1678

Organic farming : Can it meet today's needs?

By

Sindhu, P.V.
(2004-21-01)

SEMINAR REPORT

Submitted in partial fulfillment for the requirement of the
Course No. Agron 751, Seminar (0+1)

DEPARTMENT OF AGRONOMY
COLLEGE OF HORTICULTURE
KERALA AGRICULTURAL UNIVERSITY
VELLANIKKARA-680656
THRISSUR, KERALA, INDIA
2005

DECLARATION

I, Sindhu, P.V. (2004-21-01) hereby declare that the seminar entitled "*Organic farming: Can it meet today's needs*" has been prepared by me, after going through the various references cited here and has not been copied from my fellow students.

Vellanikkara
20-11-2005

Sindhu, P.V.
(2004-21-01)

CERTIFICATE

This is to certify that the seminar report titled **"Organic Farming: Can it meet today's needs?"** has been solely prepared by **Sindhu, P. V. (2004–21– 01)**, under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

Vellanikkara
Date: 20-11-05

Dr. C. Geroge Thomas
Major advisor
Associate professor
Department of Agronomy
College of Horticulture
Vellanikkara
Thrissur

Contents

Introduction

After nearly four decades of globally celebrated agro technological revolution termed as "green revolution" Indian agriculture is at cross roads again. On one side of the spectrum are the developed countries with almost zero growth rate of population and threatened with a serious problem of over production in agriculture sector. On the other side are developing countries like India, with population growth out stripping agricultural productivity and required to produce more and more food, fibre and fuel from ever shrinking agricultural land.

The post green revolution problems often referred to as 'second generation problems', presently threatening the sustainability of Indian agriculture as a whole and raising serious concerns about India's food security. It is due to these problems that the echo of ecofriendly back to nature agriculture became louder.

Development of organic food markets in some developed western countries that are scared of consuming the food grown locally with high amount of pesticide residues due to excessive use of agro chemicals gave further momentum to the promoters of organic agriculture in developing countries like India.

Organic farming: Concept and definition

Organic agriculture avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives and to this list may be added the use of genetically modified (GM) crops.

Organic farming system solely depends on the use of on farm and off farm crop residues, organic wastes, animal manures, green manures, crop rotations, incorporating legumes and biological pest control to maintain soil productivity (Palaniappan and Annadurai, 1999).

The philosophy is to feed the soil rather than the crops to maintain soil health and is a means of giving back to nature what has been taken from it (Funtilana, 1990).

History of Organic Agriculture

The first 40 years of the 20th century saw simultaneous advances in biochemistry and engineering that rapidly and profoundly changed farming. The introduction of the gasoline internal combustion engine ushered in the era of the tractor, and made possible hundreds of mechanized farm implements. Research in plant breeding led to the commercialization of hybrid seed. And a new manufacturing process made nitrogen fertilizer - first synthesized in the mid-1800s - affordably abundant. These factors changed the labor equation: there were some 600 tractors in the US around 1910, and over 3,000,000 by 1950; in 1900, it took one farmer to feed 2.5 people, where currently the ratio is 1 to well over 100. Fields grew bigger and cropping more specialized to make more efficient use of machinery.

In England in the 1920s, a few individuals in agriculture began to speak out against these agricultural trends. The British botanist Sir Albert Howard is often referred to as the father of modern organic agriculture. From 1905 to 1924, he worked as an agricultural adviser in Pusa, Bengal, India, where he documented traditional Indian farming practices, and came to regard them as superior to his conventional agriculture science. His research and further development of these methods is recorded in his writings, notably, his 1940 book, *An Agricultural Testament*, which influenced many scientists and farmers of the day. In Germany, Rudolf Steiner's biodynamic agriculture was probably the first comprehensive organic farming system (the apparent beginning of which was a lecture Steiner presented in 1924).

In the early 1900s, American agronomist F.H. King toured China, Korea, and Japan, studying traditional fertilization, tillage, and general farming practices. He published his findings in *Farmers of Forty Centuries* (1911). King probably did not view himself as part of a movement, organic or otherwise, but in later years his book became an important organic reference. In 1939, influenced by Sir Howard's work, Lady Eve Balfour launched the Haughley Experiment on farmland in England. It was the first scientific, side-by-side comparison of organic and conventional farming. Four years later, she published *The*

Living Soil, based on the initial findings of the Haughley Experiment. Widely read, it led to the formation of a key international organic advocacy group, the Soil Association

The coinage of the term *organic farming* is usually credited to Lord Northbourn, in his book, *Look to the Land* (1940), wherein he described a holistic, ecologically-balanced approach to farming. J.I. Rodale coined it in an article for the publication Fact Digest. Shortly thereafter, he launched Organic Farming and Gardening (OFG) magazine — for many years the flagship publication of Rodale Press. J.I. Rodale drew his concept of organic agriculture from a number of sources, including Louis Bromfield (the author of Malabar Farm and other books on conservation farming), Dr. William Albrecht (from the Department of Soils at the University of Missouri), and the Biodynamic movement. However, his key ideas about farming came from Albert Howard.

In America, Rodale expanded on Howard's ideas. In his seminal book on organic agriculture, Pay Dirt, he identifies a number of other "good farming practices" — like crop rotation and mulching — that gave further definition and clarification to what have become accepted organic practices and inputs. This is important because organic farming embodies the elements of a sound agriculture — traditional practices that have been proven over time. In fact, a good, convenient, working definition for organic agriculture is good farming practice without using synthetic chemicals. This working definition distinguishes organic practice from the general milieu of agriculture that existed in the pre-chemical era, much of which was exploitative and unsustainable. Organic farming was never intended to be a "throwback" or regressive form of agriculture.

In 1944, an international campaign called the Green Revolution was launched in Mexico with private funding from the US. It encouraged the development of hybrid plants, chemical controls, large-scale irrigation, and heavy mechanization in agriculture around the world. During the 1950s, sustainable agriculture was a topic of scientific interest, but research tended to concentrate on developing the new chemical approaches. In the US, J.I. Rodale began to popularize the term and methods of organic growing, particularly to consumers through promotion of organic gardening.

A truly significant event in the history of organics took place in 1962, with the publication of Rachel Carson's *Silent Spring*. *Silent Spring* is a strong and dramatic statement about the impact of pesticides on the environment. A bestseller in many countries, including the US, and widely read around the world, *Silent Spring* is widely considered as being a key factor in the US government's 1972 banning of DDT. The book and its author are often credited with launching the worldwide environmental movement.

When environmentalists and others began looking around for an alternative to pesticides and industrial agriculture, organic farming was there. Not only was it an approach that did not use synthetic pesticides, it also had an attractive counter-culture name that grew to signify a philosophy of living as well as a method of farming.

While *Silent Spring* and the environmental movement were not about organic farming *per se*, they brought it to public consciousness on a vast scale. It is not uncommon, in fact, for some writers to suggest that organic agriculture began with Rachel Carson's book. Though this assertion is untrue, the book clearly played a major role in stimulating industry growth and in altering public perceptions. From the mid-1960s onward, organics was increasingly identified with pesticide issues. It became the idealized alternative for providing clean, healthy food and environmental protection.

In Japan, Masanobu Fukuoka, a microbiologist working in soil science and plant pathology, began to doubt the modern agricultural movement. In the early 1940s, he quit his job as a research scientist, returned to his family's farm, and devoted the next 30 years to developing a radical no-till organic method for growing grain, now known as Fukuoka farming. In 1975, Fukuoka released his first book, *One Straw Revolution*, with a strong impact in certain areas of the agricultural world. His approach to small-scale grain production emphasized a meticulous balance of the local farming ecosystem, and a minimum of human interference and labor.

Technological advances during World War II accelerated post-war innovation in all aspects of agriculture, resulting in big advances in mechanization (including large-scale

irrigation), fertilization, and pesticides. In particular, two chemicals that had been produced in quantity for warfare, were presupposed to peace-time agricultural uses. Ammonium nitrate, used in munitions, became an abundantly cheap source of nitrogen. And a range of new pesticides appeared: DDT, which had been used to control disease-carrying insects around troops, became a general insecticide, launching the era of widespread pesticide use.

The International Federation of Organic Agriculture Movements, abbreviated and best known as IFOAM, began life in a very historic place - Versailles, France on November 5th, 1972. It all started during an international congress on organic agriculture organized by the French farmer organization Nature et Progrès. The initiative came from the late Roland Chevriot, President of Nature et Progrès. There were five founding member organizations at the cradle of IFOAM: The Soil Association from Great Britain represented by Lady Eve Balfour, the Swedish Biodynamic Association with Kjell Arman, the Soil Association of South Africa in the person of Pauline Raphaely, Rodale Press from the United States of America whose representative was Jerome Goldstein and of course, Nature et Progrès with Roland Chevriot.

Variants of organic farming

There are several variants and incarnations of organic farming. One extreme is the agriculture practices by Amish community in the north eastern parts of U.S.A., who do not use tractors for ploughing the field since they are driven by diesel and or petrol and instead use horses for tilling the land.

Rishi krishi

Acharya Vinoba Bhave initially experimented with this approach at his Paunar Ashram (Wardha). He advocated his supporters to till the land with bare hands, as the *Rishis* possibly did for meeting their food and fiber requirements. Later he relented and allowed the use of bullocks to till the land. It was believed that cosmic energy is the only source of plant growth and no organic manures or fertilizers are required to raise the plants

(Deshpande, 2004). This approach of "do nothing agriculture" was destined from its very inception and met with an utter failure.

Biodynamic Agriculture

In this approach some nine preparations (BD 500 to BD 508) are made using cowdung from lactating cows, silica or blossoms, leaves, bark etc. of some temperate plant species filled in the hollow of cow horn, stomach, intestine, peritoneum, skull or urinary bladder of male deer's and composting them for a season by burying them in the soil during some auspicious moments. These BD preparations applied in very small quantities are claimed to have magical properties of meeting crop nutrient demands, preventing and curing diseases and pest infestations and increasing soil fertility particularly nitrate nitrogen.

A calendar developed by the Biodynamic enthusiasts attempts at linking of planetary rhythms and constellation with nutrient use efficiency, with recommendations to apply manures with an ascending moon or full moon period to derive maximum advantage (Menon and Karamarkar, 1994). Similar recommendations are made for other agricultural operations.

Homa farming

This variant of organic farming involves *Agnihothra* (burning whole rice grains mixed with cow ghee in a copper pyramid of specified size, along with chanting of mantras at sunrise and sunset). This practice is said to gather tremendous energy around the copper pyramid, which goes to the atmosphere along with holy smoke and exerts dramatic benefits to the crop growth and productivity by way of injecting nutrients to the environment and mitigating the ill effects of pollution. The ash left after performing the *Agnihothra* is treated as complete plant food though the fact remains that it contains mainly potash (Pathak and Ram, 2003).

Natural farming

A Japanese farmer, Masanobu Fukuoka who practices what he calls the "no-plowing, no-fertilizing, no-weeding, no-pesticides, do-nothing method of natural farming", developed

this method. To him the idea that people can grow crops is egocentric. Ultimately it is nature that grows crops. He sees modern agriculture as doing-this and doing-that to grow crops, but it is meaningless work. With his do-nothing method he is able to get yields in his rice fields that are equal to the highest yields attained with chemical, do-something agriculture.

Permaculture

The word "permaculture" was coined in 1978 by Bill Mollison, an Australian ecologist, and one of his students, David Holmgren. It is a contraction of "permanent agriculture" or "permanent culture."

Permaculture is about designing ecological human habitats and food production systems. It is a land use and community building movement, which strives for the harmonious integration of human residence, microclimate, annual and perennial plants, animals, soils, and water into stable, productive communities. A central theme in permaculture is the design of ecological landscapes that produce food. Emphasis is placed on multi-use plants, cultural practices such as sheet mulching and trellising, and the integration of animals to recycle nutrients and graze weeds.

Myths attached to organic farming

There are several myths being proposed among the public about organic farming. The validity of these myths has been discussed in detail by Chhonkar (2003) and Trewavas (2004). Some of these myths are discussed below.

Organic food tastes better and is of superior quality

The traditional belief that organic manure promotes quality, while mineral fertilizers promote quantity, was shown to be over simplistic by Qual (1974) on the basis of trails conducted over a decade. Regardless whether the nutrients are from organic or inorganic source, plants absorb the same in the form of inorganic ions: ammonium, nitrate, phosphate, potassium etc.

Once absorbed, the nutrients are re synthesized in to compounds that determine the quality of produce e.g. Flavour, shelf life etc., which is the function of genetic make up of plants. Thus any difference in taste of modern high yielding varieties is due to difference in genetic material.

There is no scientific evidence presented as yet to show organically produced food is of better quality and taste and the use of inorganic fertilizers deteriorates it. The better taste of organically grown food is of psychological in nature and could be attributed to 'Placebo effect' widely used in drug industry.

Studies conducted shows that levels of C vitamins, flavonoids or antioxidants in organic foods are to be two or three times the level found in matched samples of conventional foods. Although very few studies directly addressed the issue, the polyphenol content of vegetables produced by organic or sustainable agriculture is certainly higher than that of those grown in conventional or hydroponic conditions (Manach, 2004)

Organic food is more nutritious and safer

There are no consistent and valid reports of differences in the mineral contents of organic and conventional food. Many taste assessments of organic and conventional foods have been conducted. In these individuals were provided with three pieces of same produce and asked to state which two are the same. Such tests have indicated that there is common confusion of freshness for organic produce and that the public cannot easily distinguish between organic from conventional (Hasen, 1981 and Basker, 1992).

In a study conducted to assess the effect of organic sources of plant nutrients on yield and quality of brinjal (Prasanna, 1998) the ascorbic acid content of fruits was higher in treatments which received higher levels of N as compared to lower levels irrespective of the sources of nutrients.

The attitude that organic foods are safe and healthy is based on misconception that hazards in food are mainly from agro chemical additives. In fact, microbes are the major source of food borne diseases such as typhoid, gastro enteritis and dysentery etc. animal waste can be an effective nutrient source, but pathogen risk must be seriously considered. Animal waste contains intestinal bacteria many of which may present substantial human health threats. Land application of manure is particularly associated with *Salmonella, E. coli* etc. that can contaminate the soil. These pathogens are known to survive in the soil for a long period. They may be carried on to edible plant parts and get in to the food chain. They may also be introduced in to shallow surface waters as well as ground water polluting potable water supply (Mikkelson and Gilliam, 1995).

Organic farming is ecofriendly

It is advocated that organic farming is ecofreindly. It keeps the soil healthy and does not pollute the environment. It is well known that nitrate is the main end product of manure decomposition and is continuously released from organic matter undergoing decomposition. Since nitrate release is not synchronized with either crop demand or its uptake, it tend to accumulate in excessive amounts in soil and cause environmental risk. Nitrate thus formed without being taken up by plants may leach polluting ground water or may denitrify and pollute the environment. The ions irrespective of their origin whether from organic or inorganic source will behave similarly. There is no evidence that nitrate ions from organic sources are less mobile or having lower denitrifying potential than from inorganic fertilizers.

Trace elements and heavy metal concentrations in animal wastes (manures) and sewage sludge vary widely and can be at times very high (Table 1). Some times their concentration may exceed normally what present in inorganic fertilizers. Field application of such organic manures which have to be applied in very huge quantities in order to meet the requirements of major plant nutrients may lead to heavy metal accumulation in soil polluting arable land. These will find way in to edible plant parts and will get in to food chain becoming a serious health hazard (Table 2).

Increased emission of green house gases are thought to increase the potential for global warming and climate change. Carbon Dioxide, methane and nitrous oxide are the three most important green house gases associated with agriculture. CO_2 emission comes besides from burning of fuels, from decomposition of organic matter and crop residues. Methane originates predominantly from cattle manure, which is an integral part of organic farming. Nitrates formed in excess of the crop demand may further denitrify to yield nitrous oxide, which tend to further increase on Manuring as denitrification is positively correlated with microbial biomass and organic matter.

Table 1. Total concentration of selected heavy metals and trace elements in fertilizers, manures and biosolids (mg/kg of dry weight)

Source	As	Cd	Cr	Cu	Pb	Ni	Zn	Reference
Urea	<0.04	<0.2	-	<0.6	<0.04	<0.2	-	Raven and Leoppert(1997)
DAP	9.9-16.2	4.6-35.5	5.5	<2.41	2.1-3.7	7.4-222	10.3	"
MOP	0.4	<0.2	<1.0	<2.35	<0.4-10	<0.2	4.59	"
Tripple super phosphate	10.3	15.0	133	3.5	11	17	159	Charter et al., (1993)
Cow manure	-	8.1	58	62	16	29	71	Webber and Singh (1995)
Poultry manure	0.35-110.5	-	0.6-19.6	3.5-13.5	-	-	51-538	Combs et al., (1998)
Sewage sludge	3.6	2.3	35	511	65	22	705	Stchouwer, (1999)

Table 2. Cadmium concentration (mg kg^{-1}) in different parts of rice, sesame and cowpea as influenced by nutrient application

Plant	Plant parts	Treatments		
		Absolute control	Fert+FYM+Lime	Fert+Lime
Rice	Grain	1.0	2.1	1.7
	Straw	1.2	2.7	2.2
	Root	2.8	6.2	5.2
Sesame	Pod	3.2	4.7	3.5
	Haulm	4.0	5.3	5.0
	Root	7.0	7.8	8.0
Cowpea	Grain	1.2	1.7	1.3
	Haulm	1.3	2.2	2.1
	Root	3.8	6.5	4.3

(Mathew et al., 2002)

Organic farming improves soil fertility and inorganic farming deteriorates it

Long term fertilizer trails conducted at various agroclimatic conditions have shown that balanced application of nutrients through inorganic fertilizers alone or through combined use of fertilizers and manures over a period of three decades have sustained crop productivity (Table 3).

Table 3. Mean grain yield (t ha^{-1}) of crops under long term fertilization and Manuring

Location	Crops	Mean grain yield (t ha^{-1})			
		Unfertilised	100%NPK	100%NPK + FYM	150%NPK
Barrackpore	Rice	1.6	3.9	4.1	4.3
	Wheat	0.8	2.4	2.5	2.9
Bhibaneswar	Rice	1.6	2.8	3.5	3.0
	Wheat	1.4	3.0	3.7	3.3
Coimbatore	Finger millet	1.0	3.0	3.5	3.2
	Maize	0.7	3.0	3.4	3.2
Ludhiana	Maize	0.4	2.6	3.2	2.5
	Wheat	1.0	4.8	5.0	4.9
Jabalpur	Soybean	0.9	2.1	2.2	2.1
	Wheat	1.1	4.2	4.6	4.4
Pantnagar	Rice	3.1	5.3	6.0	5.3
	Wheat	1.5	3.8	4.5	4.1
Palampur	Maize	0.3	3.2	4.6	4.0
	Wheat	0.3	2.5	3.3	3.0

(Swarup and Wanjeri, 2000)

The results of the famous Broadbalk experiment started in 1843 by Lawes and Gilbert shows that the soil carbon content has increased in the manure only plot by more than two fold but the mineral only plot recorded a carbon content of 20 per cent (Johnston, 1991).

Organic farming sustains higher yields

There are dependable research evidences to show that balanced inorganic fertilizers and intrgarted nutrient management have sustained crop yields on long term basis (Dwivedi *et*

al., 2002). Results of initial four years of long term experiment on rice wheat system at Modipuram shows that the yields of both rice and wheat remained sizably low under organic farming compared with conventional farming owing to lesser number of effective tillers and fewer number of grains (Table.4).

Table 4. Yield and yield attributes of rice and wheat under conventional and organic management during the fourth year of cropping

Crop	Treatment	Grain (t ha^{-1})	Straw (t ha^{-1})	Ears/m^2	Grain/ear	Grainwt./ear (g)
Rice	Unfertilised control	2.34	3.09	196	43	0.62
	100%NPK	5.15	6.59	250	94	1.68
	75%NPK+25%N as FYM	5.24	6.48	258	95	1.75
	Soil test based NPK	5.53	6.86	285	94	1.71
	Organic farming	3.84	4.69	236	77	1.65
Wheat	Unfertilised control	2.11	2.91	238	26	1.16
	100%NPK	4.82	6.54	375	38	1.70
	75%NPK+25%N as FYM	5.20	6.95	370	42	1.74
	Siol test based NPK	5.45	7.72	380	42	1.93
	Organic farming	4.16	5.35	282	35	1.73

(Yadav *et al.*, 2002)

In the two sections of Broadbalk experiments winter wheat has been grown continuously on land either given only manure (35 t ha^{-1}) or only mineral fertilizers. After nearly 160 years of the experiment the yields remained identical. Yields have chaniged in parellal in the two sections with the introduction of new winter wheat varieties, herbicides, fungicides

and all the constantly improving agronomies that are now part of farming. It is quite clear from these data that, with in the confines of the experiment, conventional agriculture using minerals is sustainable, 160 years long enough (Rasmussen et al., 1998).

From many reports it is clear that organic yields are usually lower, the extent depends on the crop. Leake (1999) reported that organic wheat, beans and peas yields where 60-70 per cent where as oats were 85 per cent conventional yields (Table 5).

Table 5. Yields of crops grown conventionally and in organic methods

Treatment	Winter wheat	Winter oats	Winter beans	Dried peas
Organic	4.82	4.87	2.60	2.13
Conventional	7.12	5.75	3.60	3.473.47

(Leake, 1999)

Enough organics are available to replace the inorganic fertilizers

Projections on the availability of plant nutrients from organic sources for agriculture in India during 2000-2025 as worked out by Tandon, 1997 are given in table 6. and projected plant nutrient NPK addition and removal as per Katyal (2001) are given in table 7. These figures apparently reveal that all tappable nutrients from organic sources will be barely able to meet the deficit of nutrients in soil after crop removal at present level of production, what to say of replacing chemical fertilizers presently used.

Table 6. Projections on the availability of plant nutrients from organic sources for agriculture in India

Resource	$N+P_2O_5+K_2O$ (mt)		
	2000	2010	2025
Crop residue	2.05	2.34	3.39
Cattle manure	2.00	2.10	2.26
Human excreta	1.60	1.80	2.10
Total	5.50	6.24	7.75

(Tandon, 1997)

Table 7. Projected plant nutrients ($N+P_2O_5+K_2O$) addition and removal in India (million tones)

	2000	2020
Addition through fertilizers	18.07	29.60
Crop removal	28.00	37.46
Balance	-10.00	-7.86
Availability from organic sources	7.75	

(Katyal, 2001)

Organic farming and India's food security

India is the second largest populous country in the world next only to China. The total population in India was 1.0968 billion during 2003. The present growth rate in population is 1.68 per cent per annum. To feed this ever growing population there is a need for adequate food grains in a sustained manner.

Food security

Zeller *et al.*, (1997) defined food security at the house hold level as access by all people at all homes to the food needed for a healthy life.

Food insecurity includes a temporary short fall of adequate food for a proper diet, called 'transitory food insecurity' as well as a long term food shortage called 'chronic food insecurity'.

India Development Report spells out the state of food insecurity in India. The per capita availability of cereals has come down from 429.2 g per daily during 1999 to 407.1 g per day during 2003. Availability of pulses has come down from 36.5 g per day to 29.1 g per day in the same period. As of now India's 47 per cent children are malnourished, 74 per cent anemic and 36 per cent of married women in the age group of 15 to 49 in rural areas suffer from chronic energy deficiency.

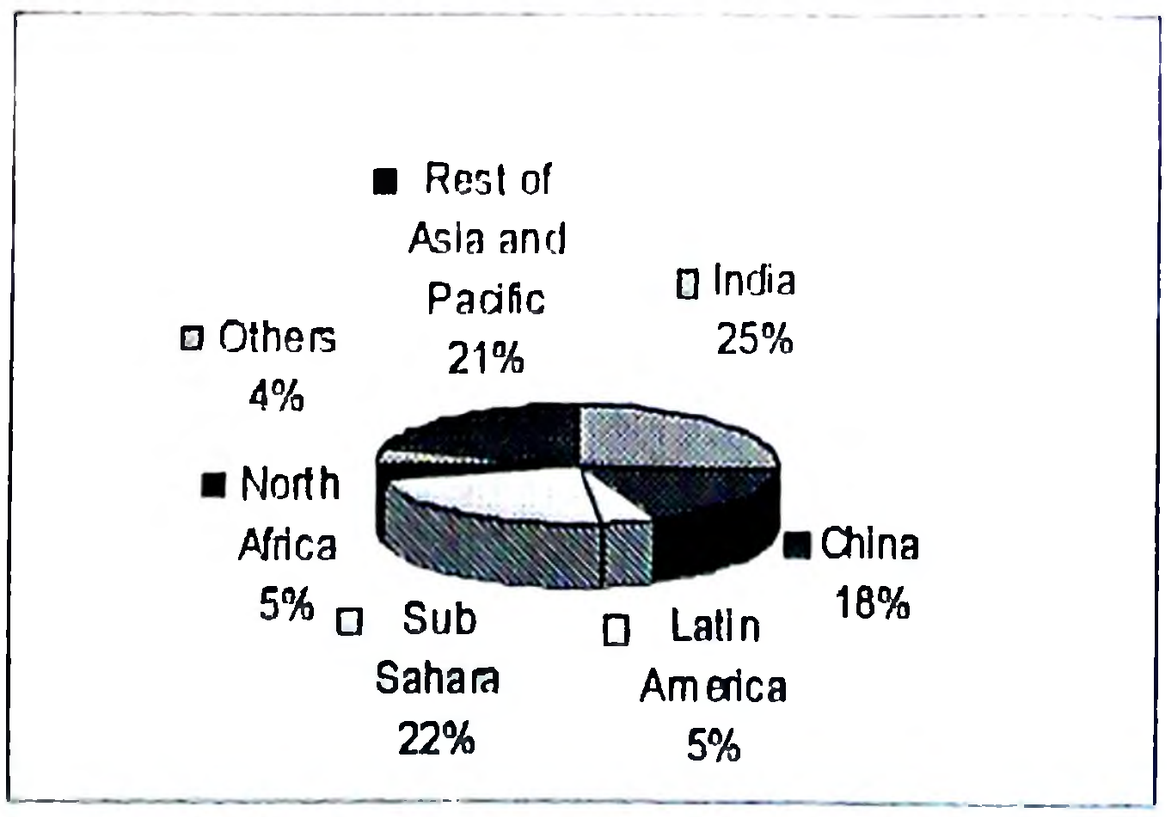
Reports on per caipta food consumption (FAO, 2000) shows that the food supply is lower in India compared to developed countries and many of our neighbouring developing countries (Table 8 and fig. 1)

Table 8. Country wise food supply in kilo calories per capita per day

Country	Food supply in (kilo calories per capita per day)
USA	3699
Belgium	3619
France	3518
Germany	3382
Israel	3278
UK	3276
South Africa	2990
Japan	2932
China	2897
Indonesia	2886
India	2496

(FAO, 2000)

Fig. 1. Undernourishment (number of persons per 1000 by region)



The primary concern of all organized communities and civilized governments is to meet the food requirements of its people. To maintain the present level of food grain production in India without input of chemical fertilizers the net additional area needed to be brought under cultivation is more than the total geographic area of the country. The countries food security will be further compromised since in this calculation the additional food demands for projected population growth as given by Sekhon (1997) has not been taken in to account (Table 9).

Table 9. Projections for population growth and food grain demand in India

	2001	2011	2021	2025
Population (million)	1032	1262	1542	1690
Demand for food grain (million tones)	206	253	308	338

(Sekhon, 1997)

Nutrient NPK addition through fertilizers (18 mt) and nutrient removal by crops (28 mt) over a period (1960-61 to 1999-2000) indicates a gap of nearly 10 mt, which was met by mining the native nutrient reserves of the soil. The fertilizer use is projected to reach 29.60 mt by 2020, following an increase of 0.58 mt $year^{-1}$. Against this projected use, the crop uptake related to removal would sum up to 37.46 mt of NPK, leaving a negative balance of about 8 mt of NPK by 2020 provided the present growth rates of production and consumption of fertilizers are maintained (Katyal, 2001).

In India per hectare use of fertilizers is lower than the developed countries and even some of our developing countries (Table 10). With in India, among the major states the per hectare consumption of fertilizers is lower than all India average (Table 11).

Table 10 . Fertilizer consumption and food grain productivity in 2002-2003

Country	NPK consumption (kg ha^{-1})	Yield of food grains (kg ha^{-1})
Egypt	438	6983
Korean Republic	410	5649
Netherlands	367	8146
UK	313	6675
Japan	291	5343
China	276	4707
Germany	220	5693
Bangladesh	178	3222
Pakisthan	138	2009
USA	110	5976
India	90	2031

(Fertiliser statistics,2003-04)

Table 11. Per hectare consumption of fertilizer nutrients in states of India

States below Indian average		**States above Indian average**	
State	Consumption (kg ha^{-1})	State	Consumption (kg ha^{-1})
Assam	46.6	West Bengal	122.4
Bihar and Jharkand	80.5	Haryana	167.1
Orissa	41.4	Punjab	184.0
Himachal pradesh	49.4	Up and Uttaranchal	126.7
Jammu and Kashmir	71.4	Anthrapradesh	136.8
Karnataka	74.9	Tamil Nadu	112.5
Kerala	63.6	Gujarath	95.1
Madhyapradesh	55.0		
Chattisgargh	46.5		
Maharashtra	65.7		
Rajasthan	40.5		

(Fertiliser statistics, 2003-04)

The most optimistic estimates show that about 25 30 per cent nutrient needs of Indian agriculture can be met by utilizing various organic sources. Since the estimates of NPK availability from organic sources are based on their total nutrient content the efficiency of these sources to meet the crop nutrient requirement of crop is not as assured as inorganic fertilizers. Further on per kg nutrient basis organic manures and residues are more expensive than inorganic fertilizers.

With ever increasing population having huge requirement of food and meager availability of organic sources, pure organic farming is not feasible in India. The commercial fertilizers will remain to be the major source (Prasad, 2000).

Organic farming disaster in China

China attempted to impose organic farming regime nation wide in 1950s aiming at increasing food production without investing in fertilizer production. The Chinese intensified their traditional efforts to collect all animal manure and night soil besides gathering as much biomass as possible. There was hardly any input of nutrients from inorganic fertilizers. After several years of mass organic farming, China suffered an appalling famine with 30 millions of starvation deaths in 1959-60. Looking at the sources (organic and inorganic) from which Chinese mobilized plant nutrients (Table 12) it is apparent that 99.9 per cent nutrients came from organic sources in 1949, which gradually declined to 30.3 per cent by 2000 with concurrent increase in the use of nutrients from inorganic sources from 0.1 to 69.7 per cent. Also there was a corresponding increase in productivity of rice and wheat. This massive gain in food production without bringing additional area under cultivation was primarily inorganic fertilizer driven, and also due to utilization all available sources of organic nutrients. This lesson of utter failure of organic agriculture in alleviation of malnutrition and sustenance of high productivity has to be learned by other developing nations, particularly India (Chhonkar, 2004)

Table 12. Proportion of organic and inorganic nutrient inputs in total nutrients applied in different years in China

Year	Total NPK applied	Source of application		Yield (t ha^{-1})	
		Inorganic (%)	Organic (%)	Wheat	Rice
1949	4.32	0.1	99.9	0.74	2.40
1965	8.68	22.4	77.6	1.09	2.94
1975	14.94	32.7	67.3	1.39	3.51
1985	31.52	56.3	43.7	2.94	4.20
1990	40.86	63.4	36.6	3.15	5.72
2000	60.28	69.7	30.3	3.74	6.27
2005*	66.31	75.0	25.0		

*projected

(Chhonkar, 2004)

The post independence India with population increasing at alarming rate and food grain production stagnating around 50 million tones was the object of mockery around world wide. The vision and collective efforts of planners, scientists and farmers proved these predictions wrong, leading to arousal of the country from ship to mouth status to self sufficient and food grain exporting nation. While listening to ecological fundamentalists, farmers and all those associated with agricultural sector must remember how India has traversed from famine to plenty and from humiliation to dignity. Any alternate technology will be welcome so long it ensures present and future food security.

Such alternate technology must answer few pertinent questions related to the food security. The questions include, what level of yield is acceptable? Is it acceptable for a country like India with a large population to feed? Are available organic sources of plant nutrients sufficient for pure organic farming? Are organic farming technologies are sustainable in long run?. Policy initiatives directed at reducing or eliminating the use of inorganic fertilizers will in long run prove disastrous for Indian agriculture.

Conclusion

Due to its lower productivity and high cost of production, organic farming will leave many Indians hungry and malnourished. Since "a hungry man is an angry man" (Swaminathan, 2003) mass hunger may even lead to social strife and unrest. As the requirement for feeding the burgeoning population, pure organic farming is not possible in India. The gap between nutrient addition and removal causing the nutrient mining cannot be allowed to continue. Therefore, organic resources should be used in conjunction with inorganic fertilizers to narrow down this gap as well as to sustain the quality soil and achieve higher crop productivity.

Sustainable farming, integrating the goals of environmental health, profitability and social and economic equity shall be the key to future needs.

References

Basker, D. 1992. Comparison of taste quality between organically and conventionally grown fruits and vegetables. *Am. J. Alt. Agric.* 7:129-136

Charter, R.A., Tabatabai, M.A. and Sehafer, W. 1993. Metal contents of fertilizers marketed in Lowa. *Communications in Soil Sci. and Plant Analysis.* 24:961-972

Chhonkar, P.K. 2003. Organic farming: science and belief. *J. Indian Soc. Soil Sci.* 51:365-377

Chhonkar, P.K. 2004. Organic farming and its implications on India's food security. *Fertil. News.* 49(11): 15-38

Combs, S.M., Peters, J.B. and Jhang, J.S. 1998. Manure: trace element content and impact on soil management. Soil palnt nalysis workshop, Council on soil testing and plant analysis, November 10-11 t. Louis No. USA p. 13

Deshpande, M.S. 2004. Souvenir, National Conference on Organic farming for sustainable production, Horticultural Society of India, New Delhi. P.9

Dwivedi, B.S., Shukla, A.K. and Sing, V.K. 2002. Annual Report (2001-02), PDCSR, Modipuram. pp. 76-80

FAI, 2003. *Fertilizer News – April 2003.* The Fertilizer association if India, New Delhi. pp. 7-8

FAI, 2004. *Fertilizer Statistics 2003-2004.* The Fertilizer association of India, New Delhi. pp.11-12

FAO. 2000. *Agriculture towards 2015/2030.* Technical Interim Report, FAO, Rome. 40p.

FAO. 2000. *The state of food security in the world.* FAO bulletin, Rome. p.16

Funtilana, S. 1990. Safe, inexpensive, profitable and sensible. International Agriculture Development , March – April 24, 1990, pp-17-20

Hansen, H. 1981. Comparison of chemical composition and taste of biodynamically and conventionally grown vegetables. *Plant Fd. Human Nutr.* 30:203-211

Johnston, A.E. 1991. Potential changes of soil fertility from arable farming including organic systems. *Fertil. Soc. News.* 8:1-38

Katyal, J.C. 2001. Fertiliser use situation in India. *J. Indian Soc. Soil Sci.* 49: 570-582

Leake, A.R. 1999. A report of results of CWS agriculture's organic farming experiments. *J. agric. Soc. Engl.* 160:73-81

Manach, S. 2004 . Polyphenols: food sources and bioavailability. *American J. Clinical Nutr.* 79(5): 15-19

Mathew, V., Venugolpal, V.K. and Saraswathy, P. 2002. Cadmium content of plants as affected by soil, application of cadmium and FYM. *J. trop. Agric.* 40:78-80

Menon, T.G.K. and Karamarkar, V.B. 1994. *Organic Farming.* (ed. Shroff, V.N.). JNKVV, Jabalpur. pp. 122-129

Mikkelson, R.L. and Gilliam, J.N. 1995. *Animal Waste and Land Water Interface.* Lewis Publishers, Boca raton. 245p.

Murthy, G.S.R. 2004.. Souvenir, National Conference on Organic farming for sustainable production, Horticultural Society of India, New Delhi. P.10

Palaniappan, S.P. and Annadurai, K. 1999. *Organic farming Theory and Practice*. Scientific publishers (India) Jodhpur, 255p.

Pathak, R A. and Ram, K.A. 2003. *Manual on vedic krishi*, Extn. Bull. No.18, CISH, Lucknow. 45p.

Prasad, R. 2000. Nutrient management strategies for the next decades: challenges ahead. *Fertil. News*. 45:13-18

Prasanna, K.P. 1998. Impact of organic sources of plant nutrients on yield and quality of brinjal. Ph.D thesis, Kerala Agricultural University, Thrissur, 220p.

Qual, S.W. 1974. Nutritional value of crops as influenced by organic and inorganic fertilizer treatments: results of 12 years experiment with vegetables. *Plant Fd. Human Nutr.* 23:333-358

Rasmussen, P.E., Goulding, K.W.T., Brown, J.R., Grace, P.R. and Jhanzen,H.H. 1998. Long term agroecosystem experiments: assessing agricultural sustainability and global change. *Science* 282:893-896

Raven, K.P. and Leoppert, K. 1997. Trace element composition of fertilizers and soil amendments. *J.Environmental Quality*. 26:551-557

Sekhon, G.S. 1997. Nutrient needs for irrigated food grain crops in India and related issues. *Plant Nutrient Needs, Supply, Efficiency and Policy Issues 2000-2005* (eds. Kanwar, J.S. and Katyal, J.C.). National Academy of Agricultural Sciences, New Delhi. pp. 29-44

Stchouwer, R. 199. Land application of sewage sludge in Pennsylvania: What ails sewage sludge and what can be done with it?. (On- Line). Available: http://www.agronomy.psu.edu/extension/facts/whatis-pdf. (15 Sep. 2005)

Swaminathan, M.S. 2003. Enhancing our agricultural competitiveness. 6th J.R.D. Tata Memorial Lecture 26th ugust, 2003. ASSOCHAM, New Delhi.

Swarup, A. and Wanjeri, R.H. 2000. *Three Decades of All India Coordinated Research Project on Long term Fertiliser Experiments to Study Changes in Soil Quality, Crop Productivity and Sustainability*. IISS, Bhopal, 59p.

Tandon, H.L.S. 1997. Organic resources: an assessment of potential suppies, their contribution to agricultural productivity and policy issues for Indian agriculture from 2000-2025. *Plant Nutrient Needs, Supply, Efficiency and Policy Issues: 2000-2025* (eds. Kanwar, J.S. and Katyal, J.C.). National Academy of Agricultural Sciences, New Delhi.
pp. 15-28

Trewavas, A. 2004. A critical assessment of organic farming and food assertions with particular respect to the UK and the potential environmental benefits to no till agriculture. *Crop Prot.* 23:757-781

Webber, M.D. and Singh, S.S. 1995. Contamination of agricultural soils(On – Line). Available: http://sis.agr.gc.ca/cansis/publications.html (10 Sep. 2005)

Yadav, R.L., Dwivedi, B.S., Prasad, K., Tomar, A.K., Shurpali, N.J. and Pandey, P.S. 2002. Yield trends and changes in soil organic carbon and available NPK in a long term rice wheat system under integrated use of manures and fertilizers. *Fld. Crop Res.* 68:219-246

Zeller, M. Gerturd, S., Braun, V., Joachim and Franz, H. 1997. Rural finance for food security for the poor. *Fd. Policy Rev.4*. International Food Policy Research Institute, Washington, DC, USA. 25p.

