

Synergetic Agriculture System & Development

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**Centre for Rural Development and Technology,
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Synergetic Agriculture System & Development

by
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CERTIFICATE

This is to certify that the thesis entitled "Synergetic Agriculture system & Development" being submitted by Mr. Ran Singh Arya to the Indian Institute of Technology, New Delhi for the award of the degree of Doctor of Philosophy is a record of bonafide research work carried out by him. Mr. Ran Singh Arya worked under our guidance and supervision and has fulfilled the requirements for the submission of this thesis, which to our knowledge has reached the required standard. The results contained in this thesis have not been submitted in part or in full to any other university or institute for the award of any degree or diploma.

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R. S. Arya
R. S. Arya

Around a century of energy intensive modern agriculture practices based on mechanization, chemical fertilizer, pesticides, hybrid seeds etc. dominated by the basic idea of "Mastery over the Nature" has brought the humanity at the brink of destruction. The ill-effect of modern farming on environment, land, water resource and human health has become acute. Agriculture is now the largest non-point source of water pollution. Problems of pesticides and antibiotic residues in food remains unresolved.

This situation of crisis has forced us to rethink over these so-called developmental processes. Club of Rome's Report- namely, Limits to Growth marked the beginning of this concern. Much talked about conference of Rio-de-jeneiro in 1992 on environmental problems was an outcome of this. This tendency to search for alternatives found expression in the form of Sustainable Agriculture, Organic and Natural Farming, Permaculture, Biodynamic farming, Ecological Agriculture, Alternative Agriculture etc.

It is now clear that seeking for alternatives to the modern practices of agriculture within the same paradigm is in vain as the very concept of modern development, of which the modern farming is just an expression, is basically unsustainable. Agriculture being not only an industry but a way of life, goes hand in hand with the world-view - the knowledge system that supports it. A need for an alternative world-view was clearly felt therefore.

A right perception, a world view that explains the man, nature and their interrelation in a mutually satisfying manner is the need of the time. Sah-Astitwa Principle (SAP) based on a deep experience of existence, provides such a world view. Sah-Astitwa means every unit is related to the other in a mutually fulfilling manner. Sah-Astitwa therefore is a guiding principle to work and evolve in complementary togetherness providing a perfect harmony within and in all relationship. It relates one with the entire natural order in a meaningful manner.

Thus, the objectives of the present study has been defined as:

- 1. To develop right (Synergetic) agriculture system and the world view to provide foundation for it.*

2. To work out the guidelines for this alternative practice- "Avartanshil" agriculture based on sah-astitwa principle.
3. To study the feasibility and the practicability of this new system in a cluster of villages in Western U.P.

This thesis entitled "Synergetic Agriculture System and Development" (organised in 9 chapters), with the above in view, starting from an overview of the existing state of modern farming and its problems, looks into the alternative practices being experimented upon. It, then, goes on to investigate the world-views, the concepts of development underlying these practices. The new world view SAP has been studied in the context of agriculture. An alternative agriculture system in the light of this world view has been worked out.

Considering the limits of time and scope, attention has been focused on two important aspects of farming - seed and plant nutrient management. This work has been carried out keeping in view a selected village cluster in Western Uttar Pradesh, a famous Green Revolution belt. The author coming from a farmer family in this area, has a broad base and strong linkages with farming community. This proved very useful in understanding the ground realities, an important aspect to be considered for developing suitable alternatives. Further, it was planned that work should range from research and development, field-testing to technology transfer, policy and planning for its propagation, so as to cover all the important aspects of the agriculture system.

For understanding the operational aspects of newly developed agriculture system, experimental work on two systems viz indigenous seed- organic manure (system A) and HYV chemical fertilizer (system B) was carried out for 5 consecutive years under controlled conditions at Micromodel, I.I.T., Delhi. Statistical analysis of the results obtained indicates the strong viability of new system based on indigenous seed in view of its capability not only at the energy, ecological and environmental front, inherent in the system but also at the level of productivity. Results of field testing carried out with selected farmers in Palri village for 3 consecutive years confirms this revealing aspect. Further about 20% water required for irrigation can be easily conserved in the new system. Detailed economic analysis of both the systems reveal very interesting results in favor of new system.

In the context of organic manure production and utilization, three new designs of composting, an improved method of heap manure and a new method of biogas slurry treatment, all based on NADEP principles have been developed. Among these, PALRI METHOD seems to be a major break through. Unlike original NADEP, it requires no water during the entire process including maintenance. Detailed techno-economic analysis of these techniques reveals that though PALRI METHOD gives economic returns comparable to biogas technology in terms of NPK availability, yet biogas system would prove more popular in view of providing gas for cooking in addition to slurry. Further, Biogas technology incorporating new method of slurry treatment would undoubtedly prove a boon to synergetic agriculture system. However, in a situation of low capital investment capacity of the farmers, other composting systems would be more viable. An integration of all these would offer an optimal solution.

Efforts have been made to popularise these results of importance by information dissemination through publishing booklets and telefilm in all regional languages . Overall impact of the experimental findings and field testing results could be felt even at the national policy level for popularisation of organic farming.

Serious thought has been given to planning aspects for newly developed agriculture system embracing a new world view. Policy issues in the context of agriculture, are briefly presented. These will provide a starting point. An extensive effort including all aspects of planning as discussed in the thesis will be called for in order to get a long term and permanent solution to human problems. Finally, it is concluded that productivity and economy are important but mere profit or production can not be the motive. These have meaning only in the context of the ultimate aim of all human activities i.e. realization of happiness, peace, contentment and bliss individually through organisation within oneself (Swamushaan) and intelligibility, prosperity, fearlessness and coexistence collectively through the realisation of organisation of system at all levels (Swarajya).

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INTRODUCTION

1.0 Present Status of Agriculture and Need for Alternative

Around a century of energy intensive modern agriculture practices based on mechanization, chemical fertilizer, pesticides, hybrid seeds etc. dominated by the basic idea of *"Mastery over the Nature"* has brought the humanity at the brink of destruction.

Sir Albert Howard who visited India and was attached to Pusa Agriculture Research Centre, made almost a prophetic declaration, right in the beginning of this century, about the then emerging practices of modern farming,. *"These mushroom ideas of agriculture are failing, mother earth deprived of her manurial rights is in revolt; the land is going on strike; the fertility of the soil is declining...Soil is no longer able to stand the strain. Soil fertility is rapidly diminishing particularly in the United States, Canada, Africa, Australia and New Zealand. The loss of fertility all over the world is indicated by the growing menace of soil erosion.... Diseases are on the increase... the diseases of crops and of animals which feed on them"* (Vasu, 1983).

All this might have sounded an exaggeration at that time, however, it has all come true rather in a magnified way. It has been reported (Ghosh, 1988) that between 1882-1952, the area of world desert rose from 1100 million ha to 2600 million ha. This is due to deforestation and the pulverization of soil arising from the chemical fertilizer's use. Pierce et al (Pierce et al, 1990) estimated that in the situation of continued present agriculture trend, land fertility would reduce by about 75% of its present state by 2100 AD. Recently, the report submitted by the prestigious academic body of U.S. succinctly summarizes the effect of modern farming in the following words, *"The 1980s have been time of change in U.S. Agriculture.... More than 2,00,000 farms went bankrupt... The Environmental*

Protection Agency has identified agriculture as the largest non-point source of water pollution. Pesticides and nitrates from fertilizers and manures have been found in ground water of most states...The issue of pesticides and antibiotic residues in food remains unresolved... Soil erosion, salinization and depletion of aquifers for irrigation are significant problems" (NRC, 1989a).

Similar reports are coming from almost all parts of the world. An extensive study of the effect of modern farming in Indian context has been made and is now readily available (Dogra, 1984; Vasu, 1983; Bajaj, 1982). Deficiency of micronutrients is reported (Samra & Randhava, 1990) to be widely spread in many parts of India which is reflected in terms of static, rather declining productivity and human health. In India, soil suffering degradation in terms of salinity, alkalinity, waterlogging, erosion etc. has been estimated as 173.6 m ha (Min. Ag. Report, 1988). Soil related constraints for the sustainable plant productivity in Indian context have been discussed by Randhava (Randhava and Abrol, 1990). Recently, in a study on sustainability of Indian agriculture (Singh, 1992), it is found that during 1971-87, for about 8 years out of these 16 years, crop production showed negative trend except in case of Punjab with similar trends for 4 years. This sufficiently indicates that huge investment and input through technology package has failed even to assure a sustainable production. Effect of modern farming on environment, land and water resource, human health etc. have been alarming. (Agarwal et al, 1985; Dudani & Kaur, 1989) Use of new HYV varieties has resulted in decreased bio-diversity leading to the outbreak of new pests and diseases. (Shiva, 1992a)

This, however, is only one side of the story-the techno-economic and at the most, environmental effect of modern agriculture. The modern farming, like industrialization and other expressions of modern civilization coming from West has caused, at least in the South East Asian countries like India, Malaysia, Philippines etc., a complete breakdown of the

social structure that make cultural diversity and plurality possible as democratic reality in a decentralized framework and has tried to introduce a highly centralized, monocultured, non-egalitarian society resulting into increasing deprivation and conflict. (Bajaj, 1982; Santosh et al, 1989) Vandana Shiva has forcefully argued that the ecological and ethnic crises in Punjab can be viewed as arising from this conflict. In her words, *"Ecological breakdown in Nature and political breakdown in society were essential implications of a policy based on tearing apart both Nature and society"* (Shiva, 1992a). It is needless to say that the socio-political and cultural cost of modern agriculture is far more and far reaching than the techno-economic inefficiency.

Propagators of Modern Agriculture - the scientists, technologists and planners - both in the West and the East have been forced to rethink over these developments, in the West by severity of environmental and ecological problems and economic inviability and in the East by the resource scarcity and their inability to make a head way. Club of Rome's report- namely, Limits to Growth (Meadows & Meadows, 1972) marked the beginning of this concern. Much talked about conference of Rio-de-Jeneiro in 1992 on environmental problems was an outcome of this. National Research Council, USA appointed a committee to make a study on the alternative farming methods (NRC, 1989b). M. S. Swaminathan, once considered the father of Green Revolution in India is now emphasizing sustainable agriculture (Swaminathan, 1989). A number of seminars, workshops have been organized all over the world. Masanobu Fukuoka, a renowned Japanese agriculture scientist took to Natural Farming (Fukuoka, 1984). This tendency to search for alternative found expression in the form of Sustainable Agriculture (Nicanor, 1995), Organic and Natural Farming (Shroff, 1992a; Dixit, 1993), Permaculture (Mollison, 1979), Biodynamic Farming (Macregor et al, 1993), Ecological Agriculture (Alteiri, 1987), Alternative Agriculture (Douglas et al, 1991), Holistic Agriculture (Widowson, 1987) etc.

Thus, the critique of modern agriculture practices who were pleading for the case of regenerative indigenous organic practices particularly in South East Asian region, were proved to be correct (Gandhi, 1908; Pyarelal, 1959; Schumacher, 1973; Dharampal, 1983; Dogra, 1984; Aggarwal, 1980).

It is revealing to note that those who ventured into alternative agriculture were mostly the farmers and very few scientists and technologists. In most part of India, for example, the farmers more or less preserved their indigenous way of farming. In country like America, it is the farmers who have successfully started the work on alternative practices on their own (NRC, 1989b). It has been emerging that an egalitarian, eco-friendly and sustainable practices of agriculture are possible. They are economically viable, technologically efficient, socially just and ecologically sound. It is quite clear from the documents available from civilizations like India, China etc. that such systems existed and gave satisfactory results over millennium (Voelker, 1893; Walker, 1983; Wallace, 1982).

As a matter of fact, agriculture being not only an industry but a way of life (Santosh et al, 1993; Ploeg & Vander, 1994), goes hand in hand with the world-view - the knowledge system that supports it. Thomassin argues that the classical paradigm fails to provide a base for sustainable agriculture (Thomassin & et al, 1991; Kumar & Murk, 1992). Beus asserts that current debates and conflicts in US agriculture reflects the competing perspectives of two increasingly distinct camps which hold fundamentally different paradigms and thus, see the world quite differently (Beus et al, 1991a; Beus & Dunlap, 1991b). It was, therefore, realized at the very early stage of the thesis work that any effort to seek for an alternative practice of agriculture without the alternative world-view will but prove in vain.

The groups working on principles and practices of alternative agriculture can be

broadly categorized at two levels. At the first level, there are those who are seeking for alternatives to the modern practices of agriculture within the same paradigm i.e. modern concept of development. Their basic concern is to somehow make this development sustainable (NRC, 1989a; WCED, 1987; IUCN, 1980; WRI & IIED, 1986). The concepts like Integrated Development, Sustainable Agriculture, Sustainable Development (Redclift, 1987) fall under this category. At the second level, there are more radical people who consider that the very concept of modern development, of which the modern farming is just an expression, is based on presumptions which are basically wrong and this development by its very nature is not sustainable (Kothari, 1989; Alvares, 1992; George, 1994). They rightly point out that modern paradigm of 'Domination or Mastery over the Nature' with the help of science and technology, of unlimited growth in disregard of the limits put by nature is bound to frustrate and end in conflicts and contradictions. They suggest that a complete shift in the very concept of development, in the very perception is needed. As Schumacher puts it, *"we are suffering from a metaphysical disease, and the cure must therefore be metaphysical"* (Schumacher, 1973).

There are varied shades among those who suggest alternative world views. There are on the one extreme, people like Thoreau who advocate minimum or no interference of Human beings in the Natural order. Then, there are those who prefer living a life of tribals, in tune with nature (Fukuoka, 1984; Goldsmith, 1991; 1992) and talk about deindustrialising the modern society, and there are thinkers who want people to progress along the world views based on concept of religion- *Dharma, Tao* (Gandhi, 1908; Schumacher, 1973) which some of the ancient civilizations like India, China, etc. have followed.

The prevalent view among the critique, particularly in the West, is that participation of man in the process of *Nature* is destructive and it should be minimized to the extent possible. This, however, neither sounds convincing nor appears realistic. Man is the flower of nature's evolution and, therefore, he/she must have a constructive role to play. While it is true that as it stands today, he is playing a negative role but that may be more because of his wrong perception. A right perception, a world view that explains the man, *Nature* and their interrelation in a mutually satisfying manner is the need of the time. *Sah-Astitwa Principle**, SAP, (Sharma, 1978; 1988c; Satya et al, 1995b) based on deep experience of existence, provides such a world view.

Recently, Abey George (George, 1994), addressing the issues of sustainability, has intensively as well as extensively studied the issues of world-view in the context of tribal society in Kerala. One of the important reasons for the collapse of traditional societies has been found to be the lack of clarity and confidence in their system and the world-view. A new paradigm of development based on the vision of *Sah-Astitwa Principle* propounded by Shri Nagraj Sharma (Sharma, 1978; 1988c) has been studied in the context of tribal development including agriculture (George, 1994).

1.1 Scope of the Present Thesis

This thesis, with the above in view, starting from an overview of the existing state of modern farming and its problems, looks into the alternative practices being experimented upon. It, then, goes on to investigate into the world-views, the concepts of development underlying these practices. A new world view which satisfies the above said requirement of defining man, *Nature* and their interrelationship in a meaningful and mutually satisfying manner should be studied in the context of agriculture. Alternative agriculture practice in

* *Sah-Astitwa Principle* was expressed originally in Hindi. The words with specific meaning are treated as technical terms and kept in Hindi only. They are italicised and their meaning is given in the Glossary.

the light of this world view will have to be worked out. Thus, the objectives of the present study are:

1. To develop synergetic agriculture system and the world view to provide foundation for it.
2. To work out the guidelines for this alternative agriculture system - *Avartanshil* agriculture based on *Sah-Astitwa Principle*.
3. To study the feasibility and the practicability of this new system in a cluster of villages in Western Uttar Pradesh.

Considering the limits of time and scope, attention has been focused on two important aspects of farming - seed and plant nutrient management. This work has been carried out keeping in view a selected village cluster in Western Uttar Pradesh, famous Green Revolution belt. The author coming from a farmer family in this area, has a broad base and strong linkages with farming community. This proves very useful in understanding the ground realities, an important aspect to be considered for developing suitable alternatives. Further, it is planned that work should range from research and development, field-testing, technology transfer and policy, planning for its propagation, so as to cover all the important aspects of the agriculture system.

Chapter 2

LITERATURE SURVEY

2.0 Introduction

A brief review of the literature available on the status of modern farming, the increasing need and search for alternative agriculture system, the alternative concepts of development i.e. world view is presented in this chapter. Special attention is paid to the work related to indigenous seed based organic farming and organic manure production through composting and biogas technology.

2.1 Problems Associated with Modern Farming

Modern practices of agriculture which were once considered to have enormous possibilities in terms of their high productivity, capacity to overcome the limits of *Nature* etc. and thereby declaring the traditional practices as inefficient and therefore something to be replaced, has now come to an impasse. It has now been increasingly felt by the farmers, (Terry, 1989; Aggarawal, 1980), scientists (Madeley, 1985; Shroff, 1992b), policy makers (Hines & Dinham, 1984; Mathen, 1992) and even common man (Kent, 1985; Shiva, 1992b) that modern farming has serious problems inherent in it. It is failing not only at environmental and ecological level but also at the technical and economical level. Since the problems associated with modern practices are now extensively documented (TWN, 1990a; NRC, 1989b; Alvares, 1992), we just present a very brief account of studies made in this direction in the following sections.

2.11 Technical

Modern farming is showing its ineffectiveness on three fronts- productivity, resource utilization and quality of food and fodder.

Productivity is decreasing despite increasing ex-farm chemical input (Alvares, 1986; Bajaj, 1982, Singh, 1992). Agriculture has become more vulnerable to insects, pests etc. (Shiva, 1992b). Modern farming has proved to be quite inefficient in utilization of resources like soil, water, energy and chemical inputs. Take for example, the case of energy utilization. 8 calories of energy is used to give 1 calorie equivalent at the output in modern farming while in traditional practices with just 1 calorie of energy at input, 5 calories are generated at the output (TWN, 1990b).

Use of chemical fertilizers, insecticides, pesticides etc. to grow grain and fodder have become serious threat to human and animal health (Caufield, 1984; Todd, 1988; Taylor, 1988; Mott & Sunder, 1988), so much so that West is now witnessing mass movements against it.

2.12 Economical

It has also become economically inefficient for two reasons- i) high input cost and ii) market dependency.

Its heavy dependency on ex-farm inputs like chemicals, machinery, water etc., and declining productivity despite increasing input has made the balance sheet show negative profit (Sidhu, 1972). So much so that, even in America, farmers are given 2.00 per bushel of compensation price over 2.40 per bushel of market price of wheat (NRC, 1989c).

Further, the ex-farm inputs are to be obtained from the market and hence the produce have to be sold in the market, thus making the farmer totally dependent on market (Nandakarni, 1992) and to the price policy based on unequal terms of trade between agriculture and industry (Joshi, 1988; Sahastrabudhey, 1986). The farmer movements in last two decades are sign of protest against this vulnerability.

2.13 Ecological and Environmental

It is basically the environmental and ecological problems that raised questions on modern farming or rather modern practices for the first time (Meadows & Meadows, 1972, Schumacher, 1973). Some serious problems caused by modern farming are mentioned below.

The problems like soil salinity, alkalinity and erosion have become acute over a last few decades all over the world (SUNS, 1989; Vermeer, 1984; Connor, 1984). In India alone, around 176 m ha of land has come under its grip (Min. of Ag. Report, 1988). 44% of arable land in England is under the risk of soil erosion (Arden & Hodges, 1987). African drought is mainly due to over exploitation of land and water (Wijkman & Timberlake, 1985).

Water logging due to excessive water flow (through canals etc.) and fall in water table (in case of tube-wells) have caused serious problems. Contamination of surface and ground water by chemicals particularly fertilizer nitrate, insecticide, pesticides etc. has become alarming (Mott & Sunder, 1988). Decreasing bio and plant diversity due to monoculture is causing serious problem of decreasing soil fertility and unprecedented insects, pest outbreak (Shiva, undated).

2.14 Socio-Cultural

Since, modern farming is based on the very concept of technocentrism, it leads to a centralized control system and eliminates the cultural diversity of the society in which it is introduced (Alvares, 1986; Shiva, 1992b). Being large scale and capital intensive, it also tends to widen the gap between the haves and have-nots (Dogra, 1984).

2.2 Search for Alternative Agricultural Systems

Numerous efforts have been and are being made to find an alternative to modern farming. Some of the prominent efforts made in this direction are-

2.21. Traditional Farming

A natural tendency for agriculture based civilization like India, China and for that matter most of the south, is to fall back upon its traditional methods have been in use for over millennium (Kumarappa, 1984; Gandhi, 1908) and which were discarded as inefficient and unscientific a century back. An extensive survey of the practices prevalent in the tradition is now available (Randhava, 1992; Pereria, 1992). Fulledged efforts are being made on the part of science and technology groups, like PPST, to revitalize these traditional practices (PPST, 1993; 1995).

2.22 Natural Farming

Masanobu Fukuoka, an agricultural scientist (pathologist) of Japan, disillusioned by the modern effort of pest control and influenced by the natural way of maintaining symbiosis between different types of microorganisms, bacteria, pests, insects etc., conceived the idea of going by the nature's way. He could show in his farm that by letting the *Nature* manage things and rather by cooperating it to play its way, we can obtain as much or even higher yield than through modern farming. It is based on the four basic principles i.e. (i) no tillage, (ii) no fertilizer (iii) no weeding and (iv) no insecticide, pesticide (Fukuoka, 1984). In Indian context, efforts have been made by Friends Rural Centre, Rasulia (Aggarawal, 1990) and a team consisting of Shoorvir Singh, a farmer of Mohanpur, T. S. Ananthu of Gandhi Peace Foundation and faculty members of I.I.T., Delhi (Ananthu et al, 1987). Bhaskar Save (Save, 1992) and a few others are working to evolve guidelines

of agricultural practices for different agro-climatic zones and cropping pattern.

2.23 Sustainable Agriculture

The concept has its origin in the realization that the modern farming can not be continued for a very long time, as it rapidly depletes the very resources it is based on. As the word suggests, it is an effort to find out agriculture practices which can be continued at least in the foreseeable future (TAU, 1992; Clive et al, 1990a; NRC, 1991). The important thing is that it only wants to ensure that the practices should be sustainable and does not raise any fundamental question on practices of modern farming unlike natural farming. It works under the same paradigm of development. (Clive et al, 1990a)

2.24 Organic Farming

Farming based on natural organic processes going on in *Nature* is known as organic farming (Somani, 1990; The Hindu, 1991; Clive et al, 1990a; USDA, 1991). Current concept includes the application of modern biotechnological methods for maintaining soil fertility, pest management etc., thus blending the traditional and modern concepts of science and technology.

2.25 Ecological Farming

The concept derives its origin from the environmental and ecological threat created by modern farming and thereby ecological farming is defined as a practice based on ecological principles (Altieri, 1987).

2.26 Homa Farming

This method emphasizes the role of subtle cosmic energy released during homa (fire worship). Other practices prevalent under Homa farming are similar to organic farming.

The subtle cosmic energy released from 'Agni Hotra' helps in regulating the pest population, decomposition of biomass and enhancing the plant growth (Parkhey, 1983).

2.27 Perma Culture

Permaculture (Permanent Agriculture) is a way of farming which treats all the elements involved in agriculture as living systems (Mollison, 1979). It assigns importance to the soil, landscape, health of seeds, crop geometry etc.

The concept of Permaculture has been developed by Bill Mollison of Australia (Mollison, 1979) and in India the research is being carried out by Deccan Development Society, Hyderabad.

2.29 Biodynamic Farming

Concept of this alternative was conceived by Rudolf Steiner in 1921 in New Zealand. It consists of a package of specific practices, biodynamic manure preparation being the unique feature where compost is prepared using the cow dung filled in the horns of dead cow. Details of the procedure for manure production, its application and effect of 'nakshtra' (planets) particularly moon on sowing time, growth of the plants, soil fertility etc. have been documented (Shroff & Ray, 1993).

This method is being popularized in many countries like U.K. Germany, Australia, New Zealand. In India, the work has started recently at two places viz Indore (Menon, 1993) and I.I.T. Delhi.

2.210 Pesticide Free Farming

The technique is based on balanced plant nutrition and optimum spacing i.e. crop geometry (Santosh et al, 1993b). It is reported by the inventor S. R. Subhedar that if

plants get balanced nutrients at proper timings and enough space to grow properly then the self defence mechanism of the crops become operative due to synthesis of hormones and anti-pathogenic substances at different stages of plant growth. Thus, plants are capable of protecting themselves against pests and diseases and higher level of productivity can be obtained without using any pesticide.

2.3 Need of an Alternative World View

The words like Sustainable Agriculture, Organic Farming, Ecological Farming etc. are used almost synonymously. However, there are significant differences at least in their expectation which need to be emphasized. Sustainable agriculture only requires that the agriculture production be sustainable on a long term basis. Ecological farming, however, puts a stronger condition by saying that not only that these practices should be sustainable, but they should not violate the environment, the ecology. Organic farming defines the process in a positive manner. It asserts that the practice should be based on organic processes going on in *Nature* and not on human artifact. This will guarantee both sustainability and eco-compatibility. Organic farming, therefore, has the highest promise in terms of conceptual formulation as well as its feasibility. As mentioned earlier, it has been distinctly realized that the search for alternative practices within the modern paradigm of development will prove in vain (Merril, 1988; Bawden, 1991). As a result, there has been a search for alternative concepts of development. A brief account of these concepts is presented in the following section.

2.4 Alternative Concepts of Development

The present discussions or efforts of finding alternatives particularly in the West, has been basically founded on the threat caused by the disaster being created by modern farming. These are therefore, more often an effort to do away with these ill-effect

(Goldsmith, 1990, 1991). Then, there are efforts in the East to articulate along the line of the traditional concept of religion as well as formulating in terms of completely new categories. A brief discussion of these can be summed up as follows.

2.41 Sustainable Development

It has been argued that the notion of sustainable practice is meaningless unless the very concept of development is changed (WRI & IIED, 1986; Thomassin et al, 1991; Curry & Bowler, 1992). As Beus puts it “without fundamental change and redirection, US agriculture is not sustainable” (Beus & Dunlop, 1994) He emphasizes the need for developing the criterion to measure this change (Beus & Dunlop, 1991b; Zook, 1994). There have been more fundamental efforts questioning the very foundation of modernity (Goldsmith, 1990; Schumacher, 1973). We need to search for development that is sustainable and not presume that the present idea of growth has to be maintained (O’Riordan, 1985; Redclift, 1987). A growth that is possible, that is natural, sustainable has to be understood and pursued (Pearce & Markandaya, 1990).

Sustainable development can be defined as improving the quality of human life while living with carrying capacity of supporting ecosystem. It is a development strategy that manages all assets, natural resources, and human resources, as well as financial and physical assets, for increasing long term wealth and well being.

2.42 Ecological Theory

In continuity with the search for alternative, it has been proposed that the major criterion to decide on the concept of development is its compatibility with the environment and ecology (Kumar & Murck, 1992; Beus, 1990; Beus & Dunlop 1991b, 1994). It is asserted that human cannot define his own process of development. He has to rather learn to live in tune with *Nature*, in conformity to the ecology as the tribals do (Goldsmith,

1992; Petulla, 1989). Human is considered at par with all other species, having no specific role to play. It is proposed that under these conditions, the present civilization has to be undone and a proposal for deindustrialising the society is made (Goldsmith, 1991). In this theory, there are two major categories- Shallow Ecology and Deep Ecology (Naess, 1972). Shallow ecology concerns itself with the assurance that practices are not damaging the ecology beyond its tolerance limit while deep ecology wants to ensure that the practices should be in tune with *Nature*, according to the order of *Nature* and should not at all be hurting to the *Nature*.

