non user farmers (Rs 25000) because of availability of family labour with the user farmers and their efficient working. The cost of seed sapling is same as it is purchased from the open market. The bio-fertilizer using farm spent less on chemical fertilizers (Rs 8500) than the non user farm (Rs.13900). Most of the bio-pesticides were home preparations and some were purchased microbial extracts at low cost. Irrigation cost is low in bio-fertilizer and bio-pesticide using farm as farm yard manure enhances the water absorption rate of the soil, so it requires bit less irrigation. The benefit-cost ratio was 2.16 on bio-fertilizer and bio-pesticide user farms and 2.00 on chemical fertilizer and pesticide user farms.

Chapter V

Results and recommendations

The final results of the project can be summarized as below:

1. Net income of the farmers increases steadily:

   It has been found that the net income of the farmers who uses bio-fertilizers and bio-pesticides does not increase steeply but steadily. The cost of cultivation decreases and initial production does not increase but as the reduction in the cost of production results in the high net income to the farmers who uses bio-fertilizers and bio-pesticides.

2. Reduction in cost of cultivation:

   Cost on chemical fertilizers, seeds and irrigation is less to the farmers who uses bio-fertilizers and bio-pesticides.

3. First decrease then increase in production:

   It has been found that the farmers who have adopted the bio-fertilizers and bio-pesticides' experiences decrease in the total production in the initial years. Later, the production starts to increase.

4. Saves water:

   The use of bio-fertilizers and bio-pesticides' reduces the use of irrigated water as vermin-compost enhances the water absorption rate of the soil.

5. Fetch high prices to the products:

   The agricultural production by using bio-fertilizers and bio-pesticides' fetch higher prices in the market as they are free from any health hazards. It has been found that the farmers fetch 15 to 20 per cent higher prices in Indian market and 20 to 60 per cent in international market.

6. Improves the living condition of the farmers:

The cost- benefit analysis shows that farmers who uses bio-fertilizers and bio-pesticides' fetch good prices for their farm products as compared to the products with chemical fertilizers and pesticides. Hence their living condition improves.

7. Minimal energy uses:

The cost- benefit analysis shows that the use of bio-fertilizers and bio-pesticides' reduces the energy uses, as most of the organic farms are tilled by oxen, legumes are grown for nitrogen fixing, and inter-cropping, crop rotation, composting, vermiculture, and so on. It helps to retain moisture, fertilize the soil and protect the crop against pests. Energy use s minimal with organic farming.

Recommendations:

1. Market level constraints and lack of awareness of farmers.It has been found that very few farmers in the study area are practicing organic farming and hence using bio-fertilizers and bio-pesticides, because the knowledge gap. Hence, measures to sensitize the farmers in this regard are need of the hour.
2. Consistency in gains eludes the bio-fertilizers and bio-pesticides users. The farmers under study have witnessed the fluctuations in yield and gain.
3. Bio-fertilizers are sold because there is no strict control over quality production. ISI specifications must be mandatory to sell.
4. Lack of quality assurance and limited resource generation by farmers is constrain in popularising the use of bio-fertilizers and bio-pesticides.
5. Bio-fertilizers production are formulated already only for some bio-fertilizers and yet location-specific strains are to be developed. Facilities and regulatory acts for testing Bio-fertilizers are meagre.
6. The present expiry period of bio-fertilizers is limited to 6 months, which is related to carrier (lignite/charcoal). High moisture content attributes contamination of microorganisms that either compete with bio-fertilizers or have antagonistic interaction. The upcoming research should focus on this important aspect also.

7. Retail shops usually do not sell bio-fertilizers because of short shelf-life, limited demand and lack of storage facilities. The reasons responsible for it are: lack of marketing infrastructure and distributing network; ignorance of farmers about bio-fertilizers; absence of public support and lack of assurance of higher benefits for retailers. A system should be developed to overcome these problems.

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