Discussion

Q: Which are the crops suitable for organic farming? And why?

A: Spices, Vegetables for house hold purpose etc. The crop which are more remunerative and has high export potential can be selected for organic farming. Most important factor to be considered is its market demand.

Q: What are the main organic certification agencies in India?

A: INDOCERT, Ernakulam and SKAL international, Banglore

Q: Response of high yielding varieties to organic farming compared to inorganic farming?

A: High yielding varieties are more responsive to fertilizers and hence they respond well in integrated management system

Q: There are reports about increases in secondary metabolite content in certain medicinal plants in organic farming system when compared to inorganic farming, what may be the reason for this?

A: For the formation of secondary metabolites presence of certain micronutrients are necessary. Usually the straight fertilizers such as urea lack these and provide only the primary major elements. If we add poultry manure or compost, in addition to major nutrients they provide micro nutrients also. This will lead to proper functioning and utilization of secondary metabolite production system in plants.

Q: To maintain the soil health and crop yield what practice of nutrient management we should follow?

A: An integrated nutrient management system, combing all the sources of nutrients such as organic manures, biofertilisers and chemical fertilizers are required for increasing the productivity of crops

Q: There are certain cropping systems which demand organic farming?

A: Pokkali rice, spices cultivation in high ranges

Q: Is there any problem spraying pesticides cropping systems?

A: If recommended pesticides or chemicals are sprayed in correct quantity, time and under the guidance of an expert there won't be any problem. But the over doses may cause problems.

Q: What is the major problem associated with organic farming and India's food security?

A: The productivity in organic faming will be very low. So the price of commodities will increase and poor Indian farmers may not able to purchase these at a higher price and result in poverty

KERAL AGRICULTURAL UNVERSITY

Department of Agronomy

Agron.751 – Seminar

Topic : **Organic farming: Can it meet today's needs?**

Presented by: Sindhu, P.V.

Admission No : 2004-21-01

Venue: Seminar hall

Date and Time: 15-10-05; 9a.m

Abstract

India is the second largest populous country in the world next only to China. The present growth rate in population is 1.68 per cent per annum (Chanda, 2005). Food supply per capita in kilo calorie per day is lower in India compared to many developed and even developing countries.

Organic agriculture avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives. Total nutrient supplying potential of some important organic sources in the country as reviewed by Tandon, 1997 is barely sufficient to meet the gap between the nutrient NPK addition through fertilizers and nutrient removal by crops. Estimates show that about 25 - 30 per cent nutrient needs of Indian agriculture can be met by utilizing various organic sources. However on unit nutrient basis, organic manures and residues are more expensive than inorganic fertilizers.

Due to its lower productivity and high cost of production, organic farming will leave many Indian's hungry and malnourished. In the name of organic farming several myths are being propagated. The claims of better taste, quality, freedom from toxic materials, better yield etc. are contentious issues and Chhonkar (2003) and Trewavas (2004) discuss these claims as merely myths.

As the requirement for food will continue to rise for feeding the burgeoning population, pure organic farming depending on the meager availability of organic resources is not possible in India. The commercial fertilizers will continue to be the major source (Chhonkar, 2003). The gap between nutrient addition and removal causing the nutrient mining from soils cannot be allowed to continue. Therefore, organic

Homestead farming

By

Sindhu, P.V.
(2004-21-01)

SEMINAR REPORT

Submitted in partial fulfillment for the requirement of the
Course No. Agron 752, Seminar (0+1)

DEPARTMENT OF AGRONOMY
COLLEGE OF HORTICULTURE
KERALA AGRICULTURAL UNIVERSITY
VELLANIKKARA-680656
THRISSUR, KERALA, INDIA
2005

DECLARATION

I, Sindhu, P.V. (2004-21-01) hereby declare that the seminar entitled "*Homestead farming*" has been prepared by me, after going through the various references cited here and has not been copied from my fellow students.

Vellanikkara
29-11-2005

Sindhu, P.V.
(2004-21-01)

CERTIFICATE

This is to certify that the seminar report titled **"homestead farming"** has been solely prepared by Sindhu, P.V. (2004 – 21 – 01), under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

Vellanikkara

Date:29-11-2005

Dr. C. George Thomas

Major advisor

Associate Professor

Department of Agronomy

College of Horticulture, Vellanikkara

Contents

List of tables

List of figures

Introduction

A homestead is an operational farm unit, in which a number of crops are grown with livestock and/or poultry mainly for the purpose of satisfying the basic needs of farmers. Home gardens can be found in almost all tropical and subtropical ecozones where subsistence land use systems predominate.

Crop production in small holdings adjacent to human settlements is the oldest and most enduring form of cultivation. Farmers utilize the land in and around their homes to undertake different agricultural enterprises. It resembles a multistoried cropping system withy the tree component occupying the uppermost vegetation and the agricultural crops, the lower most layers.

Homestead farming or Home gardens are common in the State of Kerala, where the average size of the farm holding is quite small. This type of homesteads has been one or the survival strategies of the traditional farmers of Kerala since time immemorial. The traditional home garden had tremendous structural and functional diversity with crops, livestock and other subsidiary enterprises like apiculture, sericulture and agro-based cottage industries. Unfortunately these home gardens are on the verge of disappearance due to a shift in favour of perennial cash crops, lack of family labour and high cost of labour. Homestead gardens known to be repositories of biodiversities have not been studied and documented much. The strategy of reintroducing homestead farming research has been thought upon to alienate nutritional and financial insecurity by incorporating variety of crops and by securing sustainable food production and access to the same.

Homestead farming can be seen as attempt of combining the farm related enterprises for financial, nutritional and food security to a wide range of population. It was often neglected due to its complex nature and sophisticated structure but now being revived by planners for its significance as low external unit being felt widely and maneuvering of the existing homesteads in the desired direction for it sustainability.

Definition of homesteads

The home and its adjoining land owned and occupied by the members of dwelling unit, including the immediate area surrounding the dwelling unit used for cultivation of trees and vegetables and unused space if any (Hanman, 1986).

Home gardens were defined as "man made forest fitted to family needs (Soemarwoto, 1984).

A homestead is an operational unit in which a number of crops are grown in conjunction with livestock, poultry and/or fish mainly for the purpose of satisfying farmer's basic needs (Tejwani, 1994)

Homestead farming in different countries

Found in almost all tropical and subtropical ecozones where subsistence land use system predominates. In Asia, the home garden system is common in Indonesia, The Philippines, Cambodia, Malaysia, Vietnam, Thailand, Bangladesh, Sri Lanka, Nepal and India (Landauer and Brazil, 1990).

Homestead agroforesry in Bangladesh

These are often called as 'homestead forests', since they play vital role in supplying timber and fuel needs of Bangladeshi people A typical farm in Bangladesh contains an extended family unit which lives in a '*bari*'. The *bari* contains several houses for the different sub families, vegetable gardens planted and maintained by female members and is surrounded by fences and/or trees and shrubs (William and Kibriaul, 1987).

The Kandyan gardens of Srilanka

Kandyan gardens represent a home garden system practiced in small holdings, of an average size of 1 ha, in Srilanka, mainly in Matale and Kurunegalle districts. This centuries old system consists of mixed cropping with a variety of trees and perennial or semi perennial shrubs such as spices, fruit trees, medicinal plants and timber species, where the components are arranged randomly. In most of the farms the base crop will be either coffee or arecanut (Jacob and Alles, 1987).

In the homestead gardens, fences of *Gliricidia sepium* are used, while in the intermediate and dry zones kapok is used *(Bombax malabaricum*). The canopy cover in this system is not dense, ranging from about 25% to 75% of the area of the homegarden. Animals such as cattle, goats and chickens are reared in these systems; goats are particularly common in the dry zones. *Leucaena leucocephala* spp. grows profusely in the dry- zone homegardens, increasing soil fertility and providing food and fodder. In some dry-zone homestead gardens the 'drumstick' tree, known locally as *murunga* (*Moringa oleifera*), is grown in the form of fences or hedges. In other systems, *Sesbania grandiflora* is planted

The *Chagga* homegardens of North Tanzania

These types of home gardens are characterized by an intensive integration of numerous multi purpose tress and shrubs with food crops and animals, simultaneously on the same unit of land. The *'chagga'* are skilled farmers with an intimate knowledge about the crops and their ecological requirements. They have good idea about functions and uses of the plant species on their farms. The great diversity provides for both subsistence and cash crops. It enables the farmer to keep his management options open and provides insurance against drought, pests and economic risks (Fernandes et al., 1984).

The compound farms of south eastern Nigeria

Compound gardens are homestead type of agro forestry system involving the deliberate management of multipurpose trees and shrubs in a multistoried association with agricultural crops and livestock with in the compounds of individual houses. In addition to the advantages of diversified production, risk minimization and improved use efficiency of resources, compound farms represent germplasm banks containing many of the useful tree/shrub species currently disappearing due to indiscriminate clearing of forests and woodlands (Okafor and Fernandes, 1987).

The home gardens of Andaman and Nicobar islands

Home garden Andaman and Nicobar Islands were under complete forest cover in 1691 when man first colonized the Islands. After independence, union government of India adopted an urgent programme of colonization in Andaman for the purpose of rehabilitation of refugees of East Pakistan, Sri Lankan repatriates, Burma repatriates, land less people from different parts of country and ex-serviceman families. The settlers were provided 2 ha of paddy land, 2 ha of hilly land and 0.4 ha land for house construction. Settlers raised coconut, arecanut and fruit trees in the premises of their houses, which developed gradually into home garden and became a permanent system of rural economy. Presently, home garden/homestead agro forestry is found in more than 50,000 ha land in the islands (Ghosh, 1994).

Homesteds of Kerala

In India, homestead is mostly popular in Kerala as it enjoys an equatorial climate which supporting variable plant species and where land holdings are below 0.5 ha in size as against, national average of 1.69 ha. It is especially applicable in areas where fragmentation of land and population pressure on scarce land is seen. In such cases both vertical and horizontal spaces can be efficiently utilized to generate income. Kerala's homestead is unique being more or less coconut based with an array of intercrops

resulting in multistory cropping system, thereby efficiently harnessing solar energy and using soil moisture and nutrient (Fernandes and Nair, 1986). Homestead farming can be seen as attempt of combining the farm related enterprises for financial, nutritional and food security to a wide range of population.

Characteristics of homesteads

Ruthenberg (1971) distinguished homestead cropping from arable cropping by the following features which are usually, but by no means in all cases, found simultaneously:

- cropping those plants for personal consumption that cannot be collected nor supplied by arable farming
- small plots
- proximity to the house
- fencing
- mixed or dense planting of a great number of annual, semi-permanent, and perennial crops
- a high intensity of land use
- land cultivation several times a year
- permanence of cultivation and
- cultivation with hand implements.

Classification of Homesteads

Based on physiographic features of the land and the components involved Salam, *et.al*, (1995) classified the homesteads of Kerala in to five groups. These are

- Uplands with crop components alone
- Uplands with crops and livestock
- Uplands and adjacent low lands (with crop components)
- Uplands and adjacent low lands (with crop and portents)

- Uplands and adjacent low lands and backwaters (with crops, livestock and agro based industries)

Structure of homesteads in Kerala

The homesteads of Kerala evolved in response to the pressure of shrinking land resource base coupled with a high population density, which necessitated a conscious attempt from the part of farmers to achieve their goals with in biophysical, ecological and economic constraints. High density farming involving several species of seasonal, annual and perennial crops thus evolved to meet their demands and to achieve highly efficient use of natural resource.

The selection and inclusion of crops are influenced by climate, household preferences, requirements and dietary habits of the family.

Coconut is the base crop in most of the agro climatic areas, except in high ranges. The spaces between coconut palms are used to raise an array of inter crops, resulting in a multistoried cropping patter with distinct canopy stratification. Thus, perennial crops such as coconut, arecanut, jack, mango, cashew, tamarind and forest tree species occupy the upper layer. Pepper, clove, nutmeg, cinnamon etc. occupy the second layer. Banana, cassava, yam etc occupy the third layer. The resultant canopy architecture often approaches that of a tropical rain forest in its structure and species diversity (Shehana et al., 1992).

The homesteads of Kerala very often combine crops with livestock rearing, where the components interact synergistically to sustain productivity (Salam and Sreekumar, 1990). Cows, buffaloes, goats, fishes and poultry are the most common livestock. The animal components play a vital role in maintaining nutritional status of the family members and also provides additional income by the sale of milk, egg and kids. The manure and litter of the livestock provide renewable sources of organic matter and plant nutrients and help

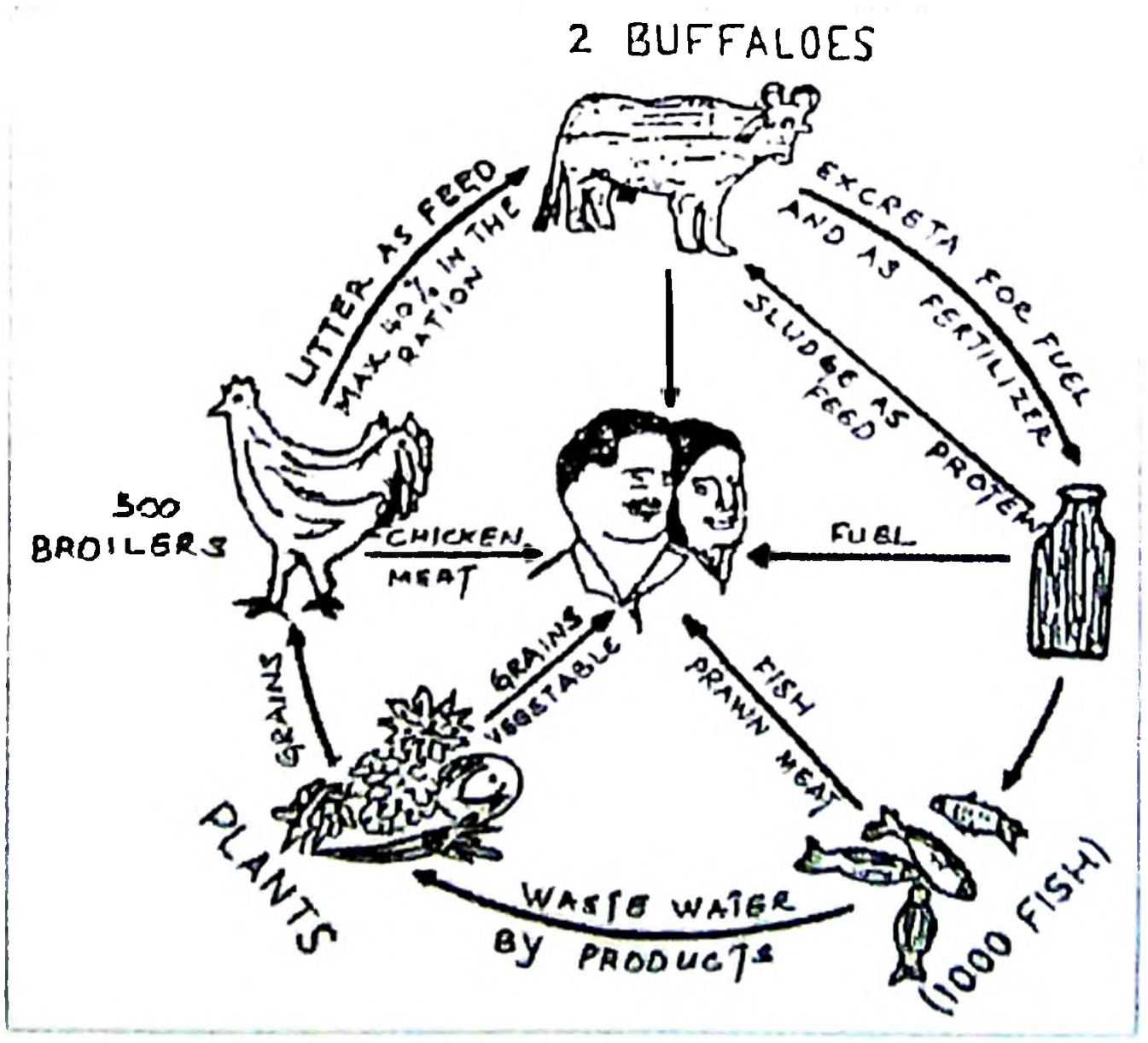
to reduce the dependence on chemical fertilizers, resulting in a high degree of organic recycling.

Mangroves form an essential part of the homesteads of backwater areas in the low lands of Kuttanad, Pokkali and the coastal tracts of northern zone. The mangroves protect the homesteads from mud and sand washed down by rivers and also from high tide. Often they constitute the boundaries between homesteads.

Wide variation in the components and cropping intensity exist between homesteads on same agro climatic zone. This can generally attributed to the differences in the socio economic conditions of the house hold and their responses to the externally determined changes, particularly prices of inputs and products.

The components are so intimately mixed in horizontal and vertical strata, as well as in time, which causes a complex interrelations and interdependence of the components, that leads to over all sustainability of the system. Figure 1 represents the schematic presentation of the interaction among major components of the homestead system.

Fig. 1 Schematic representation of energy flow in the homesteads system



Size of homesteads in Kerala

The size of the homesteads in Kerala varies from 0.04 ha to 3.6 ha with an average of 0.33 ha per holding. 95 per cent of homesteads have a size of 0.80 ha (fig. 2). Majority (58.25%) of the holdings are small sized. This is followed by very small holdings which constitute 37 per cent. The large sized holdings (>2.0 ha) constitute only 1.25 per cent (John, 1997). Between agro ecological regions there are difference with respect to holding size. The maximum was notices in high ranges (0.55 ha) followed by midlands (0.32 ha) (Table 1). This difference may be due to the difference in population density, which is highest in the mid lands.

Fig. 2. Average size of homesteads in Kerala

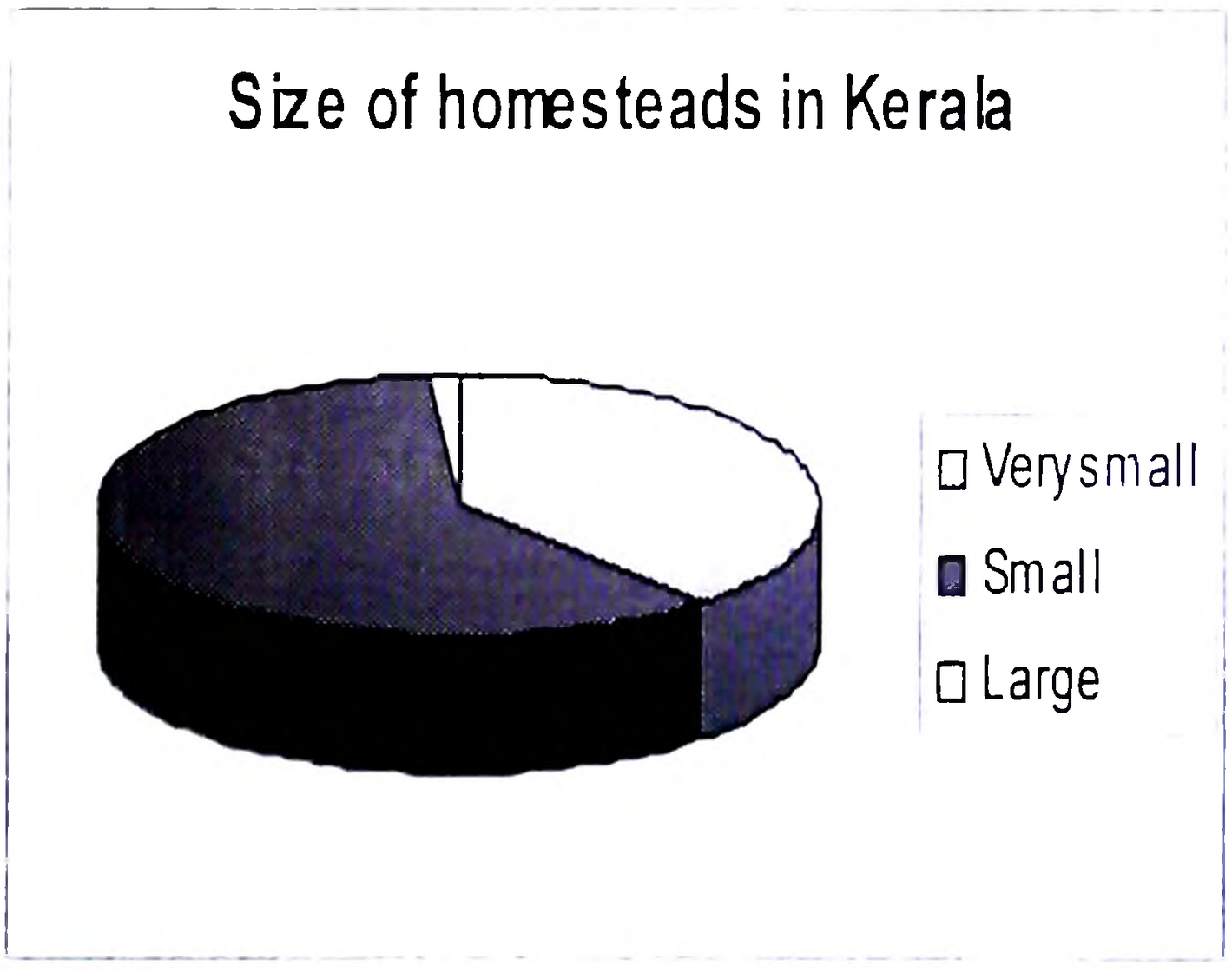


Table. 1. Difference in holding size and species diversity of the homesteads in different agroecological regions

Attribute	Average per home garden		
	High land	Low land	Mid land
Area (ha)	0.55	0.23	0.32
Total No. of plants	765	139	386
No. of species	14	13	15

(John, 1997)

Physical and chemical properties of homestead soils

Good soil is essential for a good harvest. The physical and chemical properties of the soil make it ideal for crop production. Soil must have all the nutrients necessary for plant growth. The soil structure must hold enough air and water for plant roots, but must allow excess water to drain away.

Physical and chemical properties of homestead soil were compared with that of an open soil by Issac, (2001). The results shows that the homestead soil has got a low bulk density and higher water holding capacity as compared to open soil, which makes it ideal for supporting more number of crops (Table 2). The organic carbon and organic matter contents, the most important soil parameters which decides its fertility status were higher in homesteads (Table 3).

Table 2. Physical properties of homestead soil and open soil

Parameter	Homestead	Open
% moisture	12.37	12.69
BD (g cm-3)	1.21	1.27
PD (g cm-3)	2.46	2.45
MWHC (%)	42.75	35.82

Table 3. Chemical properties of homesteads

Parameter	Homestead	Open
Organic carbon (%)	0.71	0.41
Organic matter (%)	1.23	0.70
pH	5.80	5.70

Species diversity in the homesteads

The farmers deliberately retain and manage numerous species of crops and trees in their homesteads. According to a survey conducted by Babu et al., (1992) the number of each species in each homestead vary from 5 to 40. The species diversity is a deliberate strategy aimed at producing harvests through out the year, so that there will be always some product of economic value available for household use or cash sale. Species diversity is also well planned in terms of pest and disease management risk aversion and efficient use of natural resources. Table 4 shows the relative pre dominance of different crop categories in relation to holding size.

It can be seen from table 5 that a reduction in the holding size has led to an intensification of cultivation. In such situation it is common to increase the intensity of trees (Nair and Krishnankutty, 1984).

Table 4. Relative dominance of different crops with respect to holding size

Category	Very small (0.02-0.2 ha)	Small (0.2-0.8 ha)	Medium (0.8-2.0 ha)	Large (>2.0 ha)
Oil seeds	21.70	14.40	47.80	4.40
Fruit crops	19.80	16.60	7.50	54.70
Tuber crops	41.60	47.60	66.80	16.20
Spices	5.20	4.50	1.30	1.70
Vegetables	3.50	4.20	0.60	0.20
Timber and fuel trees	3.20	3.60	0.50	0.40
Fodder crops	0.70	2.00	0.50	0
Miscellaneous	2.60	0.90	3.50	0.80

(John, 1997)

47

Table 5. Tree crop intensity in homesteads in relation to holding size

Size of holding (ha)	Mean tree cropping intensity*	Mean No. of trees/ha
Very small (0.02-0.2)	51	621
Small (0.2-0.8)	38	277
Medium (0.8-2.0)	27	212
Large (>2.0)	23	121

*% of total area occupied by the tree canopy

(Nair and Krishnankutty, 1984)

Interaction between components

A typical homestead with a multitude of crops presents a multi tier canopy configuration Under such situation it is natural to occur some sort of interactions These may be either synergistic or antagonistic Competition occurs mainly for light, nutrients and water To avoid the competition for sunlight the leaf canopies of components are arranges in such a way that they occupy different vertical layers, with the tallest component having the foliage tolerant to strong light and high evaporative demand and shorter component having foliage requiring or tolerating shade or high humidity (Nair, 1988)

Where ever coconut is present as the dominant component intercrops that are grown vary with the age and canopy size of the coconut. Table 6. Shows the percentage light infiltration in a coconut based homestead situation

Table 6. Light infiltration in coconut based homestead situation

Time (hrs)	Radiation (micro moles $m^{-2}s^{-1}$)
10-11	272.8
11-12	365.9
12-13	216.2
13-14	196.4
14-15	173.9
15-16	186.7
Total	1411.9
Percent	48.8

(Abraham, K. 1993)

Allelopathy

In a multistory cropping plant to plant interaction involving allelopathy are presumed. The accumulation of tree litter on the soil under agro forestry system of farming could have negative effects on the agricultural crops. Consequently seed germination and establishment of certain crops may be inhibited (Table 7)

Trees are rich sources of secondary metabolites and these chemicals impose certain kind of environmental stress on other plants growing in their vicinity, by a phenomenon called 'tree allelopathy'.

Table 7. Allelopathic effect of leaf extracts of different tree species on cowpea

Treatment	Germination (%)	Plumule length (cm)	Radicle length (cm
Acacia	74.7	8.93	3.93
Albizzia	89.3	4.70	1.27
Leucaena	85.3	2.50	3.37
Jack	86.7	10.30	7.90
Mango	89.3	3.23	4.03
Ailanthus	81.3	1.87	0.40
Tamarind	68.0	4.30	0.90
Nutmeg	88.0	6.07	5.27
Cashew	77.3	3.23	0.93
Control	95.0	12.03	8.70

(John, 1997)

Tannins present in the plant parts have been identified as the most effective substance causing allelopathy. This may be the reason for the severe suppression caused by ailanthus, cashew and tamarind which has very high tannin content in their leaves.

Micro climate in homesteads

The micro climate in a homestead system varies widely when compared with a pure crop system or in an un cropped land. Trees act as a buffer against drastic changes in the climate and also play a predominant role in amelioration of the micro climate.

Relative humidity

Relative humidity is an important factor indirectly influencing crop yields, by bringing changes in the rates of evapo transpiration and by incidence of pests and diseases. The

relative humidity in the homestead is always higher than in open (Mathew, 1993). Nair and Balakrishnan (1977) reported that shading reduces the air temperature in crop communities and the resultant higher relative humidity values causes considerable reduction in the rates of evaporation. They also reported that the evaporation in the ecoclimate of crop combination is always 30 per cent less that of open area and the main reason for this is the higher values of relative humidity in crop combinations

Soil temperature

The soil temperature in the homestead is always lower than the open condition. This may be due to less exposure of bare soil. The tree canopies and ground crops help to reduce temperature at the soil surface during summer months and crop combinations act as buffer against drastic changes in the micro climate. Ramakrishna and Sastri (1977) observed that the air and soil temperature were lower under crop canopies

Light intensity

Solar radiation is the ultimate source of energy for all plants. The leaf canopies in a typical homestead are arranged in such a way that they occupy different vertical layers, with the tallest component having the foliage tolerant to strong light and high evaporative demand and shorter component having foliage requiring or tolerating shade or high humidity.

The light intensity available at the floor of the different tree species in the home garden are very low. Thus, the light available for the crops grown in the inter spaces under the canopy of trees are much less of what is required for it's potential photosynthesis (Table 8). One of the main reasons for low productivity of most of the seasonal and annual intercrops grown in homesteads might be the lower availability of solar radiation (Bai, 1981).

Table 8. Effect of shade on yield of intercrops

Shade intensity (%)	Crop yield (t ha^{-1})			
	Ginger	Turmeric	Coleus	Sweet potato
0	21	49	34	8
25	22	49	27	2
50	20	53	20	0.14
75	14	29	10	0

Nutrient recycling in homesteads

One of the main principles in soil management in homesteads is to make the best use of resources There fore it is extremely useful to have a nutrient budget for the whole system based on the nutrient dynamics of the system

Nutrients taken up by the plants are either stored in the storage compartments or are used for the production of non storage organs Part of the nutrients are taken up by the plants are returned to the soil through two ways

- through litter fall
- through the process of plant cycling

Plant cycling represents that part of total uptake of nutrients which is again leached out from the vegetative parts through crown as canopy drip and stem flow. The presence of this fraction which is circulated with in the ecosystem is a sort of necessary waste (Nair,

1979) and it must be encountered while calculating nutrient budget in planting communities.

Litter fall and nutrient addition in homesteads

In a homestead system with number of tree components the major source of organic matter addition to the soil is in the form of litter fall. Table 9 depicts the amount litter fall and addition of major nutrients to soil.

Table 9. Litter fall and nutrient addition in homesteads

Tree species	Litter addition (kg ha^{-1} tree^{-1})	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
Jack	103.1	1.22	0.05	0.3
Mango	102.4	1.07	0.05	0.35
Cashew	73.36	0.90	0.04	0.16
Tamarind	16.62	0.27	0.12	0.05
Mahagony	6.29	0.07	0.002	0.03
Ailanthus	9.87	0.17	0.004	0.33
Total	311.64	3.70	0.266	1.22

(Issac, 2005)

Table 10. Half life values of tree litter under open and homestead condition

Tree species	condition	Half life (Days)
Mango	Open	108
	Homestead	90
Jack	Open	93
	Homestead	63
Cashew	Open	90
	Homestead	78

Time required for decomposition of tree leaves were lower in homesteads compared to that in open (Table 10). This difference in time may be due to the difference in micro climate prevailing beneath the tree canopies which creates a congenial environment for the activity of soil fauna and flora, the chief decomposing organisms (Table 11)

Table 11. Count of earth worm (m^{-1}) and microflora ($g\ soil^{-1}$) in soil on jack litter decomposition

Organism	**Open**	**Homestead**
Earth worm	26.2	27.97
Fungi ($x10^3$)	17.43	24.90
Bacteria ($x10^6$)	21.80	30.54
Actinomycets ($x10^4$)	10.15	12.57

Nutrient addition through stem flow and canopy drip

In addition to litter fall stem flow and canopy drip are the two important avenues of nutrient addition to soil. Rain striking on the plant surfaces causes leaching of nutrients from the plant parts either as stem flow or canopy drip and add substantial quantities of nutrients to soil. The studies conducted reveals that coconut ids the crop which add maximum amount of nutrients to soil in this way (Table 12).

In general about 60 kg N, 21 kg P and 31 kg K is added per hectare of homestead by various components (Table 13).

Table 12. Nutrient addition through stem flow (g tree^{-1})

Tree	N	P	K
Mango	0.72	0.17	1.06
Jack	0.92	0.12	1.30
Coconut	8.69	0.55	12.92

No on rainy days : 99

Total RF: 1683mm

Mathew, 1993

Table 13. Nutrient addition by various components in the homestead

Source	N (kg ha^{-1} $year^{-1}$)	P (kg ha^{-1} $year^{-1}$)	K (kg ha^{-1} $year^{-1}$)
Organic manures	49.17	19.11	21.22
Litter fall	8.49	2.00	6.37
Through fall	2.05	0.30	3.18
Stem flow	0.01	0.01	0.02
Total	**59.72**	**21.41**	**30.79**

Major differences between homestead agriculture and commercial agriculture

Characteristics	Homestead	Commercial
♣ Holding size	Extremely small	Large
♣ Major objective	Meeting home demand	Income generation
♣ Resource use level	Intensive	Extensive
♣ Species Diversity	High	Low
♣ Nature of cropping	Polyculture	Single crop
♣ Characteristics	Homestead	Commercial
♣ Integration of farm		
♣ enterprises	High	Low

♣ Nutrient recycling	High	Low
♣ Purchased inputs	Low	High
♣ Sustainability	High	Low
♣ Market linkage	Poor	Well developed

Scope for improvement of homesteads

Even though homesteads are considered as the hall marks of staggered settlement pattern in Kerala and are the most vulnerable heritage that influences the unique living standards, cultural identity and other socio economic features (Peter and Rao, 2005), these home gardens are on the verge of disappearance due to a shift in favor of perennial cash crops, lack of family labour and also high cost of labour. Since small holdings are inevitable in densely populated developing countries fine tuning and diversification of homesteads by integrating new technologies to the existing traditional methods are essential to make it economically viable and socially acceptable. Some of such interventions include

1. Correcting the farmers' practices- with respect to spacing, manures and fertilizers application, plant protection methods etc

2. Increasing cropping intensity by adding new crops – like introduction of suitable high value crops such as cardamom, vanilla, medicinal plants and tree crops like teak, mahagony etc. in tom suitable areas

3. Integrating new enterprises as subsidiary source of income to the farmers as apiary, poultry, mushroom cultivation, nursery and floriculture

4. Adoption of proper soil and water management techniques, which can sustain the soil productivity by way of preventing loss of nutrients and fertile soil through erosion

5. Promoting the recycling of farm waste by introducing farm composting, vermicomposting, bio gas plants etc. in to the homesteads and thereby increase the use of organic manure.

6. Integration of high yielding varieties of crops and livestock and there by increase the productivity and profitability

7. addition of fodder component in to the system and there by reducing the cost of livestock rearing

8. Promotion of scope for processing of farm products and production of value added products such as squash, jam etc.

9. Farm mechanization – using labour saving, user friendly and drudgery relieving implements such as coconut husking tool, jack fruit harvester, tree basin lister etc.

10. Developing better market linkages and provide better credit facilities

Results of a project undertaken at Kerala Agricultural University with the objective of developing integrated farming models for resource use efficiency in the homesteads (Regeena *et al* , 2004) shows that coconut based homesteads of Kerala has tremendous scope for improvement and profit maximization through meaningful interventions in technology and management As a result of various interventions, on an average the number of crops per homestead increased from one to five, the cropping intensity increased from 92 to 232 Consequently the there was an increase in the number of labour hours used as well as in the net farm income. Table 14 Shows the improvement in the component and system productivity achieved by the integration of new components in to the cropping system. So with the integration of new components in to the homesteads it is possible to make the system more productive, protective, economically viable, adaptable and sustainable.

Table 14. Component and system productivity of different integrated farming systems

Farming system	Component productivity (kg)					System productivity (kg ha^{-1})	% increased over CCS
	Crop	Poultry	Pigeon	Fish	Goat		
Cropping alone	12995	-	-	-	12995	-	
Crop + Fish + Poultry	26352	1205	-	2052	-	29609	128
Crop + Fish + Pigeon	24854	-	2545	1774	-	29173	124
Crop + Fish + Goat	25725	-	-	1975	9979	37679	190

(Jayanthi and Sankaran, 2005)

Conclusion

Homesteads have proven to be the most productive units that ensure conservation of biodiversity, resource recycling, water and energy use efficacy and ecological sustainability.

Almost all the homegarden systems have evolved over time under the influence of resource constraints. These include population pressure and consequent reduction in available land and capital. Moreover, physical limitations such as remoteness of the area force the inhabitants to produce most of their basic needs by themselves, and lack of adequate market outlets compel the farmers to produce some portions of everything they need. Scientific attention has seldom focused on improving these traditional systems. Scientists who are not familiar with them do not realize the importance and potential contribution of these systems to the framework of agricultural development. Others, who are under the influence of the traditional outlook of monocultural agriculture, consider homegardens to be very specialized systems adapted to subsistence land-use and structurally too complex to be suitable for manipulation and improvement.

Homegardens are very complex systems with a very sophisticated structure and a large number of components. Farmers who practice homegarden systems are guided, in the absence of a unified set of expert recommendations, by their own perceptions and convictions about species selection, admixture, and management, so that each farm unit is a specialized entity in itself. These important systems deserve more serious attention. A systems approach should provide the basis for research on homegardens, and should include studies of both biological and socioeconomic aspects.

Since small holdings are inevitable in densely populated developing countries, fine tuning and diversification of homestead farming system, integrating new technologies to the traditional methods and maximum utilization of existing methods are essential to make it economically viable and socially acceptable. The better utilization of such system will help to solve the problem of rural unemployment to a greater extent.

References

Abraham, K. 1993. Light infiltration studies in coconut based homestead situation. M.Sc. thesis, Kerala Agricultural University, Thrissur, 103p.

Babu, K.S., Jose, D. and Gokulapalan, C. 1992. Species diversity in Kerala homesteads. *Agroforestry Today* 4(3):15

Bai, E.K.L. 1981. Shade response of common rainfed intercrops of coconut. M.Sc. thesis, Kerala Agricultural University, Thrissur, 158p.

Fernandes, E. C. M. and Nair, P. K. R. 1986. An evaluation of the structure and function of tropical home gardens. *Agric. Systems* 21: 279-310.

Fernandes, E C M., Oktingati, A and Maghaembe, J. 1984. The Chagga homegardens: a multi storied agro forestry cropping system on Mount Kilimanjaro (Northern Tanzania) *Agroforestry Systems* 2 73-86

Ghosh, A. 1994 *A Study on the Development Strategy for the Andaman and Nicobar Islands* Classical Publishing Company, New Delhi, 255p

Hanman, F M 1986 *Alternative ways of incorporating women's concerns in farming systems research* Report of Asia Rice farming Systems Working Group Meeting, Philippines, 233p

Isaac, R.S. 2005 Litter dynamics of mango (*Mangifera indica* L.) in an agroforestry homegarden in the warm humid tropics of southern Kerala. Proceedings of the National Seminar on Resource Management for Sustainable Agriculture, March 17-18, 2005. Annamalai University, Annamalai Nagar , p.157

Isaac, R. S. 2001. Litter decomposition and nutrient dynamics of selected multipurpose trees in homesteads. Ph.D thesis, Kerala Agricultural University, Thrissur, 223p.

Jacob, V.J. and Alles, W.S. 1987. The kandyan gardens of Srilanka. *Agroforestry Systems* 5:123-127

Jayanthi, C. and Sankaran, N. 2004. Farming system research for improving resource use efficiency in rice: Recent advances. Proceedings of National Symposium on Input Use Efficiency in Agriculture: Issues and Strategies, 25-27 November, 2004. (eds. Mathew, J., Menon, V.M. and John, P.S.). Kerala Agricultural University, Thrissur, pp. 170-174

John, J. 1997. Structural analysis and system dynamics of agroforestry homegardens of southern Kerala. Ph. D thesis, Kerala Agricultural University, Thrissur. 202p.