2.43 Gaia Theory

Gaia theory asserts that the biosphere is a self-regulating cybernetic system (Lovelock, 1979, 1988) capable of maintaining a critical order. It is also argued that in order to maintain this homeostasis, Gaia can rearrange its environments in such a way that Homo-sapiens could be eliminated, if required.

2.44 The Way- Tao, Dharma

Old civilizations like India, China etc. have been based on the concept of *Dharma*, the law of *Nature*. They have, over a period of long time, evolved the understanding of law of *Nature* and human existence (Gandhi, 1908; Aurobindo, 1971) and have tried to mold their life style accordingly. These civilization have been successful to the extent they have rightly understood the laws of *Nature* and human. They, however, are facing the degeneration or disruption under the onslaught of modern civilization because of its lack of capacity to articulate and revitalize itself (Dharampal, 1983). They, therefore, fail to provide a viable alternative.

2.45 Sah-Astitwa Principle

Sah-Astitwa Principle is based on the right understanding of human, *Nature* and their inter relationships (Sharma, 1978; 1988b). It provides a basis of awakening of human and realization of *Vyavastha* i.e. right organisation at all levels on the basis of this awakening. This theory offers a powerful viable alternative by rightly recognizing the importance of *Nature* as well as humans (Sharma, 1988c).

Considering its possibility to offer a pragmatic sound alternative, this concept is discussed in detail in chapter 3. Based on this SAP world-view, an entirely new agriculture system termed as *Avartanshil* agriculture emerges. Guidelines for this new system for Indian conditions have been worked out and discussed in detail in chapter 3. Keeping in view the limitation of time and the scope of the thesis, two important aspects of agriculture system i.e. seed and nutrient management have been selected, and thereby work on indigenous seed based organic farming (for wheat crop) and organic manure production and utilization has been taken up.

2.5 Indigenous Seed based Organic Farming

Organic farming is broadly defined as the farming practices based on organic inputs. Seen from this angle, organic farming has been prevalent all over the world before the emergence of chemical based modern farming over last two centuries. Detailed accounts of such farming practices in India and other countries, are available (Randhava, 1992). Over last few decades, with the emerging failure of modern agriculture, organic farming has become a major field of interest and investigation once again. Extensive work is being done with a view to search for practices which are based on in-farm organic inputs and which maintains the high productivity level.

Organic farming based on indigenous seeds seems to satisfy the requirement of sustainability, compatibility with ecology, and also of *Avartanshil* Agriculture. While it gives comparable production, it is economically more beneficial (Cacek & Langner, 1986). Its development in the course of time, is being reviewed here.

2.51 Wheat Crop- Hybrid (HYV) and Indigenous Cultivars

Most of the research work done on wheat crop is restricted to HYV varieties of seed. Same is true in Indian context (Tondon & Sethi, 1986). On the basis of results of the 210 experiments carried out in different centers all over India (Gaur et al, 1971), an average increase of 200 Kg per hectare in irrigated wheat and 85 Kg per hectare in unirrigated wheat due to organic manure has been reported (Gaur et al, 1984). Extensive work related to the effect biogas slurry on productivity of different crops (vegetable, cereals, sugarcane etc.) in different states of India under field condition has been reported by Singh (Singh, 1990). Asankew studied the effect of organic manure-FYM and green manure on the yield of wheat, and showed that on red black soil of Ethiopia, it can be increased by three times; and it is economically beneficial (Daiz et al, 1990; Asankew & Tekaligne, 1991). Profit in organic farming could be as high as 2 to 3 times (Stoppler, 1989). Extensive comparative studies on effect of organic manure versus chemical fertilizers on soil fertility including biosphere, yield and quality of crops has been carried out in China (Yang et al, 1992), Finland (Poutala et al, 1994) and other places (Ryan et al, 1994; Prugar, 1994;). In case of, wheat crop with Hybrid seed, production with different types of organic manure is also studied (Smith et al, 1994; Besson et al, 1988). Effect of variety and seed rate on production of wheat in ecological farming has been studied by Eisele (Eisele, 1992). A comparative study on quality of bread made from different types of wheat indicate that medium ripening group are of best quality (Pollhamer, 1993).

The literature on the work done on indigenous seed exclusively appears to be very scanty. Although traditional agricultural practices had used indigenous seeds developed in their respective regions, present trend of HYV variety particularly in wheat and rice has replaced them completely, particularly in the areas which have adopted Green Revolution. It is now firmly believed that in order to get high yield, HYV varieties are must. However, even the limited work done in this direction shows that properly selected indigenous variety of seeds with appropriate dose of manure and water can give as high and even higher yield than the prevailing HYVs (Richaria, 1986). These experiments, however, concentrated on rice varieties. Work on indigenous wheat has been very scanty. An effort to study the productivity of indigenous variety without any manure compared to HYV with chemical fertilizers showed that indigenous is found to be less productive (Poutala et al, 1993). Another study relates to productivity of both varieties under similar conditions of no manure and full fertilizer dose (Gaignac et al, 1981; Wijeranta, 1994). The effect on productivity of indigenous variety C-306 and HYV DL-153-2 with application of different level of urea and FYM manure has been studied (Singh & De, 1987). Possibility of agro-forestry with wheat has also been explored and optimistic results are shown (Gill & Patil, 1988).

Literature survey reveals that hardly any systematic study on the effect of organic manure and chemical fertilizers on indigenous seed versus HYV has been attempted. It was this which motivated us to choose organic farming using indigenous wheat seeds for our experimental work.

2.6 Organic Manure Production and Utilizations

Another important aspect of organic farming is manure for plant growth. Greatest threat of modern farming comes from use of fertilizers and its inseparable companions, pesticides and insecticides. Thus, its replacement by organic manure would provide a great

relief. Organic manure has the capacity to substitute chemical fertilizers (Singh & De, 1987, Carandang, 1992; Dahiya, 1985), however, there are divergent views regarding the possibility of replacing chemical fertilizers completely (Gaur et al, 1984a; Patel et al, 1993).

Organic manure inherently serves a number of mutually beneficial purposes. Some of the important ones are-

- i) provides balanced macro and micro nutrients in an acceptable form (Lee & Wani, 1989; Yang et al, 1990; Sharma & Deb, 1991; Vales & Strnad, 1989) on short term as well as long term basis (Singh, 1987; Sharma et al, 1992).
- ii) helps the micro as well as meso flora-fauna to grow which sets a continuous process for improvement of soil fertility (Arihara et al, 1990; Neweigy et al, 1987; Hance & Gregoire, 1987).
- iii) Improves the soil structure by providing humus, thus decreases the tillage requirement, and increases the water holding as well as water permeability capacity of soil.

A concise idea of mutual interaction and benefits among different component of organic farming is succinctly summarized in Fig. 2.1 (Clive, 1990b).

Traditionally, organic manure was produced through i) natural digestion of the biomass left in the field, and ii) piling up of the biomass, animal excreta and other household biodegradable waste in the form of a heap under natural degradation process. In fact in traditional societies this kind of waste recycling was fundamental to the coexistence of man, animal and farm corp. But the concentration of livestock in large animal farms managed by modern technologies tends to replace this cyclic linkage of soil

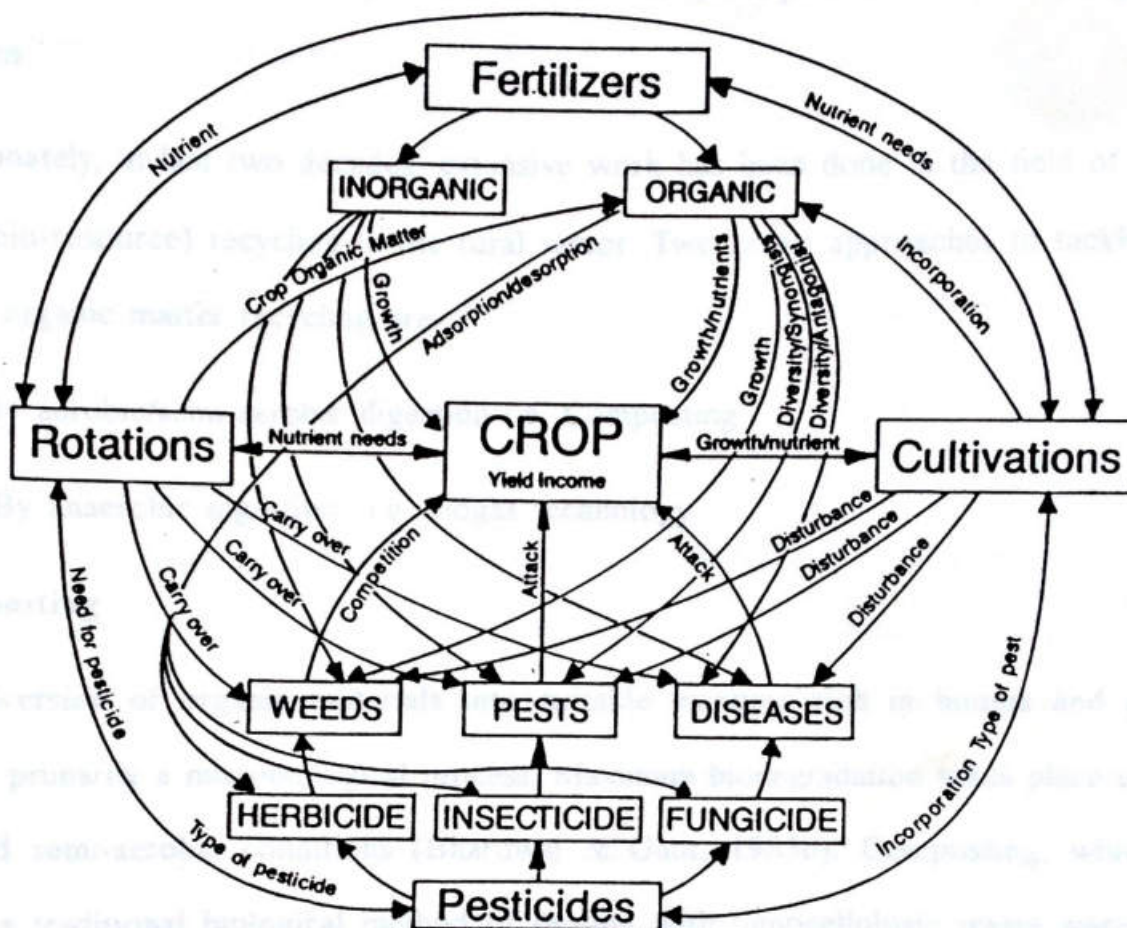


Fig. 2.1 Mutual Interaction amongst Different Component os Agriculture System*

* Source: Clive, 1990b, p260

nutrient management by an open system based on the idea of treating by-product as the waste. While such a solution can not be optimal, returning to the old cyclic linkages may not be viable (Mackrle & Mackrle, 1987). Obviously, novel technical solution should be sought within the given socioeconomic situation. The concept of organic recycling is relevant to agricultural production, particularly because of the remarkable effectiveness of the natural soil-plant-animal-soil system based on the principles of bio-processing and bioconversion.

Fortunately, in last two decades, extensive work has been done in the field of solid waste (i.e. bio-resource) recycling in the rural sector. Two broad approaches to tackle the problem of organic matter recycling are-

- (i) By aerobic/semi-aerobic digestion i.e. Composting
- (ii) By anaerobic digestion i.e. biogas technology

2.61 Composting

Conversion of organic materials into suitable manures rich in humus and plant nutrients is primarily a microbiological process. Maximum biodegradation takes place under aerobic and semi-aerobic conditions (Bhardwaj & Gaur, 1985b). Composting, which is essentially a traditional biological method of dealing with lignocellulosic waste materials, has seen a remarkable revival of interest in recent years (Anderson et al, 1987). This is an exothermic biological oxidation of organic matter carried out by different groups of aerobic microorganisms under both mesophilic (25-45°C) and thermophilic (45-75°C) conditions.

The traditional methods of composting i.e. windrow system (Heap method) is less efficient for recycling and totally inefficient for achieving sanitary environment. That is why

composting of lignocellulosic wastes is also receiving attention in a number of European countries (Plat et al, 1984; Jodice et al, 1984; Vallini et al, 1984; Verdonck et al, 1985). It is interesting to note that even in the country like Japan (Kubota et al, 1984), it has received attention of the Japanese farmers in their effort to reduce the excessive dependence on chemical fertilizers. Keeping this in view, a number of composting technologies based on reactor, non-reactor and biotechnological systems have been designed and developed. Important systems are summarized (Stentiford et al, 1987, Santosh et al, 1989b) in Table 2.1.

In addition to these, some fast composting methods using efficient microbial culture (Miller, 1990), biostimulants (Virginia, 1993), bio-organics (Espiritu et al, 1991) etc. have also been reported.

It may be noted (Zucconni et al, 1987b) that aeration process i.e. bringing about a contact between air and the solid organic matter, by turning or ventilating to promote microbial aerobic metabolism (bio-oxidation) assumes great significance in the process of composting. The main aim of aeration (Hovsenius et al, 1987) is to provide microorganisms with the required oxygen as well as to carry away carbon dioxide and heat. Several aeration control systems ranging from a simple low cost fixed rate of aeration system to microcomputer-based systems have been evolved (Stentiford et al 1985; Pereira-neto et al, 1985; Leton et al, 1983). The aeration system mainly consists of the following (Pereira Neto et al, 1987)-

- (a) Blowing into the pile i.e. positive pressure.
- (b) Sucking through the pile i.e. negative pressure.
- (c) Sucking followed by blowing i.e. hybrid system.

Further, the pile subjected to aeration by aspiration has been reported (Baruchello et al, 1987).

Composting Systems

System Type	Configuration	Aeration	Agitation
(a) Reactor			
1. Dano	Horizontal Flow	F	C
2. Earp Thomas	Vertical „	F	C
3. Eweson	Horizontal „	F	C
4. Fairfield	Mixed „	F	C
5. Metro	Mixed „	F	C
6. Paygro	Walled Container	F	I
7. Peabody	Vertical „	F	I
8. Tellemache	Walled Container	N+F	I
9. Real Earth	Vertical „	F	I
10 Thompson	Vertical „	F	I
11 BAV	Vertical „	N+F	I
(b) Non-Reactor			
1. Aerated static Pile	Batch pile	F	U
2. Indore	In trench	N*	I
3. Buhler	Batch pile	N*	I
4. Bangalore	In trench	NIL	U
5. Chinese	Batch pile	N*	U
6. Windrow (Heap)	Batch pile	N*	I
7. Pusa Pit System	In trench	N*	I
(c) Biotechnological systems			
1. Vermi-composting		N*	I
2. Excel Process		N*	U
3. Biodynamic method		-	-

Aeration: N- Natural (uniform, aerobic conditions)
 F- Forced
 N*- Natural (non-uniform, resulting in semiaerobic conditions)
 Agitation: C- Continuous, I- Intermittent, U- Undisturbed

Table 2.1

The rate of aeration must be controlled so that the appropriate temperature/time profile required for sanitization is maintained. In aerated static piles (Pereira Neto et al, 1987) normally, different wastes are thoroughly mixed before piling over a single perforated plastic aeration pipe. Then, it is covered with insulated layer of matured compost which will permit the required temperatures to be attained throughout the composting material. In the case of forced aeration (Hovsenius et al, 1987) it is necessary that the composting material has a number of free pores so that gas exchange can take place through these both by the added air flow and by molecular migration or diffusion.

A deeper analysis of the above composting systems reveal that reactor type large scale systems are suitable for treating the city garbage; whereas non-reactor type and biotechnological systems may find significant place in rural composting in view of their decentralized nature and simplicity in operation. Among the non-reactor system almost all the methods except Chinese and Bangalore method require turning the whole mass periodically, either manually or using power driven machines. In fact, Bangalore process is a hot fermentation method suitable for the treatment of human excreta. In Chinese method, though turnings for aeration are not required, fully aerobic condition seems difficult to achieve. Turning the entire mass periodically is a cumbersome process, involving health risk due to pathogens thus making it the biggest obstacle in the popularization of these composting methods in the rural areas. This problem has been solved in NADEP technology where necessary conditions for efficient decomposition are automatically achieved due to the design of composting tank and filling process.

As far as biotechnological systems are concerned, except the biodynamic method, its ecological compatibility in the context of sustainable agriculture is not yet fully ascertained (Santosh et al, 1993c). However, certain efforts made in R & D as well as

field level, using indigenous species of earthworms, are worth mentioning in this context (Senapati, 1993)

Keeping the above in view, NADEP technology for composting was selected for the present study. It may be noted that till 1988-89 when this work was started, NADEP method was not reported in scientific literature. It was only being field tested to a limited extent by the inventor, Shri. N.D. Rao Pandhri Pandhey. Details of the work done are presented in chapter 5.

2.62 Biogas Technology

Another way of a more effective utilization of animal excreta and biogas is through anaerobic digestion of the biomass. In fact it is a well proven technology where in addition to the direct energy generation in the form of biogas, a cooking fuel (Sharma, 1989) the digested slurry serves as a valuable fertilizer (USDA, 1990). The naturally available materials such as animal excreta, crop residues etc. can be used as an input to biogas plant.

The optimum process conditions for its digestion have been well identified for dung as the feed stock for biogas plant. Biogas plants ranging from 1M³ capacity to 140 M³ capacity have been designed and propagated through out the country. The most popular are KVIC (floating dome), Janta and Deenbandhu (both fixed dome) models. Deenbandhu is a modification over Janta model, and costs less due to some design differences. All these models use animal dung as feed stock.

This technology can also take care of human wastes. Some models in which agriculture residues, food processing waste, weeds etc. can be used as a supplement feed stock is available at laboratory scale (Myles, 1984; Barman, 1988). Recently, attention is being paid (Chawla, 1986; Vasudevan & Shyamladevi, 1995) to solid state digestion for

reducing the size of the digester and making the handling of digested slurry easier. However, the breakthrough is yet to come. Various uses of biogas slurry in the Indian context have been compiled by Consortium on Rural Technology through a national workshop organized at I.I.T. Delhi (CORT, 1992).

Since it is produced through anaerobic digestion, it may not be as suitable for directly adding to field as compost manure (Meier & Nosal, 1989; Santosh et al, 1993d). Further, digested slurry being semisolid in nature, its handling, transportation and utilization poses serious difficulty.

2.63 Biogas slurry Treatment

Literature survey and reports on biogas popularization reveal that the work done in the area of slurry treatment and management is very scanty and is limited to laboratory level. For example, Weber suggests a possibility of co-fermentation of slurry with other organic wastes (Weber & Hutter, 1993) and other anaerobic digestion (Vetter et al, 1987). Meier discusses different methods of mechanical separation and drying of slurry (Meier & Nosal, 1989; Mote, 1986). Hence attention was focussed to develop a simple viable method for biogas slurry treatment for a given habitat.

2.7 Conclusions

A brief survey of the existing state of agriculture reveals that there is a need to search for a new paradigm of development and a synergetic agriculture system based on it. Two important aspects of this agriculture system i.e. seed and nutrient management need major attention. In the field of organic manure production, NADEP method of composting offers a novel method and demands further investigation. Treatment of biogas slurry also deserves special attention.

Chapter 3

AGRICULTURE SYSTEM & DEVELOPMENT IN THE LIGHT OF SAP

3.0 Introduction

A world view, as stated earlier in chapter 2, must be able to define the *Nature*, the man, and their interrelationship in a meaningful and mutually satisfying manner.

An in-depth analysis of the prevalent world views indicates that these have been falling in one of the extremes. The Judo-Christian anthropocentric world view on one hand considers man as the supreme and *Nature* just a means to him to be used, to be modified, mutated and to be exploited. The eco-centric world view on the other hand reduces him to just one of the species existing in *Nature* with no important role to play. The ascetic religion, however, altogether declares *Nature* as *Maya* and therefore meaningless. All these extremes, which are mere constructs and not based on reality, sooner or later lead to contradictions and conflicts. Other world views are more or less mixture of these and therefore suffer from the same problems.

Sah-Astitwa Principle is a world view which is based on the experience by the central force of *Jivan (Madhyastha Darshan)* of Existence as it is (*Astitwamulak*) (Sharma, 1988b). The very word *Sah-Astitwa* means “being interrelated in a mutually fulfilling manner”. *Sah-Astitwa Principle* defines natural order (*Vyavastha*) as the central theme, however, it also assigns to man both the special status of being the flower of the on-going process of evolution in *Nature* and the responsibility to realize the natural order within himself (*Swanushasan*) and every where else (*Swarajya*).

3.1 Basic Concepts of *Sah-Astitwa*

Certain basic concepts of SAP which are of immediate concern to our discussion on

the idea of development and agriculture system emerging out it, are being focused upon in this section. Some other concepts which may be referred to during the discussions will be briefly discussed there only.

3.11 *Sah-Astitwa* at Various Levels

Sah-Astitwa means that everything in Existence is related to the other (*Parasparata*) in mutually fulfilling manner (*Purakata*). This can be better understood when seen at these levels:

(i) *Sah-Astitwa* of *Prakriti* (Nature) in *Satta* (space)

Prakriti (Nature), constituting of individual units is in *Satta* (space), a perennial source of energy in equilibrium. Every unit derives energy for its activity from *Satta* which permeates everywhere. *Satta* provides force to interrelate one unit to other unit, and every unit derives its self-regulation and self-organisation from *Satta*. Every unit reflects itself in every other unit through *Satta* which is transparent.

(ii) *Sah-Astitwa* among four orders of Nature

Nature can be classified into four orders -

Material order - *Padartha Avastha*: soil, water etc.

Pranic order - *Pranavastha*: plants, microbes etc.

Animal order - *Jiva Avastha*: animals, birds

Human order - *Gyanavastha*: humans

There is a *Sah-Astitwa* between all these four orders. *Sah-Astitwa* between material and plant order is in the form of *Urvarakata* (fertility) in material order and growth in plant order. Among material, *Pranic* and animal order, it is expressed in ever enriching self-

sustained eco-balance. However, among all four orders including humans, it is yet to be realized by the *Jagrit* humans in the form of cultural and civilizational eco-balance (*Swarajya*).

iii) *Sah-Astitwa* among Humans

Human beings are also in *Sah-Astitwa* with each other i.e. they are in *Paraspara-Purakata*. This finds expression at the levels of individual, family, village, nation and world.

iv) *Sah-Astitwa* within Human

The body and *Jivan* fulfil each other. *Jivan* nurtures, protects and equips the body and body offers itself for *Jivan* to express its *Jagriti*.

v) *Sah-Astitwa* within *Jivan*

Jivan is felt through its five powers- *Asha* (will), *Vichar* (thought), *Ichchha* (desire), *Sankalpa* (understanding) and *Anubhav* (experience). *Sah-Astitwa*, harmony among these five is what is desired. Such a situation is achieved under *Jagriti* (awakened) state.

3.12 *Prakriti* (Nature)

Nature consists of innumerable number of individual units. Every unit is characterized by its self-organisation and its relation to higher organisation. This self-organisation has been readily achieved during the natural course of evolution by all units except humans. Every human being has to consciously awaken his/her *Jivan* and experience his/her self-organisation.

The smallest unit in *Nature* is *Paramanu* (atoms). These atoms combine themselves to form higher units, the more and more complex ones. These complex units then organize themselves to form yet involved structural units. Thus is defined the material order from atoms

to simple molecules and compounds to a variety of huge structures and systems like mountains, rivers, etc.

Enriched material order prepares base for the emergence of *Pranic* order, which is characterized by *Pranic*, the respiration process, made possible by the complex structure developed at material order. At this level, the development takes place from cells to individual plants to complex plant communities to ecosystem embracing material order within.

The enriched plant order prepares highly flexible, adaptive bodies to be taken up (adopted) by the *Jivan*, the life force. At the level of *Jarh*, we have from cells to bodies to species to community to ecosystems embracing material and plant orders. A further development of body structure leads to human body, an appropriate medium for the awakened *Jivan* to express itself.

The *Jivan* evolves itself and all its five powers gets expressed in the process till it reaches the state of *Jagriti*.

Thus, at every stage of coevolution, the next stage is visible and appears within reach. Similarly, the present level of coevolution exemplifies and manifests itself for the previous state. So, for the material order, the plant order; for plant order, the animal order; for animal order, the human order are higher stages of evolution.

3.13 The Human

The Human order, as discussed above, is defined in *Sah-Astitwa*, in *Paraspara-Purakata* with all three orders. This *Paraspara Purakata*, however, is yet to be realized and is in the process of evolution. (Sharma, 1978, 1988)

Human has body and *Jivan*. To be more precise, human is *Jivan* acquiring a body. *Jivan* evolves itself by awakening its powers and harmonizing them ultimately leading to *Jagriti*.

In the state of *Jagruti*, he is able to see the organisation within himself (*Swanushasan*) and also the organisation all over (*Swarajya*) (Satya, 1995a).

Jivan expresses itself through different structures at five levels-individual, family, village, national and world level. At each level, he operates in four dimensions of work, behaviour, thinking and experience. A healthy body, a well related family, a self organized village, a well knit nation and a harmonizing and protecting world is what is required for complete expression.

3.14 Interrelationship

Interrelationship is most fundamental to SAP. The very word *Sah-Astitwa* means an interrelationship that is mutually satisfying. To make it more explicit for the sake of understanding as well as practicing, these interrelationships have to be spelt out at each level and for each unit (Sharma, 1978).

The Interrelationship in SAP is defined as *Mulya* -the word signifies the *Maulikta*-the intrinsicness i.e. *Mulya* is defined as the intrinsicness of a unit in relationship within itself and with others. *Mulya* can be identified at different levels of existence as follows:

Level	<i>Mulya</i>
Existence	<i>Sah-Astitwa</i> .
<i>Jivan</i>	Happiness, Peace, Contentment and Bliss (harmony between life powers)
Human	<i>Dheerata, Veerata, Udarata, Daya, Kripa, Karuna.</i>
Family	<i>Sthapit</i> (Inherent) <i>Mulya</i> and <i>Shista</i> (Expressed) <i>Mulya</i>
Society	Intelligibility, Enrichment, Fearlessness and <i>Sah-Astitwa</i>
<i>Vastu</i> (Things/Substance)	Utility, Aesthetic Value

- i) At the level of existence, *Sah-Astitwa* is the basic nature of interrelationship i.e. every thing in existence is related to the other in a mutually fulfilling manner.
- ii) At the level of *Jivan*, the interrelationship within itself is in the form of harmony between five powers i.e. will, thought, desire, understanding and experience and interrelationship with the body in the form of harmony between *Jivan* and body. The harmony within *Jivan* expresses itself as feeling of Happiness, Peace, Contentment and Bliss and that with body in the form of *Swasthya* (health).
- iii) At the level of Human, interrelationship is in the form of understanding and experience of *Nyaya*, *Dharma* and *Satya* (Interrelationship at the level of human, society, and whole existence) The readiness for this is expressed in terms of *Dheerata*, *Veerata* and *Udarata*. (Conviction of the right relationships, readiness to introduce it at the level of society and willingness to facilitate this introduction.)
- iv) At the level of family, interrelationships is broadly classified as *Sthapit* Mulyas (inherent) and *Shista* (expressed) *Mulyas*. These provide harmony within the family and prepare ground for sound society.
- v) At the level of society, Intelligibility, Enrichment, Fearlessness and *Sah-Astitwa* are the basic *Mulyas*. Intelligibility implies that every member of the society is awakened and can clearly understand himself and things around him; this includes to know and to accept a unit, to recognize and fulfil one's relation with it. Enrichment stands for interaction of a society with the nature such that both are mutually enriched in the process. Fearlessness implies the assurance in each other and *Sah-Astitwa*, the coexistence in complementary togetherness at every level upto the whole existence.
- vi) At the level of things, while dealing with them, humans have to consider two aspects-

- a) utility- the usefulness of the things for meeting the goal and
- b) aesthetic sense- enhancing the effectiveness and easiness of their use for the fulfillment of the purpose.