Landauer, K. and Brazil, M. 1990. *Tropical Home Gardens*. United Nations University Press, Tokyo, 345p.

Mathew, H. 1993. Agronomic resource inventory of a homestead in the southern zone of Kerala. M.Sc. thesis, Kerala Agricultural University, Thrissur, 135p.

Nair, C.T.S. and Krishnankutty, C.N. 1984. Socio economic factors influencing farm forestry – a case study of tree cropping in the homesteads in Kerala. Proceedings of the Workshop on Socio Economic Aspects of Social Forestry in Asia Pacific Region, Bangok, Thailand, pp. 25-28

Nair, P.K.R. 1979. *Intensive Multiple Cropping with Coconuts in India*. Verlag Paul, Hamburg, 250p.

Nair, P.K.R. (ed.) 1988. *Agroforesrtry Systems in the Tropics*. Kluwer Academic publishers, London, 657p.

Nair, P.K.R. and Balakrishnan, P. 1976. Pattern of light interception by canopies in a coconut cocoa crop combination. *Indian J. agric. Sci*. 46:453-462

Okafor, J.C. and Fernandes, E.C.M. 1987. The compound farms of south eastern Nigeria: a predominant agro forestry home garden system with crops and livestock. *Agroforestry Systems* 5:153-168

Peter, K.V. and Rao, G.S.H.L.V.P. 2005. Homestead farming in the warm humid tropics of Kerala. *Kerala Calling* 6:30-32

Ramakrishna, Y.S. and Sastri, A.S.R. 1977. Micro climate under *Acacia tortilis* plantation. CAZRI Annual Progress Report, 1971, CAZRI, Jhodhpur, India, 120p.

Regeena, S., Jacob, V. and Preetha, D. 2004. Integrated farm models for resource use efficiency in South Kerala. Proceedings of National Symposium on Input Use Efficiency in Agriculture. Issues and Strategies, 25-27 November, 2004 (eds. Mathew, J., Menon, V.M. and John, P.S.). Kerala Agricultural University, Thrissur, pp 142-142

Ruthenberg, H. 1971. *Farming Systems in the Tropics*. Clarenden Press, Oxford, London, 365p

Salam, M.A. and Sreekumar, D. 1990. Coconut based mixed farming system to sustain productivity. *Indian Cocon. J.* 20(10) 1-3

Salam, M.A., Babu, K.S. and Mohanakumaran, N. 1995. Home garden agriculture in Kerala. *Fd Nutr. Bull.* 16(3): 10-15

Shehana, R.S., Baby, K.S. and Salam, M.A. 1992. Spices: a multipurpose homestead component in South Kerala. *Spice India* 5(9):15-18

Soemarwoto, O. 1984. The Javanese rural ecosystem. *An Introduction to Human Ecology Research on Agricultural Systems in South East Asia* (eds. Rambo, I. and Sajise, E). University of Philippines, pp. 254-287

Tejwani, K.G. 1994. *Agroforestry in India*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 350p.

William, A.I. and Kibriaul, K. 1987. Homestead agro forestry in Bangladesh. *Agroforestry Systems*. 5:139-151

Discussion

1. Which variety of fish you recommend for homesteads?

   Rohu, Catla

2. Scope of terrace cultivation in homesteads?

   Terrace cultivation can be successfully recommend for urban areas where there is scarcity for land for cultivation. This system will help the urban people to get fresh fruits and vegetables.

3. What are the ideal tree crops for homesteads?

   Multipurpose trees like jack, mango, tamarind etc are more ideal. Also we can include trees like teak, *Macharancha* etc.

4. In India, which are the states where homestead cultivation is practicing?

   Kerala is the major state, then also in West Bengal and north eastern parts of India

5. What is plant cycling?

   Plant cycling represents that part of total uptake of nutrients which is again leached out from the vegetative parts through crown as canopy drip and stem flow The presence of this fraction which is circulated with in the ecosystem is a sort of necessary waste

6. Scope of kitchen garden in homesteads?

   In almost every homestead there will be a kitchen garden, but may not be in the scientific manner People grow vegetable crops like cowpea, drumstick, curry leaf, bhindi, brinjal, chilly, lab lab bean etc depending on the preferences of the family members

7. Describe your homestead

   The size of my homestead is only 5 cents Four coconut palms, two three clumps of palayankodan banana, one curry leaf plant, few mounds of colacassia are there. In addition to these we cultivate vegetables on the terrace of my house.

8. Scope of vermicomposting in homesteads

   Vermicomposting can be successfully practiced in homesteads. This will help to solve the problem of waste disposal and at the same time will give high quality compost.

Appendix 1.

List of some crop species found in the homesteads of Kerala

Common Name	Scientific name
Amaranthus	*Amaranthus sp.*
Aonla	*Emblica officinalis*
Arecanut	*Areca catechu*
Arrow root	*Maranta arundinacea*
Bamboo	*Bambusa arundinacea*
Banana	*Musa paradisiaca*
Betel vine	*Piper betel*
Bhendi	*Abelmoschus esculentus*
Bitter gourd	Momordica charantia
Black pepper	*Piper nigrum*
Bottle gourd	*Lagenaria siceraria*
Bread fruit	*Artocarpus altilis*
Brinjal	*Solanum melongina*
Cacoa	*Theobroma cacao*
Cardomom	*Elettaria cardamomum*
Cashew nut	*Anacardium occidentale*
Chilli	*Capsicum annuum*
Chinese potato	*Coleus parviflorus*
Cinnamon	*Cinnamomum zylanicum*
Clove	*Syzygium aromaticum*
Coconut	*Cocos nucifera*
Coffee	*Coffea spp.*
Cow pea	*Vigna unguiculata*
Cucumber	Cucumis sativus
Custard apple	*Annona squamosa*
Dioscorea	*Dioscorea spp.*
Drumstick	*Moringa oleifera*
Elephant foot yam	*Amorphophallus companulatus*

Erythrina	*Erythrina indica*
Garcinia	*Garcinia indica*
Giant taro	*Xanthosoma sp.*
Ginger	*Zingiber officinalis*
Glyricidia	*Glyricidia sepium*
Guava	*Psidium guajava*
Guinea grass	*Panicum maximum*
Jack	Artocarpus heterophyllus
Lemon grass	*Cympopogon citratus*
Lemon	*Citrus lemon*
Little gourd	*Coccinia grandis*
Mango	Mangifera indica
Mung bean	*Vigna radiate*
Napier grass	*Pennisetum purpureum*
Nutmeg	*Myristica fragrans*
Orange	*Citrus aurantia*
Papaya	*Carica papaya*
Passion fruit	*Passiflora edulis*
Pigeon pea	*Cajanus cajan*
Pineapple	*Ananus comosus*
Pummelo	*Citrus grandis*
Pumpkin	*Cucurbita moschata*
Ridge gourd	*Luffa acutangula*
Rubber	*Hevea brazilensis*
Sapota	*Achrus sapota*
Snake gourd	*Trichosanthes anguina*
Sweet potato	*Ipomoea batatus*
Tamarind	*Tamarindus indica*
Tapioca	*Manihot esculenta*
Teak	*Tectona grandis*
Tomato	*Lycopersicon esculentum*

KERALA AGRICULTURAL UNVERSITY
Department of Agronomy
Agron.752 – Seminar

Topic : Homestead farming

Presented by : Sindhu, P.V.
Admission No : 2004-21-01

Venue: Seminar hall
Date and Time: 19-11-05;10a.m

Abstract

A homestead is an operational farm unit, in which a number of crops are grown with livestock and/or poultry mainly for satisfying the basic needs of farmers. Home gardens can be found in almost all tropical and subtropical ecozones where subsistence land use systems predominate. The *kandyan* gardens of Srilanka, homestead agroforestry in Bangladesh, c*hagga* gardens of North Tanzania, home garden agriculture in Kerala *etc.* are some of the time tested homestead systems in various regions of the world

Homesteads are hallmarks of the staggered settlements in Kerala and are the most vulnerable heritage that influences the unique living standards, cultural identity and other socio economic features (Peter and Rao, 2005). The homesteads of Kerala evolved in response to the pressure of shrinking land resource base coupled with high population density, which necessitated a conscious attempt from the part of farmer to achieve their goals with in biophysical, ecological and economic constraints (Salam, *et al* , 1995)

The selection and inclusion of crop components are influenced by the climate, household preferences, requirements and dietary habits. In Kerala coconut is the base crop in most of the agro climatic areas, except in high ranges. The spaces between coconut palms are used to raise an array of inter crops, resulting in a multi tier cropping pattern with distinct canopy stratification (Salam and Sreekumar, 1990). The leaf canopies are arranged in such a way that they occupy different vertical layers, with the tallest component having foliage tolerant to strong light and high evaporative demand and

the shorter component having foliage tolerating shade and high humidity (Nair and Balakrishnan, 1977).

Mixed farming system in homesteads leads to substantial improvements in the physical and biological characteristics of the soil. The use of waste materials for feeding the cattle, poultry and fish results in efficient recycling of these wastes. The animal component plays a vital role in maintaining the nutritional status of the family members and also provides additional income by the sale of milk, egg and kids (Nair, 1983).

Like any other production system, homestead farming does not remain static over time and space. Unless the homestead's dynamics are directed in the right path, there is imminent danger to the sustainability of the system. Since small holdings are inevitable in densely populated developing countries fine tuning and diversification of homestead farming system by integrating new technologies to the traditional methods and maximum utilization of existing methods are essential to make it economically viable and socially acceptable

References

Nair, P K R 1983 Agro forestry with coconuts and other tropical plantation crops *Plant Research and Agro Forestry* (ed Huxley, P.A.). ICRAF, Nairobi, pp 79-102

Nair, P K R and Balakrishnan, T K 1977 Ecoclimate of a coconut + cocoa crop combination of the West coast of India *Agric. Met* 18 455-462

Peter, K V and Rao, G S L H V P 2005 Homestead farming in the warm humid tropics of Kerala *Kerala Calling* 6 30-32

Salam, M A., Satheeshbabu, K and Mohanakumaran, N 1995 Homegarden agriculture in Kerala. *Fd. and Nutr. Bull.* 16(3): 12-16

Salam, M.A., Sreekumar, D. 1990. Coconut based mixed farming system to sustain productivity. *Indian Cocon. J.* 5(9):15-18

Crop Residue Management in Arable Lands

By

B. Bhaskar Reddy

2004-11-01

SEMINAR REPORT

Submitted in partial fulfillment for the requirement of the course Agron. 651 Seminar

DEPARTMENT OF AGRONOMY
COLLEGE OF HORTICULTURE
KERALA AGRICULTURAL UNIVERSITY
VELLANIKKARA – 680 656
THRISSUR

DECLARATION

D. Bhaskar Reddy (2004-11-01) hereby declare that this seminar entitled "**Crop Residue Management in Arable lands**" has been prepared by me, after going through the various references cited at the end and has not been copied from any of my fellow students

Vellanikkara
Date

D. Bhaskar Reddy
(2004-11-01)

CERTIFICATE

This is to certify that the seminar report entitled **"Crop Residue Management in Arable Lands"** has been solely prepared by Mr. D.Bhaskar Reddy (2004-11-01) under my guidance, and has not been copied from any seniors, juniors or fellow students.

Vellanikkara
Date 7-11-05

Dr.Meera V. Menon
Major Advisor
Assistant Professor
Dept.of Agronamy
College of Horticulture
Vellanikkara, Thrissur

INDEX

LIST OF TABLES

Crop Residue Management in Arable Lands

1. Introduction

Crop residues are parts of plants left in the field after crops have been harvested and threshed or left after pastures are grazed. These materials have at times been regarded as waste materials that require disposal, but it has become increasingly realized that they are important natural resources and not wastes.

Soils in India are often not only thirsty but also hungry. The addition of organics in the form of crop residues plays an important role in the maintenance of soil fertility by improving physical conditions of soil for sustaining better plant growth. Therefore, what is needed is a reduction in the use of market purchased inputs and not of inputs per se. It is in this context that integrated systems of nutrient supply assume importance.

Components of crop residues

1. Harvest refuses

   Eg. straw, stubbles, stover, etc.

2. Process wastes

   Eg. coir pith, groundnut shell, rice husk etc.

2. Crop residue potential in India

A large number of crops are grown annually in India. After making use of their economic parts, the remaining portion is mostly wasted except in a few crops. The potential of crop residues of major cereals, oil seeds and commercial crops for recycling of valuable plant nutrients for sustained crop production is enormous

Table 1: Top ten states and all India crop residue potential

State	Crop residue production (million tonnes)	Available for incorporation (million tonnes)
U.P	60.00	26.00
Punjab	29.90	10.50
M.P	29.40	13.30
Maharashtra	27.80	13.30
A.P	24.60	12.40
Rajasthan	19.80	9.80
Tamil Nadu	19.70	8.10
Bihar	17.87	6.50
Haryana	15.40	6.30
Karnataka	12.80	7.10
All India	312.78	136.50

(Bhardwaj, 2003)

Table 2: Availability of organic resources for agriculture in India during 2005-2025

Resource	2005	2010	2025
Generators			
Livestock population (millions)	498	537	596
Food grain production (m t)	230	264	315
Resources (theoretical)			
Livestock dung (m t)	375	398	426
Crop residue (m t)	300	343	496
Nutrients (tappable N,P,K in m.t)			
Livestock dung	6.64	7.0	7.5
Crop residues	6.1	7.1	10.7
Total nutrients tappable	12.74	14.10	18.2

(Tandon, 1997)

Table 3: Some crop residues and their fertilizer replacement value

Crop	Total Crop residues (million tonnes)	Total N, P, K (million tonnes)	Fertilizer replacement value (million tonnes)
Rice	119.25	2.59	0.43
Wheat	93.9	1.71	0.28
pulses	17.95	0.59	0.10
Oil seeds	29.94	0.58	0.29
Total (all crops)	355.67	7.44	1.72

(Tandon, 1995)

3. Crop Residue Management

Crop residue management includes all field operations that affect residue amounts, orientation, and distribution. Residue amounts are often expressed in a percentage. Any tillage method that leaves crop residue on the surface to reduce erosion comes under this category. Crop residue left on the surface shields the soil from rain and wind until emerging plants provide a protective canopy. Crop residue also improves soil tilth, adds organic matter to the soil, and may even result in a little grain being left for wildlife. Less tillage reduces soil compaction and saves the farmer time and fuel.

Crop residue management (CRM) calls for fewer and/or less intensive tillage operations and preserves more residue from the previous crop. CRM can protect soil and water resources by reducing soil erosion and interrupting movement of nutrients and pesticides off the field. CRM is generally cost-effective in meeting conservation requirements and can lead to higher farm economic returns by reducing fuel, machinery, and labor costs while maintaining or increasing crop yields.

3.1 Crop Residue Management is managing crop residue in a way that best benefits future crop and soil needs

3.1.1 Reduced Soil Erosion: Rain drops hitting the soil surface has an explosive power that dislodges soil particles. The same is true for wind that is carrying blowing soil particles. Crop residue absorbs the energy of falling rain drops and by blowing soil particles. At least 30% of the soil surface needs to be covered by crop residue to do an adequate job. This is known as Conservation Tillage. In addition, crop residue will form millions of mini-dams all across a field that slows the water and traps soil.

3.1.2 Soil tilth: Soil tilth is influenced greatly by crop residue and the organic matter produced from it in the soil. For all of the plant mass seen growing above the ground there is an equal amount of root mass below the ground. Tillage adds oxygen to the soil which helps burn up organic matter. Less tillage allows more residue to stay on and in the soil and higher organic matter levels will result.

3.2 Three basic crop residue management systems

- Mulch-till uses such implements as a chisel plow or disk to till the entire field
- No-till leaves the soil and crop residue undisturbed except for the crop row where the seed is placed in the ground
- Zone or strip-till uses coulters to till a 5"-7" strip for injecting starter fertilizer and planting in one operation

4. Methods of crop residue management

- Tillage
- Mulching
- Residue burning
- Residue incorporation
- Composting

Crop residue management systems include reduced tillage or conservation tillage practices such as no-till, ridge-till, and mulch-till, as well as the use of cover crops and other conservation practices that provides sufficient residue cover to mitigate wind and water erosion.

5. Tillage systems

Crop residue management is an umbrella term encompassing several different tillage systems including no-till, ridge-till, mulch-till, and reduced-till.

5.1.1 Conservation tillage is any tillage and planting system that covers 30 percent or more of the soil surface with residue, after planting.

5.1.2 No-till/Strip-till is where the soil is left undisturbed from harvest to planting except for strips up to 1/3 of the row width. The strips may involve only residue disturbance or may include soil disturbance. Planting is accomplished using disk openers, coulters, in-row chisels, etc. Weed control is accomplished primarily by herbicide.

5.1.3 Ridge-till is where the soil is left undisturbed from harvest to planting except for strips up to 1/3 of the row width. Ridges are usually built 6-8 inches high and built when the crop (corn) is 12-18 inches high during row cultivation or after harvest. The ridges are preserved and the crop planted on the ridge every year.

5.1.4 Mulch-till is till width tillage involving one or more tillage strips which disturbs all of the soil surface. Mulch till is done prior to and/or during planting. Tillage tools such as chisels, field cultivators, disks, etc. are used. Weed control is often accomplished by additional tillage and/or herbicides.

5.1.5 Other tillage types include **reduced tillage** where 15-30% residue remains after planting. This method is also a full width tillage method. **Conventional tillage**

is where less that 15% residue remains after planting and generally involves plowing or multiple passes with other tillage equipment.

5.2 How it helps

- Conservation tillage helps by reducing both wind and water driven soil erosion which improves water and air quality.
- Increases soil organic matter.
- Traps soil moisture to improve water availability.
- Improves wildlife habitat and provides cover for game birds and other small animals

5.3 Effects of tillage systems on soil physical properties

Residue management practices affect the soil physical properties such as water content, temperature, aggregation, bulk density, porosity and hydraulic conductivity

Table 4: Tillage and water holding capacity

Tillage method	Water storage amount (mm)	Precipitation efficiency (%)
No-till	217	35.2
Ridge	170	22.5
Disc	152	15.2

(Unger and Weise, 2002)

5.4. Effects of tillage systems on soil chemical properties

The application of crop residues to soil increase soil organic carbon and nitrogen levels linearly. Crop residue material improves soil fertility by improving the nutrient availability and enriching the organic matter content of soil

Table 5: Tillage effects on soil (0-5 cm) properties

Tillage	Total C, g/kg
No-till	24
Chisel	16
Plough	11

(Karlen *et al.*, 2000)

5.5 Effect of tillage on microbial properties of soil

Leaving of crop residues on the soil surface provides a favourable environment for soil and surface dwelling organisms because of reduced water loss and amelioration of temperature.

Table 6: Average bacterial population in different treated soils (10^6/gm soil)

Soils	Control soils	Treatments (2% O.C.)	
		FYM	Wheat straw
Alkali soils (Delhi)	3.39	29.60	29.11
Alluvial soils (CRRI)	32.08	141.18	197.76

(Guar *et al.*, 1994)

6. Mulching

Mulch is a protective covering, usually of organic matter such as leaves or straw, placed around plants. It prevents the evaporation of moisture, the growth of weeds and (in cold climates) it prevents freezing of roots. It can have a positive effect on the fertility of the soil

The layer of mulch also provides shelter and food for beneficial insects and spiders that feed on small insects that are present in the mulch. Mulching is a cultural practice often recommended in the cultivation of vegetables (tomato, okra, cucumber, lettuce, etc.) and fruit trees. It has been found to be useful in reducing populations of

white flies and thrips. In many cases mulching helps to increase yields. Care should be taken when pests are present that use the mulch as a hiding place or for pupating.

6.1 Effect of mulching on soil properties

- Fertility maintenance
- Moisture maintenance
- Soil conservation
- Weed control
- Reduces salinity
- Reduces soil temperature

6.2 Value of Mulches

A thin layer of mulch on the soil surface (especially in sloping gardens) reduces the washing away of soil particles by rushing water. Also, mulches prevent raindrops from splashing on the soil surface. See figure 1.

Figure 1

Saving soil moisture is an important use of mulch. A mulch layer on the soil surface allows the soil to soak up more water. Mulch also reduces the rate of water loss from the soil. A 3-inch layer of mulch on the soil surface dries much faster than the soil below it. Thus it prevents water from moving into the air. See figure 2

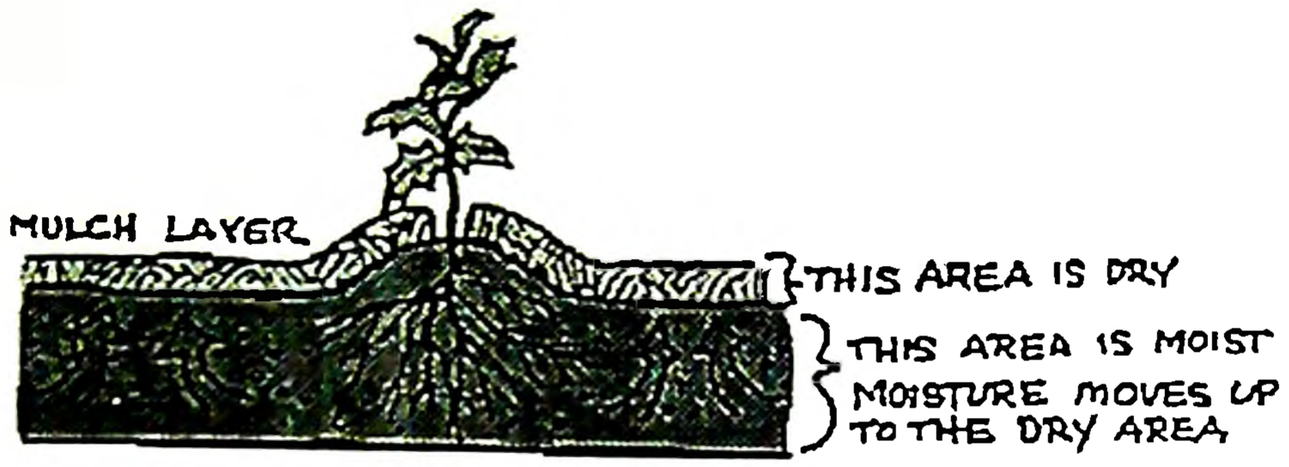


Figure 2

Organic mulches enrich the soil as they decay and provide a better environment for plant growth. Soils high in organic matter are easier to till and better suited to vegetable gardening. Adding organic material makes soils more crumbly, especially clay soils that pack and crust.

Most mulches also provide excellent weed control. Mulches do not prevent weed seeds from sprouting. However, weed seedling emergence is blocked by a mulch layer thick enough to exclude light. A 3-inch layer of mulch on the soil surface keeps most annual weed seedlings from coming through. See figure 5. Weeds that break through are removed more easily from mulched soil. Hard-to-control weeds such as nutgrass and Johnson grass may come through the mulch layer but can be pulled more easily or covered by fluffing the mulch with a fork.

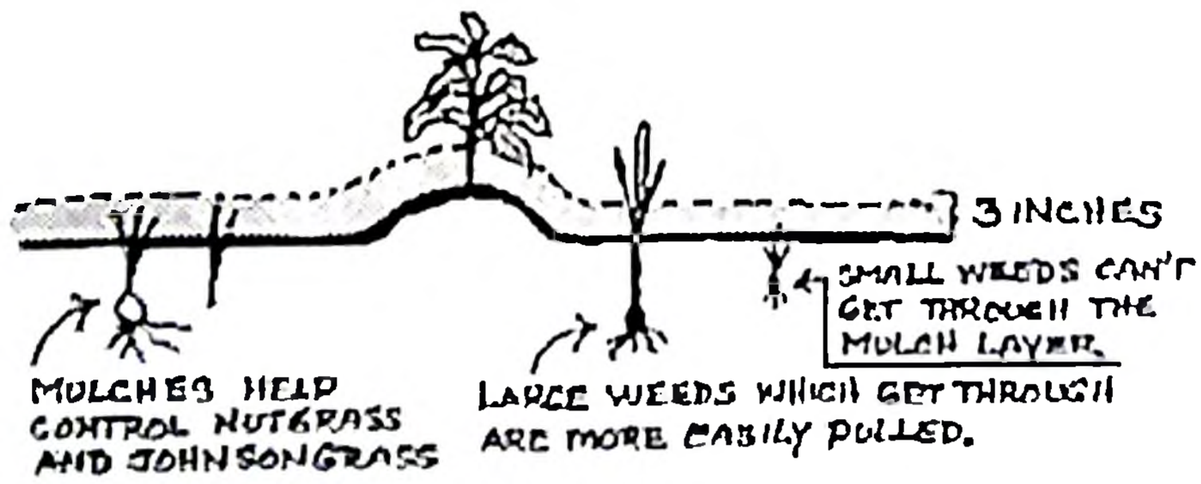


Figure 5

Table 7: Mulching and soil moisture

Mulching treatment	Soil moisture (%) 180 DAM at 15cm depth
Soya bean straw (8 kg/basin)	26.25
Paddy straw (11 kg/basin)	26.35
Local grasses (11 kg/basin)	26.40
Control	24.00

(Shirgure, 2003)

Table 8: Mulching and fruit yield

Mulching treatment	Yield, kg/tree
Soya bean straw (8 kg/basin)	66
Paddy straw (11 kg/basin)	63
Local grasses(11 kg/basin)	68
Control	58

(Shirgure, 2003)

7. Residue burning

Burning of residues on the surface of field itself is a commonly followed practice

7.1 Effects of residue burning

- Addition of potash and silicon to soil
- Considerable loss of N, P and other nutrients
- Environmental pollution
- Effect on microorganisms and earth worms

Table 9: Chemical composition of different organic residues and nutrients added

Organic material	Nutrients added, kg/ha		
	N	P	K
Green manure	87.5(2.5%)	7.0(0.2%)	21.0(0.6%)
Ash (burned straw)	0.96(0.06%)	4.5(0.28%)	29.00(1.8%)
Rice straw	36.00(0.6%)	6.00(0.1%)	60.00(1%)

(Kharub *et al* , 2004)

8. Residue incorporation

Incorporation of residue not only keeps the environment clean, which otherwise gets polluted due to burning of residue but also increases the soil productivity, when this practice is followed for longer periods.

Table 10: Effect of incorporation of crop residue on soil N, N uptake and yield of succeeding rice crop

Treatments (Preceding crops)	Mineral N in soil (Kg ha^{-1})	N uptake of rice (Kg ha^{-1})	Grain yield of rice (ton ha^{-1})
Cowpea	31 80	13 14	3 23
Groundnut	27 45	12 87	2 82
Sesbania	34 06	12 30	3 24
Fallow	21 48	10 65	2 57
CD (0 05)	7 32	1 35	0 31

(Jacob, 1994)

8.1 Residue management using cellulolytic fungi

Burning of residues leads to loss of nutrients and environmental pollution and the alternative option is the incorporation of residues in the soil but this technique has some demerits like the creation of temporary immobilization of nutrients due to high Carbon : Nitrogen ratio, leading to slow decomposition and decrease in yield of crops.

The rate of decomposition is enhanced by biological agents like cellulolytic micro organisms, and can add substantial quantity of nutrients locked in the residues leading to improvement in system productivity.

Cellulolytic fungi secrete extra cellular enzymes and growth promoting substances which are beneficial for yield increase when inoculated in residue for its rapid degradation Species used are *Aspergillus awamori*, *Trichoderma viride*, *Trichoderma reesei*.

Table 11: Effect of rice residue management practices on grain yield of wheat

Treatments	Grain yield (ton ha^{-1})			
	1999-2000	Increase %	2000-2001	Increase %
Rice residue incorporated	2.95	--	3.05	--
Rice residue burnt *in situ*	4.05	37.20	4.09	34.10
Rice residue incorporated + Cellulolytic fungi	3.96	34.20	4.00	31.10
Rice residue incorporated + N – enriched phosphocompost	4.20	42.30	4.28	40.30
Rice residue burnt *in situ* + N- enriched phosphocompounds	4.39	48.80	4.41	44.60
CD (0.05)	0.80		0.95	

(Jat *et al*., 2004)

9. Composting

9.1 Different types of composting

- Coir pith composting
- Vermi composting
- Farm compost

9.1.1 Coir pith composting

Coir industry is one of the important traditional cottage industries widely spread over South India. The case of Coco products, a small-scale industry located in Gubbi, Tumkur District, Karnataka, India, which is in the coir fibre production, is an example. Coconut husk is the basic raw material of the industry. The coir fibre extracted from the husk is used in local bedding, mat and matting, rubberized coir mattress, yarn and rope making etc. The byproduct of this industry is coir pith.

In the process of extraction of coir fibre from husk, generally about 1/3rd of it is obtained as fibre and 2/3rd of it is obtained as coir pith. Coir pith with a range of interesting properties finds various applications. Coir pith has a high lignin (31%) and cellulose (27 %) content and a carbon-nitrogen (C/N) ratio of 104 : 1 (Shekar, 1999). Coir pith also has a very high water holding capacity of 5 to 6 times its weight. It should be noted that coir pith is very stable because of the presence of high percentage of lignin. Hence coir pith left to itself takes decades to decompose. Studies by various institutions have resulted in methods to speed up the process of decomposition (lignin reduction) by fungal/microbial culture. The decomposing or composting of coir pith is done near agricultural fields, in heaps generally by the *Pleurotus sajor caju* species, an edible mushroom, which takes around 35-45 days for the process. Composted coir pith is used along with organic supplements in crop fields in horticulture and floriculture. It is also used as a rooting and growing medium for certain ornamental flowering plants. Decomposed coir pith is also used in hydroponics systems for growing roses and vegetables under controlled conditions. The coir pith in sterilized condition finds use in mushroom cultivation and

floriculture. The coir pith also finds application as an alternative for 'Peat Moss' the extraction of which has been banned in most of the European country. It also finds application as a mulching material for grapevine.

Coir pith has a calorific value of 3975 k cal/kg, close to 4200 k cal/kg of coal. It can also be used as fuel briquettes with the ash content almost 1/10th of coal. A proper methodology or technology for briquetting. Coir pith is yet to be developed for manufacturing a commercially viable product.

Here in our case, on an average a husk weighs about 300 g, 80-85 g is obtained as fibre and around 200 g is obtained as coir pith. Further on an average 5000 husks are defibred per day, which yields 1000 kg (1 ton) of coir pith per day while around 5-6 tons is composted or decomposed in batches for every 35-45 days depending upon the requirement. As mentioned earlier, out of the rest of coir pith, some quantity is sterilized and dispatched to be used chiefly in floriculture. Thus, the coir pith, which was once a waste and had a disposal problem, has a commercial value In fact today it is even being exported to other countries by some other units and has both internal and external market. Finally, we have arrived at cleaner and eco-friendly as well as profitable method of disposing the byproduct - coir pith

9.1.2 Methods of Coir Pith Composting

Since Coir pith takes decades to decompose and in the early 1990's it posed environmental hazard and disposal problem Various research institutions were successful in methods to speed up the process of decomposition by fungal or microbial culture Coir pith can be successfully composted either in the area of the industrial yard or in the agricultural fields itself. The coir pith composting is done by using mushroom cultures or fungal cultures. The mushroom popularly used belongs to the *Pleurotus* species. They are commercially sold in spawn bottles. Normally one spawn bottle weighs around 300g. Further to compost about 1 ton of coir pith 1.5 kg of spawn and 5 kg of urea are needed. The composting technique is as described below.

Mark an area of 5 m length and 3 m width in selected place which is preferably under shade. Spread uniformly on the marked area, one hundred kilogram (approximately) of coir pith. Inoculate with one bottle of the spawn of *Pleurotus* species by applying uniformly over the well spread coir pith. Cover uniformly with another hundred kilogram of coir pith over the *Pleurotus* species inoculated layer of coir pith. Apply one kilogram of urea uniformly over the layer of coir pith. Cover the applied urea with the next layer of one hundred kilogram of coir pith. Repeat the process of sandwiching the *Pleurotus* species and urea alternatively with hundred kilogram layers of coir pith to a height of one meter. Sprinkle water if the moisture content of coir pith is below 200 %. Normally the heaps of coir pith at the industry have 500 percent moisture Therefore if the coir pith is found over dried, sprinkling of water is required Keep the heap for thirty days of decomposition and sprinkle water if necessary periodically At the end of thirty days, the Coir pith may be found turned into dark or black mass of compost, having a reduced C : N ratio of 24 1 and with increased availability of macro nutrients and micro nutrients.

Table 12 : Nutrient Level of Coir Pith in kg/t

Nutrient	Coir Pith
Nitrogen	4.42
P_2O_5	0.71
Potash	1.02

(Joachim, A W R)

9.1.2 Vermicompost

Vermicomposting uses earthworms to turn organic wastes into very high quality compost. Worms eat food scraps, which become compost as they pass through the worm's body. Compost exits the worm through its' tail end This compost can then be used to grow plants. To understand why vermicompost is good for plants, remember that the worms are eating nutrient-rich fruit and vegetable scraps, and turning them into nutrient-rich compost.

9.1.3 Advantages of vermicompost

- Rich source of nutrients
- Excellent base for microbes
- Presence of growth promoters
- Quick response
- Good aeration
- Effect on soil properties

Table 13: Effect of vermicompost on nodulation

Treatments	Number of nodules/plant Soyabean
FYM@12.5 t/ha	20.39
Sugarcane trash vermicompost @12 5 t/ha	24.50
Recommended inorganic fertilizers	18.0

(Kuppaswami *et al* , 2002)

Table 14: Effect of vermicompost on yield

Treatments	Grain yield Kg/ha Soya bean
FYM@12 5 t/ha	1309 3
Sugarcane trash vermicompost @12 5 t/ha	1427 3
Recommended inorganic fertilizers	1429 5

(Kuppaswami *et al* , 2002)

10. Conclusion

To conclude, leaving crop residues in the field and associated no tillage crop production have been advocated as a cost effective means of reducing pollution caused by run off, nutrient loss and erosion from agricultural lands, leading to loss of soil productivity. In developed and affluent countries, utilization of crop residues is a

major concern for environmental production and sustained productivity. It is less difficult in developing countries where crop residues are routinely removed for use as a source of fodder for farm animals. How ever, removal of crop residues from fields, what ever reason reduces the soil organic matter and often leaves the soil susceptible to accelerated soil erosion. This is the major problem of resource development in developing nations.

The proper management of all types of residues not only augments the supply of plant nutrients but will also sustain crop production and maintain a cleaner environment on our planet

11. Discussion

1 Crop residues will increase the population of bacteria, other pathogens and insects etc., in soil?

Yes Residues are harbor for harmful and as well as beneficial organisms

2 Black cotton soils are rich in plant nutrients due to its black colour?

No Black colour is due to mineral compounds present in soil

3 What is rainfed and dry land agriculture?

Rainfed agriculture means growing of crops in areas having more than 750 mm annual rainfall Mainly the crops depend upon the rain

Dry land agriculture means growing of crops in areas having less than 750 mm annual rainfall

4. When crop residues are added, it causes increase in C N ratio and that cause immobilization of nutrients, how can we over come this?

By adding inorganic fertilizers like urea we can narrow the C N ratio

5. Whether there is any disadvantages, when continuous burning of crop residues in sugarcane field is practiced?

Yes Nutrients loss and destruction of microbes occur during burning

6. What is taramira crop?

It is an oil seed crop grown in North India.

7. Which method of crop residue management is most suitable for Kerala situations?

Mulching (in orchards and plantation crops)

12. ABSTRACT

12. ABSTRACT

Crop residues in general are parts of the plants left in the field after crops have been harvested. These materials have at times been regarded as waste materials that require disposal, but it has become increasingly realized that they are important resources and not wastes.

Crop residue management has been developed to leave more or entire of harvest residues, leaves and roots on or near the soil surface. Its components are various tillage systems, residue incorporation, residue burning, mulching and composting. In the last few decades there has been increasing interest in crop residue management as a source of organic manure which not only supplies nutrients but also improves soil health.

From the large number of crops grown annually in India, a total of 350 million tonnes of crop residues are produced. (Sarkar *et al.*, 1999). The nutrient requirement for the required food production in 2004-2005 is around 28.8 million tonnes, but present status of fertilizer use is around 20 million tonnes, implying that the deficit of 8.8 million tonnes has to be met from sources other than chemical fertilizers (Bharadwaj, 2003).

Regar *et al* (2005) reported that incorporation of rice residues decreased the soil bulk density and increased the grain yield of wheat. Rice residue incorporation using cellulolytic fungi effected significant yield increase in wheat (Jat *et al*., 2004). Higher uptake of nitrogen and higher grain yield in succeeding rice were recorded when groundnut crop residue incorporation was done as compared to fallowing (Jacob, 1994). Highest fruit yield and good quality fruits were reported in Nagpur mandarin with grass mulch (Shirgure *et al*., 2003).

13. References

Bharadwaj, K. K. R. 2003. *Recycling of Crop Residues, Oil cakes and Other Plant Products in Agriculture*. New Delhi, 230p.

Guar, A.C. and Mohan Singh, M.L. 1994.*Bulky Organic Manures and Crop Residues.* New Delhi. pp. 75.

Jacob, B. 1994. Effect of incorporation of crop residues on productivity of succeeding rice crop. M.Sc(Ag.) Thesis, KAU, Thrissur.84p.

Jachim AWR. 1973. The manurial value and decomposability of coir fibre dust. *Trop. Agri.*, 272-273.

Jat, M. L., Pal, S. S. and Shukla, L. 2004. Rice (*Oryza sativa*) residue management using cellulolytic fungi and its effect on wheat (*Triticum aestivum*) yield and soil health in rice – wheat cropping systems *Indian J. Agric. Sci.* 74 (3): 117-120.

Karlen, J L and Harris C S 2000 Effect of tillage and crop residue management on soil properties *J. Soil Sci* 28 403-409.

Kuppaswami, G., Thanunathan, K., Arulmurugan, K. and Ravichandran, M. 2002. Effect of vermicompost on growth and yield of soybean cv. CO 1. *Madras Agric. J.* 89 (10 - 12) 613 – 616.

Kharub, A S., Sharma, R K., Sharma, V K. 2004. Effect of rice straw removal, burning and incorporation on soil properties and crop productivity under rice wheat system. *Indian J. Agri. Sci.*, 74 (6) 295 – 299.

Regar, P. L., Rao, S. S. and Vyas, S. P. 2005. Crop residue management for increased wheat (*Triticum aestivum*) production under saline soils of arid fringes. *Indian J. Agric. Sci.* 75(2) 83-6.

Sarkar, A., Yadav, R. L. and Gangwar, B. 1999. Crop Residues in India. Technical Bulletin, Project Directorate on Croppimg Systems Research, Modipuram, Meerut, UP, India.

Shekar, C.A. 1999. Application of Coir pith in Internal and Export Market. National Seminar on Coir, Coir Products and Coir Pith.

Shirgure, P. S., Singh, S. and Panigrahi, P. 2003. Effect of different mulches on soil moisture conservation, weed reduction, growth and yield of drip irrigated Nagpur mandarin (*Citrus reticulate*). *Indian J. Agric. Sci.* 73(5):110-115.

Tandon, H.L.S.1995. *Fertilizers, Organic Manures, Recyclable Wastes and Bio fertilizers*. New Delhi, pp. 70-75.

Tandon, H.L.S.1997. Plant Nutrient Needs, Supply, Efficiency and Policy Issues. NAAS, New Delhi, pp. 15-28.

Unger, P.W. and Weise, D.M. 2002. Conservation tillage systems. pp. 100.

MICROBIAL INTERVENTIONS IN PHOSPHORUS NUTRITION OF PLANTS

Seminar Report

For the partial fulfilment of Agron-651 Seminar

By

K. VEERASIKKAMMAL
(2004-11-39)

Department of Agronomy
College of Horticulture
Kerala Agricultural University
Vellanikkara, Thrissur

CERTIFICATE

This is to certify that the seminar report titled **"MICROBIAL INTERVENTION IN PHOSPHORUS NUTRITION OF PLANTS"** has been solely prepared by Ms. Veerasikkammal. K. (2004 – 11 – 39), under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

Vellanikkara
Date

Dr. A. Latha
Major advisor
Assistant Professor
Medicinal and Aromatic plants
College of Horticulture, KAU
Vellanikkara, Thrissur

DECLARATION

I, Veerasikkammal K. (2004-11-39) here by declare that seminar entitled "Microbial interventions in phosphorus nutrition of plants" has been prepared by me. after going through the various references cited here and I have not copied from my fellow students

Veerasikkammal K
(2004-11-39)

Vellanikkara
2.12.2005

CONTENTS

ABSTRACT

Soil microorganisms play an important role in improving soil fertility and crop productivity. In India there is a gap of 10 million tons of plant nutrients between removal by the crop and it's replenishment through fertilizer (Somani and Dadhich, 2005). Supply of nutrient from organic manure alone cannot able to fill this gap. Thus an integrated approach of nourishing the crop efficiently is the need of the hour and biofertilizers are promoted as an important component of Integrated nutrient management.

Most of Indian soils are deficient in available P and it's requirements. It is met by addition of phosphatic fertilizer but the efficiency of applied P rarely exceeds 15% Phosphatic biofertilizers increased available P of the soil by solubilising and mobilizing the unavailable phosphorus besides accessing phosphate located beyond the root zone of exploration There are mainly two types of biofertilizers.

1 Arbuscular Mychorrizhal Fungi (AMF)

2 Phosphorus solubilising microorganism (PSM)

AMF fungi consist of arbuscules, vesicles and external mycelium for the absorption, storage and release of P from fungus to plant. The experiment conducted in pepper revealed that *Glomus fasciculatum* improved the growth characters and found to be the most responsive (Ashitraj, 2001) Application of *Glomus intraradices* increased the P concentration in plant and P uptake by seedlings and grafts of cashew (Usha, 2001) Different types of mechanisms are involved in improving P uptake by external hyphae of AMF In addition to increased P availability, AMF also improved the nitrogen status, Cu and Zn content of the soil, enhanced water uptake during water stress and provided resistance to plant disease There are three different types of factors influencing the mychorrhizal symbiosis - soil, plant and agricultural practice The inoculation methods include soil application, seedling dip, pellet application etc

In addition to AMF, various bacteria,fungi and actinomycetes are found to solubilise different types of insoluble phosphates. PSM constitute 0.5-1.0% of the soil microbial population. The phosphobacteria has been found to increase the yield of plants by 5-10%.

The interaction of beneficial microorganisms have been found to mobilize significantly higher amount of P than that inoculated separately. Synergistic interaction of PSM, VAM and Rhizobium can enhance soil fertility and experiments revealed that combined inoculation increase the yields of crops (Singh and Tilak, 2001).

The introduction of efficient P solubilisers in the rhizosphere has been found to increase the availability of phosphorus from both applied and native soil P. Application of AMF alone or in combination of PSM and other biofertilizers can lead to more economical use of costly inorganic fertilizers and play an important role in sustainable agriculture.

Microbial Interventions in phosphorus nutrition of plants

Introduction

Soil microorganisms play important role in improving soil fertility and crop productivity due to their capability to fix atmospheric nitrogen, solubilise insoluble phosphate and decompose farm waste resulting in the release of plant nutrients. Phosphorus is an important plant nutrient which is fixed in insoluble form in soil

In India there is a gap of 10 million tonnes of plant nutrients between removal by the crops and replenishment through fertilizers. Supply of nutrients from organic manure has not been able to fill up this gap. Thus, an integrated approach of nourishing the crops efficiently is the need of hour. Of late, biofertilisers are being promoted as an important component of integrated nutrient management (INM). It is good beginning but the country has a long way to go.

Phosphatic biofertiliser differ from fertiliser in the sense that former don't directly supply any nutrient to crop plant and are the culture of some specific bacteria and fungi. Phosphatic biofertilisers play an important role in solubilising and mobilizing the unavailable phosphorus besides accessing phosphate located beyond the zone of root exploration. An attempt has been made to acquaint with the mechanism, potential and limitations in use of the phosphatic biofertiliser with the special reference to Arbuscular mycohorrizal fungi and phosphate solubilising micro organism

Role of phosphatic biofertilisers

Phosphate solubilising microorganism play an important role in increasing the availability of soil phosphate by making fixed inorganic unavailable phosphate compounds available to plant besides mineralizing organic P compounds.

Phosphorus, the master key element, is an essential plant nutrient required for early establishment and better plant growth. It accelerates tillering, flower formation, good pod and seed setting besides early maturity in several economically important cultivated crops

Most of the Indian soils are deficient in available form of 'P' and its requirements is met by the addition of phosphatic biofertilisers but the use efficiency of applied phosphorus rarely exceeds 30% due to its fixation either in the form of aluminium or iron phosphate in acidic soils and in the form of calcium phosphate in neutral and alkaline soil

The percentage of organic phosphorus associated with soil biomass ranges from 3-20%. On an average the proportion of C N P S in soil humus is 140 10 1 3 1 Microorganisms affect P supply to higher plants by decomposing organic P compounds with the release of available inorganic phosphate

It is mainly divided into two types

1. AMF - Arbuscular mycohorrizal fungi
2. PSM - phosphate solubilising micro organism

Arbuscular mycorrhizal fungi

Micorrhizae is a symbiotic association between fungus and plant root. The term mycorrhiza is derived from Greek word Mykes - Fungus, rhiza - roots

Structure of AMF fungi

Arbuscules, vesicles and external mycelium are the main structural components of AMF fungi. The hyphae after penetrating the root spread into inner cortex layer. On passing to inner cortex layer arbuscules are formed. They are believed to function in the bi-directional transfer of nutrients, i.e., carbohydrates from plant to fungus and minerals especially P from fungus to plant. Sac like structure, vesicles are formed when colonization process is well established. They are storage organs of the fungus containing many lipid droplets. The mycelium outside root constitute an important part of mycorrhizal system. The soil mycelium is dimorphic and essentially nonseptate It enables the plant to tap soil P not otherwise accessible to the roots. The hyphal length can reach more than one meter of hyphae per centimeter of infected root

Role of AMF in plant growth

1 It enhance plant growth

2 It improved the nutrition of the host plant

3 It increased the growth and yield of crops

Table 1 Inoculation effect of AMF on banana crop (Robusta)

Treatment	Weight of fruit (g)	Bunch weight (kg)	Fruit length (cm)	Fruit diameter (cm)	Sugar (°o)	Total solids
Control	111 66	12 50	15 40	8 15	0 06	17 03
100% N+P	127 33	22 83	17 40	3 54	13 91	18 00
50% N+P+VAM	136 66	28 07	18 00	3 82	14 61	18 05
100% N+50% P+VAM	142 00	30 80	17 83	4 02	15 36	20 33

(Natarajan, 2002)

Application of farmyard manure based inoculum of mycorrhizal fungi helped banana crop increasing their yield by 20-30% in different treatments The AMF fungi not only improved the yield but also improved the quality attributes like weight of fruit, bunch weight, fruit length, fruit diameter, sugar %, total solids, etc(Table 1) 100% N + 50% P + AMF increased the yield and quality in banana crop

Mycorrhiza occurs in 83% of dicotyledons, 79% of monocotyledons and in all gymnosperms.

Dangeard was the first to name the VAM fungus. He described a typical VAM isolate from poplar and named the endophyte *Rhizophagus populinus*. Later VAM was recognized as endogone species (belonging to family Endoganaceae).

The role of fungi, particularly those selectively colonizing the root surface of growing plant,is to increase the availability of phosphorus and to transfer phosphorus from soil into roots. It occurs in most of the plant species in the two families

1. Leguminoseae
2. Poaceae

AMF fungi inoculated to crop plants colonise the plant root system and increases the growth and yield of crop plants. The improved plant growth is due to increased nutrient uptake particularly P, Zn and other micro nutrients, production of growth promoting substances, tolerance to drought and salinity and resistance to plant pathogens Depending on the plant and fungal species involved as well as distinct morphological patterns at least 7 different types of mycohorrizal associations have been recognized

1 Vesicular arbuscular mycorrhiza
2 Ecto mycorrhiza
3 Orchid mycorrhiza
4 Ericoid mycorrhiza
5 Ecto Endo mycorrhiz
6 Arbutoid mycorrhiza
7 Monotropoid mycorrhiza

Dual association of both Ecto and AMF have been found in some trees such as Acacia, Casuarina, Eucalyptus etc

Both the autotrophic host plant and heterotrophic fungal associate drive physiological and ecological benefits from one another. They are considered to be obligate symbiont since they couldn't be subcultured externally nor do they complete their life cycle unless they colonise a suitable host.

The application of arbuscular mycohorrizae as bioinoculant for cereals, pulses, fruits and vegetables has been found to be beneficial under field trials and demonstration trials.

Table 2. Growth characters of rooted lateral cuttings inoculated with AMF in pepper

Treatments	Mean vine length (cm)	Mean number of leaves (cm)	Mean dry weight (g)	Mean root length (cm)
1. *Glomus mosseae*	7.98	3.06	7.20	4.80
2. *Glomus fasciculatum*	11.66	3.84	7.50	5.10
3. *Glomus eternicatum*	6.95	2.41	6.40	4.20
4. *Glamus monosporum*	8.94	3.33	6.60	4.40
5. Vellayani isolate	7.02	2.50	6.10	4.10
6. Control	6.48	2.35	5.80	3.00

(Ashitraj, 2001)

An experiment was conducted in the Department of Agronomy, College of Horticulture to study the effect of VAM in pepper by Ashitraj (2001) The different species of AMF are used (Table 2) and pepper responded to mycohorrizal inoculation *Glomus fasciculatum* improved the mean vine length, number of leaves, mean dry weight, mean root length, etc and it is most responsive in pepper.

Table 3 Nut yield as influenced by AMF in cashew

Treatments	Nut yield	
	Seedlings	Graft
T_1 - *Glomus fasciculatum*	110.40	842.90
T_2 - *Glomus monosporum*	16.34	184.30
T_3 - *Glomus contrictum*	86.40	697.90
T_4 - *Glomus enternicatum*	60.50	388.80
T_5 - Native isolates from Vellayeni	45.10	433.90
T_6 - *Glomus intraradices*	547.20	1001.30
T_7 – Control	12.50	223.70

(Usha, 2001)

The experiment conducted in Cashew Research Station, Madakkthara to study the effect of nut yield by AMF in cashew. *Glomus intraradices* increased the nut yields in cashew seedlings/grafts (Table 3).

Table 4. AMF on phosphorus concentration, uptake and yield of green gram

Treatments	P concentration in plants (%)	P uptake (mg plan^{-1})	Yield
Uninoculated control	0.210	4.62	6.75
Glomus mossac	0.272	12.25	8.40
Glomus fasciculatum	0.277	12.47	8.52
CD (P=0.05)	0.0062	3.45	0.64

(Hazarika, 2000)

Glomus fasciculatum increased the P concentration P uptake and yield of green gram(Table 4)

Improved P uptake by external hyphae

There are different types of mechanism involved in improved P uptake by external hyphae

1. Physiological mechanism

A dense colonization of root cortex by VAM fungi must affect root physiology and metabolism Roots stay functional longer when mycohorrizal

2. Chemical mechanism

More than 90% of total phosphate in soil is unavailable to plant AMF fungi can carry out phosphate solubilisation by

1 Producing organic acids

2 By qualitative and quantitative change in root exudation pattern of mycohorrizae plants which change the pH of the rhizosphere

3 Fungi may excrete acid phosphatase enzyme leading to accelerated formation of soluble orthophosphate

4 Higher rates of respiration (specially in calcareous soils) produce more CO_2 which reacts with surrounding medium and forms acids that increases solubility of sparingly soluble calcium phosphate

3. Physical mechanism

Phosphate is immobile in soil and plant uptake of phosphorus is much faster than ion diffusion to root surface. This causes phosphorus depleted zone (1-2

mm wide) developed around roots. VAM hyphae extend beyond the depleted zone thus carrying out absorption and translocation of nutrients over larger distance.

4. Phosphate translocation along with hyphae

The phosphate absorbed by mycohorrizae fungi from soil is accumulated in vacuoles such as poly phosphate granules which is osmotically inactive (Callow *et al.*, 1978). Poly phosphate granules are propelled through the cytoplasmic streaming to arbuscules. When P supply is excess, poly P accumulates as a storage pool in vesicles which can be used at times of increasing demand to support later stage of plant growth.

5. Phosphate transfer to root cells

The poly P granules in arbuscules are broken down by specific enzymatic activities releasing P into the cytoplasm. The plasma membrane of both symbionts, representing an intracellular contact, are separated by apoplastic space, which is site for metabolic interchange

VAM and Nitrogen Nutrition

Compared with phosphorus, there is little information on the role of VAM in nitrogen acquisition, at least in non legumes growing in P deficient soils. AMF enhances nodulation

The tripartite symbiosis between leguminous plants, Rhizobium spp and AMF led to improved growth, nodulation and N fixation

Table 5 Effect of VAM in absorption and transport of zinc in sorghum

Zn conc. applied (mM)	Zn content (mg/g dry wt.)	
	Without VAM	With VAM
Leaves 75	9.3	11.4
Roots 75	7.25	7.6

AMF and trace element

Most studies of the AMF symbiosis have been focused on the nutritional benefits to the host plant in terms of phosphorus and to a lesser extent, nitrogen nutrition. AMF mutualism enhances the uptake of various micro nutrients. When these

are in poor supply it provides protection . Enhancement of nutrient uptake can be attributed to direct hyphal uptake and indirect effects caused by morphological and physiological changes in host roots.

. The capacity of external hyphae for delivery of copper and zinc is high and might account for about 40-60% of the total uptake in white clover and 35% in maize. Zinc content in the roots and leaves of sorghum increased due to the presence of AMF as reported by Senthilkumar and Arockiasamy (1995)

AMF and water stress

The movement of water from soil to roots through AMF hyphae has been the subject of considerable experimentation. Hyphae are thought to access water held in soil aggregates (Cooper,1984). Mycohorriza enhance water uptake by roots from dry soil and there by minimize the effects of drought. Mycohorrizal hyphae can carry water to the root and bridge any gaps that formed between soil and root as root hairs. The stomatal conductance of plants recovering from water stress was larger when they were infected with AM which was ascribed to effects on hormonal balance (Somani. 2002)

AMF and plant diseases

AMF also provides resistance to plant against diseases

1 The better or changed nutrient status of the host allowing strengthening of plant so that damage caused by pathogen was offset by improved plant growth due to mycorrhiza

2 Competition for infection sites

3 Special interaction between endophytes and pathogens

Inoculum production techniques

The chief nmechanisms involved are

1. Spores of AMF fungi as inoculum source

This is suitable method for plants grown *in vitro*. Large scale production of spores is difficult. Considering 100 spores/g of inoculum, 200-2000 kg inoculam may have to be used to get desired number of spores (about 100 spores/seedling) for inoculating one hectare of field sown crop.

2. Infected Roots as Inoculum Source

Large scale production of infected roots is possible in aeroponic culture. Infected roots contain internal and external mycelium (may have spores). Infected roots can colonize host after one or two days of inoculation. Root inoculum without spores should be used within a week. The production process is difficult and expensive with other problems like infected roots introduced as inoculum act as nutrient source for several saprophytic and parasitic micro organisms, short survival time etc. Large quantity of inoculum is required. On the basis of 10 g of root inoculum per cassava plant, about 100 - 150 kg root inoculum would be needed per hectare. For beans 400 to 800 kg/ha of root inoculum could be required on the basis of 2 g root inoculum/seed.

3. Seed based inoculum

Soil inoculum is produced using a tranditonal Pot Culture technique which contains all VAM fungal structures and is highly infective. Recent experiments showed that *Rhodes* grass found to be the best host. Perlite - Soilrite mix as the best substrate and CAN and Rock phosphate to be the best N and P sources for mass production. Harvesting of pot cultures in 75 days produce high quality inoculum with maximum number of propagules. The inoculum thus produced contain nearly 2000 infective propagules/g of substrate. The shelf life of substrate based inoculum was found to be nearly 2 years at room temperature, hence there is no need to store it in refrigerator

Inoculation Methods

Various methods have been tried for introducing AMF inoculum into field crops. They are

1. Transplanted crops

Seedlings are raised in sterilised or unsterilised soils supplied with selected AMF fungi in small nursery beds or containers and planted out when mycorrhizal colonization is well established

2. Crops directly sown in field

A) Coating seeds with AMF inoculum

B) Use of mycorrhizal pellets

C) Inoculum is placed in furrow under or beside seeds sown in furrows

3. Precropping

AMF propagules are raised *in situ* by growing strongly mycorrhizal host plants and leaving the infected roots and associated spores in soil to infect the next crop grown in the same field.

Factors influencing Mycohorrizal symbiosis

There are 3 major factors affecting mycorrhizal symbiosis.

1. Soil factors
2. Agricultural factors
3. Plant factors

I. Soil factor

a) Soil disturbance

Propagules of mycorrhizal fungi may be absent from soils where severe soil disturbance has resulted in top soil loss or where host plants are limited by adverse soil or site factors such as soil acidity, salinity, water logging or climatic extremes.

Less severe form of soil disturbance including frequent agricultural tillage. soil animal activities, fire and erosion also reduce mycorrhizal propagules.

b) Soil moisture

Excess water adversely affect the mycorrhizal growth, optimum being less than water maximum holding capacity.

c) Soil aeration

Lack of oxygen affects survival and spread of growth

4. Soil fertility

There is an inverse relationship between amount of labile P and response to mycorrhizae

5. Soil pH

Well adapted to wide range from 6.2 to 7.2

6. Soil temperature

Steep rise in AMF infection is seen in the temperature range of 20°-30°C

II. Plant factors

a) P content of plant

Higher the P content in plant lower will be the soluble carbohydrate content in roots and lower will be entry of AMF in roots

b) Mycorrhizal colonization

Greater the colonization greater will be the P uptake from soil solution.

In this table there was conducted by different fungus in treatments.

Glomus intraradices increases the infection percentage and *Glomus fasciculatum* increase the P content in cashew plant.

3. Photo synthesis

Greater the availability of light and photo synthesis more will be carbohydrate availability of VAM fungi and their effectiveness.

4. C_3/C_4 pathway

C_3 plants are more mycotrophic as rate of photo synthesis is higher in them

III. Agricultural practices

a) Fertiliser addition

AMF infection has been reported to be most prevalent in soils of low fertility Perhaps the differences in degree of infection associated with fertility are related to the growth rate of roots In vigorously growing roots the infection increases and hence, the response increases A general principle is that a low to moderate fertility enhances the degree of mycorrhizal development and plant response In particular the level of plant available P appears to be a suitable index for predicting a growth response to AMF in a given soil Internal P content of the root controls AMF infection by controlling sugar content of the roots It has also been proposed that internal P may work by controlling the permeability of root cell membrane Hence mycohorrizal infection could be excluded in fertile agricultural land and soils

b) Tillage

Frequent tillage practices affects soil water, temperature and structure which affects mycorrhizal activity. Disturbance of hyphae by tillage leads to decreased root colonization

c) Crop rotation

Pre cropping with a host plant increases infection and continuous cropping builds up inoculum as the fungi are obligate symbionts.

IV. Use of fungicides

Most of fungicides stimulate crop growth by eliminating soil borne pathogens and may help the spread of mycorrhizae. Excessive application may inactivate mycorrhiza.

Tilled plots are respected to more available P content in soil. Though the difference was not significant. Herbicide treatments also should no significant difference. Plots without herbicide application registered relatively more available P.

With respect to fertiliser level highest value was recorded in plots where half the recommended dose of fertiliser was applied along with AMF inoculation and it was followed by full recommended dose of fertiliser. Available P was lowest in plots treated with organics alone.

Though the fertiliser treatment had no significant difference. VAM inoculation along with organics and

inrganics recorded the highest value because of its inherent ability to assimilate more phosphorus from deeper soil layer (Hamel, 1992).

Scope of AMF in sustainable productivity

Crop production

Now it is well established that AMF improve plant growth and nutrition and play a key role in helping the plant under several stress situations (e g nutrient deficiency, drought, salinity or soil disturbance) A logical next step is to ascertain the possibilities of harnessing the symbiosis to challenge its potential in agriculture and horticulture systems or in the establishment and maintenance of forest and grassland ecosystems It has been shown repeatedly that plants bearing dual mutualistic symbiosis, such as nodulated and mycorrhizal legumes may be well adapted to habitats with low availability of both N and P These symbioses enable the plants to play an extremely important role as pioneer colonizers of nutrient-deficient soils

Legumes because of their shallow root systems are poor competitors for scarce phosphorus as against grasses They may be overgrown by more vigorously growing grasses unless they develop an AMF association to help to meet the phosphate needs for effective nodulation. AMF also ensures a reasonable share of any subsequently applied P for legumes. It also helps in the introduction of forage legumes in new habitats. Since legume require higher levels of phosphate for growth and effective nodulation and it is known that N_2 - fixation has a high phosphate

requirement and improved P nutrition by way of the mycorrhizal association may therefore have the secondary effect of stimulating nodulation and nitrogen fixation by *Rhizobium* spp. At low soil P level AMF produced a 5-fold increase in total clover dry weight when grown alone, and a 40-fold increase when grown with rye-grass. The clover appeared to be infected in preference to the grass, and AMF induced depression in yield were observed in the grass.

Efficient Utilisation of Applied Fertilizers

Although AMF inoculation is not a substitute for phosphatic fertilisers, nevertheless, they greatly increase the utilization of native and applied P by the host plants.

Rock phosphate is known to be a good source of phosphorus to plants in acid soil AMF inoculation greatly enhances its utilization in acid soils. Recent researches have shown that VAM infection can increase plant growth and nodulation even when they are growing on neutral and alkaline soils with added rock phosphate Moreover rock phosphate does not reduce the level of AMF infection as does soluble P Since AMF plants also take up their P from the plant available phosphate fraction, the pool of labile P that is restored by chemical dissociation of phosphate ions from rock phosphate Thus rock phosphate may serve as a potential substrate for P uptake even in high pH soils

Re-establishment of Ground Cover in Eroded and Degraded Sites

The structure of AMF and their adaptation to poor fertility levels suggest that they have evolved with a particular mechanism to help the plant to survive in adverse environments *Leucaena leucocephal*, a legume tree highly dependent on AMF association for its establishment and nodulation may unfold great potential for erosion control and rehabilitation of degraded sites through their reforestation

The loss of top soil and vegetation is an obvious consequence of erosion This leads to depletion of AMF propagules from eroded soils Under such a situation reintroduction of AMF has been found to help the growth and survival of clover

Legume plants growing in coal wastes are mycorrhizal and well nodulated Such symbiotic associations are pre-requisite for the successful establishment of long term vegetation on these soils

Encouraging Vegetation on Polluted Lands

Sewage sludge of urban and industrial effluent polluted soil with heavy metals such as Cd, Ni, Zn, Cu, Pb, Mn, Fe etc. favor AMF growth which in turn play an important role in stimulating growth of crops on effluent treated soils. A large numbers of plant species have been reported to survive in tannery effluent polluted soils with the help of AMF colonization on roots.

Limitations in AMF Use

1. The large scale use of AMF in Indian agriculture is still not practised, this is largely due to the handicap of inoculum production on large scale as they can only be multiplied on host plant and can not be cultured.
2. Lack of difficulty in production of pathogen free inoculum in sufficient quantities
3. Introduced AMF fungi have to be applied at higher inoculum density because of competition
4. Soil sterilization is not possible on large scale
5. Impact of ecological factors on impact of AMF fungi has to be established
6. Lack of acquaintance of farmers with beneficial role of AMF association
7. Easy availability of AMF culture is more difficult
8. Indian efforts with regard to AMF research are far from adequate and there is lack of indepth qualitative analytical data from available studies

Phosphate Solubilizing Microorganism (PSM)

Phosphate solubilizing microorganism (PSM) play a major role in the solubilisation and uptake of native and applied soil phosphorus

Most of the Indian soils are deficient in available form of 'P' and its requirement is met by the addition of phosphatic fertilizers but the use efficiency of applied phosphorus rarely exceeds 30 per cent due to its fixation either in the form of aluminium or iron phosphate in acidic soil and in the form of calcium phosphate in neutral and alkaline soils. In our country high grade rock phosphate required for the manufacture of phosphatic fertilizers is becoming costlier and limited by its low reserve, therefore the need to utilize vast reserves of low grade rock phosphates becomes inevitable.

In this context, phosphate solubilizing microorganism plays an important role in utilization of unavailable native phosphates as well as added in soluble

phosphates by bringing about changes in micro environment by producing chelating agents and organic acids.

Distribution of phosphate solubilizing microorganmisms

Many fungi *Aspergillus, Pencillium, Mucor, Fusarium, Candida* etc.), bacteria (*Bacillus, Pseudomonas, Micrococcus, Flavobacterium*) and actinomycetes (Streptomyces) were involved in phosphate solubuilization. The population of phosphate dissolving microorgānisms is more in the rhizosphere compared to non-rhizosphere and the higher population of PSB in the rhizosphere is of great relevance to plants especially in 'P' problem soil as it helps in the solubilization of phosphorus.

Crop response to PSM inoculation

Beneficial influence of artificial inoculation with PSM has been observed for different crops under diverse agro climatic conditions. Garetsen (1948) was the first to report the increased yield accompanied with high phosphorus uptake in oat plants inoculated with PSM. He reported increased yield in several crops inoculated with Bacterium-P, a tricalcium phosphate solubilizing organism.

In India by developing improved techniques for isolation of rock phosphate solubilizing microorganism, new efficient bacteria and fungi such as *Pseudomonas striata, Bacillus polymyxa, Aspergillus awamori* and *Penicillium digitatum* were selected for preparation of carrier based inoculant.

In USSR the use of phosphobacterium has been found to increase yield of plants by 5-10 per cent. The increase in crop yield has been attributed to:

1. Increase soluble phosphate nutrition to plants
2. Synthesis of growth promoting substances
3. Production of antibiotic like compounds

Interaction of beneficial micro organisms

Plants inoculated with AMF and PSM have been found to mobilize significantly higher amount of phosphorus than those inoculated separately with these micro organism. The plant inoculated with Rhizobium and PSM together has improved yield as well as nodulation. The definite synergistic interactions among Rhizobium, PSM, and AMF need to be explored for soil fertility. Combined inoculation of PSM and AMF results in greater growth response of black gram and

green gram. The greater growth response due to PSM and AMF combined inoculation than with alone in PSM inoculation in phosphate amended soils can be explained as the activity of AMF fungus in transporting the extra P solubilised by PSM from and beyond, the P depleted zone to plant roots.

Table 6. Response to Brady rhizobium, VAM and phosphate solubilisers inoculation on nodulation, plant growth and grain yield of soyabean var. PK-261

Strain	Nodule No./pl.	Nodule dry wt. mg/pl	Shoot dry wt. g/pl		Grain yield (t/ha)
			30 days	60 days	
Uninoculated control	14.5	157	9.57	23.53	2.685
Pseudomonas straita (S_1)	32.7	464	12.23	27.20	3.753
Bacillus polymyxa (S_2)	29.8	464	11.93	28.47	3.380
$S_1 + S_2$	31.8	478	10.37	30.47	3.796
Indigenous VAM (M_1)	25.0	386	13.13	26.70	3.935
Glomus fasciculatum (M_2)	35.5	381	10.60	25.53	3.611
Bradyrhizobium japonicum (I)	39.3	483	10.90	28.10	3.956
$I + S_1$	34.3	530	10.87	33.20	3.333
$I + S_2$	43.0	403	10.73	23.90	3.704
$I + M_1$	17.7	454	12.43	34.90	3.750

(Singh,H P ,1994)

Bradyrhizobium japonicum + AMF increase the grain yield and increased the nodulation in plants (table 6)

Table 7 Interaction effect of Rhizobium, PSB and P sources on total N & P uptake (kg ha^{-1}) of grain of pea

Source	Rhizobium alone	PSB alone	Rhizobium + PSB	Mixed culture	Mean
	Grain	Grain	Grain	Grain	Grain
SSP_{30}	13.0	13.2	16.9	16.4	14.9
SSP_{60}	14.4	13.7	16.8	16.6	15.0
MRP_{30}	13.1	13.5	16.6	16.2	14.9
MRP_{60}	11.3	11.4	11.4	11.3	11.4
Mean	12.9	12.9	15.4	15.1	-

(Somani, 2002)

The combined inoculation of Rhizobium and AMF significantly increased the grain yield content than other individual inoculation (table7)

Table 8. Yield of cashew as influenced by Azotobactor, Azospirillum and AMF

Treatment	Yield (kg/tree)
T_1 - Azotobactor alone	2.91
T_2 - Azospirillum alone	3.25
T_3 - Azotobactor + Azospirillum	3.51
T_4 - Azotobactor + Azospirillum + VAM	3.65
T_5 – Control	2.83

(Usha, 2001)

Combined inoculation of Azotobacter, Azospirillum + AMF increased the yield in cashew.

Table 9. Effect of inoculation of AMF and PSB on the quality and yield parameters of tomato

Treatment	pH of pulp	TSS (%)	Ascorbic acid content (mg 100 g) of fresh fruitcot	Fruit yield (g/plant)
Control	5.65	4.64	23.10	1012.73
Glomus + PSB	3.86	4.82	28.18	1368.00
Glomus fasciculatum	3.67	4.52	25.10	1205.82
PSB	3.76	4.70	26.62	1222.78

(Narayanan, 2000)

In tomato fertilizer combined with *Glomus fasciculatum* increased the yield by 35% and also improved the fruit quality. Combined inoculation not only improved the quality but also improved the characters like ascorbic acid content, pH of the pulp, total soluble sugars etc

Conclusion

Biofertilizers are effective supplement to fertilizers, ecofriendly and reduces the cost towards fertiliser use especially N and P.

The use of phosphatic fertiliser can definitely supplement plant P requirements. While PSM solubilise insoluble and fixed P compounds in the soil, the VAM can able to exploit phosphate present in the zone beyond the reach of plant roots and make them accessible to plants.

Agricultural importance of VAM fungi is mainly due to their ability to increase the phosphate uptake and other major and micro nutrient requirement of crop plant. Inoculating crop plant with VAM fungi alone or in combination of PSM can lead to more economical use of costly inorganic fertiliser and better exploitation of in expensive fertiliser.

DISCUSSION:

1. What are the phosphatic fertilisers available in Kerala?

Rock phosphate, Rajphos, SSP

2. What is pre cropping? How it's use in VAM inoculation?

VAM propagules are raised *in situ* by growing strongly mycohorrizal host plants and leaving the infected roots and associated spores in soil to infect the next crop grown in the same field.

eg. Maize, sorghum crop

3. What are the other microbes solubilising phosphate?

1. Bacteria
2. Fungi
3. Actinomycetes → streptomycin

4 How is the availability of PSM in market?

It is easily available in the market and is cheap.TNAU supplies VAM to the farmers at cheaper rates

5 Name of commercial product of VAM?

Surya, Roja

References

Ashithraj, N. 2001. Effect of biofertilizers on early rooting, growth and nutrient status of black pepper. M.Sc. (Ag.) thesis, Kerala Agricultural University, Thrissur, 69p.

Cooper, K.M. *Physiology of VAM mycorrhizal associations*. Verbescular Arbuscular Mycorrhiza (eds. Powell, C.L. and Bagyaraj, D.I.) CRC press, Boca Raton. pp.155-156

Duetti, P P 1998 Role of Tillage/Agro chemical use on VAM in cowpea in rice fallow M.Sc (Ag.) thesis, Kerala Agricultural University, Thrissur, 71p.

Harini, K.M., Bagyaraj, D.J. and Secilia, J.J. *Soil Biol. Ecol.* 12: 30-40

Senthil, S and Arochiasamy, D.I. *Indian J. Microbiol.* 35: 185-188

Sieverding, E and Sait, S.R. VAM-mycorrhiza management: a new, low cost, biological technology for crop and pasture production on infertile soils. *Centre international de Agricultural tropical*, cali

Singh, G and Tilak, K.V.B.R. 2001. *Fert. News.* 46(9): 33-36

Singh, G and Tilak, K.V.B.R. 2001. Interaction effect of AMF and PSB in chilli. *Fert. News.* 46(9): 50-56

Singh, H P 1994. Indian *J. Microbiol.* 34: 27-31

Somani, L.L. and Dadhich, S.K. 2005. *Ind. J. Fert.* 1(2): 21-28

Somani, L.L. (2002) Phosphatic Biofertilisers. Agrotech publishing Academy, Udaipur

Usha, K.E. 2001. Integrated nutrient management in cashew in relation to yield and quality. Ph.D. thesis, Kerala Agricultural University, Thrissur, 89p.

Wilcol, H.E. In "The Plant Root, the Hidden Half" (Y. Waisel) A., Eshel and U. Katkafi, eds.) 1:731-765 Marcel Dekker, New York

SOIL POLLUTION AND REMEDIATION

By

Santhosh, C.
(2004-11-29)

SEMINAR REPORT

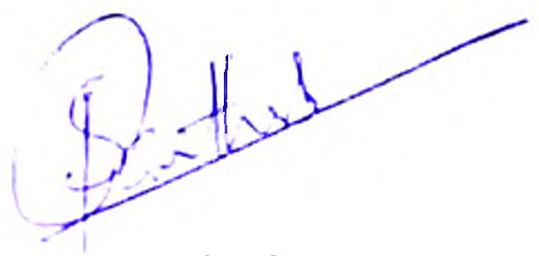
Submitted in partial fulfillment for the requirement of the
Course No. Chem 651, Seminar (0+1)

DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
COLLEGE OF HORTICULTURE
KERALA AGRICULTURAL UNIVERSITY
VELLANIKKARA-680656
THRISSUR, KERALA, INDIA

2005

DECLARATION

I, Santhosh, C. (2004-11-29) hereby declare that the seminar entitled "SOIL POLLUTION AND REMEDIATION" for the course Ag. Chem. 651 has been prepared by me, after going through the various references cited here and has not been copied from my fellow students.



Vellanikkara
29-11-2005

Santhosh, C
(2004-11-29)

CERTIFICATE

This is to certify that the seminar report entitled "SOIL POLLUTION AND REMEDIATION" has been solely prepared by Mr. Santhosh.C (2004-11- 29), under my guidance, and has not been copied from any seniors, juniors or fellow students .

Vellanikkara

29 – 11 –2005

Dr.K.A.Mariam
Major Advisor
Associate Professor
Dept. of SS&AC
College of Horticulture
Vellanikkara, Thrissur.

INDEX

List of tables

LIST OF FIGURES

Introduction

"Quality of environment is one of the major indicators of the level of development of a country"

Nature and mankind are an inseparable part of life that includes land, water, air, space, energy, flora and fauna, which are interconnected, interrelated and interdependent. There are unlimited forms of life on earth. Man is one among the many species competing with all others for survival. In the name of progress, the human race has changed from being hunter-gatherer to a self-centered modern man, a destroyer of nature so much so that development in a sense has become synonymous with environmental degradation and progress with pollution. There is also a growing recognition that the indiscriminate usage of natural resources has led to serious problems.

Environmental pollution in India has become a major issue of public policy and research in the recent years. Unprecedented economic growth during the last few decades has led to extensive environmental degradation of all parts of the ecosystem. Most studies on soil contamination in India have been carried out by scientific groups on localised problems around the pollution sources. These reports clearly show increasing soil contamination due to antrhropogenic activities. With increasing urbanisation and industrialisation the recycling of heavy metals and other pollutants in the environment through biotic and abiotic pathways is bound to increase with the increasing use of metals, pesticides and other chemical-based commodities in the society.

Causes for environmental pollution

- Environmental problems have arisen in India due to many causes. The ever-growing populations of human beings and animals have led to uncontrolled over-exploitation of the natural sources.
- The general indifference of the industrial sector towards the aspects of environmental safety and protection has been the major cause for the pollution of soil, water and air.
- The economic growth in our country in the recent years has necessitated increased use of energy generated mostly from fossil fuels for industrial,

agricultural and domestic purposes. India has been listed by the World Resources Institute as the fifth biggest contributor of greenhouse gases.

- The policies of the State and Central Governments have not incorporated environmental safety accountability conditions and so, many development projects have been conceived and contemplated for short-term gains without concern for environmental safety.

The awareness and concern for environmental safety is very low among the common public, because of which the violators causing environmental pollution do not have the social accountability, being primarily interested to make personal gains irrespective of the negative effects of their activities on the environment.

Water - Scarcity and Pollution

Water is the basic necessity for all life. Water received as rainfall has been estimated to be 4000 km^3 annually. But it has been possible to harness only 690 km^3 for beneficial use The ground water potential is estimated at 450 km^3. The pattern of water use in India is such that 93% is used by the agricultural sector and 3.73% by the domestic sector. About 80% of the 14 perennial rivers in India are polluted with sewage. Industrial effluents, agricultural run-off, dumping of toxic wastes in rivers and other large water bodies are the cause of water pollution

To control water pollution, effluent treatment plants must be installed in industries. Water quality monitoring stations must be created in all the major river systems. A legal provision to prevent and control water pollution is also provided in the form of the Water Act

DEGRADATION OF LAND RESOURCES

India has a total land area of about 324 mha, of which only 266 mha is under proper usage. Land degradation and change in land use patterns are the main problems concerning land resources in India. In urban areas, land pollution is caused by disposal of solid wastes and discharge of effluents. In rural areas, it is due to intensive agricultural practices and excessive use of chemical fertilizers and insecticides

INTENSIVE AGRICULTURE

At the expense of forestlands, the land under agriculture has almost doubled. The Green Revolution emphasized hybrid varieties, excessive use of fertilizers, insecticides and weedicides, and has now rendered nearly 13 mha irrigated land unfit for agriculture. Groundwater depletion for agriculture is twice the rate of recharge. Agriculture has degraded 125 mha of land with monoculture, salinization and water logging. Intensive agriculture has converted many fertile lands to waste lands.