Having discussed the notions of *Nature*, man and their interrelationships according to SAP, we are now in a position to dwell upon the concept of development and the guidelines for agriculture system emerging out of it.

3.2 Concept of Development

Development in SAP unlike in modern paradigm which sees it as a human construction, a result of technological innovation, is the appreciation and understanding of the evolution already taking place in *Nature* and molding of oneself according to it so as to reach the ultimate goal of self-organisation (*Swanushasan*) and world organisation (*Swarajya*). It is not the development of one by the other, or of one at the cost of the other, or of one oblivious of the other, it is rather development of one in the very process of the development of the other. Development, therefore, is better defined as *Vikas* (coevolution)- a natural unfolding in a mutually reinforcing manner.

The central idea in the process of development is, therefore, (i) understanding of evolution taking place at different levels in *Nature* and (ii) constructively participating in realizing and enhancing this process of evolution through self-awakening.

This coevolution can be broadly classified in the following two categories.

3.21 Development (*Vikas*) in Material & *Pranic* Order

As discussed in section 3.12, starting from the basic units, atoms, material world keeps on evolving to molecules to more complex molecules and compound huge structures and systems.

The rich complex material system provides a base for the *Pranic* order. It supports the *Pranic* (respiration) process and makes the growth possible. At the plant order, coevolution takes place from cells to individual plants, to complex plant communities to ecosystem embracing and enriching material order within.

It is clearly seen here that higher organisation (Structure) does not develop at the cost of the lower one, rather the higher organisation ensures the enrichment of the lower one or lower one finds its purpose and fulfillment in the higher one (Sharma, 1988).

As stated earlier, at every stage of coevolution, the next stage is visible and appears within reach, similarly the present level of coevolution exemplifies and manifests itself for the previous state. So is the case between material and plant order.

The plant order increases the *Urvarakata*, fertility and thus complexity of the material order; Enhanced *Urvarakata* results in evolution of higher and more complex plant structures and ecosystems.

3.22 Development (*Jagriti*) in Human (*Jivan*)

Development (Coevolution) at material and plant order is natural process going by itself, however, development at the level of Human order (termed as *Jagriti* i.e. awakening) is a conscious process. *Jivan* entrusted with *Kalpanashilata* (Imagination) and *Karmaswatantrata* (freedom to work) has to awaken his different powers and harmonize them properly. Only under the awakened state, he is able to see the organisation that exists within himself (*Swanushasan*) and can work for the realization of organisation in the world (*Swarajya*) i.e. in the light of this perception of the organisation in the *Nature* can he/she positively participate in furthering the process of development of material, plant and animal as well as human order.

Broadly, the Human development (*Jagriti*) can be classified in three categories:

Level	Perception	Quality	Objective
<i>Jagritishil</i> (awakening)	<i>Priya, Heet, Labh</i>	<i>Dinta, Hinta, Krurta</i>	bodily needs
<i>Jagrit</i> (awakened)	<i>Nyaya, Dharma</i>	<i>Dheerata, Veerata, Udarata</i> <i>Daya, Kripa</i>	<i>Samajikata</i> <i>Swarajya</i>
<i>Jagritipurna</i> (realized)	<i>Satya</i>	<i>Karuna</i>	<i>Satya</i>

These can be characterized in terms of the perception, objective (purpose) and the quality that they own. These are summarized in the above Table. The development takes place from *Jagritishil* to *Jagrit* to *Jagritipurna* Human.

3.23 System (*Vyavastha*) and Participation of Human in its Development

The *Jagritishil* (awakening) humans are characterized by sensual, bodily and profit loss consideration as their purpose. Devoid of any concept of right relationship (*Nyaya*), they try to fulfil their aim through servility, deceptivity and cruelty. As they have no idea of the natural organisation, the organisations or institutions created by them will further degenerate the humans as well as the organizations. All system and devices, designed and developed further reinforces the disorganization. It is for this reason that despite the increasing availability of food and other material resources, deprivation and conflicts are on the increase. Not only this, they are destroying their very natural base such as soil, air, etc.

Thus, seeing no hope finding answers to their problems in organisation, they tend to

believe that only individualistic answers are possible. This leads to further degeneration, ruling out the very possibility of collective process.

The *Jagrit* (awakened) humans on the other hand are able to understand the Natural organisation within themselves and in the whole world of existence. They are able to realize and fulfil the *Mulya* associated with each relationship. This is what is called *Nyaya*. Further, they understand and hence can introduce the *Vyavastha* which makes possible the realization and fulfillment of these values, called *Dharma*. Under fully awakened, realized state, the humans can experience the existence in its completeness and hence can live in complete harmony and oneness with the existence and its organisation, thereby, providing motivation and clarity to *Jagritishil* humans. This feeling of oneness with the existence is *Satya*. *Nyaya*, *Dharma* and *Satya* is materialized through *Dheerata*, *Veerata*, *Udarata*, and *Daya*, *Kripa*, *Karuna*.

Since *Vyavastha* set up by awakened humans are in accordance with *Nature*, it brings harmony right from individual to global level. Since, he/she is trying help the natural organisation realize itself, unfold itself, it is simple, smooth and easy. As a matter of fact, such organizations already exist and are well managed at level of material, plant and animal order. It is only the ignorant humans, who unaware of the organisation at human level as well as other levels, introduce *Avyavastha*. New systems and organisations that the *Jagrit* humans introduce are designed with the clear understanding of Natural organisation and are easy to implement and create the harmony and sense of fulfillment in all its participants.

Thus, the central theme of SAP is the evolution of humans from present level of their inability to understand themselves, *Nature* and their organizations to a higher level, one of understanding the organisation within (*Swanushasan*) and realization of the organisation all over (*Swarajya*).

3.24 Purpose of All Developments

All developments, i.e. *Vikas* (coevolution) in material and *Pranic* order and *Jagruti* in human order are aimed at the realization of complete harmony of *Vyavastha* at individual as well as existential level. This, however, is possible only through complete awakening (*Jagruti Purnata*) of humans which expresses itself as *Swanushasan* (self-organisation) at the individual level and overall organisation (*Swarajya*) at the community level or rather at the level of existence as a whole. *Mulya* experienced at the level of *Jivan* are happiness, peace, contentment, and bliss and at the level of society are *Samadhan* (intelligibility), enrichment, fearlessness and *Sah-Astitwa*. *Samadhan* (intelligibility) stands for clarity of working of existence as a whole, felt at the level of *Jivan*, *Samriddhi* (enrichment) implies the feeling of having all opportunities in *Nature* for every ones enrichment, felt at the level of family, fearlessness from other humans is felt at the level of society, and *Sah-Astitwa* is feeling of being interrelated in a complementary manner with every thing at the level of existence.

To sum up, the purpose of existence of humans is to reach through *Sah-Astitwa* to a state where happiness, peace, contentment and bliss is experienced by every human individually and *Samadhan*, enrichment, fearlessness and *Sah-Astitwa* collectively and to establish its *Parampara*.

3.3 The Concept of *Swarajya*

It is important to throw some light on the concept of *Swarajya* - the right organisation realized at human and other levels, so as to be able to get some understanding and draw some outline for the natural processes with human participation such as agriculture system.

Swarajya has following five dimensions (for details see appendix-I) (Sharma, 1992; Satya, 1995)

(i) *Siksha* (Education)-*Sanskar* system.

- For awakening of *Jivan*

(ii) *Swasthya* (Health)-*Sanyam* (discipline) system

- For nurturing and maintaining the body for expression of *Jagriti*.

(iii) Production-Work system

- For maintenance and enrichment of family.

(iv) Exchange-Saving system

- For maintenance and enrichment of community.

(v) *Nyaya-Suraksha* System

- For maintenance and enrichment of the whole *Nature*.

(i) *Siksha-Sanskar* system focuses on awakening of *Jivan*, of giving the right understanding of the self and the whole existence. While *Siksha* (Education) stands for giving the knowledge, *Sanskar* is the effective implementation of the acquired understanding.

(ii) *Swasthya* (Health)-*Sanyam* System

Swasthya relates to maintenance of health and nourishment of the body while *Sanyam* is the acceptance of *Jivan* to nourish and protect the body.

(iii) Production-Work systems

Work relates to human interaction with *Nature* in order to fulfil his general and specific requirements (needs) as well as the enrichment of *Nature*. Production is the outcome of such an interaction in the form of a thing, an object.

(iv) Exchange-Saving system

Exchange is done amongst the families with a view to fulfil their mutual complementarity, not with the motivation of profit. Similarly, saving is giving the excess of production at the family level for the development and maintenance of organisation at the village level.

(v) Nyaya-Suraksha System.

Nyaya is giving what is due to other human, as per the *Mulya* associated with the relations. *Suraksha* is preservation and meaningful utilization of the natural resource of the material and *Pranic* order.

3.4 Avartanshilata

3.41 Concept of Avartanshilata

All natural processes follow the law of *Avartanshilata*. *Avartanshilata* means ongoing cyclic process in which every participant is enriched. This is the very outcome of *Sah-Astitwa*, the *Paraspara-Purakata* that exists in *Nature* rather in whole existence as described earlier. *Avartanshilata* is not the growth of one at the cost of the other, as is believed to be the case in all developmental process. But, it is the enrichment of the one in the process of growth of the other. All four orders in *Nature* are to be in a relation of *Avartanshilata*. While it has already been realized at the first three orders viz material, plant and animal, it is in the process of being realized at the level of human order. As pointed out earlier, human with his *Jivan* awakened can understand this *Avartanshilata* and constructively participate in the fulfillment of all three orders. A *Jagrit Jivan* can naturally visualize the *Avartanshilata* existing in different natural processes and also see his constructive role in it.

3.42. Expression of *Avartanshilata* in Natural Processes

As stated earlier, it is natural for *Jagriti Jivan* to visualize *Avartanshilata* involved in each natural process and also to see how he can play his role of mutual fulfillment in the process of *Avartanshilata*. However, it is still imperative to spell out certain basic characteristics of *Avartanshilata* as observed in Natural processes.

The three broad requirements of *Avartanshilata* can be stated as below.

- (i) any process we introduce or we participate in, must be cyclic in nature
- (ii) every unit participating in the cyclic process must be enriched.
- (iii) the process introduced should not hamper the other already existing natural processes, rather it should enhance these processes too.

3.43 Role of Human in *Avartanshilata*

Having discussed the concept of *Avartanshilata* and its expression in Natural process, it is now possible to outline the role of Human in maintaining this *Avartanshilata* in Natural processes. This is also described as Human Production-Work System, a component of *Swarajya*.

Following aspects of the Production- Work System are important and need elaboration

- (i) Human Needs- The ultimate aim of the whole existence is *Jagriti* in *Jivan* and *Swarajya* in the existence. For the fulfillment of self-organisation of humans, every human at individual level needs education for *Jagriti* of *Jivan* and health for expressing it through body. However, humans always evolve in *Sah-Astitwa* with others, the smallest unit of human interaction being family. It is basically the family as a unit which interacts with society and *Nature*. This interaction is called *Vyavasaya* (Production-Work System). It is, therefore, necessary to spell out the needs of humans in a family.

The needs can be categorized in two as below:

- (a) General needs- food, shelter and adornment (equipment)
- (b) Specific needs- communication and transport

Food is required for nourishment and growth of the body, shelter is related to protection of body and adornment is required to facilitate the body in its work. The specific needs are required for maintaining the organisation at social and higher levels. These needs are felt in the family, needed for the family and are fulfilled by the family as a whole in the community.

(ii) Human capacity- The capacity that humans have or have to acquire are- know why and what , know how and ingenuity. By know why and what is meant the *Samadhan* (intelligibility), clarity of what to do and , by know how is meant the technique or art of doing things (*Nipunata*- capacity to materialize the use value of a thing), and by ingenuity is meant *Kushalata*- making the production safe and sound, which are obtained through *Siksha Sanskar* system.

(iii) Human labour and its utility- Human expresses *Samadhan* obtained in his *Jagriti*, in the outer world through his body. His body labour, therefore, is basically a means to give realization to his *Jagriti*. It is not a drudgery as is believed today. It certainly becomes so for a person who does work not out of his own motivation but, is forced to do so. It then becomes something to be avoided at all cost. In Production-Work System, therefore, human labour should be given the first and the foremost priority. Only when there is a work which can not be accomplished by human labour, it should be supplemented by labour of animals with whom a relation of mutual complementarity has been established. Only in cases, when both of these don't suffice, the use of

automatic machines should be made. These machines should be run by the energy obtained through renewable resources like flow of water, solar-energy fixed through bio and plant system such as oil seeds etc.

The value of a production should be in fact measured on the basis of the *Shram* put by the human. *Shram* is defined as applying one's *Samadhan*, *Nipunata* and *Kusalata* on the natural resource to establish utility or aesthetic value. It is basically this *Shram* value which should form the basis of exchange and not the symbol-currency as is the case today.

(iv) Fulfillment of humans in mutuality of the animals- *Sah-Astitwa* at this level, should be seen as human providing the facility in terms of nourishment, protection, and adornment to animals to do his work on the one hand, and on the other hand the animal providing means to complement human efforts of *Vyavasaya*. These means can be broadly considered as labour, milk, wool, dung, urine, leather, bone etc. By making the proper utilization of these, a large portion of human needs can be met with. Take the example of fertilizer; with all human artifacts and development of technology, we are able to generate around 3 million tons of nitrogen while with animal dung and urine alone we are in a position of generating around 4 million tons of Nitrogen (Gaur et al, 1984a).

Humans should realize that while they are endowed with the capacity of imagination and creativity and the possibility of *Jagriti*, they are also entrusted with the responsibility of ensuring the right organisation at all four orders. Humans are expected to fulfil the requirements of all three orders in their interaction with them, and not to subdue them or to establish their dominion over them with a view to just meeting their own personal

needs. At the level of animals, human has to ensure, therefore, the proper nourishment and protection of animals.

(v) Humans and animals fulfillment in mutuality of plants- Human has the responsibility of ensuring the *Vikas* of the *Pranic* order, plant being a part of it, during his interaction with them; this would mean protection, nourishment and diversification of the *Pranic* order. If he is oblivious of these aspects or considers it as his right to plunder the *Pranic* order for his short term gain, it is a sign of his lack of *Jagriti* and the disorganization resulting thereby.

Pranic order enriches human and animals by providing resources for food, shelter, adornment, energy, medicines etc. and proper selection of plants should be made depending on the needs to be satisfied. *Pranic* order also contributes in enriching the material order such as soil quality in terms of its fertility, water retention capacity and quality of water, air etc..

(vi) Human, animal and plant orders fulfillment in mutuality of material order- Material order through its components such as sun, moon, earth, soil, water, air, minerals, flow, fertility, seasons, rain, energy etc. provides the basis for the fulfillment of the human needs- both the general needs (food, shelter, adornment) and specific needs. It does so for the animal and *Pranic* orders also. It is natural, therefore, for human to derive his requirements from the material order. However, he has the responsibility of ensuring the enrichment of material order in the process of his interaction. Human has to guarantee its protection, right utilization and also its *Vikas* expressed through its fertility. It was made clear that this is ensured only when the concept of *Avartanshilata* is followed properly.

(vii) Human agriculture and industries- Human Production- Work System is broadly classified in two categories- agriculture and industries. By agriculture is implied all those production activities which relate to multiplication of available materials through *Pranic* order using the fertility of the soil.

It is only in the light of proper understanding of these aspects of *Vyavasaya* and fulfillment of the expectation of each of these aspects that human can rightly play his role of *Avartanshilata*. It can be summed up by saying that in order to constructively participate in the natural processes humans should rightly understand the above aspects and fulfil their requirements in every of his *Vyavasaya*. It equally applies to agricultural practices which are but a part of Human *Vyavasaya*. In agriculture, therefore, the selection of any practice or component should be made on the basis of consideration of these aspects. However, the following considerations about the practices or components are important and provide an outline for the agriculture system based on the principle of *Avartanshilata*.

3.5 *Avartanshil* Agriculture System

An outline in the light of the principle of *Avartanshilata*

(1) **Ploughing-** Deep ploughing as done today is quite undesirable because it disturbs the whole biological processes going on in the soil. The ploughing should be done in such a manner that-

- i) Ploughing is not done as a rule. It is done only when found necessary.
- ii) Ploughing is done with a view to provide aeration and water access facility to the soil.

- iii) It creates minimum disturbance in the natural growth of the microorganisms.

(2) Seed and Sowing time-

Seed- Following aspects are important in the selection of seeds.

- i) In a natural process, seeds for further growth and enrichment of a particular variety are automatically developed. All that is needed therefore, is the identification and selection of right types of naturally grown seeds (suitable to the soil and climate of the area).
- ii) Before introducing any seed foreign to the area, it should be insured that it satisfies the criterion of *Avartanshilata* i.e. it enriches all the components involved in the agriculture process.
- iii) Seeds can be and should be managed at the level of farmers only. However, they can exchange seeds amongst themselves to ensure further enrichment. This will on the one hand ensure *Avartanshilata* and on the other reduce dependency of the farmers on the market.

Sowing Time- As everything in existence is related to each other, other planet like sun, moon etc. have significant effect on the growth of plants, insects, birds, animals etc.. Sowing time of the plant therefore has considerable effect on-

- i) Growth of plant
- ii) Effect of other insects, pests etc.

Suitable sowing time should therefore be chosen for every crop.

(3) Type of crops- Types of crops to be grown will have to be decided on basis of its suitability in terms of providing both quality and quantity-

- i) food for human
- ii) fodder for animals
- iii) diversity for plants and
- iv) fertility for soil.

(4) Cropping pattern- In order to ensure a variety of food and fodder requirements, the increased diversity of plant and the enhanced fertility of soil, the crop pattern will have to be-

- i) Multilayer
- ii) Multi-cropping
- iii) Mixed-cropping
- iv) Crops enriching the bio-diversity
- v) Perennial crops for ensuring the humus throughout the year necessary for the bio-culture under and on the soil surface, water conservation and nutrient cycle.

(5) crop geometry- *Avartanshilata* implies the growth in mutual complementary manner. It is therefore, required that in agriculture, proper growth of every plant and its interaction with the other plants should be facilitated. The crop geometry, therefore, should be such that-

- i) It facilitates the growth of individual plants by providing enough scope for sun, air and biosphere.
- ii) Its interaction with other plants takes place in a complementary manner.

(6) Nutrient management- If the above mentioned cropping patterns are followed, the

major part of the nutrient requirements will be naturally met with. However, the cycle involving humans and animal food and fodder can be completed by recycling the human and animal excreta and other wastes through suitable aerobic and anaerobic processes and using it for plant nutrient. Green manuring crop may also be incorporated in cropping pattern for this purpose.

(7) Water-management- With the above multilayer mixed cropping and perennial crops it will be possible to maintain the humus of the soil through out the year, even with the ordinary rain water. However, certain practices which will enhance the water availability and water conservation are as follows.

- i) Planting tree for extracting ground water in a natural way and regulating the hydrological cycle.
- ii) Keeping the soil covered with perennial crops, mulches etc., so as to maintain the humus throughout resulting in increased water holding capacity of the soil.
- iii) Use of available surface water through river or ponds for irrigation.
- iv) Extracting ground water at a natural rate of regeneration.

(8) Weeds and weed control- Weed is generally defined with respect to the crops that are planted in the field. Every thing other than crop is considered as undesirable today and therefore, something to be done away with. When seen from the SAP point of view, one would find that crop does not grow in isolation, at least not in *Nature*. It grows in *Sah-Astitwa* with other plants, other elements of material order, insects, birds, animals and humans, so, the appropriate environment for its growth should be found and provided. The right approach towards other plants would be (rather than discarding all of them as undesirable):

- i) selection of right types of plants, grasses etc. to be grown with the crops.
- ii) controlling and not trying to exterminate the plants other than crops.

(9) Pests and pest control- Pests and insects are part of the natural environment of the crops and there is a *Sah-Astitwa* between them. However, imbalance created by human interference, by his indiscriminate acts cause certain types of insects or pests to multiply in an uncontrolled manner which may affect the crops. Other reason for insects or pests affecting the plants may be the improper growth of the plants due to important nutrient management. The following practices should be adopted to ensure that the insects and pests contribute positively in the growth of the plant:-

- i) Reviving the natural balance of the material, *Pranic* and animal environment corresponding to the crop under consideration by:
 - a) providing alternative food for the insects and pests so that they don't live on the crops.
 - b) border-cropping and intercropping of the suitable plants
 - c) allowing to develop insects and pests which will control the outbreak of any particular type of insects or pests and maintain an overall symbiosis.
- ii) using other time tested control measures such as neem and certain chemicals of plant origin.

(10) Flora and fauna (Biosphere)- Microorganisms, a part of the *Pranic* order play a very important role in the interaction between soil and plants. According to SAP, the growth always takes place stepwise and therefore, proper nourishment and protection of these intermediate units is a must for higher growth to take place. These beneficial microorganisms,

therefore, must be given proper importance and their nourishment, protection and *Vikas* must be ensured.

(11) Harvesting and threshing- Harvesting should be done manually. Use of big mechanical harvesters disturb the micro and meso culture of the soil. Threshing can be done using human and animal labour. This will ensure the creative and purposeful utilization of human labour and proper *Avartanshilata* with animal.

(12) Storage and post harvest technology- Storage should not be done from the point of view of earning profit, but to preserve the grain for the whole year and share the surplus with the community. Keeping this in mind, storage should be done in such a manner that-

- i) Nutrient value of the grain is preserved.
- ii) Grain is not contaminated. Naturally grown grains can be stored for a longer period without much deterioration. If very necessary, certain natural products like neem or chemicals of plant origin can be used.

Post harvesting processing of the grain should be such that nutrient value of the grain remains intact. It should be done with a view to make it suitable for human needs and not for enhancing its appearance or market value as is the case today.

(13) Marketing- Agriculture is to be done with the motive of fulfilling human needs. Hence, marketing of agricultural products should be done not with the motive of earning profit but with a view to share one's surplus with community. Unfortunately, the motive of profit has made the agriculture cash-crop oriented to the extent that increasingly large percentage of land is being devoted to cash-crop despite the fact that millions are dying of hunger.

(14) All this for the purpose of *Swanushasan* and *Swarajya*- While doing all this in agriculture, or any other production activity, it should always be kept in mind that all these

activities are for the purpose of realization of *Swanushasan* and *Swarajya* which only are the source of eternal happiness and peace.

3.6 Conclusions

We now have world-view that clearly defines man, *Nature* and their interrelationship in a mutually satisfying manner. SAP asserts that everything in existence is in *Sah-Astitwa* with other i.e. they are related to each other in mutually fulfilling manner. Development in *Nature* takes place through this concept of *Sah-Astitwa* which is seen as *Vikas* in material and *Pranic* order and as *Jagriti* of *Jivan* in human order. The ultimate aim of *Nature* is to realize the state of *Swanushasan* at the level of human and *Swarajya* at the level of society and *Nature*. *Vyavasaya* (Human production-work system) one of the five important components of *Swarajya*, defined with respect to family as the basic unit provides the outline of interaction of human with the rest of the *Nature*- animal, *Pranic* and material order. Agriculture system which is but a part of *Vyavasaya* when seen in the light of this and the concept of *Avartanshilata* yields an outline for practices of what we term as *Avartanshil* agriculture system.

4.1 Site Selection

Further, keeping in view the importance of relationships between the agriculture system, agro-climatic and conditions and socio-cultural aspects, Patti village located in a green revolution belt in western U.P. was selected as an experimental model. In the context of plant nutrient management, attention was focused on two important aspects of organic

Chapter 4

SITE SELECTION, METHODOLOGY AND MATERIALS

4.0 Introduction

As discussed earlier, the objective of this work is to search for an agriculture system which is self-sustaining and a world view which provides a sound foundation for such a system. In chapter 3, we developed a new world view, namely *SAP* and laid guidelines for the new *SAP* based agriculture system namely *Avartanshil* Agriculture. In the succeeding chapter our objective will be to develop operational aspects of this agriculture system that are in accordance with the principle of *Avartanshilata*; i.e. it fulfills, enriches all the constituents involved in the process of agriculture.

Broadly speaking, an agriculture system involves the following components - soil, seed, plant nutrients, water, agricultural implements, animals, human beings and ecosystem (including all micro, macro and meso flora-fauna). Ideally speaking, one could have studied the effect on and of interrelation between all these participants in different agro-climatic conditions to verify the guidelines for a new agriculture system. However, keeping in view the limitation of time and resources, it was decided to focus attention on two principal constituents i.e. seed and soil nutrients to study the viability of the new agriculture system.*

4.1 Site Selection

Further, keeping in view the importance of relationships between the agriculture system, agro-climatic soil conditions and socio-cultural aspects, Palri village located in a green revolution belt in western U.P. was selected as an experimental model. In the context of plant nutrient management, attention was focused on two important aspects of organic

* The new agriculture system so developed seems to be close to indigenous seed based organic farming in the aspects considered herein.

manure production i.e. composting and biogas technology. Experimental work related to these aspects was carried out in Palri village. A small plot at Micromodel complex, I.I.T., Delhi was also identified and necessary facilities were developed for carrying out experiments related to the comparative study on two different seed varieties of wheat crop along with different types of organic manure and chemical fertilizer, under strictly controlled conditions and supervision.

4.11 Palri Village

4.111 Reasons for Selection

Village Palri was selected for the following reasons:

i) Green Revolution Belt

Palri and nearby villages situated in the district Meerut of Western U.P. came under the influence of Green Revolution as early as 1966. The ill-effects of Green Revolution are also becoming evident in terms of decreasing soil fertility and crop productivity despite increasing dose of fertilizers and other inputs; falling underground water table; increasing crop diseases etc.. Farmers are now looking for new agriculture practices.

ii) Representative of a Large Area

Village Palri is representative of thousands of villages in the area in terms of educational facilities, general awareness and agriculture practices. The land structure and its use represents a large area generally known as 'Doab' i.e. the plain belt between Ganga and Jamuna river including major parts of Western U.P. and some parts of Haryana.

iii) Accessibility for the Author

Major consideration in extension and field work particularly in agriculture, calls for

willingness of the farmers to try out new methods. This along with other things requires acquaintance and faith in the persons involved. The author, a resident of this village and having a broad social background enjoyed such a confidence. Further, his family had agriculture land which has been available for the experimental work and field testing.

4.112 Certain Details

Certain details about the Palri village are being presented:

i) Location

It is one of the so-called progressive villages of a prosperous, politically and socially developed Meerut district of Uttar Pradesh. It is located on Barnawa-Daha road in Binauli block of Sardhana Tehsil. Palri is situated at 41 kms from Meerut in the North-Western part of the district, between $27^{\circ}.2'$ north latitude and $72^{\circ}.1'$ East longitude and at a height of 680 meters from the sea level. It is about 90 kms. from Delhi, the capital of India.

The total geographical area of the village is 1722 acres. The soil is primarily of loam and clay loam nature. The climatic variation in this area is indicated below:

- a. Summer Season : March to June
- b. Rainy Season : June to September
- c. Winter Season : October to February

The average ambient temperature is $10-15^{\circ}\text{C}$ and 32°C in January and July respectively.

ii) Cropping Pattern and Agriculture Practices

Average annual rain fall is 35" (89 cms.) and 90% of this occurs during June-September (rainy season). Entire agricultural land is irrigated by tubewells. It may be noted

that as early as 1952, government tubewells were in operation in this area and subsequently in 1969 the village also got electricity connection.

Almost all the crops can be successfully grown in this area. There has been a change in the types of crop being cultivated 1965 onwards. Till then farmers used to grow, as per their own needs, crops like wheat, barley, peas, gram, pulses, (*masur, urd, moth*), oil seeds (mustard, til), coarse grain (millet, sorghum), rice, sugarcane, potato, cotton, etc. They also used to grow crops for green manuring. Mango orchards were in plenty and so were the other fruits. A number of vegetables were also grown.

Mixed-cropping and multi-cropping were in practice, particularly, wheat, gram and mustard were sown together. Despite the lack of proper irrigation facility, a production as high as 820 Q/ha of sugarcane and 36 Q/ha of wheat was recorded (Arya, 1995).

Today, sugarcane is the main crop occupying around 75% land. Wheat is grown on 7-10% and remaining land is used for growing other crops. Around 25% of land under sugarcane is reused for wheat every year, thus making the total percentage around 25-35% of land for wheat crop.

Palri being in Green Revolution belt, agriculture is done using modern techniques i.e. modern machines, hybrid seeds, chemical fertilizers, pesticides etc.

iii) Use of Hybrid seeds and Chemical Fertilizers

Use of chemical fertilizer in Palri started right since 1952. By 1965, the dwarf variety of wheat was introduced. Due to the propaganda of the government machinery and market forces, agriculture became market oriented losing its basic characteristic of being need oriented.

An estimate of the average quantity of fertilizer being used and the average production of wheat during the period 1975-1995 is given in Table 4.1 below (Arya, 1995).

Table 4.1 : Fertilizer Consumption and Wheat Production

Year	Fertilizer used		Wheat production Q/ha
	Urea Kg /ha	DAP	
1975-80	120	50	45
1980-85	156	80	42
1985-90	220	102	38
1990-92	240	110	36
1992-95	264	108	34

Farmers mainly use urea and DAP. The practice of soil analysis for determining the amount of fertilizers to be used is not prevalent. Farmers have neither faith nor adequate facility for it. Use of Potash is done by very few farmers. Some of them have also started using micro nutrients for sugarcane cultivation.

Farmers also add some organic manure every 2-3 years depending upon the availability and other socio-technical factors. Some of the farmers who plough with oxen and have biogas plant are able to add the organic manure every alternate year, thus reducing the quantity of chemical fertilizers.

4.12 Micromodel Complex (IIT, Delhi)

I.I.T. Delhi has about 2.5 acre land near the academic block by the name of Micromodel complex. It serves as a field laboratory for different departments of the Institute. In this complex, around 0.25 acre land has been earmarked for agricultural

experiments and the facilities for irrigation, threshing etc. have been developed. It may be noted that this piece of land was lying fallow for several years and was covered with wild grasses and bushes. The soil of the field is sandy loam.

4.121 Field Preparation

In the first year i.e. 1988-89, in September, the land was ploughed and leveled with the help of tractor. It was irrigated once and was ploughed at appropriate time using spade. The plot was divided as per the outline drawn in Fig 4.1. Ploughing was done again after adding organic manure or chemical fertilizer as mentioned in Fig 4.1, followed by sowing and finally the land was leveled manually.

In the subsequent years, every time after clearing the wild grasses, the field was irrigated and then ploughed with spade twice, and seeds were sown in the ploughed field.

4.2 Methodology

Methods of allocation of plots to different treatments, sample collection, analysis etc. are briefly discussed here.

Experiment in Micromodel complex was conducted using random block design as shown in Fig. 4.1.

4.21 Statistical Analysis

The statistical analysis was done using the standard method of Analysis of Variance (ANOVA). Critical Difference were calculated for 1% and 5% (Pansey & Sukhatme, 1954) and significance was decided on the basis of this Critical Difference at 5% as it was considered adequate.

P5 HD - 2329 C. F.	P10 C-306 B. G. S.	P15 C-306 CON.
P4 HD - 2329 B. G. S.	P9 C-306 H. M.	P14 C-306 C. F.
P3 HD - 2329 H. M.	P8 C-306 N. C.	P13 C-306 B. G. S.
P2 HD - 2329 N. C.	P7 C-306 C. F.	P12 C-306 H. M.
P1 HD - 2329 CON.	P6 C-306 CON.	P11 C-306 N. C.

Micromodel Lab, IIT Delhi

Fig 4.1

4.22 Analysis of Soil and Organic Manure

For soil analysis, samples were collected from (i) depth of 0-15 cms. and (ii) depth of 15-30 cms. using standard procedure. The samples were dried, ground, passed through a 2 mm sieve, and then used for subsequent physico-chemical analysis.

For the analysis of organic manure, 10 samples of manure from different places in the heap were collected and mixed together. The samples were dried, ground, passed through a 2mm sieve, and then used for subsequent chemical analysis.

Following standard methods were used for analysis of physico-chemical properties.

4.23 Methods of Analysis

Analysis of soil and manure samples was done using standard techniques. The pH value was determined in 1:2.5 soil water suspension using a Systronix pH meter with glass electrode. The electrical conductivity was measured using Solubridge. Estimation of organic carbon was done by Walkley and Black's rapid method described by Piper (Piper, 1950). Nitrogen content was determined by using Micro-Kjeldahl's method (Singh & Pradhan, 1981); Phosphorous by colorimetric method (Dicman & Bray, 1940) and Potassium by using flame photometer (Jackson, 1967). Micronutrients analysis for soil was done by DTPA method (Lindsay & Norvell, 1978).

4.3 Materials

4.31 Seeds

Two types of seeds i.e. indigenous variety (C-306) and HYV variety (HD-2329) were used in experimental work. These were obtained from genetic division of IARI Delhi.

The specifications of these are given below: (Austin & Hansals, 1983; Tondon & Sethi, 1986).

Property	C-306	HD-2329
Botanical name	Triticum aestivum	Triticum aestivum
Gene Type	(Regent 1974x ch 23)	HD 1962-E 4870x K65/
	C591 (P 19x C 281)	HD 1553x UP 262
Year of release	1965	1985
Recommended for		
(i) Area	NW & NE Plains Zone	N Plains Zone
(ii) Production Conditions	Timely sown, low fertility, rain-fed.	Timely sown, good fertility, irrigated.

Main characteristics

C-306: A tall variety of wheat of medium late maturity. Grains are medium in size, amber, hard, lustrous and attractive. Very good for *chapati* making. Protein over 12%. Does well under low fertility and limited irrigated conditions.

HD-2329: A double dwarf wheat of medium early maturity and high yielding potential. Fairly resistant to rusts, highly resistant to lodging. Grains are amber, hard, lustrous and bold. Very good for *chapati* making. Protein over 12%.

4.32 Manures and Fertilizers

Five different treatments mentioned in Fig. 4.1 and used in the experimental work correspond to-

- (i) CON - Control
- (ii) N.C. - NADEP Compost

- (iii) B.G.S. - Biogas Slurry
- (iv) H.M. - Heap Manure
- (v) C.F. - Chemical Fertilizer

These are termed as T0, T1, T2, T3, T4 respectively.

In the year 1988-89, the work was started with the then available manure, however, during the year 1989 to 1993, the manure generated under the controlled conditions were used. The analysis of these two sets of samples for 1988-93 and 1989-93 are presented in Table 6.2.

Thus, this chapter provides the details of the site, methodology and materials used in the experimental work discussed in chapters 5, 6 and 7.

1. Non-availability or increasing scarcity of chemical fertilizers due to depletion of natural resources
2. Decreasing native fertility of soil, resulting in static/declining productivity despite giving increased dose of chemical fertilizers
3. Environmental and health problems, created by use of chemical fertilizers and its inseparable companion- pesticides.

Under these conditions, we have been forced to realize the limitations of modern agriculture practices and think of alternative systems with the emphasis on the use of renewable plant nutrients which can be generated in-farm in a cyclic manner and which is well integrated within the agricultural system. Such a system should be self sufficient, eco-balancing, pollution-free and its produce conducive to human and animal health.

Such an alternative has been readily available in the form of organic manure, an alternative which was at one time discarded as less efficient or inefficient. With the idea of considering technology superior to Nature is now finding ground in general.

Chapter 5

ORGANIC MANURE PRODUCTION AND UTILIZATION

5.0 Introduction

The greatest strength of modern agriculture was considered to be its capacity to make available the plant nutrients in an unlimited amount (in the form of chemical fertilizers, an off-farm input) and ingenuity to develop the seed varieties which can respond to this type of plant nutrient system. This has been possible due to the then considered unbounded availability of petroleum and other mineral non-regenerative resources.

This, however, is losing its ground due to the following reasons-

1. Non-availability or increasing scarcity of chemical fertilizers due to depletion of natural resources
2. Decreasing native fertility of soil, resulting in static/declining productivity despite giving increased dose of chemical fertilizers.
3. Environmental and health problems, created by use of chemical fertilizers and its inseparable companion- pesticides.

Under these conditions, we have been forced to realize the limitations of modern agriculture practices and think of alternative systems with the emphasis on the use of renewable plant nutrients which can be generated in-farm in a cyclic manner, and which is well integrated within the agricultural system. Such a system should be self sufficient, eco-balancing, pollution-free and its produce conducive to human and animal health.

Such an alternative has been readily available in the form of organic manure, an alternative which was at one time discarded as less efficient or inefficient. Well the idea of considering *technology superior to Nature* is now loosing ground in general.

Organic manure today is accepted as a possible and viable alternative. An in depth study, at least in Indian context shows that potentially, organic manure available from different sources such as animal and human excreta, crop residues, green mass, bio-fertilizers are sufficient enough to meet the total requirement of plant nutrient. It is estimated that from animal and human excreta alone around 6.414, 1.973, 2.662 million tons of N, P, K can be produced (Gaur et al, 1984a). This potential can easily be harnessed through composting methods and biogas technology. Other advanced methods of organic manure production like vermi-composting, biodynamic process, biofertilizers etc. will enhance it further. All that is really needed, therefore, is to properly gear up our resources and efforts in this direction.

Composting and biogas offers the most promising way of producing organic manure in terms of its availability of resource (as stated above), its ease of operation both in terms of economy and skill, over and above its contribution towards hygiene of rural/urban areas. Using biomass for energy production has the twofold advantage. It creates a renewable energy resource of fuel and manure while effectively disposing off the wastes, leading to better sanitary conditions in rural areas.

Thus the present work concentrates on compost and biogas slurry production and utilization.

5.1 Composting

Conversion of organic materials into suitable manures rich in humus and plants nutrients is primarily a microbiological process. Maximum biodegradation of biomass takes place under aerobic and semiaerobic conditions (Bhardwaj & Gaur, 1985b). Composting, which is essentially a traditional biological method of dealing with lignocellulosic waste

materials, has seen a remarkable revival of interest in recent years (Anderson & Smith, 1987). It is an exothermic biological oxidation of organic matter carried out by different groups of aerobic microorganisms under both mesophilic (25-45°C) and thermophilic (45-75°C) conditions.

5.11 Prevalent Methods/Techniques for Composting

Different methods of composting available in literature have been summarized in chapter 2. An in-depth analysis keeping in view the Indian rural situation especially in terms of people's life style, socio-cultural and economic aspects, indicates that large scale centralized systems (i.e. reactor type) are not suitable. Biotechnological systems should be examined for their ecological effect on long-term scale before taking up their large scale popularization. Further, as already mentioned in chapter 2, among non-reactor type methods, NADEP technology seems to be superior in terms of its operational aspects, as it does not require turnings of the entire mass to ensure fresh air supply to microbes for their decomposition activities.

In fact, due to the design of composting tank and simple procedure for its operation and maintenance, necessary conditions i.e. aeration and humidity required for efficient decomposition of biomass can automatically be achieved. Hence, NADEP composting technology was selected to study its suitability for Palri area. It may be noted that till 1988, when this work was started, it was not reported in scientific literature but only being field tested to a limited extent by the inventor, Shri. N. D. Rao Pandhari Pandhey. It is hoped that this literature would bring it before the scientific community and policy makers. In addition to NADEP composting, attention is also focused on improving the efficiency of traditional heap manure method.

5.2 NADEP composting

This technology is based on the research work carried out by Shri N. D. Rao Pandhri Pandhey (Pandhey, 1978) at Shri Kumarappa Go-Gobardhan Kendra, Pusad, (Maharashtra). This method has the advantage of producing 40 kg of compost with an input of 1 kg. cow dung along with other local biomass residues, village garbage and soil. In the village economy it is important to conserve cow dung also for a variety of uses including fuel and plastering unless suitable alternative technologies are available.

5.21 Special Features

The special features as reported by Pandhri Pandhey (Pandhey, 1978) are as follows.

- (i) This process has been evolved to utilize minimum amount of cowdung which is an important resource of rural areas.
- (ii) This compost is more effective than the traditional heap manure.
- (iii) It is designed to utilize any biomass even the village garbage, thus converting it into useful manure.
- (iv) The technology is pollution free and keeps the surroundings and atmosphere clean, thus achieving village sanitation.
- (v) The process does not require any commercial energy or special skill. It is very simple and even small farmers can adopt it without much investment.

5.22 Technical Details of Manure Production

Aeration Tank

A rectangular tank of brick having dimensions, 10 ft. length, 6 ft. breadth and 3 ft. height is constructed on the ground. The thickness of the side walls should be 9 inches.

The top most layer of the bricks should be fixed with cement for the sake of durability. A number of rectangular holes (12" x 6") are made in all the four walls. These can be made during the construction by removing every alternate brick length wise from every third row of the bricks. After the construction is complete, the inside walls and floor of the tank are plastered with cow dung and water mixture. The tank is left undisturbed till the plastering gets completely dried. It is shown in Fig. 5.1. The tank thus constructed can be used again and again and has fairly long life.

Materials Required

- | | | |
|------|---------------------------------------|------------------|
| i) | Agricultural residues/village garbage | = 1350-1400 Kgs. |
| ii) | Cow dung | = 92 Kgs. |
| iii) | Fine dried soil | = 1575 Kgs. |
| iv) | Water | = 1350 liters. |

All these materials have to be procured before starting the filling up of the tank because filling and sealing must be completed within 48 hours. Partial filling or time gap in filling may hamper the decomposition process.

The Filling Process

The tank is filled layer by layer with biomass (agricultural residues/village garbage), dung slurry and soil in the following way :

First Layer

Biomass layer of 6 inch-thickness weighing approximately 100-110 kg is placed on the floor of the tank and pressed manually.

Constructional Details of NADEP Tank

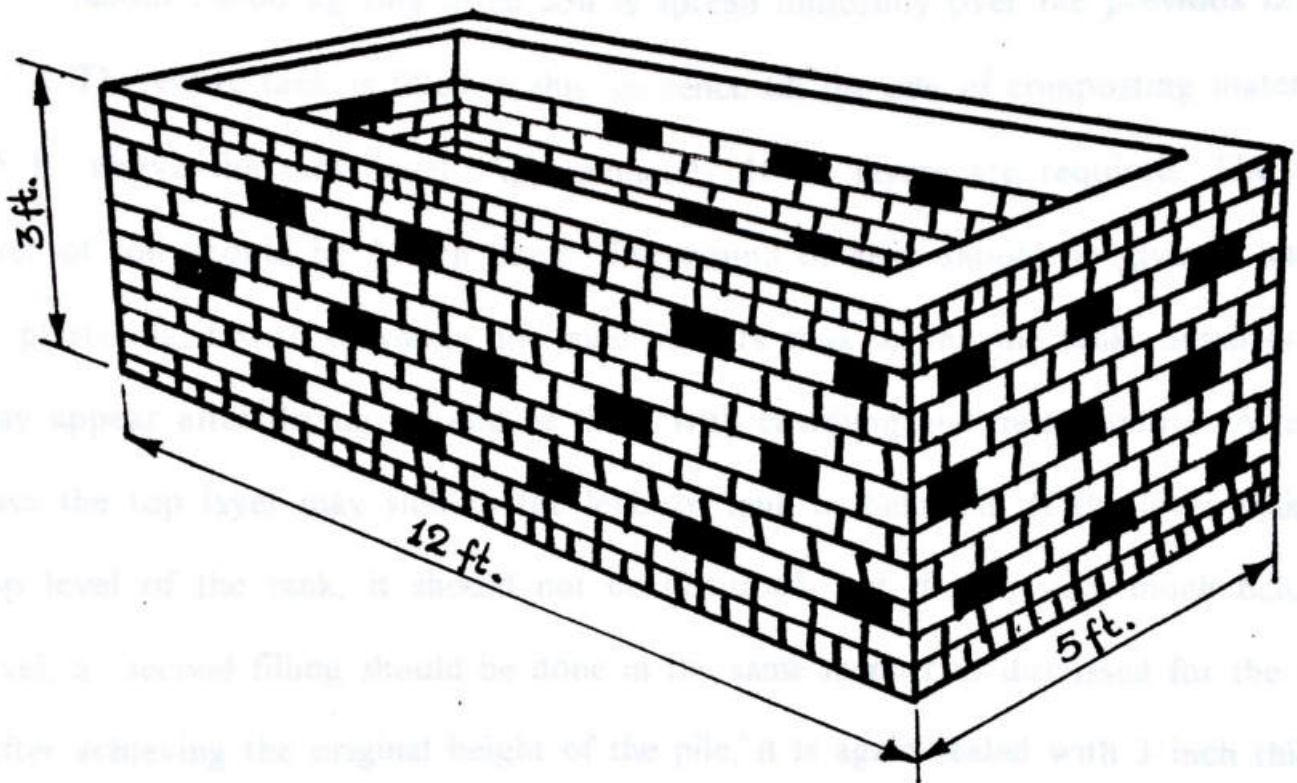


Fig 5.1

Weighed quantity of dung (4% of the biomass used in first layer) is thoroughly mixed with water (1.25 times of biomass) and sprinkled over the biomass filled in the tank. In this case 4 kg. dung is diluted with 135 liters of water. It may be noted that quantity of the water depends on the moisture content of the biomass and type of the soil.

Third Layer

About 50-60 kg fine dried soil is spread uniformly over the previous layer.

The entire tank is filled in this sequence till the pile of composting material is about 1.5 ft. above the tank level. Approximately 10-12 layers are required. The upper most layer of soil should be 3 inch thick. The mound of heap should be given a smooth finish by plastering it with cowdung and mud mixture thus sealing the tank. Small cracks which may appear after drying, should be filled with cowdung and mud mixture. After about 20 days the top layer may sink to the level of tank or below it. If the layer sinks upto the top level of the tank, it should not be disturbed, but if it is very much below the top level, a second filling should be done in the same manner as discussed for the first filling. After achieving the original height of the pile, it is again sealed with 3 inch thick layer of soil and plaster with cowdung and mud mixture.

Maintenance of Tank

It takes about 90-120 days for the compost to mature depending upon the type of biomass, season and climatic conditions. The tank should not be disturbed during this period. In summer season water is sprinkled through the holes and on the top most layer so that proper humidity is maintained inside the tank. The cracks are also repaired. After 90-120 days the tank is opened and the compost is thoroughly mixed and now it is ready for application.

5.23 Scientific Assessment

The above description of the NADEP technology indicates that in this process natural aeration is achieved without any agitation. Thus, this novel process is a new development in the field of composting and adds a new dimension to the Table 2.1 under non-reactor with operational parameters as Aeration-N and Agitation- U.

Results obtained from the tank filled in Palri village for experimental purpose indicate that about 65 kg dung and 1290 kg soil are capable of decomposing 900 kg village garbage/agricultural residues. Thus, the amount of dung used for decomposition of garbage is about 7%. Experiments have shown (Anderson & Smith, 1987b) that the various agricultural and domestic wastes by virtue of natural contamination, contain the necessary heterogeneous flora required to carry out the composting. Also, in decomposing the agricultural residues, 10% dung was found (Bhardwaj & Gaur, 1985c) almost as effective as the three microbial cultures (e.g. *Aspergillus* sp., *Paecilomyces fuisporus* and *Trichurus spiralis*). This explains very well the decomposition process in the NADEP Tank, where about 7% dung has been used.

Importance of holes in the walls of the tank for natural aeration is also explainable when no turning is practiced. The mycelian layer keeps the compost inside the pile in a thermal stationary phase, which might otherwise prove to be insufficient for the compost pasteurization in the lower parts of the heaps (Le Bozec & Resse, 1987b). Control of aeration and humidity in a compost pile accelerates the maturation process. In the NADEP process such reaction conditions are automatically achieved. The holes provide natural aeration and sprinkling of water through the holes ensures the necessary humidity. Further, composting in static pile with forced aeration demands (Hovsenius & Hovsenius, 1987) that the composting material should have a number of free-pores. NADEP process (with

natural aeration) is extremely important in this context, as any type of biomass/garbage can be converted into compost. However, the number and size of the holes have to be optimized for proper aeration control. As for the sealing of the tank with mud layer and plastering with dung, it is found that this type of sealing may be compared with the sealing by matured compost layer as reported earlier (Zucconni, 1987a). The upper insulated layer of the NADEP tank, in addition to maintaining the thermophilic temperature inside the pile, also acts as a filter layer against odour emission.

It has been reported that the excessive height of the pile (over 3 meter) is not considered optimal as it inhibits adequate aeration (De Bertoldi et al, 1985) and achievement of high temperature in the upper regions of the mass (Finstein & Miller, 1985). This parameter has been taken into consideration in the NADEP process where height of the tank is kept much below this limit. Generally aerated static piles have proved more effective than the windrow systems in terms of pathogen inactivation and nitrogen loss and this is also true for the NADEP process.

5.24 Constraints Faced in the Field Application

NADEP composting certainly provides an effective method of organic manure production. However, during its field testing with farmers in Palri village, following problems were faced indicating some technical and social constraints of this technology requiring further research and development work in this field.

1. Dung availability is more as compared to the other biomass due to several prevalent uses of biomass in this area. This makes it difficult to satisfy the ratio of biomass to dung required in NADEP method. In that case, the farmer can fill the tank only once in a year.

2. It is difficult to fill the tank within 48 hours and seal it.
3. As amount of soil required is very large, transporting the soil to tank site and manure back to field was found difficult.
4. In certain cases, space with air ventilation from all four sides may not be available.

5.25 Research and Development Work

It was felt that these constraints will hamper its extension in the area. Hence it was decided to take up R & D work on NADEP for making it suitable in Palri area, keeping the novel features of this method intact.

Scientific assessment of NADEP technology, carried out and presented in the previous section, enabled us to understand the basic principles of this technology which would help in designing experimental setup for its modifications. Following parameters demanded attention for further research work.

- i) Ratio of dung, biomass and soil.
- ii) Filling time.
- iii) Aeration method under space constraint.
- iv) Tank cost.

5.26 Experimental Work

As NADEP composting requires large amount of biomass including agricultural waste, all the experimental work was carried out in Palri village. Following sets of experiments were designed and conducted.

5.261 First Setup

- (i) Nine sets of experiment were designed for optimizing the above mentioned parameters. Accordingly, tanks with different specifications were constructed. These were filled under different sets of conditions with regard to raw material ratio, filling process, filling time, mode of aeration etc. These are mentioned below.

Tank 1

Same as NADEP original method i.e.

- tank - made of brick above ground
- filling - systematic
- aeration - through holes in all four side walls
- filling time - 48 hr.
- materials - as specified in original method.

Tank 2

- filling time - 6 days
- other conditions same as tank 1

Tank 3

- filling time - 6 days
- materials - dung (~ 50%), biomass and household ash (~ 30%), Soil (~20%)
- filling process - systematic
on a 6" thick layer of dung; biomass and household ash were uniformly spread. Then it was covered with soil.
The tank was filled in this sequence and sealed with 2"



NADEP Tank



A View of R & D Work on NADEP in Palri

thick soil layer. It may be noted that no water was added either during filling or maintenance as is done in original NADEP method.

Tank 4

- filling time - 6 days
- materials - dung (~90%) being the main constituent, biomass and ash (~10%), Soil - nil
- filling process - unsystematic

tank was filled in a similar way as tank 3 except without sealing with soil layer. It may be noted that like tank 3, no water was added at any stage.

Tank 5

- aeration - through holes in 2 side walls only
- other details same as tank 2

Tank 6

- aeration - in addition to holes in 2 side walls, 4 bamboos of 2" dia and 5' length with holes in the middle and on the sides at a distance of 1.5" alternatively, inserted vertically in the tank.
- other details same as tank 2

Tank 7

- tank observations with - 'kuchcha' pit dug under the ground
- filling - unsystematic
- other details same as tank 4

Tank 8

tank - 'kuchcha' pit dug under the ground

filling - systematic

other details same as tank 3

Tank 9

tank - 'kuchcha' pit dug under the ground

filling - systematic

other details same as tank 2

The tanks were filled as per the above specifications and maintained properly according to the given procedure. During the rain the tanks were covered with plastic sheet and uncovered thereafter. It may be noted that available biomass (sugarcane dry leaves being the main constituent), was mixed thoroughly to get a uniform raw material for all the tanks.

Tanks were opened after 4 months and observations with regard to physical appearance of manure, degree of digestion of raw material at different geometry points in the tank, tank structure etc. were made. Based on these observations, tanks were again filled in a similar way except amount of soil in tank 2 and 3. In tank 2, the amount of soil was reduced from 50% to 30%. In view of cracks developed, amount of soil in tank 3 was increased from 20% to 30%.

Tanks were maintained according to the given procedure. After 4 months, these were opened and observations with regard to parameters as mentioned earlier, were made. The whole experiment was evaluated after two trials and on the basis of observations, it was decided to carry out research work on 3 new designs based on changes in filling process

and duration, ratio of raw materials, aeration control etc. and compare these with original NADEP.

5.262 Second Experimental Setup

Tank (a) - same as original NADEP

Tank (b)

filling process - as original NADEP

filling time - 6 days

raw material - dung (20%), soil (30%), biomass (50%)

Tank (c)

all details except mode of aeration are same as tank (b)

aeration - In addition to holes in 2 side walls, 4 bamboos of 2" diameter and 5' length having holes in the middle and on the sides at a distance of 1.5" alternatively, were inserted vertically in the tank.

Tank (d)

filling process - systematic as in tank 3

filling time - 6 days

raw material - dung (50%), soil (30%), biomass and ash (20%)

These tanks i.e. tank (a), (b), (c) and (d) are referred as NADEP I, II, III, and IV respectively in Table 5.1. The experiment was repeated with these tanks two times under similar experimental conditions.

5.27 Analysis of Compost Samples

Compost samples were collected from the second experimental setup according to the procedure given in chapter 4 and analyzed using methods discussed in chapter 4. The results of the analysis are presented in Table- 5.1.

5.3 Heap Manure

Composting by heap method has been done traditionally and hence, is still most prevalent among the farmers. This method is less efficient for solid waste decomposition and totally ineffective in achieving sanitary environment. Further, since it is most widely used method, even a slight improvement in it will contribute significantly in overall manure production. Hence, it is worthwhile to study it from the point of view of making proper modifications.

5.31 Existing Status

Following problems have been observed in this method.

- i) In the absence of proper aeration to microbes, digestion of biomass takes long time and still remains incomplete.
- ii) Manurial value is affected due to flushing of nutrients by rain water as it lies as such under natural weathering conditions.
- iii) It causes unhygienic conditions in the village for both humans and animals

5.32 Experimental Work for Improvement

After serious deliberations and discussions with farmers, efforts were made to overcome these problems, while keeping the simplicity of the method intact. Special attention was given to preventing the loss of nutrients and proper digestion of biomass. Following experiment was designed and carried out. The steps involved are:

- i) A pilot kuchcha pit (underground) of size 10' x 8' x 1' was made. It was filled semi-systematically with dung, biomass, household ash etc. in a similar way as tank 3 except filling duration, in the form of a heap till its height reaches 4' above the ground level. The pit was filled in a normal course (daily) as is done traditionally. Then it was covered with a thick layer of soil. It may be noted that in this case soil was not added as a layer. Also, no water was added either during the filling or maintenance of the tank.
- ii) Arrangement was made to prevent rain water entering into the heap by raising the soil around the heap by 6 inches.
- iii) Material was turned around to provide aeration after every two months and then covered with soil.