Fertility of these degraded lands can be regained by adopting traditional farming methods and by substituting chemical fertilizers with organic manure and bio-pesticides. Sustainable agricultural practices to produce enough food to feed the growing population, with least stress on the land and water resources, are the challenges faced by the agricultural sector.

MANAGEMENT OF WASTE

Waste management aims at curtailing the waste from the initial stage of production. Wastes could be managed by making the manufacturing process efficient, reusing the waste generated and by recycling the waste products.

Waste is generally defined as "something, which is not put into proper usage at a given time". As the population increases, the amount of waste generated also increases. The accumulation and improper disposal of waste leads to environmental pollution and accelerates the spread of communicable diseases.

Global climatic change and agricultural production

The predicted changes in climate, especially increased atmospheric CO_2, temperature and precipitation, associated with changes in nitrogen deposition, tropo- and stratospheric ozone levels, UV-B radiation, *etc.*, can have great impacts on world agricultural production and supply patterns. In order for agricultural production to be sufficient to meet the demands of the ever-growing human population, the impact of the climate must be understood and integrated in any future planning.

Effects on soil fertility

A sudden doubling of the atmospheric CO_2 concentration and associated higher temperatures as in most experimental setups, both enclosed and under free-air enrichment may result in soil degradation including nutrient depletion. A potential increase in initial soil fertility under elevated atmospheric CO_2 can be expected if the increase in CO_2 occurs gradually, as in practice and as is the case in crop models that take into account the gradual transient increases.

The Underlying Causes of Environmental Degradation

Environmental degradation is a result of the dynamic inter play of socio-economic, institutional and technological activities. Environmental changes may be driven by many factors including economic growth, population growth, urbanization, intensification of agriculture, rising energy use and transportation (Stefano Pagiola, 1995) Poverty still remains a problem at the root of several environmental problems.

Social Factors

Population

India supports 17 per cent of the world population on just 2.4 per cent of world land area It's current rate of population growth at 1 85 per cent continues to pose a persistent population challenge Population is an important source of development, yet it is a major source of environmental degradation when it exceeds the threshold limits of the support systems

Poverty

Poverty is said to be both cause and effect of environmental degradation The circular link between poverty and environment is an extremely complex phenomenon Inequality may foster un-sustainability because the poor, who rely on natural resources more than the rich, deplete natural resources faster as they have no real prospects of gaining access to other types of resources.

Urbanisation

Lack of opportunities for gainful employment in villages and the ecological stresses is leading to an ever increasing movement of poor families to towns. Mega cities are emerging and urban slums are expanding.

Economic Factors

To a large extent, environmental degradation is the result of market failure, that is, the non existent or poorly functioning markets for environmental goods and services. In this context, environmental degradation is a particular case of consumption or production externalities reflected by divergence between private and social costs (or benefits). Lack of well defined property rights may be one of the reasons for such market failure. On the other hand, Market distortions created by price controls and subsidies may aggravate the achievement of environmental objectives.

Economic development

The manufacturing technology adopted by most of the industries has placed a heavy load on environment especially through intensive resource and energy use, as is evident in natural resource depletion (fossil fuel, minerals, timber), water, air and land contamination, health hazards and degradation of natural eco-systems.

Transportation

Transport activities have a wide variety of effects on the environment such as air pollution, noise from road traffic and oil spills from marine shipping. Transport infrastructure in India has expanded considerably in terms of network and services. Thus, road transport accounts for a major share of air pollution load in cities such as Delhi.

Direct impacts of agricultural development on the environment arise from farming activities which contribute to soil erosion, land salination and loss of nutrients.

The agents of pollution includes

Distillery effluents

In India, large quantities of waste-water generated in the form of distillery effluents are discharged on land and into the river courses. The distillery waste waters are characterized by low pH, high BOD (Biological oxygen demand) and COD (chemical oxygen demand) values and contain high percentages of organic and inorganic materials.

Tannery and textile industrial effluents

The effluents generated from tanning and textile industries are characterized by high values of BOD, COD, Na and dissolved solids. The addition of tannery effluents will cause deflocculation of soil particles and will destroy the soil microstructure. Similarly, deleterious effects such as increase in sodicity, EC and pH have been observed by the discharge of textile effluents on land. Salinization and alkalization of the soil and ground water will occur under the land on which tannery and textile effluents are applied.

Tannery effluents

There are about 3060 tanneries in India mostly spread over Tamil Nadu, Karnataka, Maharashtra, Uttar Pradesh, Rajasthan and Punjab. In leather processing, large quantities of chemicals like sodium chloride, chromium sulphate, calcium and ammonium salts and organic dyes are used. The tannery effluents are considered as the worst pollutants among all industrial waste waters. The effluents from chrome tannery will contain much higher amounts of suspended solids, dissolved salts and chlorides compared to those from vegetable tanning. Tannery effluents, when let on the lands, will reduce the porosity and hydraulic conductivity of the soil, will increase the bulk density due to deflocculation of clay particles and will affect the chemical and biological properties of the soil.

Table.1. Tolerance limits for disposal of tannery effluents

Parameters	Permissible limits of effluents to be discharged	
	into inland surface water	on land for irrigation
pH	6.0-9.0	6.0-9.0
BOD	30	100
Suspended solids	100	200
Chloride (as cl)	1000	200
Chromium (as Cr)	2.0	2.0
Sulphides (as S)	2.0	-
Sodium (%)	-	60
Oil and grease	10	10

All parameters except pH are expressed in mg L^{-1} or otherwise stated (Environment (Protection) Rules 1986)

Pollutants from textile industry

In the textile industry, a large number of chemicals including different salts of sodium, bleaching powder, mordants and detergents are used. The effluents emanating from textile units are characterized by high salinity, BOD, COD and excessive concentration of sodium and carbonate ions. Discharging of effluents from the textile industries will increase the sodium, carbonate and bicarbonate contents of soils and will increase the SAR and RSC.

Pollution from pulp and paper mills

Solid and liquid wastes are disposed off from pulp and paper industries. Wood-dust, lime-sludge, coal-ash and fly-ash are the solid wastes from the pulp and paper industries. The most important problem in the pulp and paper industries is the disposal of large volumes of effluent waste water. Large quantity of water (230 m^3 to 500 m^3 water for one tonne of paper) is used in this industry and the waste water from the pulp and paper industry carries chlorides and sulphates of sodium and calcium and varying amounts of suspended organic materials. Extensive chlorine bleaching of the pulp material will produce a wide range of organic chemicals many of which have known carcinogenic or mutagenic properties. Unless the potentially toxic compounds in the effluent are ameliorated by processes such as degradation, volatilization and sorption, land treatment may result in adverse environmental effects contamination of ground and surface waters,

plant uptake and phytotoxicity, entrance to the human food chain and toxicity to soil organisms.

Coal combustion residues

Combustion of coal, predominantly for generation of electricity produces large amounts of residues called flyash hich have the potential to contaminate soils and surface as well as ground waters. It is composed predominantly of fine particles collected in emission control devices such as electrostatic or mechanical filters. Flyash is sometimes mixed with bottom –ash which is the residue from coal combusting that remains in the boiler that is generally a mixture of ash and slag. The physical, mineralogical and chemical properties of fly-ash depend on the composition of the parent coal, conditions during coal combustion and the efficiency of emission control devices. Particle sizes are commonly between 0 01 and 100 µm Flyash contains predominantly Si, Al and Fe. Other elements like As, B, Ca, Mo, S, Se, Sr, Cd, Cu, Mn and Zn are also present.

The main environmental contamination problems resulting from the disposal or utilization of flyash relate to its high soluble salts content and potential toxicity of some individual elements like B

MIGRATION OF CHROMIUM IN SOILS

The effluent and sludge disposed from tannery industries into rivers and on to land has led to extensive degradation of productive land The tannery wastes typically consists of salts (Sodium, chloride, sulfates etc) and chromium, both of which threatens surface and subsurface land and water resources The fate of Cr in tannery wastes contaminated soils and its impact on the environment is shown in Fig 1 High concentrations of heavy metals in soil due to effluent and sludge is of concern because of possible phytotoxicity or increased movement of metals in to the food chain (Chaney, 1990).

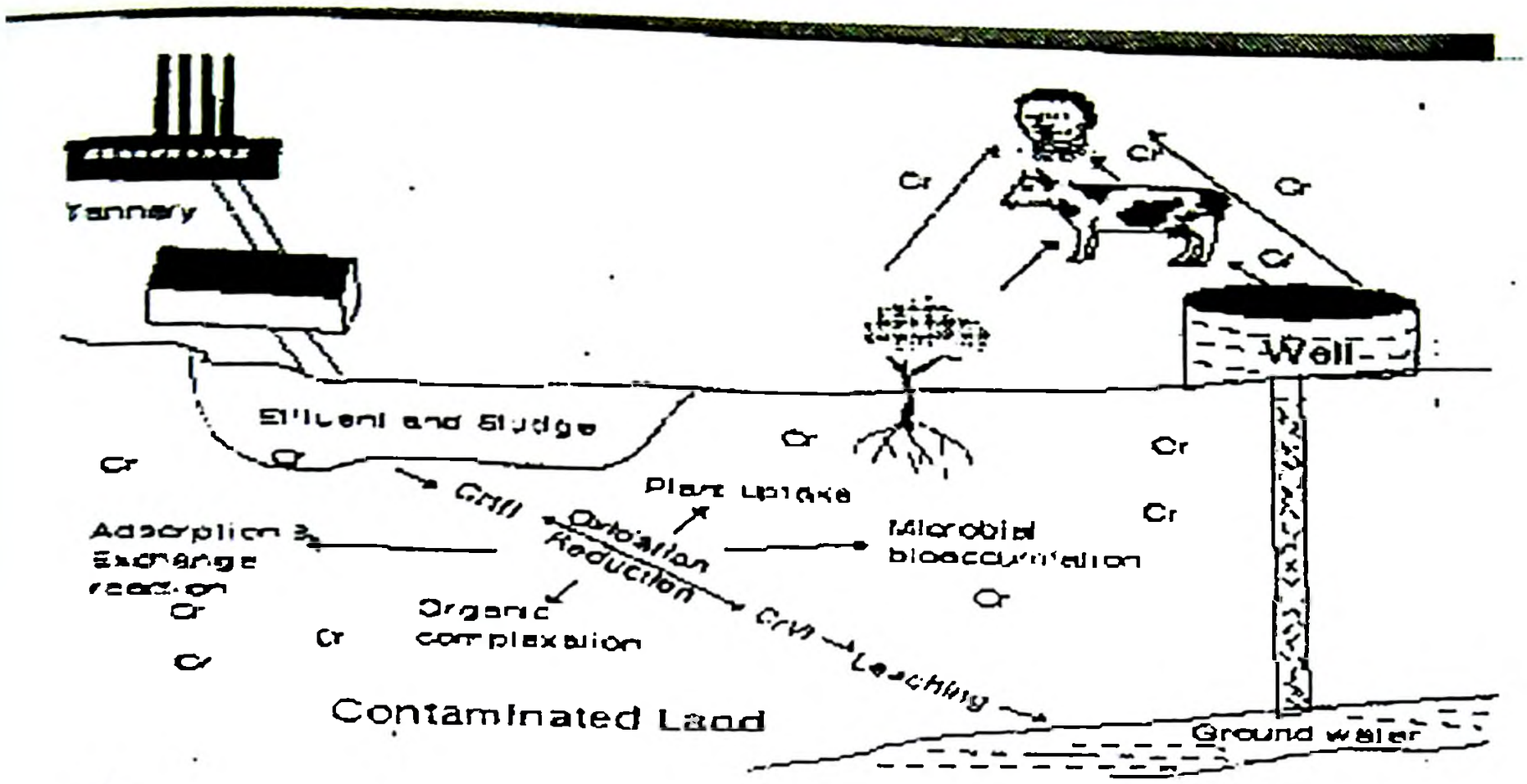


Fig. 1. The fate of Cr in tannery wastes contaminated soils and its impact on the environment

Chromium in soil

The mean values of Cr in surface and subsurface soils collected around selected tanneries at Ambur and Vaniyambadi are depicted in fig 2. At both the locations the Cr content did not show a definite pattern with soil depth but accumulated in soil. This may be due partly to the varying texture of the soil and hydrological features of the sampling site, which may have influenced the mobility of Cr and resulted in differential accumulation in the soil profile. Nevertheless at Vaniyambadi the Cr contamination exceeded 70,000 mg/kg at depths exceeding 70 cm. The differences in the chemical constituent of effluent/sludge also contributed to the variations in Cr accumulation. In nature Cr can occur in both hexavalent Cr VI and trivalent Cr III form depending on the nature of environment which exists primarily as CrO_4^{2-}, and $HCrO_4^-$ in natural systems (Richard and Bourg 1991) is of particular concern, even at low concentrations, it is toxic to both plant and animals. The Cr VI is more soluble and more mobile in the environment than Cr III.

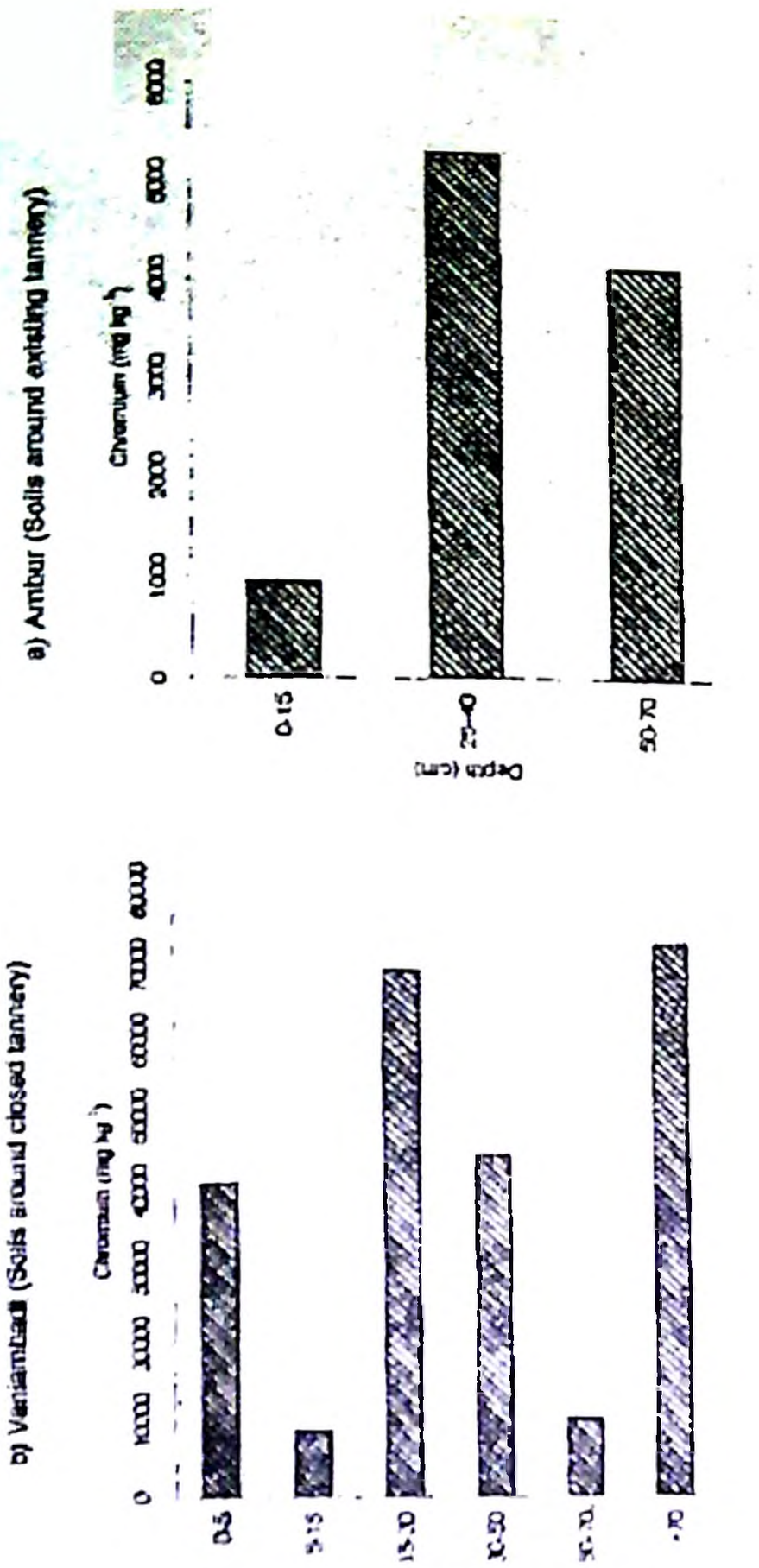


Fig. 2 Depth wise chromium content in the soils of Ambur and Vaniyambadi

Potential problems of chromium

Chromium and salts are potential pollutants of soil, surface water, ground water, sediment and air, where the soils do not originate from serpentine minerals, high Cr content of the soil is often associated with human induced contamination mainly from industrial operations such as tanning and direct disposal of sludge and waste water for land application. The toxicity and mobility of Cr depend on its oxidation state. The trivalent form are relatively immobile, more stable and much less toxic than the hexavalent forms. Chromium forms a large number of relatively kinetically inert

complexes which can be isolated in solids. Well known complexes are amines. Chromium is not a significant contaminant of plant tissues except at sites with specific discharge points. Toxicity to plants depends on the pH of the media and hence the availability of the free presence of organic chelators, cations, nutrients and other heavy metals in solution, influence the toxicity to plants.

ORGANIC POLLUTANT CONTAMINATION IN SOIL AND WATER

Organic pollutants in soil

Soil is polluted with the pesticides in several ways such as through deliberate use for controlling soil inhabiting pests, through fall out during spraying or dusting or through disposal of pesticidal containers or the soil near vicinity of industry sedimentation of particles carried out through air. Thus, the soil is reservoir of pesticidal contamination.

Fate of pesticides in soil

Quite often, pesticide is applied directly to soil for control of pests, when it comes into contact with the soil it is immediately subjected to various reactions with soil and environmental factors. The fate of pesticides in soil pertains to their interaction with the soil environment, which is governed by several factors *viz*., Adsorption, Leaching, Volatility, microbial degradation, chemical degradation and photo decomposition.

1. Adsorption

The attraction of ion or compounds to the surface of a solid. The adsorption of pesticides by soil is determined largely by the characteristics of the pesticides and of the soils to which they are added. The presence of certain functional groups such as -OH, $-NH_2$, $-CONH_2$ and –COOR in the chemical structures encourages adsorption, especially on the soil humus. In general, the larger the size of the pesticide molecule, the greater is its adsorption. Maximum adsorption occurs at low pH levels where protonation occurs. The adsorption of pesticides by soil colloids encourages the persistence of the pesticide in soil for long periods.

2. Leaching

Strongly adsorbed molecules are not likely to move down the profile. Conditions that encourage adsorption will discourage leaching. Leaching takes place readily in permeable sandy soils that are low in clay and organic matter. In general herbicides are more mobile than either fungicides or insecticides. Soil texture, soil permeability, volume of water flow, adsorption of pesticides to soil colloids and water solubility of pesticides are the principal factors influencing leaching.

3.Volatility

Volatility is the phenomenon by which a chemical passes from the solid or liquid state to the gaseous state Volatility of pesticides becomes important when economic loss occurs. In this process pesticides will be distributed throughout the soil profile eg., methyl bromide fumigation to control soil insects.

Jayakumar (1995) reported that the ester form of 2, 4-D compounds are volatile and the gases evolved injured the susceptible crops like cotton and tomato. The gas may also more in porous soil thus causing injury to germinating seeds. The loss of pesticides through volatilization may be reduced by soil incorporation and using special formulations such a granules

4. Microbial degradation

Table 2. Bio-degradation of organic pollutants by microbes

Pollutants	Microbes capable of degrading them
Insecticides	
Dieldrin	Anacystisnidulans, Actinomycetes and *Pseudomonas*
Endosulfan	Bacteria, Fungi, Soil Acetinomycetes
Endrin	Micrococcus and *Pseucomonas*
Parathion	*Bacillus subtilis* and *Chlorella pyrenoldosa*

Lindane	*Chlamydamonas reinhardi*, *Chlorella vulgaris* and *Clostridium*
Herbicides	
Monuron	Pseudomonas
2,4,-D	*Achromobacter*, *Corynebacterium* and *Flavobacterium*
MCPA	*Achromobactor* and mycoplana
Dalapan	*Agrobacterium* and *Pseudomonas*
DNBP	*Corynebacterium* and *Pseudomonas*

It is reported that the *aspergillus niger* has got a key role in 2,4-D degradation in the rice fields (Durga Devi, 2002)

5. Chemical degradation

In contrast to biological reactions the deactivation of pesticides may occur purely by chemical reactions Chemical decomposition may destroy some pesticides or activate others. Some pesticides undergo chemical modification independent of soil organisms. Hydrolysis, reduction and oxidation are the most important chemical process. The triazine herbicides (eg , atrazine) and organophosphate insectides (e.g. malathion) are subject to hydrolysis and subsequent degradation in the soil (Jevan Rao, 1999).

Herbicides may interact chemically with other pesticides in the soil, resulting in enhanced phytotoxic effects. The ß oxidation of 2, 4-D B to 2, 4-D results in an increased phytotoxicity (Jayakumar, 1995)

6. Photodecomposition

Photodecomposition is an important mechanism for the deactivation of pesticides exposed on soil surface. Ultra violet rays and sunlight plays a crucial role in the degration of pesticides in soil and water. Amiben and trifluralin are examples of pesticides that are susceptible to photodecomposition, whereas DDT, dia quat and the triazines are subject to slow photodecomposition (Walia and Dureja, 1993).

Organic pollutants in water

Water has been found contaminated with organic pollutants by one way or the other. In order to destroy unwanted plants, weeds, insects, and fishes etc., the delibrate use of pesticide is being done due to which water is contaminated. Water has also been found contaminated with pesticides and fertilizers at places which were quite away from the site of application. Water sources are also contaminated through run off from fields, through sewage disposal, through the effluents of industries using pesticides and fertilizers, through dead and decayed plants treated with fertilizers etc. In UK, the pressure of insecticides was reported in rain water. Fresh rain water on the top of the Himalaya was found possessing pesticide residues. Snow from Artic ocean was also found to be contaminated and the tap water before falling on the ground showed the presence of insecticidal residue. Many great rivers of the world

Ground water contamination

Movement of pesticides and fertilizers applied to soil, from the site of application by leaching below crop root zone, results in possible deterioration of the quality of groundwater. The pesticide with a solubility value of more than 30 ppm and half –life grater than 21 days will have the potential to leach down (Becker *et al.*, 1989). A review by the environmental protection agency (EPA, 1989) of Western Australia showed that number of samples showed the presence of one or more herbicides. In groundwater at levels exceeding EPA criteria, have increased over recent years

Persistence of organic residues

A pesticide residue in soil includes any derivatives, such as conversion and degradation products, reaction products, metabolites and impurities. Only a portion of the pesticide residues found in soil result from direct application. Atmosphere also contains residues of pesticides that are likely to be added to soil with rainfall. Pesticides may also reach the soil from plant or animal remains which become incorporated with the soil.

The organochlorine insecticides are much more persistant than other pesticides on an average, DDT persist longest in soil followed by dieldrin, endrin, lindane, chlordane, heptachlor and aldrin in order of decreasing persistence.

It is evident from table that chlorinated hydrocarbon insecticides like aldrin, BHC and heptachlor persist in the soil for a long period while organophosphates and carbamate insecticides persist not beyond 4 months in soil. Similarly the persistence of herbicides like altrazine, simazine is for 9-12 months while that 2, 4-D, Dalaphone etc., is not more than 1 month.

The residues of carbofuran were detected in the cucumbers when the carbofuran is applied at the normal recommended rates. It is reported that the carbofuran and it's metabolite is present in the black pepper berrises even after six months of application and also recommended not to pick the immature berries for the culinary purpose because it contain carbofuran residues in higher amounts than the dried ones (Betty Bastin and Wahid, 2004)

Table.3. Persistence of pesticides in soil

Pesticides	Months (95% disappearance)	Pesticides	Months (90% disappearance)
Aldrin	24	Altrazine	9
Heptachlor	8	Simazine	12
BHC	18	Fenuron	5
Parathion	3	Linuron	5
Phorate	3	2, 4-D	1
Carbaryl	3	Chlorambene	2
Disulfaton	4	Dalapone	1
Aldicarb	4		

Techniques to minimize pesticides residues

An ideal soil-applied pesticide should persist long enough to give an acceptable period of pest control, but not so long that soil residues after crop harvest limit the nature of subsequent crops which can be grown. Various management techniques have been developed which can help to minimize the residue hazards in soil.

1. Use of optimum dose of pesticide

Hazards from residues of pesticides can be minimised by the application of chemicals at the lowest dosage by which the desired pest control is achieved.

Besides, applying pesticides in bands rather as broad cast will reduce the total amount of pesticide to be applied This will be practicable in line sown crops or crops raised along ridges such as cotton, sugarcane, sorghum maize etc.

2. Microorganisms

A new innovative method for pest control is use microorganisms like bacteria, fungi etc Being biological in nature, they do not pose any pollution problems as pesticides so Microbial degradation of pesticides is more predominant in soil and water

Enzymes isolated from *Escherichia coli*, and *Arthrobacter* strains are capable of hydrolysing OP compounds such as diazinon, methyl parathion and malathion (Rosenberg and Alexander, 1979, Barik *et al* , 1982)

3. Incineration

Incineration is a land based most effective method for disposing a variety of pesticides In India, indiscriminate pesticide dumping on fallow land/public and or in municipal solid

waste disposal sites, is a common practice. Incineration facilitates safe disposal of hazardous materials.

4. Application of farm yard manure

Farm yard manure (FYM) application is an effective method to mitigate the residual toxicity of pesticides. Application of FYM helps to absorb the pesticide molecules in their colloidal fraction and make them unavailable for crops and weeds. Besides, FYM enhances the microbial activity which in turn, degrade the pesticides at a faster rate. However, application of FYM @ 12.5 t/ha to pearl millet was found to mitigate the residual toxicity of atrazine in the succeeding soybean crop.

5. Ploughing / cultivating the land

Ploughing with disc plough or intercultivators reduce the pesticide toxicity, as the applied pesticide is mixed to a large volume of soil and get diluted. In case of ploughing, the pesticide layer is inverted and buried in deeper layers and thereby the residual toxicity reduced It is reported that the damage caused by herbicides was reduced by ploughing (Dinakar *et al*, 1986)

Table 4. Effect of ploughing on plant emergence (%)

Herbicide	Not ploughed	Ploughed
Propyzamine	5	58
Trifluralin	48	85
Atrazine	29	100

6. Leaching the soil

Leaching the pesticide by frequent irrigations is possible, especially in case of water soluble pesticides. In this case, the pesticides are leached down to lower layers i.e. beyond the reach of the crop roots.

Nitrate pollution in agricultural ecosystem

1.Nitrite and nitrate

Nitrate has a close relative called nitrite, the difference between the two is that nitrite has one less oxygen atom than nitrate. This results in appreciable differences in the chemical and biological behavior of the two substances. What we find in the present context is that nitrate is a nuisance when in the wrong place in the environment but not in itself a threat to our health, where as nitrite is definitely a potential health hazard. However, this depends on it being in the wrong place at the wrong time; in other circumstances it can save life

2.Nitrate pollution of groundwater

Leaching causes nitrate pollution of groundwater. The magnitude of loss depends on soil conditions, agricultural practices, agro-climatic conditions and type and method of fertilizer application. The time taken by the nitrate to move from the root zone to water table varies considerably. In sandy soils with high water table and high rate of fertilizer application, it may reach the water table in matter of days, whereas in heavy soils low rainfall and low rate of application with deep water table it may take years.

3. Nitrate pollution under different land management systems

A case study conducted in Punjab under different land use systems revealed that the average nitrate distribution in soil profiles under *Eucalyptus* system was much lower when compared to others. The substantial amount of nitrate nitrogen in soil profiles under orchards was possibly due to soil remaining covered for long duration frequent and

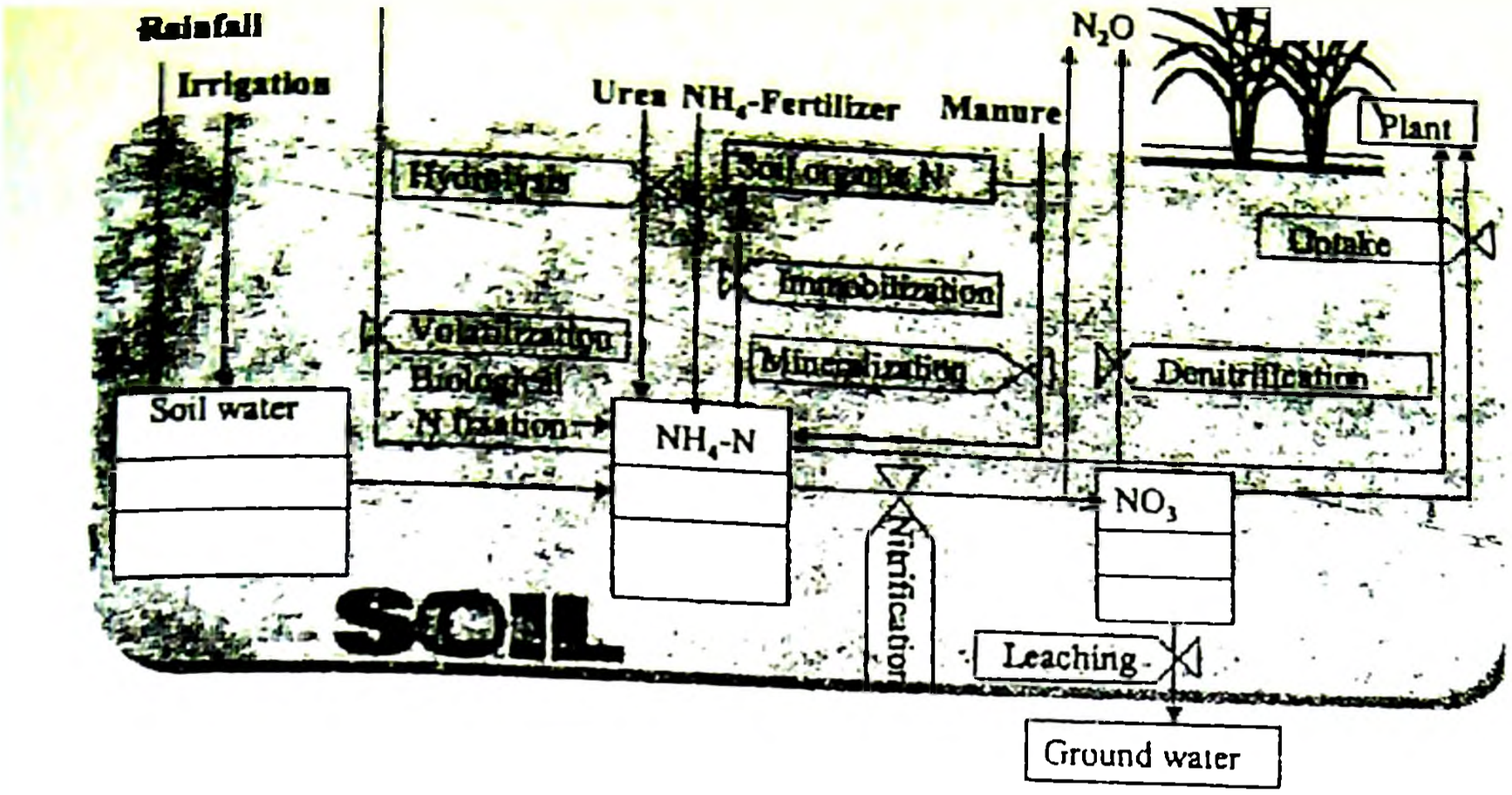


Fig. 3 Relational diagram of nitrogen in soil-plant-atmosphere (Pathak *et al.*, 2002)

intensive cultivation and Irrigation and large quantities of crop residues. Intercropping in horticultural crops also accounts for nitrates in the top one-meter profile.

In maize-wheat and cotton-wheat rotations, more nitrate-N is accumulated in soil profiles under maize as compared to cotton, possibly due to the deep root system associated with the latter crop (Fig 4)

The percentage of wells delivering ground waters containing up to 5 mg NO_3-N L^{-1} was lowest when rice – wheat cropping system was followed The reason was that the crops rice and wheat are having more of fibrous root system that ensures utilization of a large fraction of the applied N

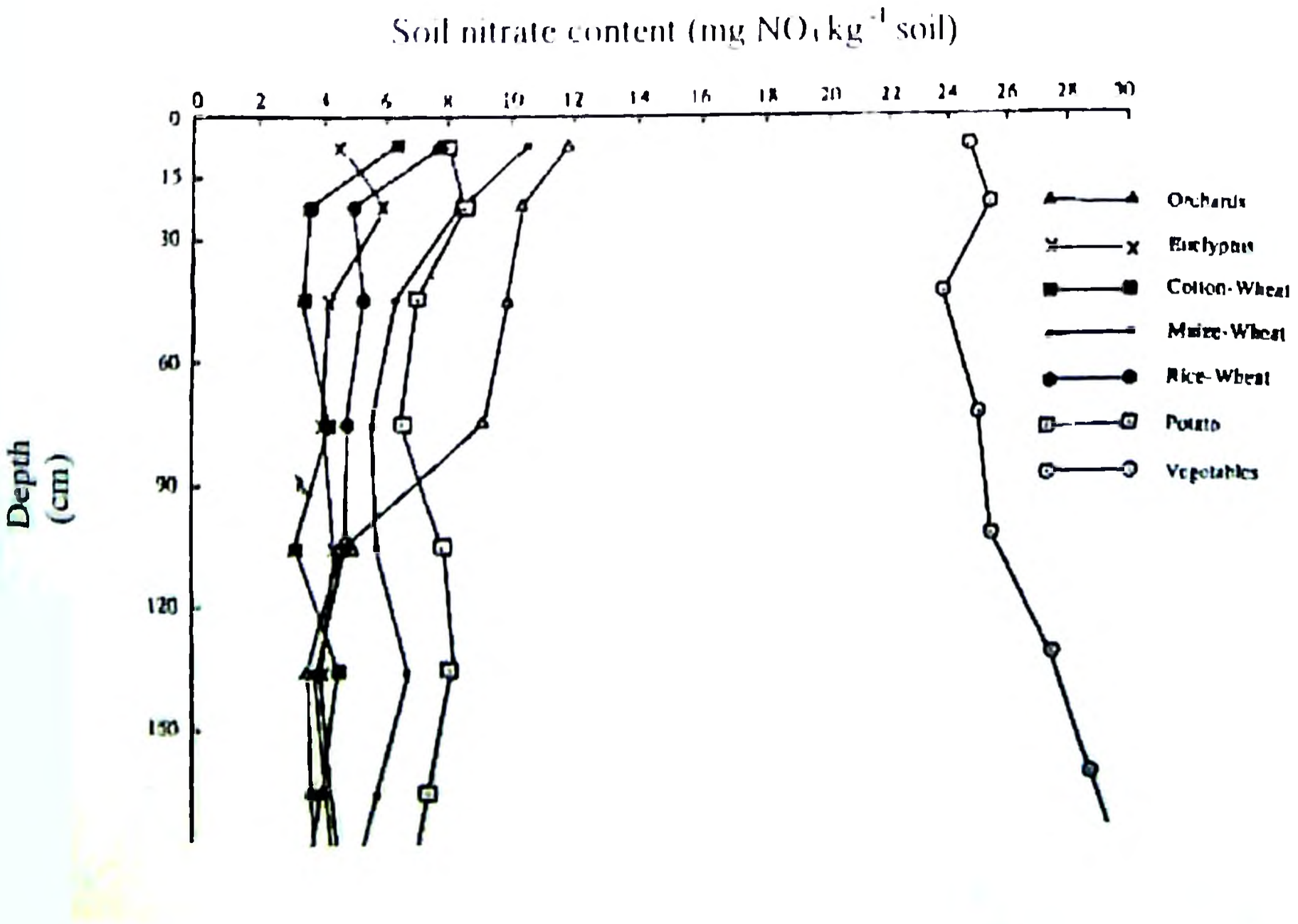


Fig. 4

Leaching rate of NO_3-N

A study conducted in a sandy soil with different rates of irrigation and timings of fertilizer application to wheat revealed that the loss and NO_3-N increased with heavier irrigations and fewer splits of N (Chaudhary and Batnagar, 1976).

Table.5. Accumulation of NO_3-N in different soil layers under different rates of irrigation and split doses of N

Soil layer (cm)	Rates of irrigation											
	Light				Medium				Heavy			
Splits	1	2	3	4	1	2	3	4	1	2	3	4
	NO_3-N (kg ha^{-1})											
0 - 60	7	9	10	19	9	10	10	18	7	9	10	21
60 – 120	17	18	21	23	13	15	22	30	10	13	25	39
120 - 180	25	26	19	26	23	24	26	32	19	21	28	30

U S Public Health Service has set an upper limit on nitrate in drinking water as 10 mg N L^{-1} (45 ppm of NO_3)

It is a disease which reduces capacity of blood to carry enough oxygen for proper functioning of human body When nitrates are reduced to nitrite by microflora if intestine, nitrite reacts with haemoglobin leading to the formation of methaemoglobin

Environmental hazards of nitrate

1. Methaemoglobinaemia

It is a disease which reduces capacity of blood to carry enough oxygen for proper functioning of human body When nitrates are reduced to nitrite by microflora if intestine, nitrite reacts with haemoglobin leading to the formation of methaemoglobin

2. Illness in cattle and sheep

Similar illness in cattle and sheep can also occur. Complex digestive system in herbivorous cattle permits reduction of nitrate into nitrite in the forage and may result in methaemoglobinaemia. High levels of nitrate intake by cattle and sheep can be through water or plants which have high nutrient contents.

3. Formation of N – nitrosamine

In relation to nitrate toxicity, nitrosamine have received considerable attention on account of their carcinogenic and mutagenic properties. Nitrate, Nitrites, secondary and tertiary amines are the precursors of nitrosamine. In animal, nitrosamines can be formed by the simultaneous ingestion of nitrate and secondary amines.

4. Stomach cancer and nitrates

A number of epidemiological studies carried out by many workers have found correlation between incidence of stomach cancer and nitrate content in drinking water is more than 20 mg L^{-1}.

5. Elevated nitrate levels and foetal marformations

Nitrate rich waters may cause foetal malformatins if the nitrate concentration is higher than 45 mg/liter in the drinking water.

Nitrate removal technologies

1. Biological technique

Denitrification by biological method essentially comprises of various stage like

a) Fixing the microorganisms on a substrate in adequate quantity.

b) Deoxygenate the water with high nitrates to be treated.

c) Provide carbon sources

d) Reoxygenate the water for aerobic conditions

e) Chlorination as a polishing step

Two types of enzyme systems are involved in biological denitrification. Assimilatory nitrate reduction converts nitrate (NO_3) to Ammonia (NH_4) where as dissimilatory nitrate reduction involves conversion of NO_3 to molecular nitrogen gas as end product.

Dissimilatory biological process is popularly known as denitrification technique and involves reduction of Nitrate to nitrogen gas. It is a respiratory mechanism in which nitrate replaces molecular oxygen. In the absence of oxygen nitrate acts as electron acceptor.

In dissimilative denitrification, the term anoxic rater that anaerobic is used since the principal biochemical pathways are not anaerobic but only a modification of aerobic pathways. When the rate of oxygen uptake exceeds that of supply, the system becomes practically devoid of oxygen and then nitrate serves as electron acceptor for the respiration. The mechanism of anoxic nitrate reduction is as follows:

$$NO_3 \longrightarrow NO_2 \longrightarrow NO\uparrow \longrightarrow N_2O\uparrow \longrightarrow N\uparrow$$

In anoxic denitrification, most of the bacteria are capable of utilizing a vide range of carbon compounds as a source of electrons.

Carbon compounds get oxidized completely to carbon dioxide Via Kreb's cycle. Most of the active denitrifying microorganisms are heterotroph and autotrophs and belong to the genera pseudomonas, Achromobacter bacillus and micrococcus.

Various sources are used as electron donor viz solid sulphur, liquid alcohols like methanol, ethanol and organic acids like acetic acid and gas like hydrogen its toxicity.

Biological denitrification process is mote suitable for surface water than ground water because bacterial activity is more supported due to comparatively higher temperature complicated operation and maintenance of biological technique is the main limitation and it will not be technically suitable particularly under rural condition for ground water supplies

Physico–chemical techniques

1. Chemical reduction

The possibility of reducing nitrate chemically using ferrous hydroxide precipitated in situ has been investigated in USA 8 moles of iron per mole of nitrate are requires 1-5 ppm of cupric or silver ions as catalyst. The optimum pH involving precipitation of iron as ferrous hydroxide was found to be eight. Very close control of treatment conditions is essential / necessary to successfully operate this technique and this limitation has made the process unfeasible.

2. Photo-chemical reduction

The photochemical reduction of nitrate to nitrogen gas on nitrous oxide in presence of organic compounds. It is a multistage reduction carried out at pH 8. The main advantage of the process is that no special chemical or microorganisms are required. Acetic acid, Ethyl alcohol and other products of food industry (ascorbic acid, citric acid formic acid etc.) can be applied as organic compound. UV light is used for irradiation or excitation of system as external source of energy at 185 nm. wavelength.

3. Reverse osmosis

Reverse osmosis is a pressure driven process and well proven reliable technique for desalination of sea and brackish waters. During this process pure water can be separated from salts, Reverse osmosis however cannot separate nitrates individually, but the concentration of dissolved solids including nitrates is reduced.

Certain Reverse osmosis membranes exhibit low nitrate reduction coefficients. Pre and post treatment is required to avoid scale formation and carbon dioxide stripping disposal of concentrated waste also needs special efforts. Hence Reverse osmosis is not an appropriate option for nitrate removal

4. Electro dialysis reversal

This technique employs the principles of Electro dialysis – combined with the use of selective membranes for removal of nitrates. The principle characteristics of the process are average specificity and limited efficiencies need for pretreatment and generation of concentrated waste

5. Ion Exchange

It is the only method that is currently used to remove nitrates from waters in large treatment plants. Laboratory and pilot experiments have show that strong base and weak base ion Exchange resins are nitrate selective and can remove the nitrates from the concentration as high as 250 mg/l to 2.5 mg/l (NO_3).

RADIOACTIVE CONTAMINATIONS IN THE TERRESTRIAL ENVIRONMENT

Increasing reliance on the nuclear fuel cycle to meet future energy needs and testing of nuclear weapons have added to the natural levels of radionuclides in the environment. Several radioactive isotopes of common elements (e.g., ^{3}H, ^{14}C), of trace elements (e.g., ^{90}Sr, ^{103}Ru, ^{106}Ru, ^{125}I, ^{129}I ^{131}I and ^{137}Cs), and of transuranic elements, all generated by fission, activation and decay during nuclear reactions.

The possibility exists of an accident that can result in a release of radioactive material into the environment. As nuclear facilities are not normally sited in densely populated areas, the adjacent land is likely to be agricultural or at least rural.

Radionuclides forms and behavior

The mobility of radioactive fission products in the soil depends on the form in which they occur. The movement of radionuclides along the surface might occur as a result of run off and / or erosion processes. The extent of vegetative cover also influences the radionuclide movement

Knowledge about the form in which the radionuclides are present in the soil and the patterns of their migration in the environment can provide the foundation for the theoretical considerations entering into hydrological, hydro-geological, medico biological and technical planning. Knowledge about the form in which the radionuclides are present in the soil and the patterns of their migration in the environment can provide the foundation for the theoretical considerations entering into hydrological, hydro-geological, medico biological and technical planning. In addition the distribution of radionuclides in soil and the form in which they are present depend on the physico-chemical properties of the soils and on the chemical properties of fission products. Their occurrence in soils is distributed in the following way

Komarov (1990) also observed that as the amount of organic matter increased the migration of radionuclides in the soil also increased. The capacity for migration increased in the sequence: sandy-podzol << podzol << peaty marshy.

CHEMICAL REMEDIATION METHODS FOR RECONSTRUCTING THE CONTAMINATED SOILS

Chemical Remediation Techniques

Chemical remediation techniques involve adding some chemical material to polluted soils, in order to reduce the concentration of contaminants. These chemical materials include the following :

- Lime materials, to increase the soil pH and reduce the solubility of trace elements.
- Iron hydroxides, Manganese oxides or Zeolite to increase the adsorption sites of trace elements
- Heavy applications of phosphate to increase the precipitation of metal ions and phosphate ions

Classification of remediation strategies

Remediation strategies can be divided into two general categories ex situ and in situ. The technologies that are currently being used and evaluated are presented in Table

i) Ex situ methods

Soil removal is the most common *ex situ* method employed and is used extensively in residential areas with Pb contaminated soils. Use of the remaining *ex situ* methods is generally restricted to small sites with highly contaminated soils because of the obvious problems with dealing with large quantities of soils and the generation of waste products requiring further processing or storage

ii) *In situ* methods

Phytostabilisation is the most common *in situ* method used, particularly for old mine sites with large areas that require remediation. Encapsulation and attenuation have been used to a limited extent. The use of soil amendments is often combined with phytostabilization. The use of P to reduce Pb bioavailability is being evaluated as an alternative to soil excavation.

Table . 6.Remediation strategies currently employed for metal contaminated sites

Method	Details
Ex situ methods	
olidification	Addition of a cementing agent to produce a hardened, nonporous, nonleachable material
Virtification	Heating to produce a glass-like, nonporous, nonleachable material
Washing	Chelate or acid extraction
Leaching	Pile or batch leaching with chelates or acids
Particle size segregation	Selective removal of fine particles that have the highest metal concentrations
Soil excavation	Soil removal and disposal
In situ methods	
Solidification	Addition of a cementing agent to produce a hardened, nonporous, nonleachable material
Virtification	Heating to produce a glass-like, nonporous, nonleachable material
Encapsulation	Cover site with impermeable layer
Attenuation	Dilution with uncontaminated material
Electrokinetics	Electric current induces movement of ions to electrodes
Phytostabilization	Promote vegetative growth to immobilize metals
Phytoextraction	Removal of metals by plants
Soil amendments	Reduce bioavailability of metals with P or other soil amendments
Immobilization	Decrease the solubility and bioavailability of metal contaminants

Fundamental remediation principles

A clean-up technique is always based on one or more fundamental removal principles. A removal principle makes use of differences in properties between the pollutants or polluted particles and the other soil substances. Properties on which a technique for removal of heavy metals can be based on the volatility of a pollutant (in the case of mercury); the solubility or leachability of a pollutant in a liquid phase; the electrical properties of a pollutant; the bioleachability of the pollutant; the tendency of a pollutant to hyper accumulate in plants; the magnetic properties of a pollutant; the size, shape or density of a (particulate) pollutant.

Options for *ex situ* treatment

Based on these fundamental remediation principles, various options for ex-situ and in-situ remediation of soil contaminated with heavy metals are available. The most important remediation options for ex-situ treatment of soil are: wet classification, chemical extraction, bioleaching, electro reclamation, thermal treatment, virtification and physical / chemical stabilization

Wet classification

This technique is aimed at the selective removal of heavy metal containing particles from the non-polluted soil particles. The process makes use of an aqueous phase to which one or more additives have been supplemented. Process steps to achieve this separation are sieving, screening, hydro cyclone treatment, magnetic separation, attrition and spiral classification.

Chemical extraction

This process involves dissolving the heavy metals, present as particles or adsorbed onto the soil matrix, into an aqueous solution containing strong mineral acids such as hydrochloric acid, chelating agents or surfactants. After separation of the soil, the liquid phase can be treated to concentrate the heavy metals.

Soil washing methods based on using extractants to dissolve contaminants are capable of removal of cationic heavy metals from contaminated soil (Ganguly et al., 1998). Unfortunately, field application of soil washing remediation methods is limited t0o sandy soils with clay and humic content values less than 15 per cent (Rulkens *et al.* 1998).

Bioleaching

In bio leaching the heavy metals in the soil are mobilized by acidophilus bacteria of the genus *Thiobacillus* that oxidize reduced sulphur compounds to sulphuric acid, increasing the solubility of the heavy metals. If reduced sulphur is not present, an external reduced sulphur source has to be added to the soil. After separation of the treated soil and the metal sulphates containing liquid phase the latter can be treated to concentrate the heavy metals.

Electrokinetic treatment

This is a clean-up method based on the application of an electro current between a cathode and anode placed in the soil. As a result of this electric current heavy metal ions and electrically charged small colloidal particles are transported through the water phase in the soil to the electrodes where they are concentrated and removed.

Thermal treatment

This method is aimed at removal of pollutants by heating the soil to a temperature sufficiently high to vaporize the pollutants. The vaporized gas phase with the pollutants has to be treated in a subsequent treatment step. With regards to heavy metals, only mercury and mercury compounds can be removed from soil by thermal treatment.

Virtification

This is a treatment process in which the soil is heated to such a high temperature that the soil melts and the heavy metals present are incorporated in glassy structure. The melt is

formed under oxidizing conditions promoting the conversion of heavy metals to oxides, silicates, etc., resulting in a strong reduction in leachability of the heavy metals.

Physical / chemical immobilization and stabilization

The aim of these treatment methods is to decrease the leachability of the heavy metals by physical / chemical processes such as reduction, oxidation or encapsulation of the heavy metals in a matrix. Various treatment agents may be supplemented to produce favourable conditions for such an immobilization.

In-situ immobilization of metal contaminants is an alternate remediation approach where the metals are not removed from contaminated soil. In this approach, soil treatments and / or additives are used to decrease the solubility and bioavailability of metal contaminants Phosphorus-based treatments have been very successful in decreasing solubility of Pb, Zn and Cd (Chlopecka and Adriano, 1996).

Techniques for remediation contaminated soils

i) Use of minerals

The main strategy is to reduce the concentration of metals in labile fractions and increase the least mobile fraction, i e , the residual fraction Data from this study clearly show a redistribution of metals to the residual fraction

Apatite and zeolite significantly reduced metal concentrations in the plant tissues and enhanced the yield of plants

ii) Use of amendments

Naturally occurring or man made additives as soil amendments have been used to immobilize contaminants in the past decade (Phillips, 1998) Soil amendments such as zeolite, carbonate, lime, compost, phosphate and Fe and Mn oxides are capable of improving the sorption properties of heavy metal contaminated soil, hence their ability to remove heavy metals from the soil solution (Chen *et al* 2000).

iii) Use of chemicals

Greenhouse pot experiment conducted by Alloway *et al.* (2001) with lettuce using the As contaminated soil. The treatments comprised: Fe oxides (0, 0.2, 0.5 and 1%) applied as $FeSO_4$ and $CaCO_3$ (0, 0.25, 0.625 and 1.25%) applied as agricultural lime. As concentrations were reduced highly significantly by the 0.2 and 0.5 per cent Fe oxides treatments but the 1 per cent treatment gave no extra reduction compared to the 0.5 per cent treatment. However, there were highly significant reductions in lettuce yield accompanied by significant increases in Al and Mn concentrations for the 0.5 per cent Fe oxides without lime and the 1 per cent oxides with less than 1.25 per cent lime and these were due to the acidifying effect of the $FeSO_4$ treatments.

Whenever the remedial action is taken to treat contaminated soils, the methods or measures to be used, is based on the following considerations

- Short-term effectiveness
- Long-term effectiveness
- Reduction in the toxicity, mobility, or volume of the heavy metal concerned
- Whether implementation is feasible
- Cost
- Compliance with government standards or guidelines
- Overall benefit to the environment
- Whether the measures are acceptable to the government *and*
- Whether the measures are acceptable to local people

- Chemical extraction methods can be used for sites where the soil contains medium levels of contamination
- Chemical immobilization methods and acid-leaching process can be used for sites that are seriously contaminated
- Remediation with growing plants can be used only on sites where contamination with is very slight. Suitable plant species must be selected for polluted sites.

- Chemical stabilization seems to be the most cost - effective remediation technique for contaminated soils. However, methods involving the removal of polluted soils and the addition of clean soil to the surface were also effective.

Heavy metal contamination in soil.

The main source of heavy metal contamination come from fertilizers.

Table .7. Heavy metal contents (average) in fertilizers

Fertilizer	Heavy metal (mg kg^{-1} fertilizer)					
	Cu	**Zn**	**Mn**	**Mo**	**Cd**	**Pb**
Single super phosphate	26	115	150	3.3	187	609
Diammonium phosphate	-	-	-	109	188	-
Muriate of potash	3	3	8	0.2	14	88
Ca-ammonium nitrate	0.2	6	11	-	6	200
Urea	0.4	0.5	0.5	0.2	1	4
Ammonium sulphate	0.5	0.5	70	0.1	-	-
Triple super phosphate	7	75	200	0.1	-	-
Ammonium phosphate	3	80	160	2	-	-
Complex fertilizer	22	276	-	-	6	128
Rock phosphate	100	200	0.5	-	-	-

(Ramanathan, 2002)

Phytoremediation

Most plants inhabit toxic soils do so by either, avoiding heavy metals or accumulating them in their tissues. The use of such heavy metal tolerant and accumulator plants provide an alternative remediation technology. Cultivating such plants on industrial waste site can provide a clean, cheap, alternative to the "suck, muck and truck" cleaning approach to decontaminate heavy metal contaminated soils. Phytoremediation involves

the use of plants to remove, transfer, stabilize and/or degrade contaminants in soil, sediment and water (Hughes ***et al.***,1997).

Categories of Phytoremediation

According to the contaminants, the conditions at the site, the level of cleanup required, and the plants used, the phytoremediation system can be divided into the following categories:

Phytostabilization - is the use of certain plant species to immobilize contaminants in soil, through absorption and accumulation by roots, adsorption onto roots or precipitation within the root zone, and physical stabilization of soils Tomato has the the potential to absorb large quantities of cadmium on their roots (Vanisree, 2004)..

Rhizofiltration (*rhizo-* means *root*) - is the adsorption or precipitation onto plant roots or absorption into the roots of contaminants that are in solution surrounding the root zone. Rhizofiltration is similar to phytoextraction, but the plants are used primarily to address contaminated ground water rather than soil

Rhizodegradation, also called *enhanced rhizosphere biodegradation*, *phytostimulation*, or *planted-assisted bioremediation degradation*, is the breakdown of contaminants in the soil through microbial activity that is enhanced by the presence of the root zone (the *rhizosphere*) and is a much slower process than phytodegradation.

Phytodegradation, also called *phytotransformation*, is the breakdown of contaminants taken up by plants through metabolic processes within the plant, or the breakdown of contaminants external to the plant through the effect of compounds (such as enzymes) produced by the plants. Some enzymes breakdown and convert ammunition wastes, others degrade chlorinated solvents such as trichloroethylene (TCE), and others degrade herbicides.

Phytovolatilization is the uptake and transpiration of a contaminant by a plant, with release of the contaminant or a modified form of the contaminant to the atmosphere from the plant. Phytovolatilization occurs as growing trees and other plants take up water and the organic contaminants.

Phytoextraction - also called phytoaccumulation, refers to the uptake and translocation of metal contaminants in the soil by plant roots into the above ground portions of the plants. Certain plants called 'hyperaccumulators' absorb usually large amounts of metals in comparison to other plants and the ambient metals concentration.

Plant used as hyper accumulators

Water hyacinth (Eichornia crassipes)	Pb, Cu, Cd, Fe and Hg
Penny worth (Hydrocotyle umbellate)	
Duck weed (Lemna minor)	
Water velvet (Azolla pinnata)	
Thlaspi caerulescens	Pb, Zn, Ni and Cd
Brassica Juncea	
Alyssum murale	
Sunflower, rye, corn, marigold	Cr
Alternanthera Sessilis	
Cynodon dactylon	

A good phytoextractor should have the following characteristics.

1. Rapid growth rate and potential to produce high biomass.
2. High rate of heavy metal accumulation especially non economic plant parts.
3. High uptake and should be of metal specific.

4. Be of some economical interest and
5. Unattractive to animals.

At present, there are two basic strategies of phytoextraction being developed : Chelate – assisted phytoextraction which was termed as induced phytoextraction and

ong-term continuous phyto extraction of the two process, chelate-assisted phytoextraction is the more developed and is presently being implemented commercially

Induced Phytoextraction

The There are no reliable reports of plants capable of naturally accumulating the most environmentally important toxic metals such as Pd, Cd, Ar and radionuclides. Application of chelates to the soil bring metals into solution through desorption of sorbed species, dissolution of Fe and Mn oxides and dissolution of precipitated compounds.

Table 8. Ability of Brassica juncea to accumulate lead in shoots

Experiment	Pb soluble in soil (g ha-1)	Pb-content (mg kg^{-1} dw)
Control	0 002	0 1
NTA added	0 02	0 2
EDTA added	0 2	0 6
NTA + glyphosate added	0 03	0 3
EDTA + glyphosate added	0 2	1.7

Felix et al (1999)

Continuous phytoextraction

There plants are naturally able to accumulate >1% of shoot dry biomass as Zn, Ni, Mn or Se.

Table 9. The ability of crops and wild species to accumulate cd in aerial parts :-

Plants	harvest yield (t ha^{-1})	cd – content (mg kg^{-1} dw)
Alyssum murale	0.8	34
Thlaspi Caerulescens	16	12
Nicotiana tabacum	9	10
Zea mays (B 37 inbred line)	10	8
Brassica juncea	21	3
Salix viminalis	10	22

- Felix et al (1999)

Bioconcentration Factor (BCF)

Bioconcentration factor is a criteria for identifying hyper accumulators. An ideal hyper accumulator should have BCF more than 1000. (Zayed et al., 1998)

$$BCF = \frac{\text{Trace element concentration in plant tissues (mg } kg^{-1}\text{) at harvest}}{\text{Initial concentration of the element in the external nutrient solution (mg } l^{-1}\text{)}}$$

water hyacinth is a good Cd and Cr accumulator, having BCF of 2150 and 1823 respectively in roots

Advantages of Phytoremediation

1. Cheapest, environmentally friendly method and best suited for low and medium contaminated soils.
2. Easy monitoring

3. It improves soil physico – chemical properties and biological activities

4. In the long run it is the best method available to reduce heavy metal toxicity

Disadvantages

1. Needs long time period to decrease the metal level in the soil

2. Cannot drawn metals beyond the root zone (1-2m)

On the other hand, optimizing agronomic practices employed during phytoremediation such as irrigation, fertilization, planting and harvest time and timing of amendment application should increase the efficiency of the phytoremediation.

RECYCLING OF URBAN AND DOMESTIC WASTES

Composition of Urban Waste

The composition of urban and municipal waste is observed to vary demographically. The urban waste can be differentiated as decomposable and recyclable. The recyclables are made of plastic, metals, glass and paper whereas the decomposables are made of vegetable waste fruit wastes and kitchen leftovers

Table .10. Characteristics of Typical Urban Waste

Sl No.	Type	Qty (%)
1	Street sweepings	8.6
2	Domestic waste	29.4
3	Garden clippings	15.0
4	Vegetable residues	15.0
5.	Textiles	12.0
6.	Plastic/ poly bags	19.0
7.	Glass/ metal	1.0

(Ramakrishnaparama, 2002)

The moisture content varies from 40-70% and sometimes 90%, the calorific value varies between 800-1000 k cal/kg on dry weight basis.

Production of Urban Waste

Urban waste is produced at micro and macro levels. The macro level producers include - marriage halls, markets, big hotels, restaurants and agro industries. Micro level producers include - individual households, small eateries and small business establishments.

The approximated quantity of urban waste produced at these levels show that

At macro level – Marriage hall of 1000 capacity generates

750 kg of bio degradables

250 kg of plastics and papers

- Market of 1000 shops selling vegetables, fruits and miscellaneous items produces

100 to 200 tonnes of waste

At micro level - an individual household of four to five members produce approximately ½ to 1 kg per day

A community of 2000 households produces about 1 to 1.5 tonnes of domestic waste per day

Disposal of urban waste

The most commonly used urban waste treatment and disposal methods are

1) Composting 2) Sanitary landfill 3) Incineration and Pyrolysis and 4) Recycling and reuse

With seventy percent of the urban waste being decomposable it would be of great importance to convert urban waste into useful organic matter. Therefore composting of urban waste would be a worthy option so as to harness the plant nutrients present in the urban waste

Methods of Composting Urban Waste

Urban wastes can be processed to form compost at individual household level to mass scale composting. The methods adopted could be characterized as

Decentralized urban waste processing facility

1. Individual house units (UAS composter)
2. Community/ multiple housing unit (Forced aeration method/manual turning method)

Centralized urban waste processing facility

Large scale composting yards (Windrow method and Vermicomposting)

REHABILITATION OF POLLUTED SOILS: A BIOTECHNOLOGICAL APPROACH

Phytochelatins

Phytochelatins (PCs) are a group of proteins that are inducible in plants when the plants are faced with heavy metal stress. They act in such a way that free metal ions are bonded to the proteins and placed into vacuoles where they are no longer toxic to the plant and they can eventually be used in the normal growth of the plant that is if the metal is an essential element to the plant's growth, like copper or zinc. To understand the role of PCs in the detoxification of heavy metals, one must understand several traits of the proteins. The structures of PC's, Biosynthesis, function, and structure of PC-metal complexes must all be examined

PCs consist of just three amino acids, cysteine, glycine, and glutamic acid. PCs have been identified in many groups of plants and photosynthetic organisms, ranging from algae, through gymnosperms and monocots, to dicots. This suggests that the PC producing pathway evolved very early and has been important in the dexterity of vascular plants and their ability to evolve and grow in potentially hostile and toxic environments. There is some variation in the structure of PC's in the plant world.

Metallothioniens

Metallothioniens (MTs) are similar proteins to PCs in many ways, including the high number of cysteine molecules in the proteins, and the fact that both are responsible for the detoxification of heavy metals. In fact, PCs were originally classified as class 3 MTs, until they were deemed sufficiently different in structure and synthesis pathway to be classified as PCs. All MTs have three characteristics in common: they have low molecular weight, a large fraction of cysteine residues, and a high metal content with coordination of metal ions in metal-thiolate clusters. The classification of MTs places all animal MTs into class 1, and all other MTs (including plant) into class 2.

ENVIRONMENTAL EDUCATION: RESTORATION/REHABILITATION OF DEGRADED SOILS

Environmental Education – Role of voluntary agencies

Environmental Education is a new kind of integrative teaching characterized by encouraging inclusive thinking by a continuous training of habits in small steps and by the development of a general attitude of openness to new aspects.

- Environmental Education has assumed great importance in recent times because many of the environmental issues are global in nature and require the understanding and co-operation of all the people
- Environmental Education should play in creating an awareness and a better understanding of environmental problem
- Economically backward nations are often forced to ignore the consequences of environmental degradation in favor of economic consideration.
- Poorer nations too should realize the need to integrate environmental consideration in development planning because environment is a base in determining the quality of life, both rural and urban areas.

- Environmental education programmes and materials require an inter – disciplinary approach.
- Environmental Education should also be broadcasted through literature, leadership camps and camps for meanings.
- Eco development camp with emphasis on resources management, tree planting, soil and water conservation.
- The media have played a vital role in educating the people about environmental issues and associating problems.
- All India Radio and Doordharshan also play an important role in motivating, educating and sustaining internet among the public about the environment.

UGC sponsor, training and seminars on clear technology and profitable pollution management also helps in awareness among the society.

Scientists view on environmental education :

- ✓ Individual farmers are too poor to adopt the recommended practices
- ✓ A collective approach is necessary
- ✓ Farmers expect the Government to do the job
- ✓ Awareness is not translated into action due to farm specific constraints
- ✓ Problem is multidisciplinary, so a team work is useful
- ✓ There is technology to protect environment but its transfer to the field is slow
- ✓ INM must be popularised
- ✓ Subsidies should be incentives, not cost sharing
- ✓ Self help groups will be more successful
- ✓ Educating, motivating, involving women will enhance effectiveness
- ✓ Problem must be explained as peoples' concern and not Govt. targets

4. Future Research Directions

There are major environmental issues that require detailed research to enable regulatory bodies to impose guidelines for the protection of our environment. Some of the areas which need urgent attention are

- ❖ Compilation of a register of potentially polluting industries, estimation of the extent of the contaminants reaching the soil environment and

analysis of the soil environment, surrounding such industries for toxic contaminants.

- ❖ Determination of quantities and qualities of sludges generated in waste-water treatment plants and identifying best method for disposal of such sludges.

- ❖ Estimation of toxic metal contaminations in the neighbourhood of industrial areas which generate toxic metals such as tanneries, electroplating industries and investigation of the extent of transfer of metals to feed and food crops grown in such areas.

- ❖ Qualitative and quantitative evaluation of the solid wastes and effluents and their use for agriculture.

- ❖ Development of suitable technologies for reclaiming contaminated soils.

The survival of human beings as a species depends upon how we manage and protect the environment. If we manage well, the quality of life will improve; if not we will have to face the disaster in the course of time. Let us be cautious and careful following the philosophy of '*Prevention is better than cure*' regarding the contamination of the natural resources through our activities and ways of life.

Discussion

1.What are green house gases ? Do they have any role pollution ?

Even this thing will not come under the purview of my topic ,it include the carbon dioxide , sulphur dioxide , methane etc.

They have a role in pollution because they will increase the atmospheric temperature and will make a change in the global climate finally affect the existence of life

2.Fate of heavy metals in plants ?

Depending up on the mechanism of phytoremediation it differs. In some plants it gets immobilized in the vacuole and in some it will be escaping the plant tissue via transpiration.

3 Is there any agency which collects and processes the urban waste?

There are so many voluntary agencies and in Thiruvanathapuranm an agency named POABS is collecting the urban waste and processing it

4 Are the Eucalyptus plants used in the pollution control and where it is?

Yes, these plants are used in the heavy metal decontamination near the areas of fertilizer industries.

Conclusion

The introduction of pesticides and fertilizers played a major role in the green revolution that was witnessed in many parts of the globe. Unfortunately, the unwise and indiscriminate use of pesticides and fertilzers has unquestionably left our ecosystem polluted. The soil we live and the water we drink all contains traces of these unwanted residues. Strict followup and enforcement of insecticides act, 1968 and instructions of Central Insecticides Board will be helpful regarding control of pollution and safety aspects.The best weapon in pest control which is safest to the environment is the development of hybrid species of crops that are resistant to their traditional enemies. For example, losses due to corn borers or sugarcane borers have been cut by 70% in new varieties. Strains of cereals such as barley, corn, oats and wheat have been developed that resist leaf blights and rusts.

The classical biological control of pests is to introduce other insects or microorganisms that prey on the pest or parasites to it, or give the pests a disease. In the entire world, more than 100 insect pests are successfully controlled by these approaches. Integrated pest control, the combining of biological control with pesticides is being increasing used to reduce overall dependence on chemicals.

The hazards to soil and water can be minimized to a greater extent if the residues are kept below their prescribed safe level (Maximum residue limit). However, besides this approach we have to keep surveillance on several other approaches for the better management of pesticide pollutants like, control of toxic chemicals discharge from pesticide industry in the environment, use of eco-friendly biochemical pesticides like neem, improved method of pest control like sterile male insert techniques and application of selective and rapidly degradable pesticides in to the environment.

New plant types can be developed to use nutrients more efficiently so that there would not be much loss of applied nutrients. New strains of nitrogen fixers (*Rhizobium* and blue green algae) with higher N-fixation capacity can be developed so that thereby reducing the threat of fertilizer pollution.

To feed the growing population it is necessary to conserve the degrading lands and use them more productively. Multidisciplinary approaches in developing location specific strategies in balancing the differential needs of each degraded land will be more appropriate. Modern technology has provided the means for massive alteration and pollution of the environment. Technology intelligently applied with a strong environmental awareness provides the means for dealing with problem of environmental pollution and soil degradation. This can be achieved through various environmental educational strategies

References

Alloway, B., Warren, G., Lepp, N., Singh, B., Bocherane, F. and Penny,C. 2001. Remediation of As and Cd contaminated soils with adsorptive minerals. Paper presented in the 6 th international conference on the Biogeochemistry of trace elements, Guleph pp. 281

Barik, S., Munneeke, D.M. and Fletcher, J.S. 1982. Enzymatic hydrolysis of malathion and other dithioate pesticides. *Biotechnol Lett.*, 4 : 795-798.

Becker, R.L., Herzfeld, D., Ostlie, K.R. and Stamm-Katorich, E.J. 1989. Pesticide surface run-off, leaching and exposure concerns, Minnesota extension service, AG-BU-3911 University of Minnesota (personal communication).

Betty bastin and Wahid P.A 2004 Dynamics of soil applied carbofuran and accumulation of residues by black pepper vine grown on laterite soil.*J.plant.crops* 32(1): 18-24

Chaney, R.L 1990 Public health and sludge utilization part. 2. *Biocycle*. 31: 68-73.

Chaudhary, T N and Bhatnagar, V K 1976 The leaching of Nitrates as influenced by the rates of irrigation and the timing of fertilizer application to wheat on a sandy soil *Indian J. Ecol.* 3 (2) 125-131

Chen, Z S., Lee, G J and Liu, J C 2000 The effects of chemical remediation treatments on the extractability and speciation of cadmium and lead in contaminated soils. *Chemosphere* 41 235-242

Chlopecka, A and Adriano, D C 1996 Mimicked In situ stabilization of metals in a cropped soil . Bioavailability and chemical form of zinc *Environ. Sci. Tecnol.* 30 : 3294 - 3303.

Devi, D.K.M 2002.Asseesment of 2,4-D residues in the major rice fields of Kerala. Ph.D (Ag) thesis , Kerala Agricultural University, Thrissur.177p.

_inakar, V.S., Bhardwaj, R.B.L. and Kulshershtha, G. 1986. Studies on persistence of isporoturon in soil. *Indian J. Agron.*, 31: 305-307.

EPA, 1989. The environmental protection authority. Western Australia, Bulletin, No. 407, 67 p.

Felix, H.R., Kayser, A. and Suhulin, R. 1999. Phytoremediation field trials in the years 1993-1998. In : proceeding of extended abstracts of 5th ICOBTE'99, Austria, pp12-17

Ganguly, C., Matsumoto, M.R., Rabideau, A.J. and Vanbenschoten, J.E. 1998. Metal-ion leaching from contaminated soils: Model calibration and application. *J. Environ. Eng. ASCE* 124:1150-1158.

Hughes, J.B., Shanks, J., Vanderford, M., Lauritzen, J. and Bhadra, R. 1997. Transformation of TNT by aquatic plants and plant tissue cultures. *Environ. Sci. Tech* 31, 266-271

Jayakumar, R. 1995. Herbicide residues in soil – plant water system. In : Agricultural Inputs and environment (ed. SP. Palaniappan). Scientific Publishers, Jodhpr, pp. 389-409

Jeevan Rao, K. 1999. Pesticide pollution in Agriculture. *J. Environment and People*, pp. 14-19

Komarov, V.I. 1990. Radioactive contamination and decontamination in the 30 km zone surrounding the Chernobyl nuclear power plant. Proc. International Symposium on Environmental Contamination Following a Major Nuclear Accident. 2. IAEA, Vienna

Krueger, J.P., Robers, G.B., Altalah, Y.H. and Cork, D.J. 1989. Isolation and identification of microorganisms for the degradationof dicamba. *J. Agric. Food Chem.*, 37 : 534-538.

Phathak, H., Biswas, D. R. and Raman Deep Singh 2002. Fertiliser use and environmental quality. *Fert. News* 47 (11): 13-20.

Phillips, I.R. 1998. Use of soil amendments to reduce nitrogen, phosphorus and heavy metal availability. *J. Soil Contamin.* 7:191-212.

Ramakrishnaparama, 2002 .Recycling of urban and domestic wastes as a nutrient source for agriculture. Proceedings of the summer school on Rehabilitation and reconstruction of polluted agricultural ecosystem; 21-30 July; 2002; Tamil Nadu Agriculrural university.pp101-129.

Ramanathan, 2002. Soil contamination research in Tamil Nadu. Proceedings of the summer school on Rehabilitation and reconstruction of polluted agricultural ecosystem; 21-30 July; 2002; Tamil Nadu Agriculrural university.pp101-129.

Richard, F.C. and Bourg, A.C.M. 1991. Aqueous geochemistry of chromium. A review. *Water Research.* 25: 807-816.

Rosenberg, A. and Alexander, M. 1979. Microbial cleavage of various organophosphorus insecticides *Appl. Environ. Microbiol.*, 37 : 886-891

Rulkens, W.H., Tichy, R. and Grotenhuis, J.T.C. 1998. Remediation of polluted soil and sediment: Perspective and failures. *Wat. Sci. Tech.* 37:27-35.

Vanisree, 2004. Assessment of selective retensionsites of cadmium and lead in Tomato (Lycopersicon esculentum (mill)) M.Sc. (Ag) thesis ,Kerala Agricultural University, Thrissur 94p

Walia, S. and Dureja, P. 1993. Photochemical and microbial degradation of insecticides. *Pestic. Res. J.*, 5: 133-150

Zayed, A., Gowthaman, S. and Terry, N. 1998. Phytoaccumulation of trace elements by wetland plants: I. Duckweed. *J. Environ.Qual.*, 27, 715-721.

ABSTRACT

Nature and mankind are inseparable part of life that includes land, water, air, space, energy, flora and fauna, which are interconnected, interrelated, interdependent. In the name of progress man has became a destroyer of nature so much so that development in a sense has become synonymous with environmental degradation and progress with pollution. Environmental pollution in India has become a major issue of public policy and research in recent years. Environmental changes may be driven by many factors including economic growth, population growth, urbanization, intensification of agriculture, rising energy use and transportation. There are different sources of soil pollution such as distillery effluents, tannery and textile effluents, and pollutants from pulp and paper mills, coal combustion residues, pesticides, fertilizers etc. Tannery effluents contain large amounts of chromium which pollute river, land etc.

Organic pollutants in soil include pesticide and oil spills. The fate of pesticides in soil pertains to their interaction with soil environment. The ester form 2,4-D are volatile and gases evolved injured the susceptible crops like cotton and tomato (Jayakumar, 1995)

The triazine herbicides (eg. atrazine) and organophosphorous insecticides (eg. malathion) are subjected to hydrolysis and subsequent degradation in the soil (Jeevan Rao,1990) Use of optimum dose of pesticides, detoxification by microorganisms, incineration, application of FYM, ploughing of land etc. are some of the suggested remedial measures Enzymes isolated from *E. coli* and *Arthrobacter* strains are capable of hydrolyzing OP compounds (Rosenberg and Alexander, 1979). The damage caused by pesticides was reduced by ploughing (Dinakar *et al*., 1986).

Use of fertilizers contributes to the soil and water pollution. Nitrate pollution in agricultural ecosystem has got great importance. Leaching rate of NO_3^--N differs with rates of irrigation and splits of fertilizer application (Chaudhary and Bhatnagar, 1986). Heavy metal contamination is a serious problem. Cultivating phytoextractors on industrial waste site can provide a clean and cheap alternative to the "Suck, muck

and truck" cleaning approach to decontaminate heavy metal contaminated soils (Brown *et al.*, 1995).

Urban wastes also contribute to pollution. The most commonly used urban waste treatment methods are composting, incineration and pyrolysis etc.

CONTRACT FARMING

By

CHITHRA.M.S.
(2004-11-07)

SEMINAR REPORT

Submitted in partial fulfillment for the
requirement of the course
Ag.Econ. 651 – Seminar

DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF HORTICULTURE
KERALA AGRICULTURAL UNIVERSITY
VELLANIKKARA – 680656
THRISSUR

DECLARATION

I, Chithra, M.S. (2004-11-07) hereby declare that this seminar entitled "CONTRACT FARMING" has been prepared by me, after going through the various references cited at the end and has not been copied from any of my fellow students.

Vellanikkara
Date: 18-10-2005

Chithra, M.S.
(2004-11-07)

CERTIFICATE

This is to certify that the seminar report titled **"CONTRACT FARMING"** has been solely prepared by Ms. Chithra. M.S. (2004–11–07), under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

Vellanikkara,
Date: 18.10.2005

Dr.K. Jesy Thomas,
Major advisor,
Associate professor,
Department of Agricultural Economics,
Vellanikkara,
Thrissur

CONTENTS

Introduction

The agricultural sector has been slow in assimilating the process of liberalisation. Domestic reforms in the sector are limping and the resultant distress signals are there for all to see even in relatively promising areas. The news of farmers' distress in various states has become the sore issues for policy makers. If we look into the causes of distress that have been identified by the experts in the country, they fall into two broad groups: causes that are beyond farmers control and those that could be averted through proper policy interventions. The major problems faced by farmers require intervention at four important points.

- Price assurance
- Assurance about product marketability
- Elimination of intermediaries in the market
- Timely availability of production credit.

Supply of all these four factors could make the farmers live much easier and prepare them to face the uncertainties due to climatic factors, imperfect markets, fluctuating prices and presence of large number of intermediaries in different markets.

In this background, contract farming can benefit farmers to an extent possible. Also it forms the heartening part of the vision of the National Policy on Agriculture.

Definitions

Contract farming is an agreement between the primary producer (farmer) and an agri-business firm (sponsor) to procure certain pre-agreed quantity and quality of a produce at a particular time and price in future. It can purely be a procurement transaction or can extend into supply of inputs or even beyond (FAO, 2001).

A form of vertical coordination between growers and buyer processors that directly shape production decision through contractually specifying market obligations such as value, volume, quality, and at times price, provides specific inputs and exercise some control at the point of production (Little, 1994).