It was opened after 8 months. This setup was repeated again under similar conditions.

5.33 Analysis of Compost Samples

Samples for analysis for both the systems i.e. i) experimental heap and ii) traditional unsystematic heap were collected as described in chapter 4. These were analyzed using the standard methods. The results are presented in Table 5.1.

5.4 Biogas Technology

Anaerobic digestion of organic matter is a well known technology which is used to produce biogas from wastes like the animal dung. It must be noted that in addition to the direct energy production in the form of biogas, the digested slurry serves as a valuable fertilizer, thus opening up the possibility of innovation, particularly in India, where animal dung is used as fuel. The optimum process conditions for its digestion have been well

identified for dung as the feed stock for biogas plant. Biogas plants ranging from 1 M³ capacity to 140 M³ capacity have been designed and are in use through out the country. The most popular models are KVIC (floating dome), Janta and Deenbandhu (both fixed dome). Deenbandhu is a modification over Janta model, and costs less due to some design differences. All these models use animal dung as feed stock.

This technology can also take care of human wastes. Some designs for digestion of agriculture residues, food processing waste, weeds etc. as a supplement feed stock are available at lab. scale (Myles, 1984; Barman, 1988). Attention is being paid to solid state digestion for reducing the space requirement and making the handling of digested slurry easier (Chawla, 1986, Vasudevan & Shyamladevi, 1995). However, the breakthrough is yet to come.

Biogas technique has additional advantage over composting in terms of energy available in the form of biogas while preserving the plant nutrient value in the form of slurry. This has significance particularly in the context of Indian villages where a large amount of dung and crop residues are directly burnt as cooking fuel. However, several problems like quality, quantity and pressure of gas, efficiency of biogas burners, slurry handling etc. observed at the field level demand further attention (Santosh et al, unpublished). In the context of present thesis, study is confined to production and utilization of biogas slurry as organic manure.

5.41 Installation of Biogas Plants for Field Study

To begin with one biogas plant (Deenbandhu model) of 3M³ capacity was installed in Palri village. Its performance was evaluated and monitored for 2 years. People in the village got enthused towards this technology and came forward to adopt this model. With the financial support of government 30 biogas plants of varying capacity were put up and

15 were connected with the toilets. In this duration training programs for masons for getting construction details and also for women for its operation and maintenance were organized. Surprisingly, while gas obtained was utilized properly for cooking, maintenance of slurry pit was totally neglected resulting in plant nutrient loss and difficulties in the field application of biogas slurry. Following problems were specifically observed:

- (i) Slurry collection in a 'kuchcha' pit resulted in loss of water soluble nutrients due to seepage
- (ii) Loss of nitrogen in slurry due to volatilization in hot weather
- (iii) Slurry being wet, difficulty in transportation to the field

Keeping this in view attention was focussed on developing a suitable method for biogas slurry treatment.

5.42 Biogas Slurry Treatment

It was found through literature survey (chapter 2), that not much work has been done in the area of slurry management. Hence attention was paid to the above mentioned problems observed under the field conditions.

5.43 Experimental Work

Experiment was designed to solve these problems and a new method based on NADEP principles was developed.

Outlet slurry tank was divided into two parts and used alternatively. In one part biomass (containing leaves, grasses, straw, etc. and ash), around 15% by weight of slurry biomass (containing leaves, grasses, straw, etc. and ash), around 15% by weight of slurry to be collected was spread on the bottom to a height of 9" to 1'. Slurry was then allowed to flow over this layer in the tank till it spreads evenly on the biomass to an approximate thickness of 6". Then, soil amounting equal to biomass was spread over it. Finally

miscellaneous biomass i.e. cattle yard garbage, available daily (roughly amounting to 15-20% of slurry) was also added in the tank.

This sequence of filling was repeated till the tank was filled. Finally, it was covered with a layer of soil. In summer, it was further covered with leaves and grasses to avoid fast drying. The bamboos having holes were inserted vertically at specific distances. The tank was left undisturbed for three months, Then it was opened and slurry was mixed properly. After filling the first part of tank, another part was filled in a similar way and maintained. It may be noted that unlike NADEP method, no water is used at any stage of the entire process including maintenance.

5.44 Analysis of Slurry Samples

Samples of untreated as well as treated slurry were collected and analysis was done as mentioned in chapter 4. The results are presented in Table 5.1.

5.5 Results and Discussions

Results obtained from experimental work related to NADEP composting, Heap manure and Biogas slurry treatment are presented in Table 5.1. Analytical data is matching well with earlier studies (Le Bozec & Resse, 1987a ; Gaur et al, 1984a). Amount of Potash in samples of NADEP IV and Pilot NADEP as compared to other samples may be due to the addition of household ash during the filling process. A close analysis of data reveal important achievements in the context of organic manure production and utilization.

Technical and social constraints associated with NADEP technology under a given habitat situation can be tackled very well through the newly developed designs. For example, duration of filling the tank can be increased from 48 hours to 6 days without affecting the efficiency of decomposition process as seen in terms of its C/N ratio and

Nutrient Content of Different Types of Organic Manure

S.NO.	Sample	pH	C/N	N %	P %	K %
1.	NADEP Compost I	7.0	14.05	1.40	0.71	0.80
2.	NADEP Compost II	7.1	13.21	1.37	0.73	0.78
3.	NADEP Compost III	7.1	13.28	1.42	0.68	0.86
4.	NADEP Compost IV*	7.0	11.64	2.10	1.05	1.12
5.	Pilot NADEP Compost	7.4	14.78	1.15	0.57	1.18
6.	Biogas Slurry	7.2	11.21	2.05	0.95	0.99
7.	Treated Biogas Slurry	7.0	11.90	1.76	0.77	0.81
8.	Improved Heap Manure	7.1	11.14	1.98	0.85	0.89
9.	Traditional Heap Manure	7.3	15.45	0.72	0.36	0.51

*Now named as *PALRI METHOD* of composting.

Table 5.1

manurial value (Table 5.1). With regard to the raw material ratio in original NADEP, it is found that amount of dung can be increased from 5% to 20% and that of soil can be reduced from 50% to 30-35%, thus solving the major problem related to biomass (including agricultural residues) availability on one hand and transporting the large amount of soil on the other. Further, in case of non availability of space for aeration from all four sides of the tank, proper aeration can be provided using bamboos with holes.

However, efforts made to simplify the process to a great extent, i.e. just dumping the available dung, biomass, household ash etc. in the tank like traditional heap and covering with mud layer proved unsuccessful. The tank developed cracks possibly due to large amount of heat generated during the process which in case of the original NADEP seems to be absorbed in the soil layer in between. Also, some amount of dung remain undigested even after 6 months. Interestingly, if systematic filling using increased amount of dung (50%) along with 20% biomass and household ash and 30% soil is done, (tank d referred as NADEP IV), no problem of cracks in the tank is observed. In fact, this seems to be best among the designs evolved in view of i) simplicity of filling process, ii) no requirement of extra water at any stage in entire process including maintenance and iii) use of large percentage of dung, a resource plentifully available in this area.

All these results indicate towards the importance of systematic filling process and manifold utility of using substantial amount of soil. Further work may be taken up in this direction.

In case of heap method, modifications suggested based on experimental work are really encouraging. With slight modification especially systematic filling of the pit, then covering it with thick layer of soil and intermittent turnings for aeration proved quite effective in increasing the efficiency of digestion process. It may be due to the fact that

uppermost covering with soil bring the system in a thermal stationary phase necessary for proper decomposition of dung and biomass. Simple method of raising soil mound around the heap may help in checking the entry of rain water in the pit thus reducing the possibility of loss of plant nutrients due to flushing with rain water. Finally covering the heap with soil layer will result in better sanitary environment in the surroundings. Aeration through bamboo having holes may be tried out in place of intermittent turnings as future research work.

Finding the application of NADEP principles for developing a new method for biogas slurry treatment is really remarkable. Problems associated with slurry handling can easily be solved by this method. Adding biomass, soil, household ash etc. results in almost doubling the quantity of manure while preserving the nutrient percentage as in untreated slurry. Similar observations have been made in the literature. For example, influence of treatment methods on the properties of slurry has been reported (Vetter, 1987). Cofermentation of slurry with organic waste from food processing industries also seems to give similar results (Weber 1993). Finally, aerobic digestion of slurry coming out of biogas plant before taking it to the agriculture field, would reduce the possibility of harmful effect, if any, on the soil micro ecosystem.

A close analysis of the new design of composting NADEP IV, hereby named as *PALRI METHOD* of composting, and improved method of heap manure reveal that with increased amount of dung (50%) and less biomass (~20%), no extra water is required at any stage in the entire process including maintenance. In fact, it is one of the important aspects, specially in situation of water scarcity where original NADEP may not be simply acceptable due to huge water requirement. Further, in this context, *PALRI METHOD* of composting seems to be superior to improved heap manure as no turning for aeration is required in the former.

Chapter 6

INDIGENOUS SEED BASED ORGANIC FARMING

6.0 Introduction

Wheat (*Triticum aestivum*) is an important crop of Green-Revolution belt around the Palri village, the area under study. A brief analysis based on literature survey (Chapter 2) reveals that studies related to indigenous seed and its potential in alternative agriculture system are scanty. Hence, it was considered important to focus attention on this aspect of the newly developed system of *Avartanshil* Agriculture. This chapter deals with the study and experimental work carried out on two combinations viz indigenous seed (C-306) - organic manure and HYV (HD-2329)- chemical fertilizer for a period of 5 consecutive years. In the context of organic manure, efficacy of three types of materials namely heap manure, NADEP compost and biogas slurry with both the systems has been studied. In addition to recording the data for total production, attention is given to evaluate the fertility of soil, an important resource base for agriculture.

6.1 Experimental Work

6.11 Experimental Setup

Experiment was conducted at the Micromodel complex of I.I.T. Delhi (see section 4.1 for details). The land was cleared and prepared for cultivation.

6.111 Plot Design and Assignment

Experimental setup for both the systems i.e. with Indigenous wheat seed (C-306) and HYV (HD - 2329) was designed under 5 different treatments given to each one of them. These 5 treatments correspond to-

- i) CON - Control

- ii) N.C. - NADEP Compost
- iii) B.G.S. - Biogas Slurry
- iv) H.M. - Heap Manure
- v) C.F. - Chemical Fertilizer

These 5 treatments are termed as T0, T1, T2, T3, T4 respectively. One set of experiment is conducted with HYV seeds while it is repeated 2 times in case of Indigenous seeds to ensure the higher accuracy of the result. Thus, we have 5 treatments corresponding to HYV seeds and 5 treatments with two replications corresponding to indigenous seed with the result that total adds up to 15. Therefore, 15 plots were taken for the experimentation.

The experiment was conducted in these 15 plots each of area $5\text{m} \times 4\text{m} = 20\text{m}^2$. Selection of treatment and its assignment to a particular plot was made according to the standard procedure of random block design. Other conditions were kept similar in all plots. An outlay of the plots and the seed variety and treatment given to each plot is given in Fig 4.1.

6.112 Time Reference

The Rabi crop was taken every year in the period of October-April and repeated for a period of 5 years from 1988-1989 to 1992-1993.

6.113 Soil Analysis

The physico-chemical properties of the soil of the experimental field were analyzed according to standard methods discussed in chapter 4. It is a sandy loam soil having 55.77% sand, 31% silt, and 13% clay. Soil has high percentage of Calcium Carbonate content and pH as 8.3. Micro and macro nutrients status of the soil was also analyzed and is presented in Table 6.1

S.No	Soil Properties	Values	
		0-15 cm.Depth Soil	15-30 cm. Depth Soil
1.	pH	8.30	8.60
2.	E.C.	0.33	0.17
3.	O.C.	0.44%	0.26%
4.	Available P ₂ O ₅ (ppm)	16.00	8.10
5.	Available K (ppm)	106.00	98.00
6.	Cu (ppm)	0.88	0.63
7.	Fe (ppm)	3.18	3.25
8.	Zn (ppm)	2.51	0.45
9.	Mn (ppm)	23.25	24.25

Table 6.1

Nutrient Content of Different Organic Manures and Fertilizers Used

Year	Treatment	pH	N %	P %	K %	C/N
1988-89	T1 - NADEP Compost	7.7	0.90	-	-	17.58
	T2 - Heap Manure	7.6	0.60	-	-	13.84
	T3 - Biogas Slurry	7.4	0.80	-	-	18.80
1989-92	T1 - NADEP Compost	7.0	1.40	0.71	0.80	14.05
	T2 - Heap Manure	7.3	0.72	0.36	0.51	11.14
	T3 - Biogas Slurry	7.0	1.76	0.77	0.81	11.90
1988-92	T4 - Chem. Fert. DAP Urea	-	18.00	46.00	-	-
		-	46.00	-	-	-

Table 6.2

6.12 Materials Used

6.121 Analysis of the Organic Manure

In order to calculate the amount of different manures viz Heap manure, Biogas slurry and NADEP compost, to be used in the experiment, these were analyzed for their NPK content. Their quality was also assessed in terms of pH and C/N ratio. The dose for each manure was decided on the basis of its nitrogen content. It may be noted that in the first year i.e. 1988-89, the work was started with the then available manures, however, in the subsequent years i.e. 1989-93, the manures generated under controlled experimental conditions were used. Data obtained for the above two sets of samples for 1988-89 and 1989-93 are presented in Table 6.2.

As mentioned earlier the 5 treatments given to seeds are termed as T0, T1, T2, T3, T4. The desirable dose of Nitrogen and Phosphorous was kept at 100 kg. and 50 kg. per ha. respectively. Since the amount of potash was already sufficient in the soil, no Potash was added. The quantity of Phosphorous required was automatically satisfied in all three types of organic manure. Required quantities of organic manure per plot were as follows.

Manure/Fertilizer	1988-89	1989-93
N.C.	22.22 kg.	14.28 kg.
H.M.	33.33 kg.	27.78 kg.
B.G.S.	25.00 kg.	11.36 kg.
C.F.	0.21 kg DAP	0.21 kg DAP
	0.35 kg Urea	0.35 kg Urea

6.122 Seeds- Indigenous and HYV

Two types of seeds, namely indigenous C-306 and HYV- HD 2329, procured from

genetic division of IARI, New Delhi, were used. 5 treatments were applied to each variety, with a repetition in case of indigenous one. Details of the type and properties of seeds are discussed in chapter 4.

6.13 Experimental Procedure

In the month of September of the first year i.e. 1988-89, the land was ploughed twice and leveled with the help of tractor. It was irrigated once. At an appropriate time, the land was ploughed with spade. Ploughing was done again after adding organic manure or chemical fertilizer as per the scheme given in Fig 4.1. Seeds were sown. Finally, the land was leveled manually. Five treatments were applied to each variety of seed, with a repetition in case of indigenous one, thus making a total of 15 cases. Based on the amount of Nitrogen available in organic manure, the quantity required for every plot was decided as mentioned earlier. Specific practices used in sowing, irrigation, weed control etc. are as follows.

- (a) Physical Protection- The plot was in a isolated place and hence wire fencing was used to protect it from the animals. Nylon net at a height of 6 feet was used to protect the crop from birds during the maturing stage.
- (b) Sowing of the crop- The seed rate for both varieties and for all treatments was kept same at 250 gm. for each plot. Both the varieties were sown at the same time- roughly in the 2nd/ 3rd week of November, every year. The seed was broadcast evenly and it was ploughed with spade.
- (c) Irrigation- Number of irrigation was kept same for all the plot. Generally, every plot was irrigated 6 times, however, when there was rain in time, number of irrigation was reduced by 1.



R & D Work at Micromodel, IIT, Delhi



(d) **Weed and disease control-** Manual weeding was done during the crop period to remove some wild-grasses. No treatment of pesticides or insecticide was given either to the seeds or to the crops.

(e) **Harvesting and Thrashing-** Harvesting was done during 15-20th April every year. First three years thrashing was done manually, however, in last two years, it was done using a mini thrasher.

The production of wheat and straw in each plot was measured and documented in Table 6.3. Same procedure except tractor ploughing was followed in the subsequent years.

6.14 Analysis of Soil Samples

After 5 years, the soil samples of each treatment were analysed for its fertility status. Data is presented in Table 6.8.

Data regarding production of grain and straw were statistically analysed.

6.2 Results and Discussion

6.21 Yield of Wheat and Straw

Yields of wheat and straw for HYV and indigenous seed obtained for different treatments for period of a 5 years are tabulated in Table 6.3,

6.211 Statistical Analysis

The data was analysed by the method of variance. The Standard Error of Mean and Critical Difference (C.D.) were calculated at 5% and 1% level of significance wherever 'F' Test was found significant (Pansey & Sukhatme, 1954). Results are presented in the following tables.

Table 6.4- Analysis of Variance (ANOVA) for wheat & straw yield

Yield of Wheat & Straw for C-306 and HD-2329 Under Different Treatments
(in Kg./ 20 m² plot)

Yr. 1988-89				Yr. 1989-90			Yr. 1990-91			Yr. 1991-92			Yr. 1992-93		
Pl. No.	W	S	W+S	W	S	W+S	W	S	W+S	W	S	W+S	W	S	W+S
1.	6.17	10.35	16.52	5.10	8.52	13.62	4.70	7.88	12.58	3.90	6.43	10.33	3.50	6.00	9.50
2.	7.34	11.42	18.76	7.00	10.13	17.13	6.30	11.26	17.56	6.45	9.77	16.22	6.72	10.62	17.38
3.	7.84	11.91	19.75	7.35	10.73	18.08	6.94	11.08	18.02	6.15	10.57	16.72	6.67	9.99	16.66
4.	7.59	11.25	18.84	7.90	12.03	19.93	7.25	10.79	18.04	6.80	10.33	17.13	7.17	11.60	18.77
5.	9.53	13.15	22.68	9.00	12.90	21.90	8.50	12.46	20.96	7.73	11.85	19.58	8.02	12.25	20.25
6.	7.15	15.65	22.80	6.61	12.75	19.36	6.00	13.00	19.00	5.48	11.19	16.67	4.50	9.13	13.63
7.	7.60	17.03	24.63	7.92	15.10	23.02	7.33	16.22	23.55	7.50	15.15	22.65	6.83	16.30	23.13
8.	8.76	16.55	25.31	8.32	15.18	23.50	7.62	14.82	22.44	8.07	13.65	21.72	7.82	13.85	21.67
9.	9.12	16.20	25.32	8.10	13.90	22.00	7.60	13.15	20.75	8.70	14.37	23.07	8.61	14.73	23.34
10.	8.80	15.75	24.55	8.45	14.49	22.94	8.25	14.90	23.15	7.90	13.25	21.15	8.30	13.65	21.95
11.	8.32	15.60	23.92	8.15	16.20	24.35	7.95	15.40	23.35	8.23	16.60	24.83	8.55	15.15	23.70
12.	8.80	17.15	25.95	7.80	14.90	22.70	8.25	15.18	23.43	8.40	16.21	24.61	8.60	15.25	23.85
13.	9.00	16.15	25.15	8.31	14.89	23.20	7.95	15.30	23.25	7.75	14.11	21.86	8.29	15.05	23.34
14.	7.27	17.72	24.99	8.01	15.73	23.74	6.81	16.65	23.46	7.31	16.05	23.36	6.97	15.55	22.52
15.	7.25	15.03	22.28	7.00	14.75	21.75	6.27	13.00	19.27	5.72	12.45	18.17	5.38	12.38	17.76

W = Wheat,

S = Straw,

Pl. = Plot

Table 6.3

Analysis of Variance (ANOVA)

Source of Variation	d.f.	WHEAT			STRAW			WHEAT+STRAW			F. Table Value	
		S.S.	M.S.S.	F.Cal.	S.S.	M.S.S.	F.Cal.	S.S.	M.S.S.	F.Cal.	5%	1%
Replication	4	9.77	2.44	-	34.68	8.67	-	84.09	21.02	-	-	-
Variety (V)	1	10.90	10.90	49.54	295.88	295.88	439.97	329.63	329.63	354.44	4.00	7.08
Treatment (T)	4	58.56	14.63	66.50	105.88	26.45	39.33	236.15	59.04	63.48	2.53	3.65
V x T	4	17.31	4.33	19.67	9.09	2.27	3.37	148.74	37.19	39.98	2.53	3.65
Variety V ₂	1	0.02	0.02	0.09	10.11	10.11	15.03	10.66	10.66	11.46	4.00	7.08
Treatment Within V ₂	4	0.53	0.13	0.60	5.33	1.33	1.97	9.66	2.41	2.59	2.53	3.65
Error	56	12.36	0.22	-	37.66	0.67	-	52.12	0.93	-	-	-
Total	74	109.45	-	-	498.56	-	-	871.05	-	-	-	-

d.f. = degree of freedom
 S. S. = Sum of square.
 M.S.S. = Mean sum of square

Table 6.4

Table 6.5- Average yield of wheat and straw over a period of 5 years. with different treatments (T0 to T4)

Table 6.6- Critical Difference (C.D.) at 5 % obtained from above data for variety & treatment

Results obtained above for Wheat and Straw yield have been rearranged in descending order to make it self explaining. It is presented in Table 6.7.

6.212 Conclusions

Based on the experimental data for 5 years, certain important conclusions could be drawn as follows:

- (1) Table 6.5 clearly indicates that the yields of wheat and straw both under T1, T2, T3, T4 treatments (O.M. and C.F.), were significantly higher than T0 (no manure) in HYV as well as indigenous seed.
- (2) It also shows that under CONTROL (T0) condition, the yields of both wheat and straw is higher in indigenous seed than in case of HYV
- (3) For Wheat, data in Table 6.7 shows that-
 - (i) For HYV, the yield of grain under Treatment T4 (CF) is significantly higher than under T2, T3, T4, (OM). Significant Difference exists between the yield under T3 (B.G.S.) and T1 (NC).
 - (ii) However, in case of indigenous variety, the result is quite different i.e. Yields of the grain under T1, T2, T3 (OM) is significantly higher then under T4 (CF). No significant difference exists between T1, T2, T3.
- (4) For straw, data in Table 6.7 indicates that

Average Yield of Wheat & Straw (Over a Period of 5 Years)
(in Kg/20m² plot and the equivalent value in Q/ha in parenthesis)

Treatment	WHEAT		STRAW		WHEAT+STRAW	
	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂
To (CON.)	4.67 (23.35)	6.14 (30.70)	7.84 (39.20)	12.93 (64.65)	12.51 (62.55)	19.07 (95.35)
T ₁ (N.C.)	6.76 (33.80)	8.18 (40.90)	10.64 (53.20)	15.30 (76.50)	17.40 (87.00)	23.47 (117.35)
T ₂ (H.M.)	6.99 (34.95)	8.40 (42.00)	10.86 (54.30)	15.10 (75.50)	17.85 (89.25)	23.50 (117.50)
T ₃ (B.G.S.)	7.34 (36.70)	8.30 (41.50)	11.20 (56.00)	14.75 (73.75)	18.54 (92.70)	23.01 (115.05)
T ₄ (C.F.)	8.56 (42.80)	7.36 (36.80)	12.52 (62.60)	16.15 (80.75)	21.17 (105.87)	23.50 (117.50)
Mean	6.84 (34.20)	7.67 (38.35)	10.61 (53.05)	14.85 (74.25)	17.48 (87.40)	22.51 (112.55)

Variety V₁ = H.D. - 2329 Variety V₂ = C - 306

Table 6.5

Critical Difference (C.D.)(Corresponding to yield in Kg./20m² and in Q/ha. in parenthesis)

C.D.	WHEAT		STRAW		WHEAT + STRAW	
	Variety	Treatment	Variety	Treatment	Variety	Treatment
at 5%	0.265	0.419	0.464	0.733	0.545	0.862
	(1.325)	(2.095)	(2.320)	(3.665)	(2.725)	(4.310)

Table 6.6**Yield in Descending Order for Both Varieties**

WHEAT					
V ₁ (H.D. 2329)	T ₄ (C.F.)	T ₃ (B.G.S.)	T ₂ (H.M.)	T ₁ (N.C.)	T ₀ (CON.)
C.D. = 2.095	42.80	36.70	34.95	33.80	23.35
V ₂ (C-306)	T ₂ (H.M.)	T ₃ (B.G.S.)	T ₁ (N.C.)	T ₄ (C.F.)	T ₀ (CON.)
C.D. = 2.095	42.00	41.50	40.90	36.80	30.70

STRAW					
V ₁ (H.D. 2329)	T ₄ (C.F.)	T ₃ (B.G.S.)	T ₂ (H.M.)	T ₁ (N.C.)	T ₀ (CON.)
C.D. = 3.665	62.60	56.00	54.30	53.20	39.20
V ₂ (C-306)	T ₄ (C.F.)	T ₁ (N.C.)	T ₂ (H.M.)	T ₃ (B.G.S.)	T ₀ (CON.)
C.D. = 3.665	80.75	76.50	75.50	73.75	64.65

Table 6.7

- (i) Yield of straw under T4(CF) is significantly higher than those under T1, T2, T3 (OM) for both for HYV and indigenous seed.

(5) For both wheat and straw

- (i) For HYV, the total yield is significantly higher in case of T4 (CF) as compared to T1, T2, T3 (OM).

- (ii) For indigenous variety, the total yield is not significantly different in all four conditions T1, T2, T3, and T4.

- (6) Average yield of wheat (averaged over five years) in case of indigenous variety (42.0 Q/ha) is comparable to that in case of HYV (42.8 Q/ha). However, average yield of wheat (averaged over all treatments) in case of indigenous variety (38.3 Q/ha) is significantly higher than that in case of HYV (34.2 Q/ha).

Yield of grain in case of HYV is higher only with chemical fertilizer while in the remaining cases of organic manure and control, it is higher with indigenous seed.

- (7) Average yield of straw is also significantly higher for indigenous seed.

- (8) Total yield (grain + straw) is higher with indigenous seed for each of the five treatments.

In case of HYV, the higher yield with chemical fertilizer as compared to organic farming is in accordance with the findings of Besson (Besson et al, 1988). Studies have also shown that comparable yield is obtained with organic manure or combination of organic manure and chemical fertilizer (Asnakew & Tekaligne, 1991; Daiz et al, 1990). Studies also confirm that indigenous varieties give lower yield with chemical fertilizer as compared

Analysis of Soil After 5 Years Crop Production

Variety $V_1 = \text{H.D.-2329}$

0-15 cm. Depth										
S. No.	Treatment	pH	E.C.	O.C. %	P_2O_5 (ppm)	K (ppm)	Cu (ppm)	Fe (ppm)	Zn (ppm)	Mn (ppm)
1.	CON.	8.4	0.39	0.26	8.5	60	0.61	3.36	2.02	21.73
2.	N. C.	8.2	0.48	0.48	16.0	80	0.88	3.45	3.24	27.53
3.	H.M.	8.3	0.58	0.52	19.1	89	0.95	4.09	3.00	28.20
4.	B.G.S.	8.4	0.62	0.50	26.0	85	1.03	4.80	3.90	31.00
5.	C.F.	8.5	0.43	0.22	28.0	61	0.62	3.20	1.90	19.10
15-30 cm. Depth										
1.	CON.	8.7	0.23	0.24	6.1	80	0.53	2.60	0.20	20.96
2.	N. C.	8.5	0.30	0.29	9.0	84	0.62	3.00	0.45	28.60
3.	H.M.	8.6	0.31	0.30	11.0	91	0.67	3.33	0.50	26.10
4.	B. G. S.	8.6	0.33	0.32	13.0	96	0.85	3.90	0.60	29.00
5.	C.F.	8.8	0.29	0.18	14.0	85	0.51	2.50	0.17	19.17

Table 6.8a

Variety $V_2 = \text{C-306}$

0-15 cm. Depth										
S. No.	Treatment	pH	E.C.	O.C. %	P_2O_5 (ppm)	K (ppm)	Cu (ppm)	Fe (ppm)	Zn (ppm)	Mn (ppm)
1.	CON.	8.3	0.37	0.34	14.6	65	0.72	3.45	2.13	23.25
2.	N. C.	8.1	0.50	0.53	23.0	85	0.95	4.17	3.52	28.60
3.	H.M.	8.2	0.48	0.58	21.3	81	1.02	4.37	3.36	28.20
4.	B.G.S	8.2	0.57	0.62	30.0	95	1.37	5.05	4.64	31.30
5.	C.F.	8.4	0.43	0.31	34.0	66	0.68	3.35	2.10	20.25
15-30 cm. Depth										
1.	CON.	8.6	0.26	0.26	7.5	86	0.56	2.61	0.29	21.00
2.	N.C.	8.4	0.32	0.29	11.5	90	0.60	3.30	0.50	26.00
3.	H.M.	8.5	0.30	0.32	12.0	96	0.83	3.59	0.57	26.45
4.	B.G.S.	8.5	0.36	0.31	14.0	98	0.90	4.00	0.70	38.61
5.	C.F.	8.7	0.29	0.22	17.0	80	0.56	2.60	0.22	20.00

Table 6.8b

to HYV (Sidhu, 1972). No literature, however, seems to be available on the comparative study of HYV- chemical fertilizer combination and indigenous seed- organic manure combination. The results obtained in the present study on this account are quite important and they show that even purely in terms of productivity, indigenous seed- organic manure system is comparable to HYV- chemical fertilizer system. Detailed evaluation on the basis of economic, ecological and other points of view is presented in chapter 8.

6.22 Soil Fertility Status

Macro and Micro nutrient content of the soil of each of the set was analysed after 5 years of experimentation. The results are compiled in Table 6.8.

Results obtained through soil analysis are very revealing. Interestingly enough, in case of indigenous seed-organic manure system, native fertility of the soil seems to be getting regenerated. In fact improvement in soil fertility status even with HYV, with the use of organic manure, mulching etc. has been reported by several authors from different countries (Yang et al, 1992; Poutala et al, 1994; Ryan et al, 1994; Prugar, 1994). However, the distinguished fact observed in case of indigenous seed is that the genetic properties of this indigenous cultivar with organic manure could help in regenerating the micro ecosystem in the soil, resulting in the restoration of the native fertility of soil. It may not be surprising; as micro ecosystem which is quite powerful in deciding the soil fertility status, is likely to influence the availability of certain micro nutrients present in the soil resource reserve. This micro ecosystem is certainly hampered by the use of using chemical fertilizers and pesticides. For establishing this wonderful capability of indigenous cultivars, intensive as well as extensive R & D work is required. This indicates the future scope of research work in this direction in the context of *Avartanshil* Agriculture system.

FIELD STUDIES AND TECHNOLOGY TRANSFER

7.0 Introduction

Research and development work related to agriculture is meaningful only if it finds way in the field of the farmers. Field testing, therefore, is a must to ensure that the results of research are equally valid even in the field conditions. If this is verified, the next step would be to take it to the farmers and the agencies responsible for agricultural policy in the country. In fact research and development and field testing/technology transfer is an interactive two way process. It provides an opportunity to scientific community to incorporate the time tested indigenous local knowledge in the overall R & D system thus enhancing the quality and utility of the research work. This aspect is especially true in case of rural technology in general and agriculture in particular. Such a synergetic system will be based on ground realities and would give inner satisfaction to the research team.

Keeping this in view, it was decided that the important results of the present research work should not remain limited to the laboratory. To ensure this, the difficult task of field testing was also taken up.

In this chapter, methodology for field testing and technology transfer for NADEP composting and indigenous seed based organic farming are discussed and final outcome in terms of its impact is also presented.

7.1 Methodology

The results of the experimental work on organic manure production and utilization discussed in chapter 5 and on indigenous seed based organic farming in chapter 6 were so encouraging that it motivated us and the farmers involved during experimentation in

Palri village, to go for the pilot testing (Field testing) and technology transfer in and around Palri village. To be more precise, since the experimental work on organic manure production and utilization was carried out in the village Palri with the participation of the selected farmers, in the very process of experimentation, the farmers started using these manures in their agricultural field and thus the process of field testing started in a natural way. However, systematic work on this aspect started since February 1991 and the work on technology transfer (on a limited scale) followed a year after.

The results obtained from field testing and technology transfer were so promising and encouraging that it found way not only in scientific community, but could create an impact at the policy level.

7.11 Site Selection and Person Identification

Palri village was selected for field testing for the reasons described in chapter 4 and also for the obvious reason that during the conduction of experimental work on organic manures (i.e. NADEP composting and Biogas technology), a close interaction developed with the farmers and they were quite willing and enthusiastic to try out new methods.

Five farmers were identified to work with this process of field testing on the basis of-

- (i) Their willingness to adopt new methods.
- (ii) Their confidence on us and readiness to cooperate with us.
- (iii) Their knowledge and better organizational capacity.

Details of the identified farmers are as below-

1. Babu Narayan Singh, retired as a cashier in Sugarcane Cooperative Society
2. Shri Karam Singh, a progressive educated farmer

3. Master Raj Singh, a school teacher and farmer.
4. Shri Rajbir Panchliwale, an educated farmer.
5. Shri Rakesh Kumar, an educated small farmer.

It may be noted that in the process of technology transfer, in view of the interaction and contacts of the author in several villages in different districts of western U.P., large number of farmers participated in meetings and training programs organized in Palri village. Some of them took up these technological packages in their respective villages. This greatly helped us in understanding the feasibility of these technologies in different agro-climatic and socio-cultural conditions.

7.2 Field Studies

7.21 NADEP Technology

Details of the process adopted in introducing NADEP technology is discussed in this section. Original method of NADEP composting was adopted. Some minor modifications to suit the local conditions of the farmers were made.

7.211 Setting up of a Pilot Plant

Three farmers Shri Karam Singh, Shri Narayan Singh and Shri Rakesh Kumar, were selected for this work. In each family, NADEP tank of size 8'x 5'x 3' was constructed. Tank was filled by the family members of the farmers under our direct supervision.

Seasonally available biomass of which sugarcane leaves formed the main constituent, was used as basic raw material. The amount of soil was kept at 35% and that of dung at 10%. Water used was 15% more than the weight of biomass. Tank was filled according to the standard NADEP procedure within 48 hours.

7.212 Operational Maintenance and Monitoring

All the three tanks were maintained according to the given procedure. About 10-15 liters of water was sprinkled through holes in the side wall (i.e. ventilators) two times in a month at an interval of about 10 to 15 days. Cracks which developed on the upper sealing were filled with dung and soil paste.

Tanks were opened after 100 days. In all three tanks, almost all the biomass except some sugarcane trash and tree twigs, was properly digested. Compost was taken out of the tank, mixed thoroughly and then piled up in the form of a heap. Ten samples were collected from each of the three heaps and mixed together to form one group of sample. This sample was analyzed using the procedure discussed in chapter 4. This is referred as Pilot NADEP compost in Table 5.3.

The heap was covered with a layer of soil and water was sprinkled over it intermittently. It was left for 15-20 days and then used in the field.

7.22 Indigenous Seed based Organic Farming

Similar steps as in NADEP composting were followed in case of indigenous seed based organic farming.

7.221 Setting up of Pilot Level Experiment

Four farmers namely Shri Narayan Singh, Shri Karam Singh, Master Raj Singh, Shri Rajbir Panchliwale were selected for this work. Except Mr. Raj Singh, who did not use any manure for last 5 years, other farmers used organic manure every alternate year. Each farmer provided two bighas (1 acre = 4.75 bigha, a local unit of measurement) of land for the pilot testing. One bigha was used for indigenous seed C-306 with organic manure and the other one was used for HYV seed HD-2329 with chemical fertilizer. Details about

the land area, seed, manure, irrigation etc. used by each of the farmers are given in Table 7.1.

7.222 Monitoring and Evaluation

Farmers were contacted regularly for data record and other observations. It was found that these farmers used different amount of organic manure and chemical fertilizer for indigenous and HYV seeds respectively. Similarly, different amounts of irrigation were given to the crops by these farmers. Details are given in Table 7.1.

The field testing was started in the year 1992-93 and was continued for three years consecutively. It may be noted that due to several reasons farmers could not confine to the same plot. Further, conditions like amount of manure, fertilizers and number of irrigation varied to some extent. All these have been recorded properly. However, Shri. Karam Singh and Shri. Narayan Singh could maintain the same plot for the entire period of field testing.

7.223 Results and Discussions

The results of pilot level testing of NADEP technology were quite encouraging which raised the enthusiasm of the farmers. Its scope, utility and popularization at large scale was discussed in a meeting of interested farmers. It revealed some technical as well as social constraints in the large scale popularization of this technology. In fact, these results paved way for further R & D work, which was taken up and presented in chapter 5.

Production of wheat in the fields of every farmer were recorded. The results of all the three years from 92-93 to 94-95 are presented in the same Table 7.1.

Average Yield of Wheat Production Under Systems A & B
(Results obtained in Field - Testing)

Ran Sinh PhD - IITD_c

S. No	Name of Farmers	Year	O.M. (Q/ Bigha)		C. F. (Kg/ Bigha)		Irrigation		Wheat (Q/Bigha)		Straw (Q/Bigha)	
			V ₂	V ₁	V ₁		V ₂	V ₁	V ₂	V ₁	V ₂	V ₁
					D.A.P.	Urea						
1.	Narayan Singh	1992-93	20	-	6	15	4	5	3.10	3.20	6.00	4.20
2.	Karam Singh		25	25	5	8	3	5	2.88	2.92	5.68	3.96
3.	Raj Veer		-	-	-	10	4	5	2.80	2.88	5.40	3.80
4.	Raj Singh		-	-	8	15	2	4	2.42	2.60	5.20	3.20
1.	Narayan Singh	1993-94	30	-	7	15	4	5	3.44	3.60	6.20	5.00
2.	Karam Singh		20	20	5	15	3	5	3.38	3.28	6.08	4.52
3.	Raj Veer		15	-	10	18	3	4	2.94	2.60	5.60	3.40
4.	Raj Singh		-	-	-	-	-	-	-	-	-	-
1.	Narayan Singh	1994-95	8	8	6	20	3	4	3.04	3.20	5.72	4.16
2.	Karam Singh		12	-	10	20	4	5	3.24	3.40	6.32	4.48
3.	Raj Veer		-	-	-	-	-	-	-	-	-	-
4.	Raj Singh		10	-	10	16	3	4	2.76	3.20	5.60	4.00
Average			14.0	5.3	6.7	15.2	3.3	4.5	3.00	3.09	5.78	4.07
Average production (Q/ha)									36.00	37.08	69.36	48.84

System A : Indigenous seed (V₂)- organic manure

System B : HYV (V₁)- chemical fertilizer

Area under cultivation = one bigha (for every farmer under each system)

Table 7.1

The results obtained were quite encouraging (the details of productivity and economic aspects are discussed in chapter 8). In field testing, yield of wheat as high as 3.44 Q/bigha (41.28 Q/ha) has been achieved with indigenous seed-organic manure system; while highest yield with HYV-chemical fertilizer system is 3.60 Q/bigha (43.20 Q/ha). The average yield in first system of 3.00 Q/bigha (36.00 Q/ha) is comparable to a yield of 3.09 Q/bigha (37.08 Q/ha) in the second. This result confirms our experimental results discussed in detail in chapter 6 and is in accordance with the findings of Asnakew, Daiz etc. (Asnakew & Tekaligne, 1991; Daiz et al, 1990). Farmers also reported that the indigenous seed organic manure system requires less amount of irrigation (3 to 4 times) as compared to that in HYV (4 to 5 times). Further, farmers reported improvement in the soil properties like texture, water retention capacity etc. in case of indigenous seed organic manure system. This improvement in soil properties is in tune with the findings in case of organic manure (Poutala et al, 1994; Yang et al, 1992b).

7.3 Technology Transfer

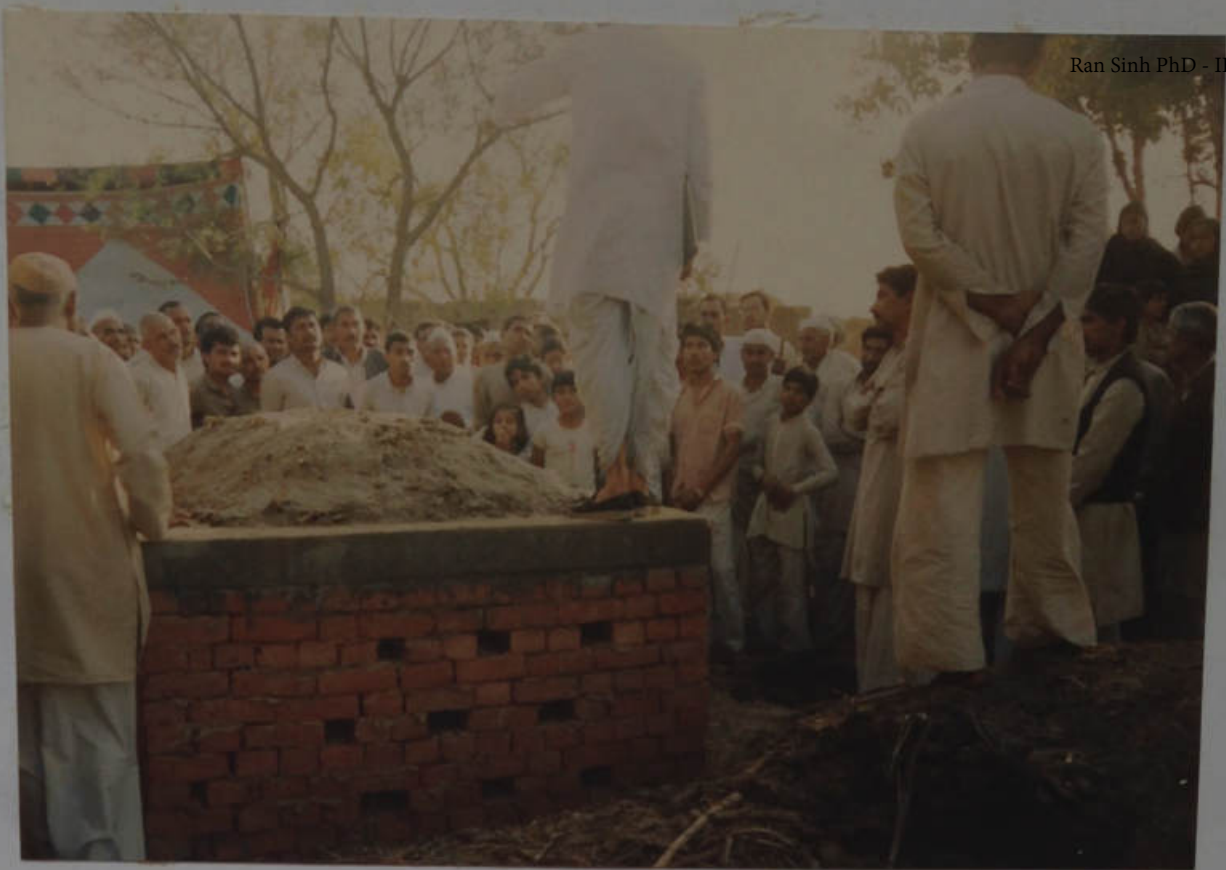
Encouraged by the results of the R & D work at Micromodel I.I.T. Delhi and Palri village and the response of field testing, it was considered important and worth while to popularize these technologies and, therefore, the work on information dissemination was taken up. Various modes required for technology transfer were designed and adopted.

7.31 Methodology and Process

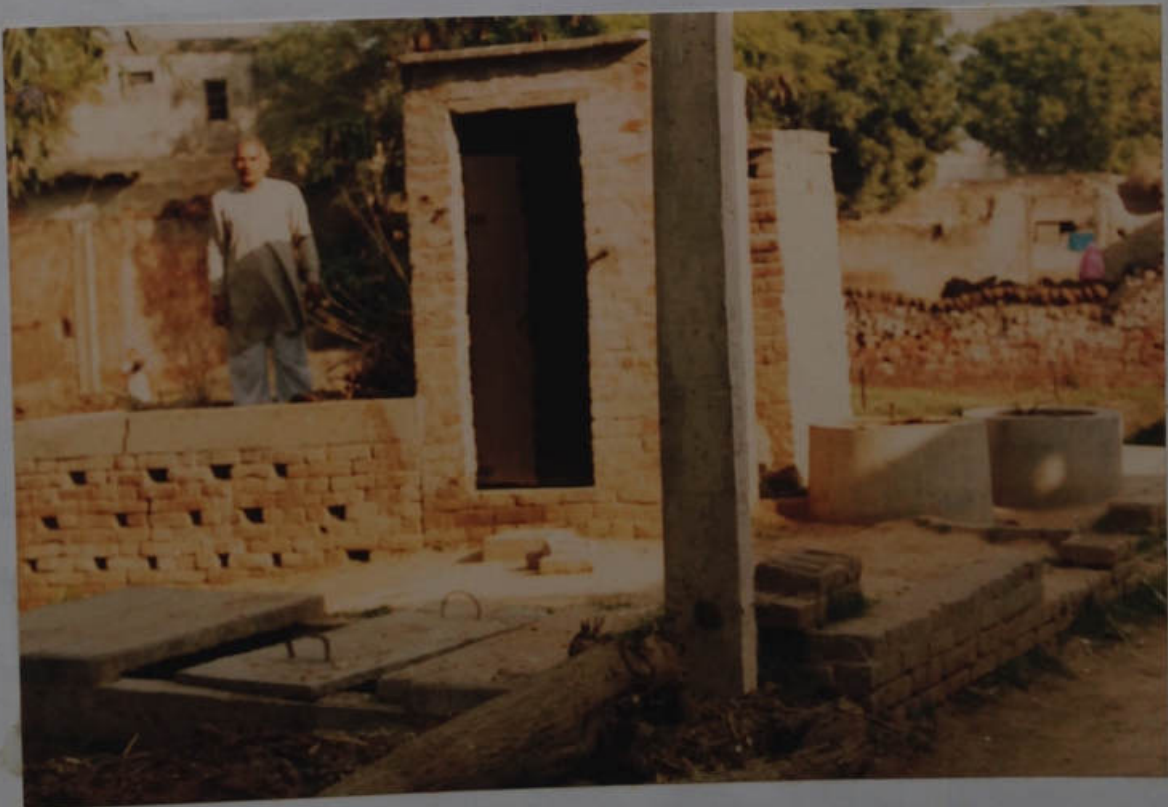
Following modes have been adopted to popularize technologies for organic manure production and indigenous seed based organic farming.

7.311 By Method of Direct Observation

Since the experimental work on organic manure production and utilization was



Demonstration of NADEP Method Composting in Palri



Integrated Nutrient Management System in Palri

carried out in the Palri village itself, farmers started showing interest and started learning about the process on their own without any conscious effort on our part. Some of them even came forward to start these in their cattle yard and agriculture field. Such farmers were encouraged and given necessary technical support.

7.312 Demonstration and Training Programs

Demonstration and training programs were organized for farmers and also for interested groups such as bank officials, voluntary organisations. These were organized both at I.I.T. Delhi and village level.

i) For Farmers

At village level, four training programs were organized in Palri and Garhi Sakhawatpur villages. In addition to the trainees, school teachers, village Pradhans and other dignitaries, *Sarvodaya* workers from nearby villages, were also invited. Shri. N. D. Rao Pandhri Pandhey, the inventor of NADEP technology, government officials and experts from NGO also participated on some occasions.

A NADEP tank was constructed for demonstration purpose and entire process of compost making was explained. In all these programs, more than 400 people including women participated and received training. Response of the participants was quite positive. Many farmers specifically expressed the view that productivity is declining despite increasing the amount of fertilizers and some way out is necessary. They strongly felt that there was need for organic manure production and utilization even if the current level of chemical input is maintained, as they express it "*organic manure is food for the mother Earth while chemical fertilizers are like tonics*".

In addition to organizing such programs in a formal way, another mode was also

adopted i.e. by going to individual households where NADEP tank had been built. This way of imparting training particularly to women folk proved very effective.

ii) For Specific Interested Groups

In addition to the training camps in selected villages, tailor-made training programs were also organized on request. Participation of officials of financing agencies like Banks would help in policy making for large scale popularisation of these technologies.

7.313 Organizing Meetings in Villages

A number of meetings were organized by the author in selected villages. Several farmers showed their willingness to adopt technologies for organic manure production and organic farming at least on small scale to begin with. Thus this technology package was transferred in different agroclimatic conditions and soil types. Results are quite encouraging and indicate towards the adaptability of indigenous seed in poor soil conditions also. All this reveals the inherent potential of indigenous seed based organic farming at national level.

7.314 Interaction with Voluntary Agencies and Innovative Farmers

A number of voluntary agencies have shown interest in biogas-cum-toilet, NADEP composting and organic farming. Necessary technical support has been provided to them.

Using the broad base of the author in the Palri and nearby areas, personal contacts were made, particularly with the innovative farmers of these areas.

7.315 Participating in Lectures, Seminars, Workshops

Efforts were also made to popularize these technologies among agriculture universities, institutions and related agencies by participating in seminars and working as resource person in workshops, orientation programs etc.

7.316 Film

A Tele-film "Jaivik-Kheti" was made by Delhi Doordarshan taking this experimental model at Palri as a base. It was telecast in April-May 1994 in all regional languages. This film has generated enormous interest among the people specially farmers, research workers and voluntary agencies. Hundreds of inquiries in this connection has been received from such people.

7.317 Publication of Booklets

With the financial support of DST New Delhi, two booklets in Hindi were published exclusively with a view for information dissemination to farmers and other interested agencies.

1. *Bharatiya Kheti ke Punarutthan ki Disha*. I.I.T. Delhi, 1989.

2. *Swavalambi Kheti ki Oar*. I.I.T. New Delhi, 1993.

Both the booklets generated a positive response. Several voluntary agencies and some academicians have shown keen interest.

7.4 Impact on National Level Policy

The results obtained from experimental work, field testing and technology transfer process being very encouraging and promising, helped in creating an impact at the policy level. NABARD's (National Bank for Agriculture and Rural Development) decision for refinancing the program of NADEP Technology popularization and important policy decisions of Ministry of Agriculture, New Delhi to support organic farming programs, are worth mentioning.

Chapter 8

EVALUATION AND PLANNING OF PROPOSED AGRICULTURE SYSTEM

8.0 Introduction

Evaluation, planning and policy are dependent on our perspective, the objectives we have set for ourselves and ultimately on the world view, the paradigm of development that we share. Modern farming with its peculiar one dimensionality of modern paradigm tends to consider single input, single output system for evaluation of performance, undermining all other aspects (Mathen, 1992; David & Satyendra, 1992; Dasgupta, 1989). Evaluation in this thesis is attempted in a unique way from both modern paradigm as well as SAP based paradigm. While evaluating from modern paradigm, all three important dimensions - technical, economical and ecological are considered. In SAP, attention is mainly focused on complementary fulfillment among four orders of *Nature* viz material, *Pranic*, animal and human. Planning is done in the light of understanding developed through SAP which essentially sees the entire existence as an integrated whole and hence interrelated in a mutually fulfilling manner. Certain policy issues of immediate importance are discussed in brief.

8.1 Evaluation

As mentioned above, evaluation is done from both modern as well as SAP point of view. It is important to mention in this context that *Avartanshil* agriculture is a complete system in itself embracing the new world-view. Indigenous seed based organic farming, experimented upon in the present thesis, is certainly close to this newly developed system, and hence would fulfill the basic criterion of evaluation to a significant extent.

8.11 Evaluation from Modern Paradigm

Three aspects have acquired significance in the modern times. The evaluation in this paradigm is, therefore, done for technological, economical and ecological aspects of the system under evaluation.

8.111 Technological Aspects

In modern farming emphasis is laid on single-input, single-output/function whereas multi-input, multi-output/functions aspect is in-built in organic farming system. Hence, the very criterion of evaluation changes. Technological aspect of the agriculture system here is evaluated for total productivity, efficiency of water, energy and nutrient utilization.

8.1111 Productivity

Data related to productivity both at experimental and field level is compiled and presented in Tables 6.5 and 7.1. It reveals that the average production of indigenous seed based organic farming (termed as system A) is comparable to HYV-chemical fertilizer system (termed as system B). Under experimental conditions, the production for C-306 and HD-2329 has been obtained to be 42.00 Q/ha and 42.8 Q/ha. respectively. However, at field testing level, it comes to 37.08 Q/ha and 36 Q/ha respectively.

Similarly, for Straw, at experiment level it is 75.50 and 62.60 Q/ha and at field-testing it is 69.36 and 48.80 Q/ha respectively for indigenous and HYV variety.

8.1112 Efficiency of Water, Energy and Nutrient Utilization

The efficiency of water utilization is higher in case of indigenous seed based organic farming as compared to HYV based chemical farming. The first one needs 3 to 4 irrigation while the latter one requires 4 to 5 irrigation. Thus, it is estimated that HYV-chemical fertilizer system requires around 25% more water than Indigenous seed based system.

While no direct calculation has been made on the energy requirement in this case,

there is enough data to show that output/input ratio for energy in indigenous traditional farming is greater than 1 (as high as 5) and that in case of modern farming is less than 1 (as low as 1/8) (TWN, 1990b)

In terms of nutrient utilization efficiency, organic farming is much more efficient than HYV-chemical fertilizer based farming. This is evident from the improved soil fertility status after cultivation for 5 years in case of organic farming (see section 6.22) as compared to HYV-chemical fertilizer case. As a matter of fact, organic manure is regenerative in the sense that it regenerates and nurtures microecosystem which in turn contributes in generating macro and micro nutrients in available form for plant growth whereas, chemical fertilizers and pesticides set a degenerative process by killing the microorganisms already existing. (Shiva et al, 1991; Ryan et al, 1994; Yang et al, 1992).

8.112 Economical Aspects

The economical aspect is evaluated from both direct cost-benefit analysis as well as unequal terms of trade due to dependency on market. Results obtained from the data of field testing is presented in Table 8.1 to 8.3.

8.1121 Net Profit in Wheat Production

Balance sheet of two practices under study is most revealing. While organic farming is a profitable proposal, modern farming is simply not. The results obtained from the detailed economic analysis shown in Table 8.1, clearly demonstrate that on an average (over all the 4 farmers over 3 years) in indigenous seed based organic farming a profit of Rs.9,732/ha is made over an expenditure of Rs.16,098/ha thus making the percentage profit of 60%; while in HYV-chemical fertilizer just a profit of Rs.2,352/ha is obtained over an expenditure of Rs.17,358/ha, thus making the percentage profit to a minimal of 14%. The result is similar in case of the individual farmer, Shri Karam Singh who earned a profit of Rs. 11,064/ha over an expenditure of Rs.16,518/ha (percentage profit = 67) in case of

Cost of Cultivation

www.madhyasth-darshan.info - Information Portal

Price of the Produce

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Particulars	System A			System B		
	Yield (Q/Bigha)	Rate (Rs./Q)	Amount (Rs.)	Yield (Q/Bigha)	Rate (Rs./Q)	Amount (Rs.)
Wheat	3.00	525.00	1575.00	3.09	400.00	1236.00
Straw	5.78	100.00	578.00	4.07	100.00	407.00
Total			2153.00			1643.00

Table 8.1 (ii)

Profit - Loss Account

Particulars	System A	System B
Output value	2153.00	1643.00
Input Cost	1342.00	1447.00
Profit/bigha	811.00	196.00
Profit/ha.	9732.00	2352.00
% Profit	60.43%	13.54%

- (i) Environmental cost not included.
- (ii) Health aspect not considered
- (iii) Indigenous seed does not require costly treatment for storage

Table 8.1 (iii)

system A and a profit of Rs. 2,292/ha over an expenditure of Rs.18,252/ha in case of system B (percentage profit = 13).