Contract farming are those contractual arrangements between farmers and companies whether oral or written specifying one or more conditions of production and/or marketing of an agricultural product. This definition was considered too broad as it included marketing or forward contract (Roy, 1963).

It is a system for the production and supply of agricultural and horticultural produce under advance contracts, which involve a commitment to provide an agricultural commodity of a type (variety or quality), at a time and a price and in the quantity required by known buyer. It is an institutional arrangement that allows agro-processing firms to participate in, and exert control over, the production process without owning or operating the farms. It enables the vertical coordination between growers and processors of agricultural products. It is a demand/market driven phenomenon unlike traditional farming that first produces and then looks for the market.

The advocates of contract farming view it as a dynamic partnership between agri business companies and small farmers that benefit both without sacrificing the rights of either. It is offered as a vehicle for the transfer of technology and the modernization of peasant smallholdings. However, critics allege that it would lead to disruption of subsistence production and the inevitable impoverishment of the rural poor. It has been criticized as being a tool for agri business firm to exploit an unequal power relationship with growers (Key and Runsten, 1999).

Contract farming is a "form of disguised proletarisation" as it secures the farmers land and labour while leaving him with the formal title for both. The control exercised by the company is indirect but effective; the "farmer" control is legal but "illusory" making him a "propertied labourers" (Clapp, 1994).

Need for contract farming

- To reduce the load on the central & state level procurement system.
- To increase private sector investment in agriculture.
- To bring about a market focus in terms of crop selection by Indian farmers.
- To generate a steady source of income at the individual farmer level.
- To promote processing & value addition.
- To generate gainful employment in rural communities, particularly for landless agricultural labour.
- To flatten as far as possible, any seasonality associated with such employment.
- To reduce migration from rural to urban areas.
- To promote rural self-reliance in general by pooling locally available resources & expertise to meet new challenges.

(Anon., 2001)

Fundamental elements of a contract design involve three basic economic components in any transaction relationship: allocation of values (the distribution of gains from trade), allocation of uncertainty (any associated financial risks), and allocation of decisions bearing on the relationship. These three dimensions are inherently interdependent and each one is likely to have implications for the others; as for example, the producer may demand a higher price for assuring the certainty of growing a new product or variety (Sykuta and Cook, 2001)

Types of contract farming

Type of contract depends on the nature of crop, company's objective, area of operation etc. There are mainly four types of contract farming. They are:

1. Marketing contracts
2. Production contracts
3. Resource providing contracts
4. Product specification contracts

1. Marketing contracts

Refer to oral or written agreement between a contractor and a grower that sets a price and an outlet for the commodity before harvest or before the commodity is ready to be marketed. Most management decisions remain with the growers since they retain ownership till the final disposal of the commodity. The producer bears all the risks of production but bears the price risk with the contractor.

2. Production contracts

Specifies in detail the quality and quantity of a particular commodity to be procured and the type of compensation the producer would receive for his effort.

3. Resource providing contracts

The firm may supply all the inputs to the growers.

4. Product specification contracts

Firm closely monitor the quality produced and the production practices it follows tend to dominate the terms of contract.

Beginning and brief history

Contract farming began in Taiwan in 1895. Japanese government in Taiwan used contracts for sugar production. In the early twentieth century US companies used contracts in banana plantation in Central America. Contract farming in firms began in late 1970s and its popularity gained momentum throughout the 1980s.

Popular examples:

- Hybrid coconuts in Indonesia
- Pineapple, palm oil and asparagus in Thailand
- Tomato, potato and chilly in India
- Sugarcane in Mauritius and South Africa
- Asian vegetables in Kenya and Dominican Republic
- Frozen vegetables in Mexico
- Cotton in Zimbabwe

Application areas of contract farming

Contract farming helps when competitive domestic markets do not exist or are underdeveloped; conversely contracts diminish in importance with the development of competitive markets. It works when quality requirements are to be met. They are ideal for a win-win situation since they represent a natural mutual dependency. Cereals, common fruits and vegetables and commodities with established mass markets, considerations for contract cultivation are ruled out. Seed multiplication, organic foods, vegetables, fruits and exotic produce/plants, export crops, aromatic, herbal and medicinal plants, other cropping activities with specific requirements of quality/cultivation practices.

Contract farming models

Contract farming can be structured in a number of ways depending on the crop, the objectives and resources of the sponsor and the experience of the farmers. Contracting out production is a commercial decision to facilitate an adequate supply within a designated period and at an economic price. Using any of the models can theoretically contract out any crop or livestock product; however, certain products favor specific approaches.

Broadly speaking, contract farming arrangements fall in to one of the following five models.

- The centralized model
- The nucleus estate model
- The multipartite model
- The informal model
- The intermediary model

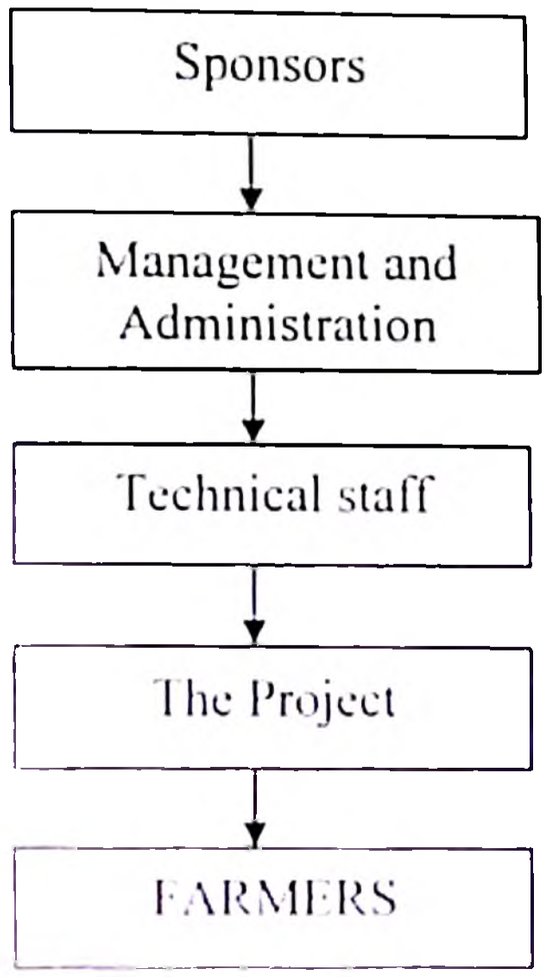
Decisions by sponsors on the type of model to follow should be made on the basis of market demand, production and processing requirements and the economic and social viability of plantation versus smallholder production. Where market requirements necessitate frequent changes to the farm technology with fairly intensive farm-level support from the sponsor, the permanent organization and maintenance of a production chain under a centralized model is vital. Organizations that require stringent processing standards rely largely on the centralized model. For crops such as tea, sugar and oil palm, with which farmers may have had little or no experience; sponsors are more likely to follow, where possible, the nucleus estate approach. Such crops require a significant long-term investment and, generally, immediate processing after harvest. However, the lack of adequate land or political opposition to estate development may dictate a centralized rather than nucleus estate approach. Where quality control is not the predominant concern, the informal model may suffice. In some examples, sponsors use third parties or intermediaries to sub contract production out to farmers.

If the sponsor considers that a field trial is warranted prior to the introduction of a crop to farmers or that a guaranteed minimum throughput is required for the processing facility, a nucleus estate model is often most appropriate. Where capital investment in processing facilities is considerable and the number of contract farmers is high, either the centralized or the nucleus estate structures can be used, accompanied by strong managerial inputs and backed by formal contracts. Seasonal, short-term crops characterize the informal model, which may become more widespread in the future, with only minimal material support to farmers.

Often, the operational structure of projects changes over time. For example, the distinctions between the centralized model and the informal model are sometimes blurred. Successful individual informal developers may expand their operations into activities that eventually evolve into the centralized category.

1. The centralized model

This is a vertically coordinated scheme where a single processor buys crops from many small farmers under strict quality control. Sponsors' involvement in production varies from minimal input provision to the opposite extreme where the sponsor takes control of most of production aspects. It is used for tree crops, annual crops, poultry, and dairy products, which often require a high degree of processing such as tea or vegetables for canning or freezing.



The Centralised Model

2. The nucleus estate model

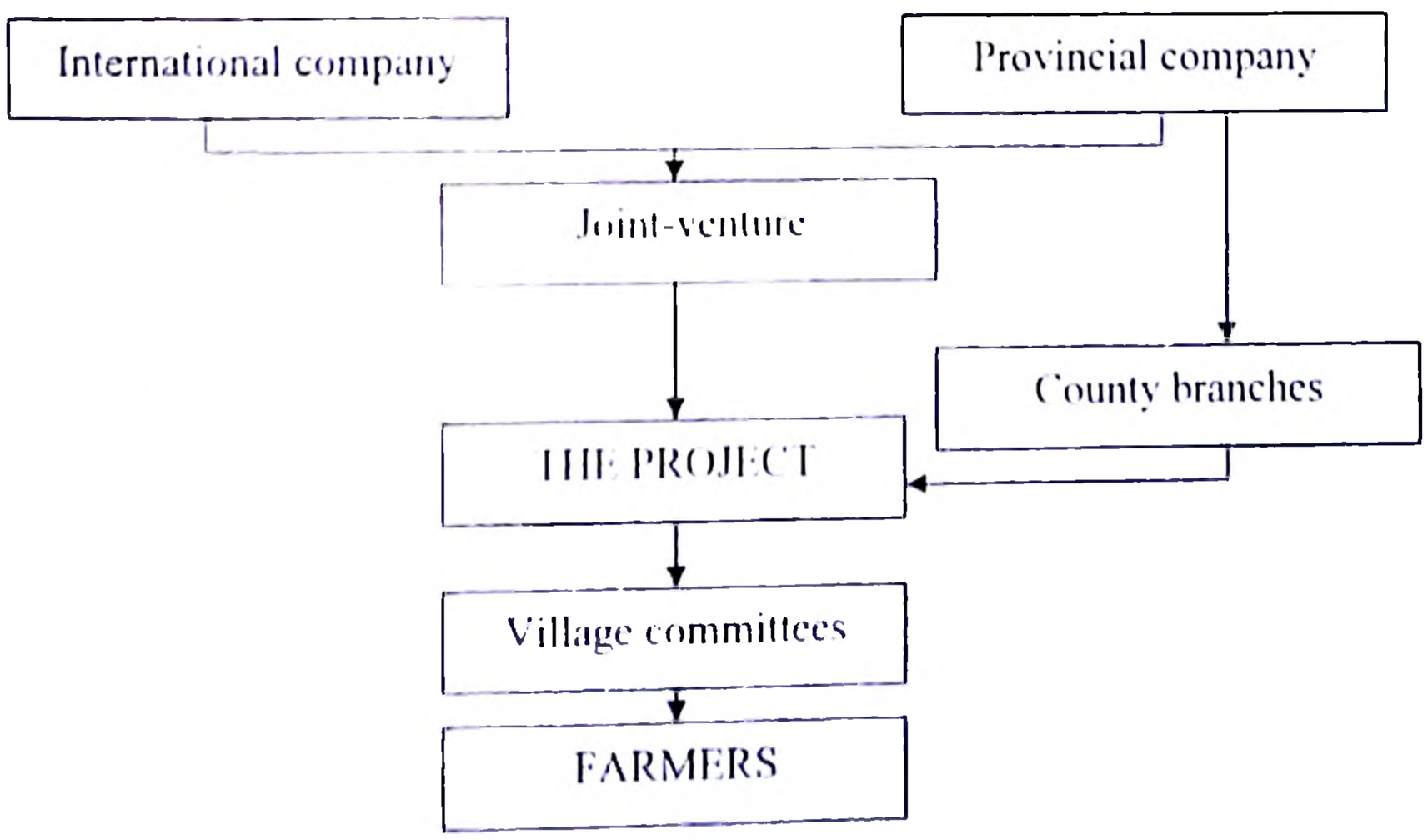
It is the most common form of contract farming. It is a variation of centralized model where the sponsor also manages a central estate. It involves a firm growing some of the crop itself on a plantation and contracting the rest out to small farmers near the plantation. It involves a significant provision of material and management inputs. The British based Common Wealth Development Corporation (CDC) was a pioneer of this model although it no longer develops such estates. It is mainly used for tree crops and dairy production. A common approach is for the sponsors to commence with a pilot estate then, after a trial period, introduce to farmers (sometimes called "satellite" growers) the technology and management techniques of the particular crop. Nucleus estates have often been used in connection with resettlement or transmigration schemes, such as in Indonesia and Papua New Guinea, for oil palm and other crops. While mainly used for tree crops, there are examples of the nucleus estate concept with other products. Indonesia, for example, has seen the operation of dairy nucleus estates, with the central estate being primarily used for the rearing of "parent stock".

3. The multipartite model

Under this model, variety of organizations including government manages the scheme. It can be developed from centralized or nucleus estate models. It may have separate organizations responsible for credit provision, production, management, processing and marketing etc. It is common in China where government departments and foreign companies have entered into contracts with farmers.

Figure outlines a multipartite project in China. In this particular case, the county branches, through their agronomists and field technicians, were responsible for implementing and maintaining the terms and specifications of the agreement. There were formal contracts between the joint venture and the branches, and written contracts between the counties and the village committees, but only a verbal understanding between farmers and their respective committees. In theory, farmers were expected to carry out cultivation as specified by the joint venture. In practice, however, county officials only followed instructions from the joint venture if to do so was in the county branch's immediate economic interest, irrespective of quality standards and long-term production objectives. The lack of coordination between the joint venture and the county management, village cadres and farmers eventually resulted in the collapse of the venture.

The multi partite model
A joint-venture contract-farming project in



181

In Colombia, a company started buying passion fruit in 1987, using the centralized model. The company ran into difficulties because it proved impossible to control extra-contractual marketing. It therefore developed a multipartite model in which all farmers were expected to belong to associations or cooperatives and public institutions became involved as providers of credit and extension. This arrangement significantly reduced both the risk of extra-contractual marketing and the company's costs of dealing with individual farmers, while being generally welcomed by farmers. Problems remained, however, most notably in relation to the lack of management skills on the part of the farmer associations and cooperatives.

4. The informal model

This model applies to individual entrepreneurs or small companies who normally make simple, informal production contracts on seasonal basis particularly for crops such as fresh vegetables, watermelons and tropical fruits. Crops require only minimal amount of processing. Material inputs are often restricted to the provision of seeds and basic fertilizers, with technical advice limited to grading and quality control matters. It involves greater risk on extra-contractual marketing. A common example of the informal model is where the sponsor, after purchasing the crop, simply grades and packages it for resale to the retail trade. Supermarkets frequently purchase fresh produce through individual developers and, in some cases, directly from farmers. Financial investment by such developers is usually minimal. This is the most transient and speculative of all contract-farming models, with a risk of default by both the promoter and the farmer. Nevertheless, in many developing countries such developers are long established and in numerous cases they have proved an alternative to the corporate or state agency approach.

5. The intermediary model

In this model, firms purchase produce from intermediaries like farmer associations or private middlemen and not directly from farmers. There is a danger that the sponsor loses control of production and quality as well as prices received by the farmers. In addition, the technical policies and management inputs of the sponsors can become diluted and production data distorted. In short, subcontracting disconnects the direct link between the sponsor and farmer. This can result in lower income for the farmer, poorer quality standards and irregular production.

In the snap-frozen vegetable industry in Northern Thailand, two companies directly contract out to middlemen, or "collectors", who organize over 30 000 farmers to grow soybeans, green beans and baby corn, primarily for the Japanese market. Each collector normally controls and supervises from 200 to 250 farmers.

Collectors are responsible for all field activities from sowing to harvesting. They are paid a commission based on the total production of the farmers they supervise. The sponsors' agronomists dictate the varieties and fertilizer to be used as well as the sowing programmes and crop husbandry methods. The companies also employ field officers to provide technical support to the collectors and their subcontracted farmers.

Characteristics of contract farming structures

Sl No.	Structure - Model	Sponsors	General Characteristics
1	Centralised	Private corporate sector State development agencies	Directed contract farming. Popular in many developing countries for high value crops. Commitment to provide material and management inputs to farmers.
2.	Nucleus estate	State development agencies Private/public plantations Private corporate sector	Directed contract farming. Recommended for tree crops where technical transfer through demonstration is required. Commitment to provide material and management inputs to farmers.
3.	Multipartite	Sponsorship by various organisations, e.g.: Private corporate sector State development agencies State marketing authorities Land owners Farmer cooperatives	Common joint-venture approach. Unless excellent coordination between sponsors, internal management difficulties likely. Usually, contract commitment to provide material and management inputs to farmers
4.	Informal	Entrepreneurs Small companies Farmer cooperatives	Not usually directed contract farming. Common for short term crops; i.e. fresh vegetables to wholesalers or supermarkets. Normally minimal processing and few inputs to farmers. Contracts on an informal verbal basis. Transitory in nature.
5.	Intermediary	Private corporate sector State development agencies	Sponsors are usually from the private sector. Sponsor control of material and technical inputs varies widely. At times sponsors are unaware of the practice when legally carried out by large-scale farmers. Can have negative consequences.

(Anon.,1998)

Advantages to farmers

1. Access to product markets

Small farmers in developing countries are often limited to local markets. Corporate firms can potentially guarantee access to wider international markets that may increase profits of farmers and processing firms.

2. Access to inexpensive credit and farm inputs

Small farmers may not get low interest rate for financed credit for lack of collateral security. Firms can directly provide credit or sponsor them for bank loans.

3. Provision of extension services and farm inputs

Firms can educate farmers about new technologies to improve crop yield. They can provide agricultural inputs (seeds, fertilizers, pesticides etc) to farmers who lack sufficient capital. Farm equipment may also be provided under specified conditions.

4. Management of price risk

Advance price negotiations alleviate the risk of the market price falling after the crop is harvested.

5. Family farm employment

Usually involves labor-intensive crops, which can increase the opportunity for family members to work on their own small farms rather than perform low wage labour on larger farms.

6. Development of commercial agriculture

Schemes expose small farmers to the commercial process and develop new skills such as negotiating the terms of contract and communicating with outside parties.

Problems to farmers

1. Risk of crop failure

Often requires farmers to grow new crops, which increase the risk of crop or production failure. Those risks are most often borne by the small farmers because the firms will not pay farmers who do not harvest a crop.

2. Risk of market fluctuations

Depending on the schemes, prices for crops may be settled at the beginning of the season. This can be beneficial as well as problematic depending on fluctuations in the market. If the farmers later choose to sell in the open market, ignoring their contractual duties, they can be seriously penalized.

3. Unequal bargaining power

Firms usually have more influence on the terms of the contract and can create and can create unfavorable conditions for unwary farmers.

4. Unreliable firm management

Firm staff may be corrupt or inefficient. This affects quotas and how much crop the firm will buy from farmers as well as farmer-firm good will and durability of business relations.

5. Exclusion of small and marginal farmers

In most cases, large farmers alone participate because they can profits due to economies of scale. This widens the gap between small and large farmers.

6. Social tensions from income distribution

The selection process of contract farmers can create rifts in communities because of the resulting disparity of wealth between contract and non-contract farmers.

Advantages to sponsor

1. Public relations

It is viewed as a more socially responsible choice for the firms compared with plantation or estate farming.

2. Access to land

Agri-business firms may have difficulty in obtaining land rights on their own in developing countries. Small farmers may have easier access or already own land.

3. Risk transfer

Firms decrease their overall risk by eliminating their responsibility for production while at the same time, retaining a more reliable crop supply than on the open market.

4. Quality

Firms have a higher degree of control over the quality and uniformity of the produce because theoretically, they can dictate quality control measures and farming methods. Contract terms may state that only produce of a certain quality will be purchased, creating an incentive for farmers to pay attention to quality.

Problems to sponsor

1. Land tenure

Depending on the country, farmers may have limited security of land tenure, decreasing opportunities for long-term operations.

185

2. Social and cultural restraints

Farmers may not be willing to participate in contract farming schemes because of community wide distrust of multinational firms. If the firms are willing to participate, social and cultural traditions can pose difficulties for local managers.

3. Poor farmer relations

The relationship between farmers and firms can quickly deteriorate with poor management and misunderstanding of the practices. This can result in higher incidences of contractual breach by farmers.

4. Extra-contractual farming

If market conditions improve, farmers may ignore their contractual duties and sell on the open market.

5. Misallocation of resources

Farmers may use firm's credit and input for non-contractual operations, causing a lower yield for the contracted crops.

Contract farming in India

In India, contract farming can be traced back to colonial period when commodities like Cotton, Indigo etc where produced by Indian farmers for English factories. ITC introduced the cultivation of Virginia tobacco in coastal AP in the 1920s incorporating most of the elements of fair contract farming and met with good farmer response. This was replaced by auctions in 1984. Organised public and private seed companies, which emerged in the 1960s, had to necessarily depend on multiplication of seeds on individual farms under contract to them since they did not own lands. Faced with an acute shortage of soft wood, Wimco, the country's sole mechanized match manufacturer, instituted an innovative farm-forestry scheme for the cultivation of poplars in Punjab, Haryana and Uttar Pradesh. It met with a good farm response and success despite the trees being exotic to the regions.

Wimco also tried to procure tomatoes at the same time for its processing factories in the South through a halting recourse to contract purchase. PepsiCo introduced tomato cultivation in Punjab in the 1990s under contract farming to obtain inputs for its paste-manufacturing facility established as a pre-condition to its entry into India. This was sold to Hindustan Lever in 2000, which had earlier acquired the Kissan tomato processing facility in Karnataka. Nijjer in Punjab and Bhilai Engineering in Madhya Pradesh also took up tomato contract cultivation programmes shortly after PepsiCo. Contract farming was the strategy of choice for almost all food processing projects contemplated in the 1980s and 1990s, most of which never came up. Unreliable and uneconomic raw material availability has been their major handicap. Smaller projects involving specialised export crops, aromatics, medicinal plants and herbs, etc still actively use contracts in their own restricted areas.

Contract farming is again in vogue, and even tried for bulk production of subsistence crops, such as paddy-rice, maize and wheat. Punjab government has actively encouraged it as a means of crop diversification. Most such contracts now have specialised contract agencies as interfaces between farmers and input suppliers/crop purchasers.

Commodity co-operatives (dairies in Gujarat, sugarcane in Maharashtra), which emerged in the 1950s, provided most services envisaged under ideal contract farming to their members and bought back the supplies offered at contracted prices, although these were not strictly contract arrangements. They succeeded enormously, leading to their replication and compelling private companies also to adopt similar approaches. Contract farming is now considered to be a corrective to market imperfections and serving a useful purpose in India in its own limited sphere.

Contract farming covers loose buying arrangements, simple purchase agreements, supervised production with input provision, with possibly tied loans/advance and risk coverage, and managed production with input provision and tied loans/advance. Introduction of new crops and varieties as well as techniques of production also forms a part of some contracts. Quality parameters may be integral parts of contracts, but are not always understood properly. Defaults occur mainly through availability of alternative channels of disposal to farmers and sources of supply to buyers, which mere mention of exclusivity in contracts cannot overcome. Effective reciprocity of terms and conditions is not always assured. Contract agreements range from oral deals to formal, registered written contracts. Sugar and milk co-operatives provide significant social and community services as well. Sugar mills had contract with the sugarcane growers for the supply of sugarcane. Seed companies have carried out seed production for more than 4 decades. Organized public and private seed companies, which emerged in the 1960s, had to depend on contract farming, as they did not own lands. However, the concept of contract farming has come a long way from such origins. In the last couple of decades, contract farming is viewed as a tool to provide technology, extension services, credit etc to the farmers. It is perceived as a mutually beneficial arrangement between the firm and the farmer by the governments and international aid agencies (Asokan and Singh, 2003).

Legislation in India states that no company can hold land for agricultural purposes. This has furthered the case of contract farming resulting in control of the produce as well as costs.

Prominent examples

- Tomato cultivation in Punjab, Haryana and Rajasthan
- Mushrooms in Haryana
- Sunflower in Andhra Pradesh and Karnataka
- Gherkins in Karnataka
- Fruits and vegetables in Tamil Nadu, Maharastra and Andhra Pradesh

Multinational companies like PepsiCo and Hindustan Lever Ltd. (HLL) in Punjab and Haryana, Maxworth Fruits in AP, Karnataka and Tamil Nadu, VST Natural Products Ltd. in Andhra Pradesh; Cadburys in Karnataka etc take up contracts.

In Kerala, many auyrvedic pharmaceutical agencies like Kottakkal Aryavaidyashala, Sanjeevani, Dabur, Nagarjuna, Oushadhi etc take up contract farming of Kaipan padavalam, Adapathiyan, Marunnu koorkka, Kiriyatha, Stevia, Thulasi, Kattarvazha, Patchouli and other medicinal plants. Pepsi India has recently begun a pilot project of pineapple cultivation through contract farming. It is said that Kerala has tremendous potential in pineapple cultivation due to its vast rubber plantations, where pineapple is an ideal inter-crop in the first three years of the rubber plantlet.

Pepsi Co

In 1989, Pepsi Co started contract farming in India. It provides machines and other inputs for tomato, chilli, basmati rice and peanuts contract farming. The practice was started first in Zahura village in Hoshiarpur district in 1989 by installing a 22 crore tomato processing plant (Anon., 2003). It now covers different districts of Punjab like Jalandhar, Amritsar, Patiala, Sangrur etc. to win the confidence of the local farmers, Pepsi Co has partnered with Punjab Agricultural University (PAU) and the Punjab Agro Industries Corporation. Because of the contract farming in Punjab the yield of tomato and chilly has increased by three and two folds respectively. Five crores of rupees has been invested in setting up Basmati processing unit in Sonepat and provided the technology for optimizing production. The area under cultivation has gone up to five fold in order to meet the demands.

Seed production

Given the Land Ceiling Act in India, the seed firms cannot own and cultivate land for seed production. Therefore the only options for agri-business firms is to procure desired quality seeds are to grow seeds on leased land or have contractual arrangements with the primary producers.

Contract farming of seed in India is currently being practiced by multinational firms Pepsi, Cargill, Sandoz and Advanta India, domestic corporate like Rallis India, Indo American Hybrid Seeds, Mahbharat seeds, Mahyco, Ankur seeds Nath seeds and Namdhari seeds and various statal and para statal corporations with varying degrees of success. The seed companies and seed corporations have been able to use the contract system successfully as they work with a few farmers over a smaller area and the small costs incurred by the companies are recovered more easily.

The National Seeds Corporation (NSC) still works with 7000 farmers under contracts despite its role being superseded by the State Seed Corporations, which also practice contract farming. The National Seeds Corporation produces about hundred open pollinated varieties of vegetable seeds over an area of nine lakh hectares compared to fifteen lakh hectares by the entire private sector in India besides dealing in seventy five crops and four hundred and twenty varieties (Singh, 2003).

The contract systems adopted by different seed companies differ in their provisions so far as the relationship with farmer is concerned. These are procurement and input contracts, under which the companies not only agree to pick up the contracted

quantity and quality per acreage of produce at a pre-agreed price and time, but also provide inputs like seed on part credit and technical advice on planting, crop care and harvesting.

Profile of contracts of seed sector agencies

Aspect of contract	APSSDC	GSSC	TDC	Navbharat seeds (castor)	Pepsi Foods (Potato)
Status of growers	Shareholders	Sub-growers	Shareholders	Growers and sub growers	Growers
Nature and duration of contract	Two contracts (principal and seasonal)	Seasonal	Seasonal	Seasonal	Seasonal For 8 months
Acreage	Proportional to shares held	Specified reserved	Specified by company	Specified by company	Specified
Farm operations	Seed to be sown within 10 days of purchase	Entire cost of seed production by growers	To follow all instructions	One month specified sowing time	All farm operation costs to be borne by farmer
Price	Only minimum guaranteed price	Specified	Based on opportunity cost of seed production	As fixed by GSSC	Grade-wise specified price

(Singh, 2003)

In a study conducted about the contract wheat seed farming in Haryana state, it was found that public agency contracted medium and large farmers whereas private agency contracted all farm sizes. The wheat seed farmers of private agency received all inputs, production technology and extension services whereas the farmers of public agency were provided only the seeds (Kumar and Chand, 2004).

In a study conducted on contract farming in tomato, it was found that the holding size of the sample contract farmers indicated that the processing firms favoured large farmers while selecting for contract. Among various categories of contract farmers, large contract farmers obtained higher net returns, followed by small and medium ones, the contract farming system for tomato considerably reduced the yield uncertainty and completely removed the price uncertainty among its farmers, whereas it was very high in the case of non-contract farmers (Dileep *et al*., 2002).

Roth (1992) listed out ten ways in which firms exploit the poultry growers in the United States.

Contract Farming in Thailand

Thailand has been one of the pioneers in contract farming in Asia. It has been so largely due to the active promotion of this mechanism of coordination of agricultural production and marketing in the mid 1980s. Thailand also has largest degree of private sector involvement in contract farming. Contract farming has been a key element of Thai government's development plan reflecting a strategy of private-led integrated agricultural development.

Contract farming system emerged more than three decades ago to begin with poultry, sugarcane, tobacco, pineapple and vegetables. But in the early 1990s, contract farming was in place in the following commodities/crops in Thailand- palm oil, asparagus, maize, maize seed, castor oil, eucalyptus, baby corn, sunflower, bamboo, barley, sea shrimp, cotton, ginger, mushroom and fragrant rice.

Contract farming has been so popular in Thailand that even the Food Processing section of the Royal project has adopted it as a central hub in its operations. By the late 1990s, almost 100 percent of commercial production of poultry in the country, especially which meant for frozen chicken exports, was under some form of contract (Singh, 2002).

Though contract farming was initiated by the private sector, the government soon came to play a major role in terms of both setting broad policy directions for diversifications as well as underwriting private sector activity in a variety of ways through various institutions like

- Board Of Investment (BOI)
- National Economic and Social Development Board (NESDB)
- Agricultural Land Reform Office (ALRO)

Besides there are two other wings of the state- Ministry of Agriculture and cooperatives (MOAC) and ministry of Finance (MOF) which promotes contract farming through their own agencies, i.e., Department of Agricultural Extension (DOAE) and Bank of Agriculture and Agricultural Cooperatives (BAAC).

It is found that state policy has helped contract farming to take roots in the country.

Model Contract Farming Scheme

New Measures and Regulated Markets

The Regulated Markets legislation sought to eliminate numerous marketing malpractices by allowing transactions only in well-identified market yards and under the supervision of a statutory market Committee. Over time, procedures and paper work became focal points of market regulators, rather than facilitation and enlarging of trade and regulated markets became bottlenecks. Limited access to open trade adversely affects production of new and diversified crops. Confining trade to the existing yards and traders to recognized ones may not suit new crops with new spatial patterns and trading entities. Freeing Indian agriculture from such constraints through appropriate reform is an idea whose time has come.

The draft legislation under circulation recommends recognition of additional sub-market yards, including those managed by persons or bodies other than market committees as markets under the act and the establishment of special markets for specific commodities and special committees to govern them. This does not quite meet the purpose. It would still require the physical movement of a commodity between the place it is produced and a market, instead of an unrestricted direct movement between the points of origin and processing or consumption, to help reduce cost, delays, wastage, and quality

deterioration. The thrust of the proposed measures, albeit unintended, is to increase the extent of over-administration of the system, rather than to unshackle it.

A desirable contract-farming approach requires several actions on part of sponsors as well as administrators (financial institutions roles and actions have been listed above):

Sponsor Issues for Action

Sponsors need to define unambiguously the type and nature of the contract, as well as areas and periods covered at the outset. They have to list the scope of their own activities as also those of the growers, and their respective performance obligations. Contracts must clearly specify:

- Quantities involved (on volume, area or entire crop basis), delivery schedule, points of delivery and procedures to be followed in the event of shortfalls or excesses
- Modes and responsibilities of grading, packing and transport and costs
- Prices: fixed in advance of season, flexible prices, spot, consignment, split
- Payment modalities: time, form, hold-backs, if any
- Incentives based on quality and/or time performance
- Advances and their recoveries
- Insurance, market fee and other related costs
- Provisions in case of excess or short supply
- Indicative net realization by farmer.

Sponsors must focus on groups, and not individuals. The agreements should be simple, short and devoid of legal jargon. They must not involve property liens or attachments under any circumstances.

Development/Support Issues

- Processors or sponsors must equip themselves with suitable research and development efforts, especially concerning agronomy and the required extension drive;
- All successful contract farming is based on appropriate pricing. Given the often-cyclical nature of agriculture production, sponsors could consider establishing a price stabilization fund as a desirable step to overcome this problem;
- No contract-farming scheme would succeed in the short run. Persistence for a reasonable period extending over several years is essential.

Administration

- State governments must recognize contract arrangements of all types, and exempt them from the purview of the current or amended APMC acts.
- There should be a simple registration of all contracts with the concerned district agriculture office. This is to be performed by the buyer, to avail of the exemption from the Act. There is no need to ensure formalization or government registration and supervision of growers' groups.

Conflict Resolution

The best conflict resolution is avoidance of conflicts, as assumed in the logic of the above recommendations. Nevertheless, some conflicts might still arise, which need to be simply, effectively and quickly resolved.

Three stage process

1. Intra-group discussion and settlement.
2. Simple arbitration on the lok adalat model, with a local First Class Judicial Magistrate assisted by farmer/sponsor representatives, and one eminent person of area acting as the arbitration forum.
3. One appeal to district judge/magistrate.

The entire process must be completed in a maximum of three months, and awards under it must have judicial sanction of a decree of a civil court and must be enforceable. Legal practitioners must not be allowed to participate in the process. It should not be subject to Indian Contracts Act or further review. (Anon., 2003)

Issues for policy makers.

Contract farming is a promising trend showing promise of adaptability to Indian conditions with scope for maximum benefit to farmers. If contract farming has to be successful in India, then government has to be prepared to maneuver on the policy front. The first issue before the policy makers is the need to ensure the legal sanctity to the process of contracting and the institutions of farm contracts. The present legal framework and contract laws do not completely protect the interest of the farmers and therefore one need to look into legal aspects more closely.

Registration of the contracts with the government is to be made essential. Under the new agricultural Marketing Produce Act recently passed in Haryana, all contracts have to have details explicitly stated and need to be registered with the government as well. This system has to be replicated throughout the country.

A central level regulatory authority is necessary to deal with the issues related with regulations. Also make purchase interference by a third party in a contract-farming program, a cognizable offence. Introduce insurance policies to provide comprehensive coverage of the crops, including loss of profit to the farmers. Non-governmental and community organizations have to be involved in monitoring the working of contracts.

In addition, it is necessary to encourage contract farming by building up proper safety net programmes and provision of technical support from the state agricultural departments and universities. A new era may begin in the agricultural sector if this institution works to the benefit of the farmers.

Conclusion

Contract farming can be regarded as one of the options to create a friendly environment within the private sector for agricultural development. A well-managed contract farming is effective in linking the farm sector to sources of extension advice, mechanization, seeds, fertilizers and credit and to guarantee profitable markets for the produce. The proper implementation of government policies and proper environment for the private sector will surely pave a new way in Indian agriculture.

DISCUSSION

1. What is the difference between Pepsi model and Tamil Nadu model?

Price fixation under this model is done directly between farmer and company. A farmer enters into contract production due to the assured price, though an individual farmer is not able to bargain with the company on equal footing. Since the nature and terms of contract are decided arbitrarily and can hastily be distorted in favour of the company, there are frequent breaches of contracts and no arbitration mechanism exists. It is the most exploitative model in contract farming.

Tamil Nadu is the only state in the country that has enacted an act on contract farming. In this model, both farmer and company are free to settle the price mutually. Once the price is settled, it has to be submitted to the enforcement officer of the state government.

2. Which of the five models can be adapted to the vegetable?

The informal model can be applied to the vegetables, which require minimal amount of processing.

3. Why the contracts taken up the PepsiCo was a failure story and Basmati rice a success story?

Tomato contracts were a failure because of the breach of contracts by the company. They offered a price much lower than the market price when the commodity was harvested. This led to wide spread distrust. Later they came up with better contracting agreements for basmati.

4. Why contract farming is successful in Thailand?

In Thailand, contract farming has a good back up from the government side and that is the major reason for the success over there.

5. Is there any legal framework for the contract farming in India?

In India, an Indian contract Act was passed in September 1872. However there are no legislations regarding contract farming as such. Under the new agricultural Marketing Produce Act recently passed in Haryana, all contracts have to have details explicitly stated and need to be registered with the government as well. This system is yet to be replicated throughout the country.

ABSTRACT

Contract farming is a market driven phenomenon unlike traditional farming that first produces and then look for the market. It is defined as an agreement between the primary producer (farmer) and an agri-business firm (sponsor) to procure certain pre-agreed quantity and quality of a produce at a particular time and price in future. It can purely be a procurement transaction or can extend into supply of inputs or even beyond (Easton and Shepherd, 2001).

The different types of contract farming include marketing contracts, production contracts, resource providing contracts and product specification contracts. Contract farming arrangements fall into one of the five broad models, which include centralized model, nucleus estate model, multipartite model, informal model and the intermediary model.

Contract farming began in Taiwan in 1895. Firms started to practice contract farming in the late 1970s and its popularity increased throughout in 1980s. In India, contract farming can be traced back to the colonial period. However, the concept of contract farming has come a long way from such origins. In the last couple of decades, it is viewed as a tool to provide technology, extension service, credit etc to the farmers. it is perceived as a mutually beneficial agreement between the firm and the farmer. by the government and international aid agencies (Asokan and Singh, 2003).

Contract farming in India is being practiced in various crops like tomato, mushrooms, sunflower, gherkins, chilies, medicinal plants, poultry etc in various states like Punjab, Haryana, AP, TN, Karnataka, Kerala etc. Legislation in India states that no company can hold land for agricultural purposes. This has furthered the case of contract farming resulting in control of the produce as well as costs.

Contract farming of seed in India is practiced by multinational firms like Pepsi, Cargill, Sandoz, etc and domestic corporate like Rallis India, Advanta India, Indo-American Hybrid seeds, Nath seeds etc and the public sector. The National Seeds Corporation (NSC) still works with 7000 farmers under contracts (Singh, 2003).

Thailand has been one of the pioneers in contract farming practice in Asia. It has been so largely due to the active promotion of this mechanism of coordination of agricultural production and marketing in the mid 1980s. Contract farming has been a key element of the government's development plan reflecting the strategy of private-led integrated agricultural development (Singh, 2002).

For successful contract farming, the government has to be prepared to manoeuvre on the policy front. Legal sanctity of the process of contracting and the institution of farm contracts should be ensured. Registration of the contracts with the government should be made necessary to prevent exploitation of both contracting parties along with the provision of technical support from the state agricultural departments and universities.

Contract farming can be regarded as one of the options to create a friendly environment within the private sector for agricultural development. A well-managed contract farming is effective in linking the farm sector to sources of extension advice, mechanization, seeds, fertilizers and credit and to guarantee profitable markets for the produce. The proper implementation of government policies and proper environment for the private sector will surely pave a new way in Indian agriculture.