It may be noted that even with the same market price of both type of wheat variety, the new system is profitable. These results are in tune with the comparative study made by Sidhu in the context of Punjab (Sidhu, 1972) and Poutala in the context of Finland (Poutala, 1994). In an extensive study for Germany, it has found that with ecological farming "despite upto 20% lower yields, lower variable costs and higher prices mean that gross margins per ha can be twice or three times as high as for conventional method" (Stoppler, 1989).

8.1122 Net Profit in Organic Manure Production

A techno-economic analysis of different methods of manure production (chapter 5) in terms of the percentage nutrient content, total production, total investment, cost of production and percentage profit has been carried out. It may be noted that in case of biogas technology, a 3M³ biogas plant without toilet connection was selected for study. The average annual biogas production is based on the measurements of quantity of biogas production/day in different seasons. Further, price of biogas is fixed on the basis of the calorific value. Data is presented in Tables 8.2 and 8.3. Calculations are done assuming the rates of chemical fertilizers as standard. In terms of the percentage profit, 6 types of manure production systems have the following order.

Treated Biogas Slurry- 81.58% > NADEP compost (IV)- 81.33% > Improved Heap Manure- 78.03% > Biogas Slurry- 70.42% > NADEP Compost- 49.05% > Traditional Heap Manure- 14.76%.

Since the percentage profit, taking chemical fertilizer prices as base, in all case of organic manure is positive, it is a clear indication that each of these forms of manure production have a better economic performance as compared to chemical fertilizers.

Economic Analysis of Different Types of Organic Manure

S. No.	Particulars	Manure Production (in Ton)	Nutrient Content Kg. (Ton)			Equivalent Value in terms of Nutrients/ton (Rs.)				Total Value (Rs.)
			N	P	K	N	P	K	NPK	
1.	NADEP Compost- I	3.60	14.0	7.1	8.0	107.10	130.64	60.16	297.90	1072.44
2.	NADEP Compost-IV*	4.00	21.0	10.5	11.2	160.65	193.20	84.22	438.07	1752.38
3.	Biogas Slurry (3M ³ plant)	10.95	20.5	9.5	9.9	156.83	174.80	74.45	406.08	4446.57
4.	Treated Biogas Slurry	18.40	17.6	7.7	8.1	134.64	141.68	60.91	337.29	6206.13
5.	Improved Heap Manure	4.00	19.8	8.5	8.9	151.47	156.40	66.93	374.80	1499.20
6.	Traditional Heap Manure	6.00	7.2	3.6	5.1	55.08	66.24	38.35	159.67	958.02

*Now named as *PALRI METHOD* of composting.

Only NPK are considered for economic analysis

Cost of N,P,K, as per the present market price

1Kg. N (through Urea)	=	Rs. 7.65
1 Kg. P (through D.A.P.)	=	Rs. 18.40
1 kg. K (through MOP)	=	Rs. 7.52

Data indicates the production of manure over six month.

Table 8.2

Economic Analysis of NADEP Compost

Size of tank = 180 Cu. ft.

Inner dimensions of the tank - 12'x5'x3'

(A) Construction cost of one tank

Item	Cost Rs.
(i) Bricks.	1050.00
(ii) Cement & sand	350.00
(iii) Construction cost	315.00
Total construction cost	1715.00

(B) Operational Cost

S. No.	Item	Quantity	Wages /Price Rs.	Cost Rs.
(i)	Dung	125Kg.	0.15/kg.	19.00
(ii)	Agro residues	1500Kg.	0.15/kg	225.00
(iii)	Soil (including transportation)	1 cart (~ 1.8 ton)	-	53.00
(iv)	Tank filling	3 labours	45.00/day	135.00
(v)	Water sprinkling charges	1 labour	45.00/day	45.00
(vi)	Opening of the tank	1 labour	45.00/day	45.00
				522.00
	Total			

Table 8.3 (i)a

Cost of Production

(i)	Operational cost	=	522.00
(ii)	Depreciation & interest on construction cost (20%/year) for six month	=	171.50
(iii)	Interest on operational cost (10%)	=	26.10
	Total		719.60

Profit - Loss Account

(i)	Income from NADEP compost (3.6 ton @ Rs. 292.72/ton)	=	1072.44
(ii)	Cost of production	=	719.60
	Profit	=	352.84
	%Profit	=	49.05

Table 8.3 (i)b

Economic Analysis of Modified NADEP Compost IV

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(A)	Construction cost of NADEP tank (180 cu. fit)		=	1715.00
(B)	Operational cost			
	Item	Quantity	Wages/price Rs.	Cost (Rs.)
(i)	Dung (kg)	2500	0.15 /kg	375.00
(ii)	Agro waste (kg)	1000	0.15/kg	150.00
(iii)	Soil	1 cart (~ 1.8 ton)	-	52.00
(iv)	Tank filling	3 labours	45.00/day	135.00
(v)	Opening of the tank	1 Labour	45.00/day	45.00
	Total			757.00

Cost of Production

(i)	Operational cost	=	757.00
(ii)	Depreciation & interest on Construction cost (20% / year) for six month	=	171.50
(iii)	Interest on operational cost (10% / year)	=	37.85
	Total	=	966.35

Profit - Loss Account

(i)	Income from NADEP compost (4.0 tons @ 438.07 / ton)	=	1752.38
(ii)	Cost of production	=	966.35
	Profit	=	785.93
	% Profit	=	81.33%

Table 8.3 (ii)

Economic Analysis of Biogas Plant**(Biogas and slurry)****(A) Construction cost**

(i)	Deen Bandhu Biogas plant (3M ³)	=	7400.00
(ii)	Burner, gas pipe etc.	=	1100.00
	Total	=	8500.00

(B) Operational cost

(i)	27375 kg dung (75 kg dung/day x 365) @ Rs. 0.15/Kg	=	4106.25
(ii)	Human labour 182.5 hours @ 30 minutes/day	=	1095.00
(iii)	Maintenance cost / year	=	100.00
	Total	=	5301.25

Cost of Production

(i)	Operational cost	=	5301.25
(ii)	Depreciation & interest on Construction cost (20%/ year)	=	1700.00
	Total	=	7001.25

Table 8.3 (iii)a

Income

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Daily gas production* (75 kg. dung)	=	2.775 M ³
Annual gas production	=	1012.875 m ³
Cost of gas @ Rs. 3/M ³	=	3038.62
Annual slurry production	=	21.90 tons
Value of slurry (equivalent nutrient price @ of Rs. 406.08/ton)	=	8893.15

Total Value of biogas and slurry = 11931.77

Profit - Loss Account

Income from gas & slurry	=	11931.77
Cost of production	=	7000.25
Profit	=	4930.52
% profit	=	70.42

* Average gas production based on measurement in the field in different seasons

Table 8.3 (iii)b

Economic Analysis of Biogas Plant**(Treated slurry and gas)**

(A) Construction cost	=	8500.00
(B) Operational cost		
(i) Operational cost for biogas plant	=	5301.25
(ii) Operational cost for slurry treatment		
(a) 5 ton agro-waste	=	750.00
(b) 3 carts of soil (~ 5.4 tons)	=	157.00
(c) Cost of bamboos	=	75.00
(d) Labour cost	=	525.00
Total	=	6808.75

Cost of Production

(i) Operational cost	=	6808.75
(ii) Depreciation & interest on Construction cost (20% /year)	=	1700.00
Total cost	=	8508.75

Income

Annual gas production	=	1012.875 m ³
Cost of gas	=	3038.62
Annual treated slurry production	=	36.80 tons
Value of treated slurry in terms of nutrients (@ Rs. 337.29/ton)	=	12412.27

Profit-Loss Account

Total value (slurry and gas)	=	15450.89
Cost of production	=	8508.75
Profit	=	6942.14
%Profit	=	81.58

Table 8.3 (iv)

(A)	Construction cost		=	0.00
(B)	Operational cost			
	Item	Quantity	Wages/price @ Rs.	Cost (Rs.)
(i)	Dung (kg)	2500	0.15 /kg	375.00
(ii)	Agro waste (kg)	1000	0.15/kg	150.00
(iii)	Soil	1 cart	-	52.00
(iv)	Labour cost	5 Labours	45.00/day	225.00
	Total			802.00

Cost of Production

(i)	Operational cost	=	802.00
(ii)	Interest on operational cost (10% / year) for 6 months	=	40.10
	Total	=	842.10

Profit - Loss Account

Income from heap manure (in terms of nutrients) (4.0 tons @ 374.80 / ton)	=	1499.20
Cost of production	=	842.10
Profit	=	657.10
% Profit	=	78.03

Table 8.3 (v)

Economic Analysis of Traditional Heap Manure

(A)	Construction cost		=	0.00
(B)	Operational cost			
	Item	Quantity	Wages/price @ Rs.	Cost (Rs.)
(i)	Dung (kg)	10,000	0.15 /kg	1500.00
(ii)	Labour cost	2 Labours	45.00/day	90.00
	Total			1590.00

Cost of Production

(i)	Operational cost	=	1590.00
(ii)	Interest on operational cost (10% / year) for 6 months	=	79.50
	Total	=	1669.50

Profit - Loss Account

		=	1916.04
	Income from heap manure (in terms of nutrients)		
	(12 tons @ 159.67 / ton)	=	1669.50
	Cost of production	=	246.54
	Profit	=	14.76
	% Profit		

Table 8.3 (vi)

8.1123 Dependency on the Market and Unequal Terms of Trade

HYV-chemical based farming requires ex-farm input like seed, fertilizers, insecticide, pesticide etc., thus making it completely dependent on market economy, not only at national but international level also. This makes the farmers vulnerable to the market and government price policy which certainly is in favour of industries (Joshi, 1988). This in fact forms the basis of widening gap between the urban and rural areas.

8.113 Ecological Aspects

The important criterion for ecological performance are fertility, biosphere, water and other pollution effects.

The effect on soil fertility is amply clear from the data available in literature (Yang et al, 1990; Sharma & Deb, 1991; Hance et al, 1987). The organic manure enhances the productivity of the soil through its nutrients as well as through providing the nourishment and growth to the biosphere, the microorganisms. The positive effect of organic farming and harmful effect of modern farming on biosphere has been extensively documented (Lee & Wani, 1991; Singh & De, 1987; Arihash et al, 1990, Neweigy et al, 1987). While the pollution of water, air and contamination of foodgrain etc. has not been studied in this particular work, there are ready references available to show that modern farming creates serious pollution effects while organic farming does not.

8.12 Evaluation from SAP Point of View

The criterion for evaluation in the new paradigm is developed on the basis of discussions about human Production-Work system presented in chapter 3. This multidimensional criterion for evaluation of agriculture system presented in this section is used for evaluating the two systems under study.

8.121 Fulfillment of and by Human Order

SAP asserts that any natural process should be mutually fulfilling. Seen from human as one participant, it must be ensured that human fulfills the agricultural process and the agricultural process fulfills the human.

a) Fulfillment of Human Needs

For human to feel the sense of fulfillment, an agriculture system has to provide the following.

(i) Ultimate aim of Realization of *Swarajya*

Swarajya, organisation in oneself and in all is possible only through mutual fulfillment of all four orders of *Nature*. Modern farming by its very *Nature* excludes such a possibility. Organic farming, however, is based on *Nature* and Natural order and in fact prospers only through mutual fulfillment.

(ii) Satisfaction of Human Needs- Food, Shelter and Adornment

Food is required for keeping the body healthy and hence, should be nutrition wise rich and conducive to human health. Chemical based farming gives rise to food produce which could neither be as nutritious nor healthy as in case of organic farming (Prugar, 1994). It has been observed (Arya, 1995) during the field testing by the farmers that indigenous seeds seem to be quite sturdy and do not require pesticide for storage like HYV seed. Further, 'chapati' made by the indigenous wheat are more tasty and remain fresh for a longer time. It certainly does not have the health hazards caused by toxic residues in the grain in case of modern farming.

(iii) For Community Need

Agriculture is done today not on the basis of community needs but on the basis of market economy. This results in a situation where on one hand we have millions dying of hunger and on the other, tobacco, tea, coffee, flowers etc. are grown over million of acres

of land. The agriculture under such conditions fails to satisfy the needs of a community. Modern agriculture being ex-farm input based is forced to depend on the market and hence, market economy. Organic farming, however, has the possibility of moving out of it to satisfy the real needs of the people.

b) Fulfillment by Human Participation

Humans in turn, have to play their role of fulfilling all three orders in *Nature* properly. In order to do so they need to ensure the following through the agriculture system.

(i) Working with Right Understanding

Humans should work with a right understanding of natural processes, the *Avartanshilata* in it as discussed in detail in chapter 3. Today they fail to do so in both cases due to lack of awakening. While organic farming provides a possibility of fulfillment of *Avartanshilata*, the modern farming does not.

(ii) Human Skill and Labour

Humans express their *Jagriti* through their skill and labour. Human skill and physical labour, not a drudgery as is believed today, should form the basis of Production-Work system, agriculture system being a part of it. They should be given the first and the foremost priority. Organic farming is based on and provides opportunity for creative investment of human labour and skill. Modern farming simply wants to do away with them, rather replace them by dead machines run by nonrenewable energy resources and chemicals. Since, his labour and skills remain unutilised, he fails to derive satisfaction of having expressed himself. Needless to say that it also creates a resource depletion on the one hand and pollution on the other.

8.122 Fulfillment of and by Material Order

Considering material order as one constituent, fulfillment of the agriculture system

by the material order and fulfillment of the material order by the system will have to be ensured.

a) Fulfillment by Material Order

Material order through its components such as sun, moon, earth, soil, water, air, minerals, fertility, seasons, rain, energy etc. provide the basis for the fulfillment of the human needs- both the general needs (food, shelter, adornment) and specific needs. It does so for the animal and *Pranic* orders also. It is natural, therefore, for humans to derive their requirements from the material order.

b) Fulfillment of Material Order

Humans have the responsibility of ensuring the enrichment of material order in the process of their interaction, agriculture in this case. They have to guarantee its protection, proper utilization and also its evolution (*Vikas*) expressed through its fertility, natural cycle of water, air etc. It was made clear that this is ensured only when the concept of *Avartanshilata* is followed properly which is the case with organic farming. In case of modern farming, however, the situation is just the reverse. HYV basically thrives by depriving the soil of its native fertility, polluting water, air, depleting minerals and energy reserves of the material world and finally producing food contaminated with toxic residues.

8.123 Fulfillment of and by *Pranic* Order (Plants, Bio-sphere)

The mutual fulfillment of the *Pranic* order with the agriculture system will have to be ensured.

a) Fulfillment by *Pranic* Order (Plants, Bio-sphere)

Pranic order enriches humans and animals by providing resources for food, shelter, adornment, energy, medicines etc. and proper selection of plants should be made depending on the needs to be satisfied. *Pranic* order also contributes in enriching the material order

such as soil quality in terms of its fertility, water retention capacity and quality of water, air etc.

Modern farming with its emphasis on monoculture fails to provide this diversity of plants and bio-sphere. Organic farming, however, is based on and takes advantages of multi-layer, multi-cropping and mixed-cropping etc. even to enrich the soil fertility.

b) Fulfillment of *Pranic* Order (Plants, Bio-sphere)

Protection, nourishment and diversification of the *Pranic* order i.e. both the plants and the biosphere must be ensured. If he is oblivious of these aspects or considers it as his right to plunder the *Pranic* order for his short term gain, it is a sign of his ignorance and the disorganization resulting thereby. Modern farming does exactly this, whereas organic farming realizes the importance of this aspect. In fact, the whole process of organic agriculture is materialized through the diversity of bio-sphere and plants. It, therefore, provides the facility for diversity and growth of biosphere and plants.

8.124 Fulfillment of and by Animal Order

The *Sah-Astitwa* between human and animal should be seen as human providing the facility in terms of nourishment, protection, and growth to animals to do his work on the one hand, and on the other hand the animal providing means to complement human efforts of *Vyavasaya*.

a) Fulfillment by Animal Order

Animal is an integral part of organic farming, its energy is used as source of power for ploughing and other agricultural operations, its excreta is used as a source of manure. Modern farming on the other has no place for animal in its scheme as such. It undermines the importance of animals altogether. It fails to realize the possible contribution by the animals. Just for exemplification take the example of fertilizer production. With all human

artifacts and development of technology, we are able to generate around 3 million tons of nitrogen fertilizer while with animal dung and urine alone, we are in a position of generating 4 million tons of nitrogen as mentioned in section 5.1.

b) Fulfillment of Animal Order

The diversified crop structure in organic farming, provides a nutritiously rich, and healthy diet for the animals. In case of our experimental work, for example, it has been found that the straw produced with indigenous seed is 1.5 times more than in case HYV seed. Animal relish the organically grown straw due to its quality and softness. In fact, monoculture of HYV deprives the animals of healthy and nutritious fodder.

8.13 Results and Discussion

Based on the experimental data (chapter 6 & 7), evaluation of indigenous seed based organic farming vis-a-vis HYV-chemical fertilizer system, both from the points of view of modern paradigm and paradigm based of SAP reveal very interesting results which indicates towards certain in-built unique characteristics of the newly developed agriculture system. Indigenous seed based organic farming certainly scores more points than chemical farming even when yardstick of evaluation is based on modern paradigm, i.e. in terms of productivity, efficiency of energy, water and nutrient utilization, over and above the environmental and ecological aspects. Most surprising fact is that this new system is equally productive even in terms of grain yield and more productive in terms of total production i.e. grain plus straw. as compared to hybrid seed based chemical farming. Further, because of low input requirement of new system as compared to modern farming, net profit is certainly higher even if market price for both type of seed variety is same. Indigenous seed based organic farming being close to *Avartanshil* agriculture fulfills the criterion of evaluation from SAP point of view to a significant extent; whereas modern farming being

conceptually far away from the new concept, fails completely.

With respect to plant nutrient management, there is simply no comparison of organic manure production system to chemical fertilizer industry, both from the modern paradigm as well as SAP point of view. Further, among the different types of method, treated biogas slurry turns out to be more profitable than *PALRI METHOD*, biogas slurry or heap manure. Further, biogas technology in view of having additional advantage for providing gas for cooking, would be more popular than composting systems. However, in a situation of low investment capacity of farmers, *PALRI METHOD* would be more viable. Thus, in terms of their suitability to conditions like initial investment, space requirement, availability of biomass etc., one or the other system will be preferred. It appears that a system integrating all three i.e. biogas incorporating new method of slurry treatment, *PALRI METHOD* and improved heap manure is desirable to take care of different conditions prevailing with the farmers.

8.2 Planning for the Proposed Agriculture System

Programmed by the reductionist approach of modern civilization, we tend to plan things in isolation. SAP, however, makes it very clear right at the outset that everything in existence is related to the other and that a right organisation can be established only by taking the natural organisation at all levels into consideration. Further, this natural organisation is to be understood by every human in himself in order to bring it into practice. Planning, therefore, calls for the following steps to be taken up.

8.21 Right World View (Paradigm of Development)

As discussed in chapter 3, we are suffering not only from a technological or environmental crisis but from a metaphysical crisis, a crisis of wrong concept of development. Other crisis are rather borne out of it. In order to come out of this

catastrophic situation, therefore, a right world view, a right perception based on right understanding of things as they are, is required. It is only on the basis of this understanding that sharing of it with the others and bringing it into practice can be taken up.

8.211 *Samadhan* (Right Understanding)

A right understanding of *Nature*, man and their interrelationship is what is required for right action, be it production or exchange or art. This is discussed in details in section 3.1

8.212 Introduction Process

Right understanding though has to be realized by and within oneself, a proper introduction of it makes it systematic, easy and faster. It is with this in view that following has been planned out for introducing these concepts.

i) *Jivan Vidya* Camps

The *Sah-Astitwa Principle* and the world view emerging out of it is termed as *Jivan Vidya*. In order that people develop the right understanding, i.e. *Samadhan*, they must be properly introduced to *Jivan Vidya*. This *Jivan Vidya* provides an outline of the man, *Nature* and the whole existence and more importantly it starts a process of self reflection and self evaluation on the basis of which humans can understand themselves, *Nature* and the Existence in a self satisfying manner. An effort in this direction has already been started by Shri A. Nagraj Sharma, propounder of this principle at *Jivan Vidya* Foundation, Govindpur (Western U.P.). People are introduced to this *Vidya* through regular camps of different levels and durations, being conducted by the people well acquainted with and experienced in it.

ii) *Jivan Vidya* school- *Siksha Sanskar* System

While it is necessary to train adults through camps, it is as much necessary to

introduce it in regular educational process of the children. The details of such a process is already being worked out. A school based on it has been started by *Jivan Vidya* Foundation, Govindpur. The result of introducing this *Vidya* based teaching to around 250 children from class 1st to 9th is quite encouraging. Firstly, it is easy for the children to grasp this concept on the basis of their own experience and evaluation and secondly, this has started reflecting in their very behaviour with their family members and other persons and their attitude towards other orders such as animal, plant etc.

8.22 Right Practices- *Swarajya*

Right understanding of life and existence and its expression in the world around is fostered only through right practices, through right, natural organisations at all levels, through *Swarajya*. *Swarajya* has five dimensions as described in chapter 3.

A meaningful, integrated and proper planning requires that it be done and implemented at all dimensions of *Swarajya*. However, considering the scope of this work, a brief discussion on planning of the Production- Work System and particularly of agriculture system follows.

8.221 Production-Work System

Work relates to human interaction with *Nature* in order to fulfill his general and specific needs. Production is the outcome of such an interaction in the form of a thing, an object.

Production system, *Vyavasaya*, based on the principle of *Avartanshilata*, will have to be planned out, taking care of the aspects of *Vyavasaya* discussed in detail in section 3.23. Two important components of *Vyavasaya* are agriculture system and industries.

8.2211 Industries

One important part of Production-Work System is industries which basically works

on the resources generated by agriculture perennially or by the *Nature* over a long period of time which may not be renewable in near future. Considering the scope of the thesis, we restrict ourselves to the discussion on the second aspect i.e. agriculture system.

8.2212 Agriculture System

In the context of agriculture, guidelines have been worked out and presented in section 3.5. Planning will have to be done in accordance with it. All the 14 aspects of i) ploughing ii) seed and sowing time iii) types of crop, iv) crop-pattern v) crop-geometry, vi) nutrient management, vii) water management, viii) weed control, ix) pest control, x) biosphere, xi) harvesting and threshing xii) storage and post harvest technology and xiii) marketing and xiv) the ultimate aim of all activities (*Swarajya*) will have to kept in mind while drafting the plan.

For implementing this system of 'Avartanshil' agriculture and related industries, policy support will be necessary. Keeping in view the scope of present thesis, policy issues in the context of agriculture only are proposed in the next section.

8.3 Policy Issues

There is no doubt that there will be a total restructuring and reorganization of all aspects of human society at five levels- Individual, Family, Community, Nation, World and in four dimensions- Experience, Thought, Behaviour, *Vyavasaya* under the influence of a new world view, SAP in this case. However, we discuss some of the policy issues which can be taken up immediately with very little infrastructural change and which will have significant contribution towards the implementation of the 'swarajya' and agriculture system conceived here.

8.31 At Community Level

1. At school level- initially it should be introduced as a part of the curriculum. however, slowly efforts will have to be made to design the whole curriculum

according to SAP point of view.

2. Organizing camps, orientation programs at the village level for farmers and youths.
3. Setting up model farms for organic farming which will also work as resource, training and knowledge dissemination centres.
4. Promoting voluntary organisations in this direction.
5. Giving incentives to the farmers adopting organic farming.

8.32 At Agricultural University/Institute Level

1. Introducing at least one course each on *Sah-Astitwa Principle* based organic farming and *Jivan Vidya* as a part of curriculum.
2. Promoting research and development programs in this area. Special fellowships, professional chairs should be introduced.
3. Arranging lectures, seminars, workshops to create awareness and generate interest in this newly developed Agriculture system.
4. Providing facilities to scientists and research workers to visit, analyze and understand the efforts going on in the area of organic farming, natural farming etc. in India and abroad.
5. Survey and documentation of the traditional practices including seeds and water management as it will provide enormous help in understanding and implementing this *Avartanshil* agriculture.

8.33 At the Government Level

1. Agriculture ministry should have a separate cell on organic farming to begin with, which should slowly expand.
2. It should issue clear-cut instructions to the state governments to follow the same.

3. Separate budget allocation for education, training, research and extension in organic farming.
4. Seminars, meetings for the officials related to agriculture ministry so that they can have a proper perspective.
5. At least one percent Krishi Vigyan Kendra should be devoted exclusively for organic farming.
6. Special protection and promotion should be given to organic manure production- both composting and biogas.
7. Policy be made favourable towards organic farming by-
 - i) Proper price policy for organic farm produce and
 - ii) Incentives to the farmers adopting these practices.

8.4 Conclusions

It should always be borne in mind that the ultimate aim of all human activities is the realisation of happiness, peace, contentment and bliss through organisation in oneself (*Swanushasan*) and the realisation of intelligibility, prosperity, fearlessness and coexistence collectively through organisation at all levels (*Swarajya*). Productivity and economy are important, but mere profit or production can not be the motive. These are to be defined and have meaning only in the context of this ultimate aim and not at all in disregard of it as is the case today.

The above mentioned policy and planning issues provide a starting point. An extensive effort with respect to paradigm shift and popularisation of new agriculture system will be called for in order to get a long term and permanent solution to the present problems of society in general and agriculture system in particular, resulting from wrong understanding of human, *Nature* and their interactions.

Chapter 9

SUMMARY AND CONCLUSIONS

The thesis was an attempt to find an alternative system of agriculture. It was, however, found during the search for an alternative that there exists no possibility of a meaningful and sustainable alternative within the present paradigm of development. A need for the alternative paradigm was realized right at the outset of the work. The attention was, therefore, first focused on finding a paradigm of development, a world-view that meaningfully defines the man, *Nature* and their interrelationship. *Sah-Astitwa Principle*, SAP, appears to satisfy this requirement.

A new agriculture system namely *Avartanshil* agriculture is evolved on the basis of SAP and its detailed outlines have been worked out. Keeping in mind the limits of time and scope, two aspects of this system- seed and plant-nutrient management were taken up for experimentation. The experimental work related to indigenous seed was carried out at IIT, Delhi for 5 years consecutively, whereas work on organic manure production and utilization was done in Palri Village. The results obtained were highly encouraging, which prompted us to go for its field-testing. The field- testing was done in Palri village with selected farmers. The results points towards the possibility of achieving high productivity while maintaining or rather enhancing the soil- fertility, improving the quality of food and enhancing the self-sufficiency. Having evaluated this newly developed system both from the modern as well as SAP points of view, a detailed planning for the introduction of the new system has been worked out and certain policy issues of immediate importance in the context of agriculture are also discussed. Thus, the work ranged from research and development, field-testing to technology transfer, policy and planning issues for its

propagation, so as to cover all the important aspects of the agriculture system.

Salient findings are presented below chapterwise :

Chapter 1- The context, scope and limit of the study are presented.

Chapter 2- A brief review of literature available on the status of modern farming reveals that it is failing not only environmentally but economically and technically also. The alternative systems include Traditional Agriculture, Natural Farming, Sustainable Agriculture, Organic Farming, Homa Farming, Biodynamic Farming etc. A deeper analysis indicates the need for the search of alternative concepts of development. Various concepts of development viz Sustainable Development, Ecological World-view, Gaia Theory, *Sah-Astitwa Principle* (SAP) are briefly discussed.

Special attention is paid to the work related to organic farming based on indigenous seeds and organic manure production and utilization. The work done exclusively on indigenous seeds appears to be very scanty. However, even the limited work done in this direction in case of rice shows that properly selected indigenous variety of seed with appropriate dose of manure and water can give as high and even higher yield than the prevailing HYVs. Detailed work on indigenous wheat variety which covers the major part of the area affected by Green Revolution, is completely neglected. It was this which motivated us to choose organic farming using indigenous wheat seeds for our experimental work.

Literature on production and utilization process of organic manure reveals that organic manure has substantial capacity to substitute for chemical fertilizers. Different methods of composting have been compiled along with their operational parameters. An analysis of these methods shows that NADEP composting has an outstanding advantage

over the other methods. Further, in the context of anaerobic digestion, handling, management and transportation of slurry poses serious problems. As work done on this aspect is highly scanty, slurry treatment needs major attention. Thus, two major aspects selected for further investigation were i) NADEP composting and ii) biogas slurry treatment and management.

Chapter 3- A new paradigm and agriculture system based on *Sah-Astitwa Principle* are discussed in this chapter.

SAP is a world-view that clearly defines the man, the *Nature* and their interrelationship in a mutually satisfying manner. SAP asserts that everything in Existence is in *Sah-Astitwa* with the other i.e. they are related to each other in mutually fulfilling manner. *Sah- Astitwa Principle* defines natural order (*Vyavastha*) as the central theme, however, it also assigns to men both the special status of being flower of the on going process of evolution in *Nature* and the responsibility to realize the natural order within themselves (*Swanushasan*) and every where else (*Swarajya*).

Development in SAP is appreciation and understanding of the evolution already taking place in *Nature* and molding of oneself according to it so as to reach the ultimate goal of self-organisation (*Swanushasan*) and world organisation (*Swarajya*). Development, therefore, is better defined as a *Vikas* (co-evolution)- a natural unfolding in a mutually reinforcing manner. This co-evolution is broadly classified as i) *Vikas* in material & *Pranic* order and ii) *Jagriti* in *Jivan*.

Natural order (*Vyavastha*) can be understood properly only by the awakened human. In case of humans devoid of any concept of right relationship (*Nyaya*), the organisation or institution created by them will further degenerate both the humans as well as

organizations themselves. Since, natural order set up by awakened humans are in accordance with *Nature*, it brings harmony right from individual to global level. In fact, such organizations already exist and are well managed at level of material, plant and animal order. It is only the ignorant human, who unaware of the organisation at human level as well as other levels, introduce chaos and disorder.

To sum up, the purpose of the existence is to reach through *Sah-Astitwa* to a state where happiness, peace, contentment and bliss is experienced by every human individually and *Samadhan*, enrichment, fearlessness and *sah- Astitwa* collectively and establish its *Parampara*.

Out of the five dimensions of *Swarajya*, Production-Work system specially in the context of agriculture is taken up for discussion. *Avartanshilata* emerges out as an important concept in the new paradigm. All natural processes follow the law of *Avartanshilata*. *Avartanshilata* means ongoing cyclic process in which every participant is enriched. Human with his *Jivan* awakened can understand this *Avartanshilata* and constructively participate in the fulfillment of all three orders.

In the light of the principles of *Avartanshilata*, guidelines of the newly developed agriculture system has been worked out. Fourteen important aspects of agriculture system viz i) ploughing ii) types of crop, iii) seed and sowing time iv) crop- pattern v) crop- geometry, vi) nutrient management, vii) water management, viii) weed control, ix) pest control, x) biosphere, xi) harvesting and threshing, xii) storage and post harvest technology, xiii) marketing and xiv) the ultimate aim of all activities (*Swarajya*) are discussed. To take an example, type of crops are to be decided on the basis of its suitability in terms of providing both quality and quantity of a) food for human, b) fodder for animals c) diversity for plants and d) fertility for soil.

Based on the discussion above, the objective is redefined as to develop the operational aspects of this new agriculture system based on the principle of *Avartanshilata* i.e. it fulfills, enriches all the constituents involved in the process of agriculture such as soil, seed, manure, water, animal, human beings, ecosystem etc.

Keeping in view the limitations of time and resources, it was decided to carry out experimental work related to two important constituents i.e. seed and plant nutrient management.

Chapter 4- A brief discussion on site selection for experimentation, methodology, materials and methods for analytical work is presented. Palri village was selected as the experimental site for the reason of its being situated in Green Revolution belt, being representative of a large area, Doab, and the accessibility to the author. Method of random block design was used for field trials conducted at Micromodel, IIT, Delhi.

Chapter 5- It deals with organic manure production and utilization. Initial field testing (in Palri village) of NADEP technology indicated some technical as well as social constraints associated with it, which need to be rectified. To understand the basic principles of NADEP method, scientific assessment of entire technical process was carried out. This helped us in working out the ways of rectifying the above mentioned constraints of NADEP and also explore the application of these scientific features in improving the efficiency of other composting systems. Three new designs of composting based on NADEP principles for the above purpose have been developed without compromising the quality of organic manure. Among these, design referred as *PALRI METHOD* is capable of taking care of cases where relatively large amount (50%) of dung and less amount (20%) of agricultural residues are available for this purpose, and further, unlike original NADEP method, it requires no water during the entire process including maintenance. It would prove a major break through in rural composting.

An improved method of heap manure has also been developed through the application of NADEP principles and keeping the simplicity of the process intact. It is found that good quality manure can be generated with little modification in this traditional method. Like new design (*PALRI METHOD*), need of any extra water is totally eliminated in this method too. Further R & D work in this direction will enhance its efficiency and simplicity.

In the context of biogas technology, with a view to understand the field problems and to carry out experimental work at user's level, 30 biogas plants (Deenbandhu model) of varying capacity (1M^3 to 4M^3) were put-up in Palri village. 15 plants were connected with toilet also. To take care of the problems associated with biogas slurry management, a new method for slurry treatment based on NADEP principles has been developed. It is simple as well as quite effective in preserving the nutrients and making its transportation and handling easy.

Chapter 6- It deals with the experimental work carried out on two systems viz indigenous seed-organic manure (system A) and HYV-chemical fertilizer (system B) under 5 different treatments. Five treatments given for each of the seed correspond to control, NADEP compost, heap manure, biogas slurry and chemical fertilizer. Experiment was carried out at I.I.T. Delhi under controlled conditions consecutively for 5 years i.e. from 1988-89 to 1992-93. Results are highly encouraging. The statistical analysis of these results reveals that both the systems are comparable even in terms of grain productivity. Data presented in Table-6.5 indicates that on an average over 5 years a maximum of 42 Q/ha grain yield is obtained in system A and 42.8 Q/ha in system B. Further, indigenous seed based system performs better in terms of total production i.e. both grain and straw.

After 5 years of experimentation, soil samples for each treatment in both the system

were analyzed for macro as well as micro nutrients. Soil fertility status seems to be improved in case of indigenous seed based system, indicating the genetic potential of this cultivar in regenerating the soil fertility. Further intensive as well as extensive R & D work is required to understand and establish this aspect.

Chapter 7- Results of experimental work presented in chapter 5 and 6 motivated us to take up the task of field testing and technology transfer. Since meaningful conclusions can be drawn only after testing the validity and utility of the technology package under real field conditions, this aspect was considered very important and taken up for study. In fact the results of initial field testing of NADEP technology founded the basis of development of new efficient designs of organic manure production through composting and biogas slurry treatment. Methodology adopted for field testing is discussed briefly. Field testing of indigenous seed based organic farming was taken up with selected farmers in Palri village for a period of 3 consecutive years. Data (Table 7.1) reveals that even under the real field conditions, yields of both the systems i.e. indigenous seed-organic manure (37.08 Q/ha) and HYV-chemical fertilizer (36 Q/ha) are comparable. Further, it is found that nearly 20% water can be conserved easily in indigenous seed based system.

Based on the results of field testing, task of technology transfer on limited scale was also taken up. Various modes adopted for information dissemination include organizing meetings, workshops, training programmes etc. both at I.I.T. Delhi and Palri village. Two booklets in Hindi has been published for this purpose. A Telefilm *Jaivik Kheti* taking the present work as a base, made by Delhi doordarshan was telecast in all regional languages. All this helped in creating an impact at national level policy for organic farming popularization.

Chapter 8- It deals with the evaluation, planning and policy issues of the newly

developed agriculture system. Evaluation of both the systems is attempted in a unique way i.e. from the modern view point as well as from the view point based on SAP. Detailed techno-economic analysis has been carried out and data is presented in Table 8.1. Surprisingly, indigenous seed based organic farming seems to be superior to modern farming even when evaluated from the point of view of modern paradigm; whereas HYV based chemical farming totally fails to fulfil the criterion based on SAP. Further under the present marketing structure, 60% net profit can be achieved in new system as compared to only 14% net profit in modern farming.

Comparative techno-economic evaluation of different types of organic manure production methods has been carried out and data is presented in Tables 8.2 and 8.3. It reveals that though *PALRI METHOD* gives economic returns comparable to biogas technology in terms of NPK availability, yet biogas system would prove more popular in view of additional advantage of providing gas for cooking. Further, biogas technology incorporating new method of biogas slurry treatment would really prove a boon to synergetic agriculture system. However, in a situation of low capital investment capacity of the farmers, other composting systems would be more viable. An integration of all these would offer an optimal solution.

Having done this extensive evaluation, planning for the newly developed agriculture system including the new paradigm of development based on SAP is presented. Policy issues in the context of agriculture system are briefly discussed.

Based on the results following important conclusions are drawn :

1. Modern farming practices based on energy intensive off farm chemical inputs like chemical fertilizers, pesticides, machinery, intensive irrigation, hybrid seed etc. are unacceptable on account of its ill effect on health, high production cost and

unsustainability from the environmental and ecological point of view.

2. Alternative farming practices suggested for 'sustainable development' mostly try to find the alternative within modern paradigm of development which itself is unsustainable. Thus, any effort of developing alternative agriculture system without a sound world view may prove in vain.
3. A new world view based on *Sah-Astitwa Principle* clearly outlines the interrelation between different units, at each level, as mutually-satisfying. Its concept of *Avartanshilata* provides standard for evaluation of any natural process. Based on this, a new alternative agriculture system (named *Avartanshil* agriculture) has been developed and guidelines have been worked out.
4. For understanding the operational aspects of newly developed agriculture system, experimental work on indigenous seed based organic farming was carried out for five consecutive years. Results obtained indicates the strong viability of the new system based on indigenous seed in view of its capability not only at the energy, ecology and environmental level, inherent in the system but also at the level of productivity and quality of produce. Results of field testing for 3 consecutive years, confirms this revealing aspect. Further, about 20% water required for irrigation can easily be conserved. Detailed economic analysis of both the systems reveal very interesting results strongly in favor of new system.
5. In the context of organic manure production and utilization, a newly developed composting technology, *PALRI METHOD* seems to be a major breakthrough in the field of rural composting. Similarly, improved method of heap manure would be popular in view of its simplicity over other methods.

Biogas technology incorporating newly developed method of slurry treatment would really prove a boon to synergetic agriculture system. However, in a situation of low capital investment capacity of farmers, other composting systems would be more viable. An integration of all these would offer an optimal solution.

6. Overall results along with planned efforts in the direction of introduction of the new agriculture system embracing the new paradigm of development indicate the strong feasibility of a path towards self sufficiency on a long term sustainable basis.
7. Finally, it is concluded that productivity and economy are important but mere profit or production can not be the motive. These have meaning only in the context of the ultimate aim of all human activities i.e. realization of happiness, peace, contentment and bliss individually through organisation within oneself (*Swamushasan*) and intelligibility, prosperity, fearlessness and coexistence collectively through the realisation of organisation at all levels (*Swarajya*).

<i>Abhay</i>	- fearlessness, implies the assurance in each other
<i>Anubhav</i>	- experience of existence as it is and its continuity.
<i>Asha</i>	- will to live and to live with perennial happiness
<i>Astitwa</i>	- existence, all that is
<i>Astitwamulak</i>	- founded on the experience of existence
<i>Avartanshil</i>	- cyclic process that satisfies the condition of fulfilling all its participants
<i>Avartanshilata</i>	- ongoing cyclic process in which every participant is enriched.
<i>Avastha</i>	- state or states, there are four order in <i>Nature</i> viz material, <i>Pranic</i> , animal and human
<i>Avyavastha</i>	- absence of <i>Vyavastha</i>
<i>Darshan</i>	- experience
<i>Daya</i>	- to accept every individual as having a role in <i>Vyavastha</i>
<i>Deenata</i>	- servility, to undervalue oneself
<i>Dharma</i>	- understanding and experience of interrelationship at the level of community
<i>Dheerata</i>	- conviction of the right relationships- <i>Nyaya</i> , and <i>Dharma</i> ,
<i>Gyanavastha</i>	- human order; Human has body and <i>Jivan</i> . To be more precise, human is <i>Jivan</i> acquiring a body.
<i>Heenata</i>	- deceptiveness, attitude to acquire things by adopting deceptive means
<i>Heet</i>	- usefulness for the body
<i>Ichchha</i>	- desire
<i>Jagrit</i>	- awakened human, all the five powers awakened and harmonized; in this state human can experience the existence in its completeness but still needs the human body to exemplify his living in complete harmony and oneness with the existence and its organisation.
<i>Jagriti</i>	- <i>Jivan</i> evolves itself by awakening its powers and harmonizing them ultimately leading to <i>Jagriti</i> . In this state, he is able to see the organisation within himself (<i>Swanushasan</i>) and also the organisation all over (<i>Swarajya</i>).
<i>Jagritipurna</i>	- completely awakened humans who express themselves in <i>Swanushasan</i> (self-organisation) at the individual level and as overall organisation (<i>Swarajya</i>) at the community level or rather at the level of existence as a whole.
<i>Jagritishil</i>	- awakening human, in the process of awakening and harmonizing the five powers of <i>Jivan</i> ; characterized by sensual, bodily and profit loss consideration as their purpose.
<i>Jarh</i>	- material and <i>Pranic</i> order
<i>Jiva</i>	- animal

<i>Jivan</i>	- human consciousness as an integral unit consisting of five undissipated powers- <i>Asha</i> , <i>Ichchha</i> , <i>Vichar</i> , <i>sankalp</i> , <i>Anubhav</i> . Precisely, human is defined as <i>Jivan</i> acquiring a body for its expression.
<i>Kalpanashilata</i>	- imagination
<i>Karmaswatantrata</i>	- freedom of action
<i>Karuna</i>	- continuity of <i>Daya</i> and <i>kripa</i>
<i>Kripa</i>	- to accept every individual as having a role in the <i>Vyavastha</i> and evolve a process for the same
<i>Krurata</i>	- cruelty, to forcibly take away from other something that belongs to him.
<i>Kushalata</i>	- ingenuity, making the production safe and sound,
<i>Labh</i>	- profit
<i>Maulikta</i>	- intrinsicness
<i>Mulya</i>	- the intrinsicness of units i.e. relationship within oneself and with others.
<i>Nature</i>	- consisting of all individual units (innumerable in total). Unit is characterized by its self-organisation and its relation to higher organisation.
<i>Nipunta</i>	- capacity to materialize the use value of a thing
<i>Nyaya</i>	- <i>Nyaya</i> is giving what is due to other human, as per the <i>Mulya</i> associated with the relations.
<i>Paramanu</i>	- Smallest unit in <i>Nature</i>
<i>Parampara</i>	- continuity, perenniality
<i>Paraspara</i>	- mutual
<i>Paraspara-Purakata</i>	- a relationship of mutual fulfillment
<i>Parasparata</i>	- everything in Existence is related to the other
<i>Parivar</i>	- family, a group of <i>Jagrit</i> persons living in mutual harmony
<i>Prakriti</i>	- <i>Nature</i> , consisting of all individual units (innumerable in total). Unit is characterized by its self-organisation and its relation to higher organisation.
<i>Pranavastha</i>	- <i>Pranic</i> order characterized by the respiration process, made possible by the complex structure developed at material order.
<i>Pranic</i>	- plants, fungi etc. characterized by respiration process.
<i>Priya</i>	- dear to senses
<i>Prayojana</i>	- to sum up the purpose of the existence is to reach through <i>Sah-Astitwa</i> to a state and establish its <i>Parampara</i> where happiness, peace, contentment and bliss is experienced by every human individually and <i>Samadhan</i> , enrichment, fearlessness and <i>sah- Astitwa</i> collectively.
<i>Purakata</i>	- being interrelated in mutually fulfilling manner
<i>Purnata</i>	- completeness in the sense of perenniality
<i>Sah-Astitwa</i>	- the coexistence in complementary togetherness at every level upto the whole existence. It is being interrelated in a mutually fulfilling manner.

<i>Sah-Astitwa Principle</i>	- a world view based on the experience by the central force of <i>Jivan</i> (<i>Madhyastha Darshan</i>) of Existence as it is (<i>Astitwamulak</i>).
<i>Samadhan</i>	- intelligibility, implies that every member of the society is awakened and can clearly understand himself and things around him; this includes to know and to accept a unit, to recognize one's relation with it and fulfillment of this relation.
<i>Samriddhi</i>	- enrichment, stands for interaction of a society with the <i>Nature</i> such that both are enriched in the process
<i>Samajikata</i>	- recognition of the <i>Mulya</i> associated with the relation and its fulfillment
<i>Sankalpa</i>	- spontaneity borne out of understanding
<i>Sanskar</i>	- the effective implementation of the understanding acquired through <i>Siksha</i> .
<i>Satta</i>	- space, a perennial source of energy in equilibrium, all-permeating, transparent, and providing force to interrelate one unit to other unit. Every unit derives its self-regulation and self-organisation from <i>Satta</i> .
<i>Satya</i>	- understanding and experience of Interrelationship at the level of whole existence
<i>Shista Mulya</i>	- expression in the behaviour of the 9 <i>Sthapit mulyas</i>
<i>Shram</i>	- effort put by the human
<i>Siksha</i>	- focuses on awakening of <i>Jivan</i> , of giving the right understanding of the self and the whole existence.
<i>Sthapit Mulya</i>	- 9 inherent mulyas: Affection, Care, Mutual Confidence, Love, Reverence, Pride, Spontaneity in Acceptance of relation, Respect and Gratitude.
<i>Suraksha</i>	- preservation and meaningful utilization of the natural resource of the material and <i>Pranic</i> order.
<i>Swanushasan</i>	- <i>Jivan Jagriti</i> and realisation of the natural order within oneself
<i>Swarajya</i>	- right organisation from individual to global level; having five dimensions of <i>Siksha</i> , <i>Swasthya</i> , production, exchange and <i>Nyaya</i>
<i>Swasthya</i>	- <i>Swasthya</i> relates to maintenance of health and nurturing of the body
<i>Sanyam</i>	- the acceptance of <i>Jivan</i> to nurture and protect the body.
<i>Udarata</i>	- willingness to facilitate the introduction of <i>Nyaya</i> , and <i>Dharma</i> with one's resource.
<i>Urvarakata</i>	- fertility
<i>Veerata</i>	- readiness to introduce <i>Nyaya</i> , and <i>Dharma</i> at the level of community
<i>Vichar</i>	- thought
<i>Vidya</i>	- right understanding of <i>Jivan</i> , <i>Astitwa</i> and the behaviour of human.
<i>Vikas</i>	- co-evolution, a natural unfolding in a mutually reinforcing manner from atom to molecule to chemical substance till complex structures like human body.
<i>Vyavasaya</i>	- the interaction with <i>Nature</i> involving Production - Work and exchange-saving systems
<i>Vyavastha</i>	- natural order at the level of human, family, community and whole existence

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Swarajya*

We call *Swarajya* as the Natural Community or NC in short because it is the natural way of humans living together as a self organised community. In NC, each and every person lives happily and harmoniously through mutual complementarity. Complimentary with humans as well as with the entire *Nature* and with all the future and past generations. It is organised on the basis of the Principle of *Sah-Astitwa* (SAP in short).

In the context of NC, the SAP would imply that:-

1. Every human:

- (a) is well organised within oneself, that is, enjoys the happiness in *Jivan* and the health in the body. Such a person is a Natural Human at the Individual level (NI)
- (b) lives in the Natural Family (NF) composed of severed NIs of various age groups, both the sexes and varied genetic heritage. Note that NIs could differ from each other only in age, sex, genetic heritage and the level of *Jagriti* in *Jivan*. In NF, children are in the transitory state of *Jagriti* while the adults are in the state of complete *Jagriti*. These differences are called the human diversity. Thus NF contains Complete Human Diversity.
- (c) complements other NIs in NF both in terms of *Jivan Jagriti* as well as body health. Each one participates with enthusiasm and full responsibility in all family affairs according to ones age and sex in such a way so as to keep the family continuously functioning in a natural way for ever.

2. The NF :

- (a) provides *Nyaya* to each of its member NI. *Nyaya* means *Samadhan* to the *Jivan* and health to the body.
- (b) provides opportunity, facility and encouragement to each member for the complete unfoldment and deepest satisfaction.
- (c) the NF lives in a Natural Village (NV). The NV is the natural organisation of several families living together in the mutually complementary fashion.
- (d) participates in all the five dimensions of NV in order to make the NV continue to function in a natural way for ever.

3. The Natural Village:

- (a) provides opportunity facility and encouragement to each member NI for its complete unfoldment and deepest happiness.
- (b) has five dimensions :
 - (i) Educational - Cultural System
(शिक्षा - संस्कार व्यवस्था)
 - (ii) Health - Discipline system
(स्वास्थ्य - संयम व्यवस्था)
 - (iii) Production - Work system
(उत्पादन - कार्य व्यवस्था)
 - (iv) Exchange - Storage system
(विनिमय - कोष व्यवस्था)
 - (v) *Nyaya* - *Suraksha* system
(न्याय - सुरक्षा व्यवस्था)
- (c) participates meaning fully in the Natural Nation (NN) composed of many NVs organised together through the natural human constitution

4. The Natural Nation :

- (a) Provides opportunity, facility and encouragement to each member NV in order to make it an ever

prosperous and happier village.

- (b) participates with full responsibility in the Natural World in order to make the world continue to function in a natural way forever.

5. The Natural World:

- (a) provides opportunity, facility and encouragement to each and every Natural Nation to make them function in mutually complimentary fashion.
- (b) interacts with *Nature* in such a way that it:
 - (i) protects the entire *Nature*
 - (ii) makes the *Nature* flourish more and more for ever.
 - (iii) assures that all orders in *Nature* on this earth continue to flourish in perfect natural way.
 - (iv) makes the earth better for the coming generations.

Thus in brief, the Natural Community (*Swarajya*) is a well organised composition of and for happy people and rich *Nature* all over the earth.

Each level of natural community protects and facilitates its lower level members and participates meaningfully and responsibly at the higher level. That is, protects naturalness at lower level, complements at its own level and participates in higher level.

This is the SAP in the human context.

SAP provides a Natural Human *Parampara* on the entire earth from generation to generation. Each generation is more and more rich and beautiful and expresses its gratitude (कृतज्ञता) to previous generations, offers love (*mamata*) and care (*vatslya*) to the coming generations to assure *Jagriti* in *Jivan* and health in body.

NC is free of all the human and natural problems faced so far by the people and full of all the possible human aspirations and fullfilments.

You may wonder that this is too good to believe. Well, believe it or not, this is true as it is defined on the basis of SAP. It turns out that SAP governs not only human community but all orders of *Nature*, infact, entire cosmos. Accordingly, on this earth the *Parampara* in all other orders of *Nature* is already established, the human order is in transition phase which will be complete in near future, may be a few generations more. The description of the entire comos on the basis of SAP will be presented in some other article.

This clarity of SAP has been revealed to us by Shri Nagraj ji of Amarkantak. *Swarajya* could not be defined correctly without this principle. SAP not only defines NC but also provides the mechanism to establish it.

Having defined *Swarajya* (NC) let us come to the Science and Technology for *Swarajya*.

The Natural Science(NS) is the understanding of the *Nature* on the basis of SAP. Note that conventional science is not aware of SAP. Instead it is based on uncertainty, probability, conflict, struggle and meaninglessness. It is worthless. Most of science is being done because it is an employment which is a modern form of slavery.

The natural science on the basis of SAP, reveals a definite, complementary, co-operetive beautiful and meaningful picture of *Nature*. It frees humans not only from ignorance but also shows the path of real freedom full of happiness and enthusiasm for all. It is worthwhile.

Natural Technology (NT) is the responsible and meaningful relationship of humans to the rest of the *Nature*. The NT provides:

- (a) nourishment, protection and work for human bodies.
- (b) protection and enrichment for *Nature*.
- (c) meaningful human-*Nature* interactions.

NT integrates human order into the rest of the *Nature* so as to provide happiness to humans and beautiful richness to the *Nature*.

The conventional technology is for:

- (1) victory over the *Nature*
- (2) exploitation of *Nature*
- (3) robbing the *Nature*
- (4) isolating the human from *Nature*.

This is not surprising as conventional science interprets *Nature* as conflicting, hazardous, challenging resource. It considers humans as greedy, arrogant and pleasure seeking consumers. The result is obvious. Poverty, sickness, alienation, frustration and wars on the human side and resource depletion, ecodisasters and pollution on the nature's side.

In reaction to it, ecotechnology, traditional technology, gaia technology, holistic technology tribal technology, vernacular technology, human technology, sustainable technology, environment friendly technology are being proposed.

With utmost humility and firm conviction we declare all these phrases hollow.

As conventional technology has been supported by and worked for the cruel wars (defence?) and greedy (economic ?) trade, so do the proposed phrases. They both suffer from crisis-attitude' crisis of survival, and the fear of suffering.

Many technologies also evolved out of mysticism. The making of worship houses, human and animal sacrifices, dance and music in religious ceremonies, festivals, innumerable styles of worship, idols of gods and pilgrimages are some examples which gave rise to a variety of technologies. In the mystic consideration, one believes in the mysterious, supernatural reality and regards *Nature* as some sort of illusion (less important), a bondage for the humans.

Whatever has been the basis of the conventional and proposed technologies, it has not been SAP. Therefore harmony and happiness could not be assured.

Some support humans against *Nature*, others support *Nature* against humans. Only SAP reveals the beautiful complementarity between humans and *Nature* resulting into a harmonious and happy co-evolution.

Obviously the Natural Technology has yet to be evolved by humans. For this the basis of Natural Science has to be laid down. This can be done only by the Natural Humans (*Jagrit Manav*) as only they can understand the SAP. The present day humans are in *pre-Jagriti* state characterised by fear, greed and mysticism. They can be brought into the transitory state and then to the state of complete *Jagriti* through a well planned educational activity.

The preliminary effort in this direction is encourageing. Let us hope, soon the Natural community (*Swarajya*) will be established through the Natural Technology on the basis of the Natural Science following the cosmic Principle of *Sah-Astitwa*. The humans will be freed from all kinds of miseries and *Nature* will be well protected. All will be conflict free. The world will be naturalised with happy humans and ever fresh and rich *Nature*.

May I invite you all to work for the *Swarajya* for our own happiness, for our childrens happiness for our ancestors dreams to come true.

* This is taken from article "Technology for *Swarajya*", written by Y.S. Satya, Centre for Energy Studies, I.I.T.D in *Parivar Manav* 1(3), May-Jun. 1995.

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