SELF HELP GROUPS FOR RURAL PROSPERITY

By

LINA JOY
(2004-11-48)

SEMINAR REPORT

Submitted in partial fulfillment for the
requirement of the course
Ag.Econ. 651 – Seminar

DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF HORTICULTURE
KERALA AGRICULTURAL UNIVERSITY
VELLANIKKARA – 680656
THRISSUR

DECLARATION

I, Lina Joy, (2004 – 11 – 48) here by declare that this seminar report entitled **"Self Help Groups for Rural Prosperity"** have been prepared by me independently, after going through the various references cited herein and has not been copied or adopted from any of the fellow students or previous seminar reports.

Vellanikkara
Date: 15-10-05

Lina Joy
(2004 – 11 - 48)

197

CERTIFICATE

This is to certify that the seminar report titled "**Self Help Groups for Rural Prosperity.**" has been solely prepared by Ms. Lina Joy(2004 – 11 – 48), under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

Vellanikkara
Date: 15-10-05

Dr.A.Prema
Major advisor
Assistant professor
Department of Agricultural Economics
College of Horticulture,
Vellanikkara,
Thrissur.

198

CONTENTS

Self-Help Groups

Introduction

The history of the world is full of men who rose to leadership by sheer of self-confidence, bravery and tenacity.

Mahatma Gandhi.

Micro finance programmes are becoming a mainstream development intervention for poverty alleviation empowerment of the poor. It involves the provision of thrift, credit and other financial services and products of very small amount for enabling them to raise their income levels and improving living standards. As a concept it emerged in the early 1990's with the recognition that the poor people need a wide range of financial services covering credit, savings, insurance and money transfers. Their credit needs involves cost of feeding children, sending children to school, medical treatment and for many other puposes. Most of these credit needs are short term in nature and are meant for pure consumption purposes. In most cases they are deprived of these services from formal financial institution like commercial banks, co-operatives, etc for want of collateral. In the absence of accessibility to credit fro these formal financial institutions, the poor people manage to meet their credit requirements from informal financial institution viz, friends, relatives, chit funds, nidhis, credit unions, traders, landlords, retailers, commission agents, and money lenders even at higher rate of interest.

Micro finance programmes are operated through small groups commonly referred to as Self-Help Group (SHGs) A self-help group is conceived as a small economically homogenous and affinity group of poor, voluntarily coming together with an objectives of i) to save small amount regularly, ii) to mutually agree to contribute to a common fund, iii) to meet their emergency needs, iv) to provide collateral free loans to members with the terms decided by the group, and to v) solve conflicts through collective leadership and mutual discussion. The size of the group is restricted to small number ranging from five to twenty to ensure group solidarity. Homogeneity in terms of socioeconomic conditions and levels of living from the basis, for group formation. Periodical meeting on a weekly or fortnightly basis inculcating the habit of thrift, creating common fund through contributing regular savings from the members, on-lending to its members available major binding factors in group functioning. These group based credit programmes equip the poor to access financial services on easy terms and conditions. It has been recognized as having the capacity to enhance the socio-economic development of the vulnerable and marginalized, especially women by creating a community based structure that builds mutual support and trust.

Promotion and strengthening of self-help groups is a possible route to promote self-employment. Self-help groups provide, the benefits of economies of scale, cost effective alternative for different financial services, collective learning, democratic and participatory culture, a firm base and platform for dialogue and co-operation. Moreover, the benefits of Self-help groups are based on cooperation rather than competition. This

follows the real principle of "contribute according to your ability and extract according to your need. The SHG strategy involves forming small cohesive and participative groups of the poor. encouraging them to pool the thrift regularly and using the pooled thrift make small interest bearing loans to members. Subsequently bank credit also becomes available to the group. to augment its resources for lending to its members.

HISTORY OF SHGS IN INDIA

In India the concept of Self-help groups can be traced back to the Gandhian Grama Swaraj movement. It is mainly concerned with the poor and it is for the people and of the people.

The Bangladesh model of Grameen Bank founded by Professor Mohammed Yunus of Chittagong University and established exclusively for the poor helped to rease the myth that "credit is the privilege of few fortunate people".

The Grameen Bank now has an excellent recovery performance of 99 per cent. This is due to the mutual trust and accountability. This impetus of the present day SHG movement may be attributed to the success of the Grameen Bank (Sherin, 1999).

To boost the availability of credit supply to SHGs NABARD introduced SHG-Bank linkage programme in India. in 1996

RBI asked Banks to provide priority sector lending through SHG banking. SHG programme has given National priority during the year 1999.

Definitions and concept of group, self help group and women's group

Smith (1940) defined social as a unit consisting of plural number of separate organism (agents) who have a collective perception of their unity and who have the ability to act and / or are acting in a unitary manner towards their environment.

According to Bales(1950) a small group is defined as any number of persons engaged in interaction with one another with in a single face-to-face meeting or series of such meetings in which each member receives some impression or perception of each other member distinct enough so that he can. either at the time or in later questioning. give some reaction to each of the others individual person. even though it be only to recall the other was present

Mc David and Harari (1968) defined that socio-psychological group is an organised system of two or more individuals who are interrelated so that the system performs some function. has a standard set of role relationships among its members and has a set of norms that regulate the function of the group and each of its members.

Verhagen (1987) defines a self-help group (organization) as an institutional framework for various individuals or households who have agreed to co-operate on a continuing basis to pursue one or more objectives.

According to KHDP (1995) self-help means a group of about 20 farmers who are cultivating fruits and vegetables and whose farms are in the neighborhood and not scattered in the different wards of panchayats. They come together and join as a group on voluntary basis with the purpose of improving their income level by carrying out the cultivation of fruits and vegetables.

SHGs are homogeneous gathering of usually not more than 25 persons who join on a voluntary basis, in order to undertake some common activity through mutual trust and mutual help" (NABARD, 1996).

FORMATION OF SHGs

Reasons for formation...

At the micro level the establishment of SHGs can be traced to the existence of one or more common problems around which the consciousness of the rural poor is built. SHGs emerge particularly among people with limited means. Through SHGs their limited resources could be pooled to achieve greater objectives for the member as well as the community at large. Sreedaya (2000) suggests that SHGs are usually formed for one of the following reasons:

a) to struggle for survival
b) to fight against common enemy
c) to defend a common interest
d) to gain access to resources or services not available for the individuals
e) to pool resources of the members
f) to be the contact point for formation and education programmes
g) to build up countervailing power
h) to become a vehicle of change of mind and attitude
i) to work as a protective device for the individual in the process of change

Stages of formation

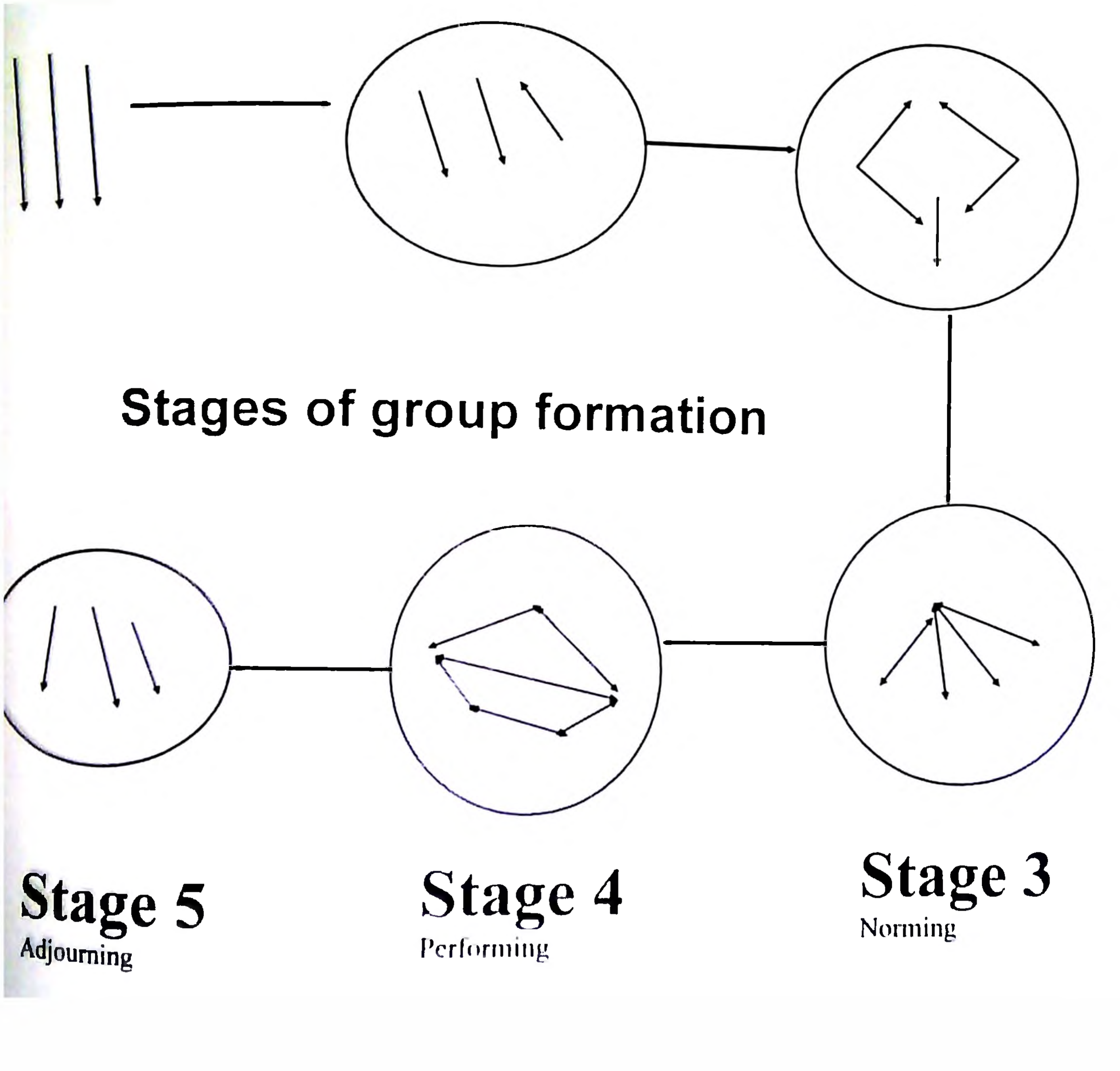
From the mid 1960's it was believed that groups passed through a standard sequence of five stages. The five stages are forming, storming, norming, performing and adjourning as proposed by Sherin (1999).

The first stage, forming, is characterized by a great deal of uncertainty about the group's purpose structure and leadership. Members are "testing the waters" to determine what types of behavior are acceptable. This stages is complete when members have began to think of themselves as a part of a group.

The storming stage is one of intra-group conflict. Members accept the existence of the group but there is resistance to the constraints that the group imposes on individuals. Further there is conflict over who will control the group. When this stage is complete, there will be a relatively clear hierarchy of leadership within the group.

The third stage is one in which close relationship develop and the group demonstrates cohesiveness. There is now a strong sense of group identity and camaraderie. This norming stage is complete when the group structure solidifies and the group has assimilated a common set of expectations of what defines correct member behavior.

The fourth stage is performing. The structure at this point is fully functional and accepted. Group energy has moved from getting to know and understand each other to performing the task at hand. For permanent work groups, performing is the last stage in their development. However for temporary committees, task forces, teams and similar groups that have a limited task to perform there is an adjourning stage. In this stage the group prepares for their disbandment.


Stage 1
Forming
Stage 2
Storming
Stages of group formation
Stage 5
Adjourning
Stage 4
Performing
Stage 3
Norming

Design Features of SHGs

SHGs have to be assessed in terms of group dynamics like cohesion, vibrancy, goal-oriented action, participation of member's democratic decision and collective leadership. The appraiser has to see whether the group is functioning, actually as a group, why the members have come together, whether it is for obtaining loan from bank or group sees other purposes, what is the group discipline and whether it is sustainable.

The basic principles on which he SHGs function are:

1. The members of the group should be residents of the same area and must have an affinity. Homogeneity of relationship could be in terms of cast/occupation/gender or economic status.

2. Savings first, credit later

3. SHGs should hold regular meetings

4. SHGs should maintain record of financial and other transactions

5. They should have norms regarding membership, meetings .etc

6. Group leaders should be elected by members and rotated periodically

7. Transparency in operations of the group and participatory decision-making

8. The group should decide rates of interest on loans

9. Group liability and peer pressure to act as substitute for traditional collateral.

SELF_ HELP PROMTING INSTITUTIONS (SHPI)

Mutual aid in farming or household work being a characteristic of rural community life, some SHGs are in existence spontaneously, but most are promoted with the active involvement of some self-Help Promoting Institutions (SHPI). Some are informal while others may be registered formal groups. Of late SHGs have come to be recognized as a pivotal means of sustainable community development. Many non-government organizations (NGOs) and even the Govt are trying to promote SHGs.

SHGs are classified according to SHPIs.

1. NGOs promoting SHGs

NGOs are trusts or societies who promote SHGs.They may initially finance from its own resources or from a bank or Govt agency. They promote, train and finance SHGs.

Eg. RASTA-Rural Agency for Social and Technical Advancement.

2. Banks Promoting SHGs

Banks promote SHGs when bank staff themselves act as SHPIs. They promote train and give credit to SHGs.Commercial banks, RRBs or Co-operatives can be SHPIs.

Eg.Krishna grameen bank –Karnataka.

3. Govt Agency Promoting SHGs

All the state and Govt entities under various schemes whose beneficiaries are SHGs comprise this type.

Eg. SGSY-Suvarnajayanthi Gram Swrozgar Yojna.

4. VVVS Promoting SHGs

VVVs (Vikas Volunteer Vahinis) are farmers clubs usually assisted by NABARD. They promote SHGs by giving trainig to farmers.

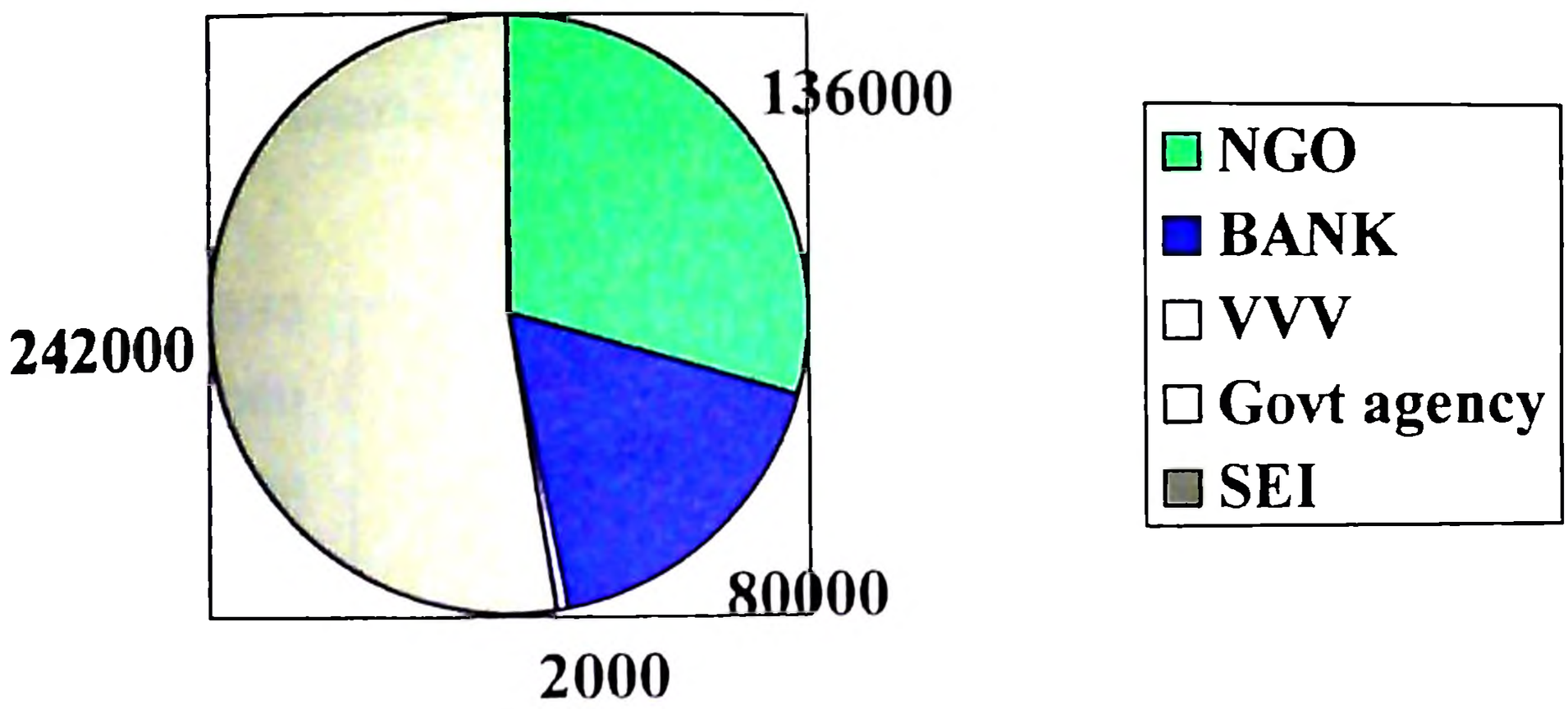
Eg. Eg:Badte Kadam Kisan Club

5. Self Employed Individuals Promoting SHGs

Individuals may promote, train SHGs.They work with or without any kind of remuneration.

Eg. Sister Stella Edathu promoting SHGs in tsunami affected areas.

Distribution of SHGs in INDIA According to SHPIs



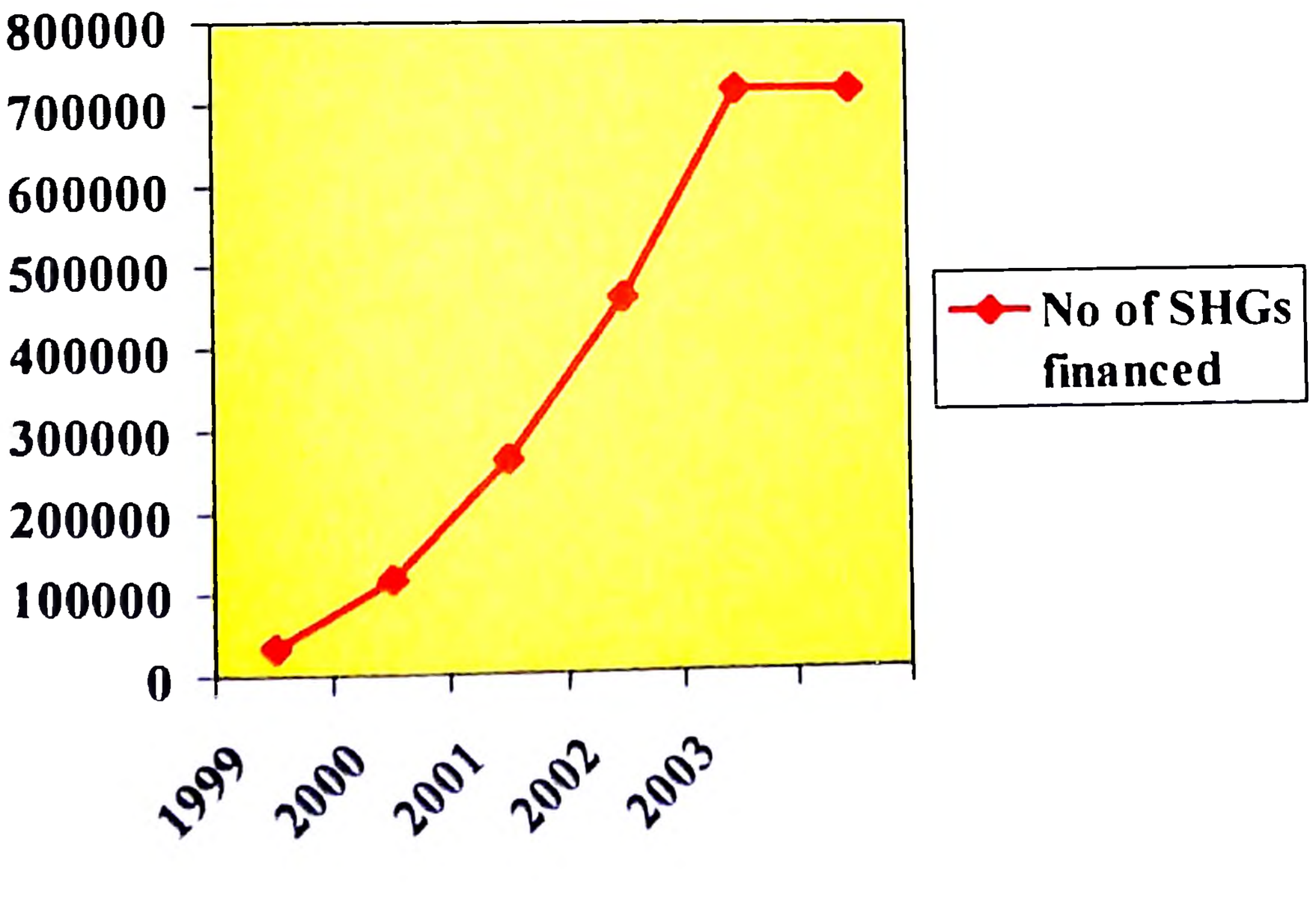
From this pie diagram it is clear that Govt agency has got maximum number of SHGs ie 2,42,000 followed by NGOs 1,26,000. VVV's SHGs are very nominal (Economic Review, 2003)

SHG-BANK LINKAGE PROGRAMME

Credit is one of the most crucial inputs for any developmental activity. If SHGs are linked with banks access to institutional credit will be easy. In short for saving mobilization and credit needs it is important that SHGs get lined with banks. In 1992 NABARD introduced SHG-bank linkage programme.

SHG-BANKING is a programme that helps to promote financial transactions between the formal banking systems in India with the informal SHGs as clients. (NABARD, 1995)This helps to promote financial transactions between the formal banking systems in India with the informal SHGs as clients.

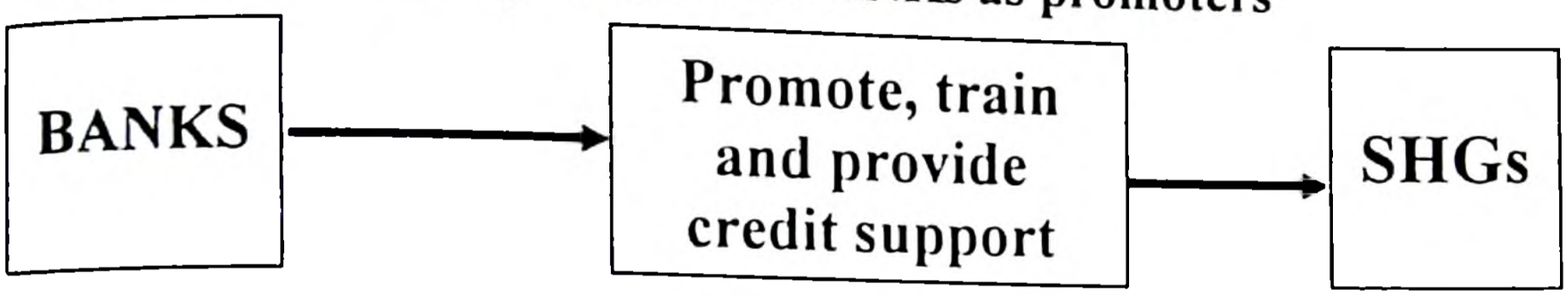
SHG –Bank linkage programme over the years



This graph show that number of SHGs linked with banks are increasing year after year that is this programme is gaining popularity. In the year 2003 over 70,000 SHGs are linked with banks (Economic Review, 2003)

EMERGING MODELS OF SHG-BANKING

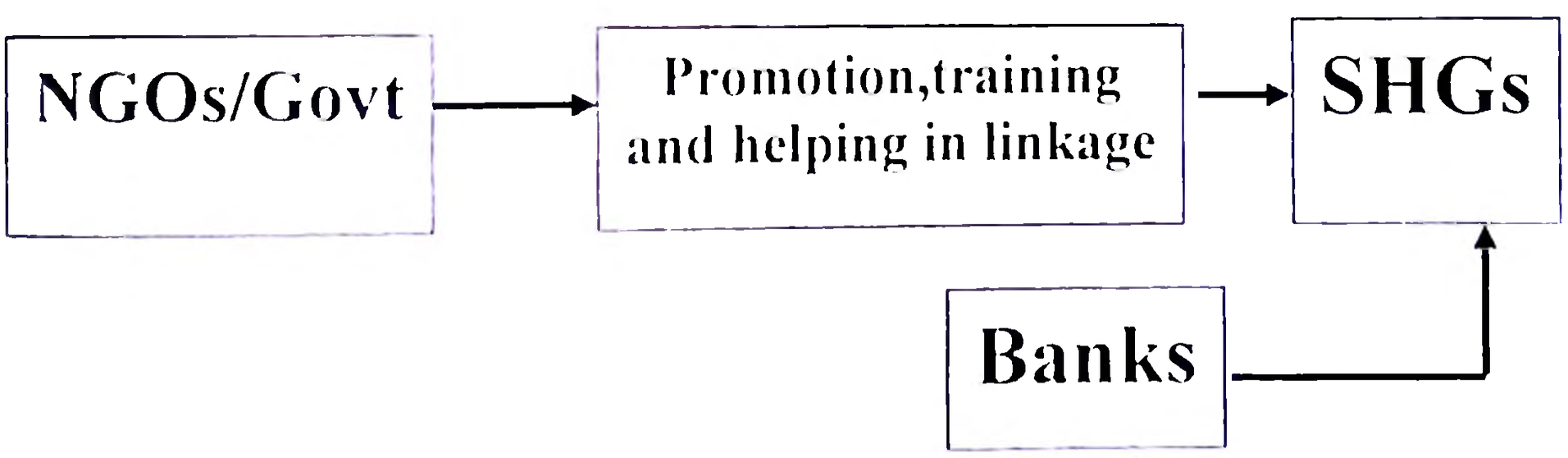
SHG-Bank linkage Model-1BANKs as promoters



In this model, the bank itself acts as a Self Help Group Promoting Institutions (SHPI). It takes initiatives in forming the groups, nurtures them over a period of time and then provides credit to them after satisfying itself about their maturity to absorb credit.

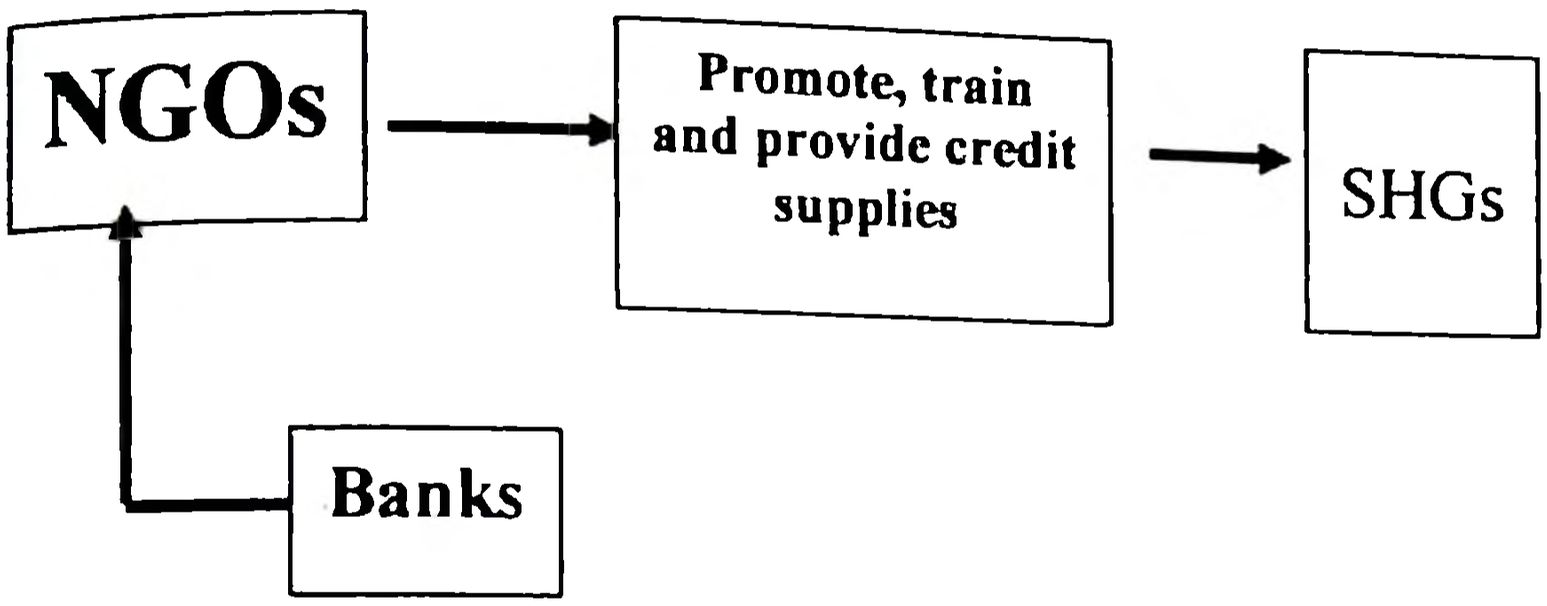
SHG Bank Linkage Model-2

NGOs as SHPIs



In this model, groups are formed by NGOs (in most of the cases) or by government agencies. The groups are nurtured and trained by these agencies. The bank then provides credit directly to the SHGs after observing their operations and maturity to absorb credit. While the bank provides loans to the groups directly, the facilitating agencies continue their interactions with the SHGs. Most linkage experiences begin with this model with NGOs playing a major role. This model has also been popular and more acceptable to banks, as some of the difficult functions of social dynamics are externalized

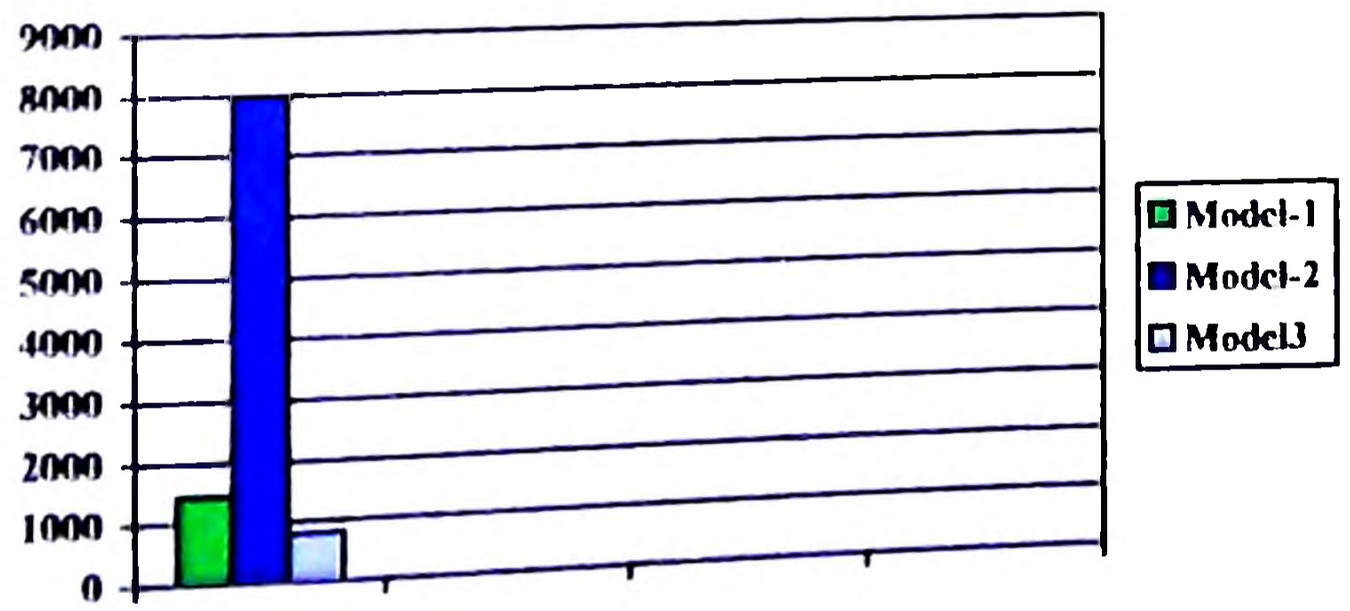
SHG-BANK Linkage Model-3



Model - III : Bank - NGO- SHG - Members

Due to various reasons, banks in some areas are not in a position to even finance SHGs promoted and nurtured by other agencies. In such cases, the NGOs act as both facilitators and micro-finance intermediaries. First, they promote the groups, nurture and train them and then approach banks for bulk loans for on-lending to the SHGs.

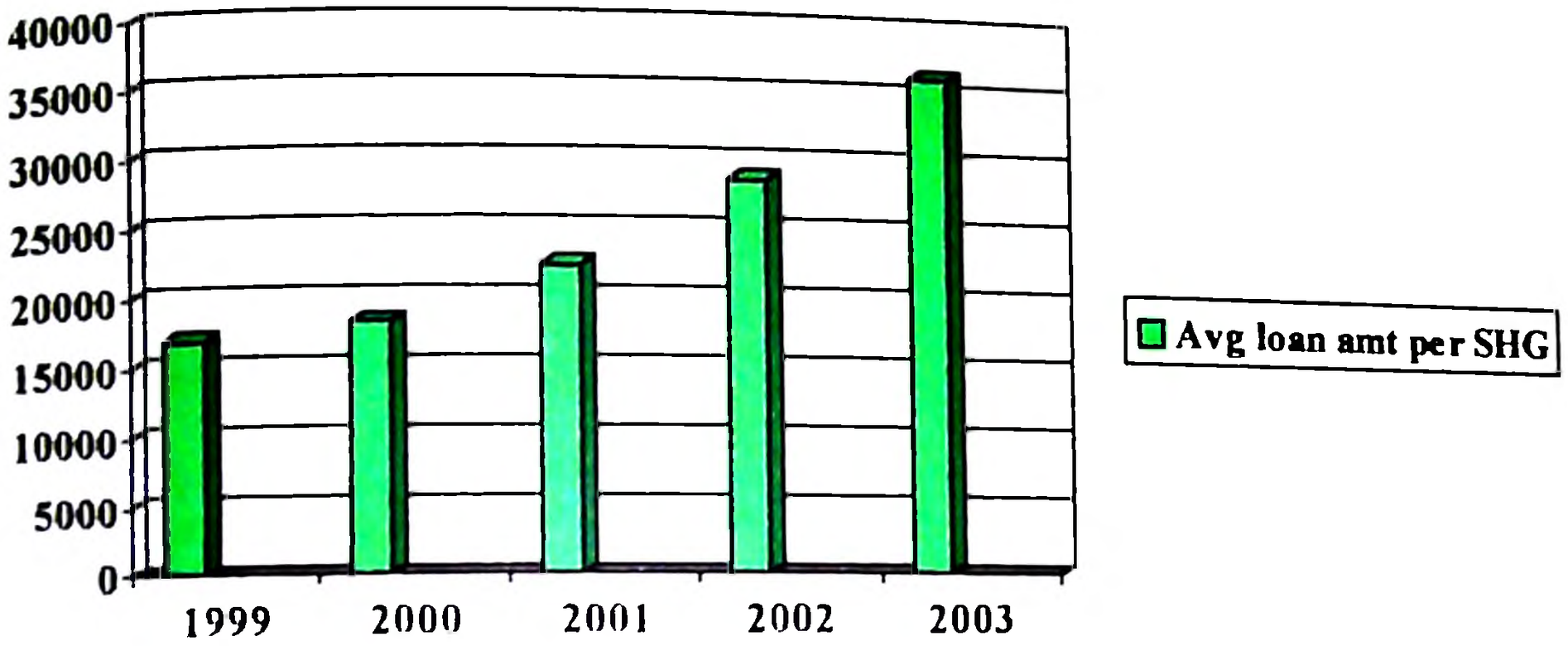
Model wise Bank loans disbursed (in million)



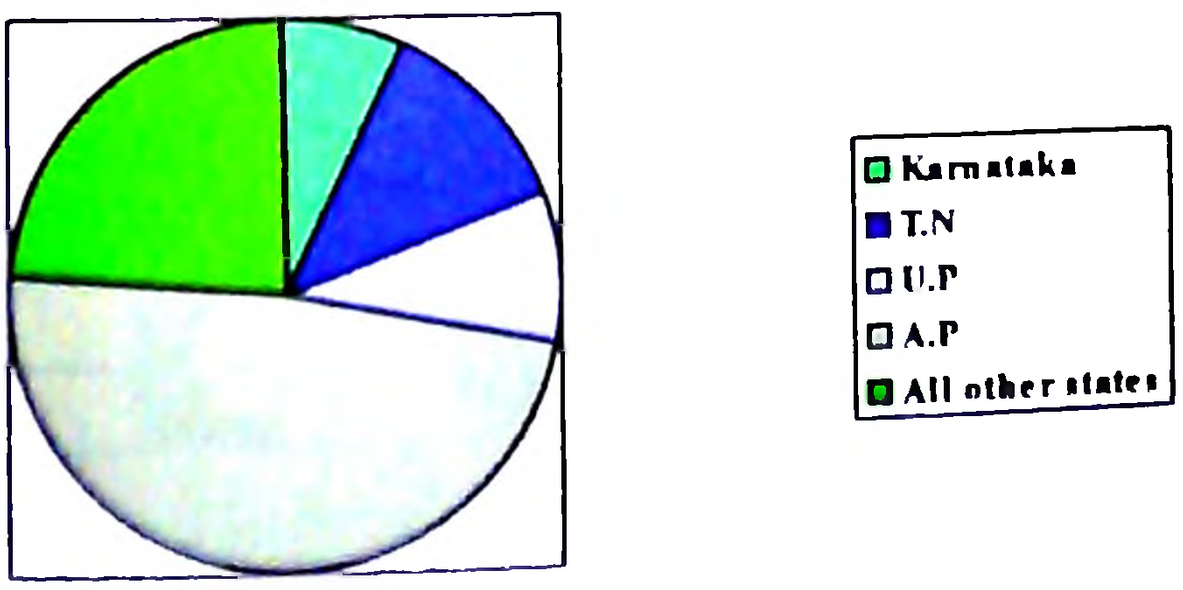
From this graph it is clear that Model-2 accounts for the highest ieRs '997million amount of loan disbursed than almost equally preferred Model-1 and Model-3. (Economic Review, 2003).

Increase in credit flow per SHG-India

Now average loan amount per SHGs is 36,000.Over the years average loan amount disbursed has shown an increasing trend (Economic Review, 2003).



Distribution of SHGs among various Indian states



It is seen that SHG experiment got success in a few pockets of the country. AP itself has 47.9% share in total SHGs. Other major states are Tamil Nadu and Karnataka and rest of the states has only 27% share (Das, 2003).

SHGs in Kerala

Kerala has achieved significant milestones in reduction of poverty percentage and increased employment rate through SHG programme.

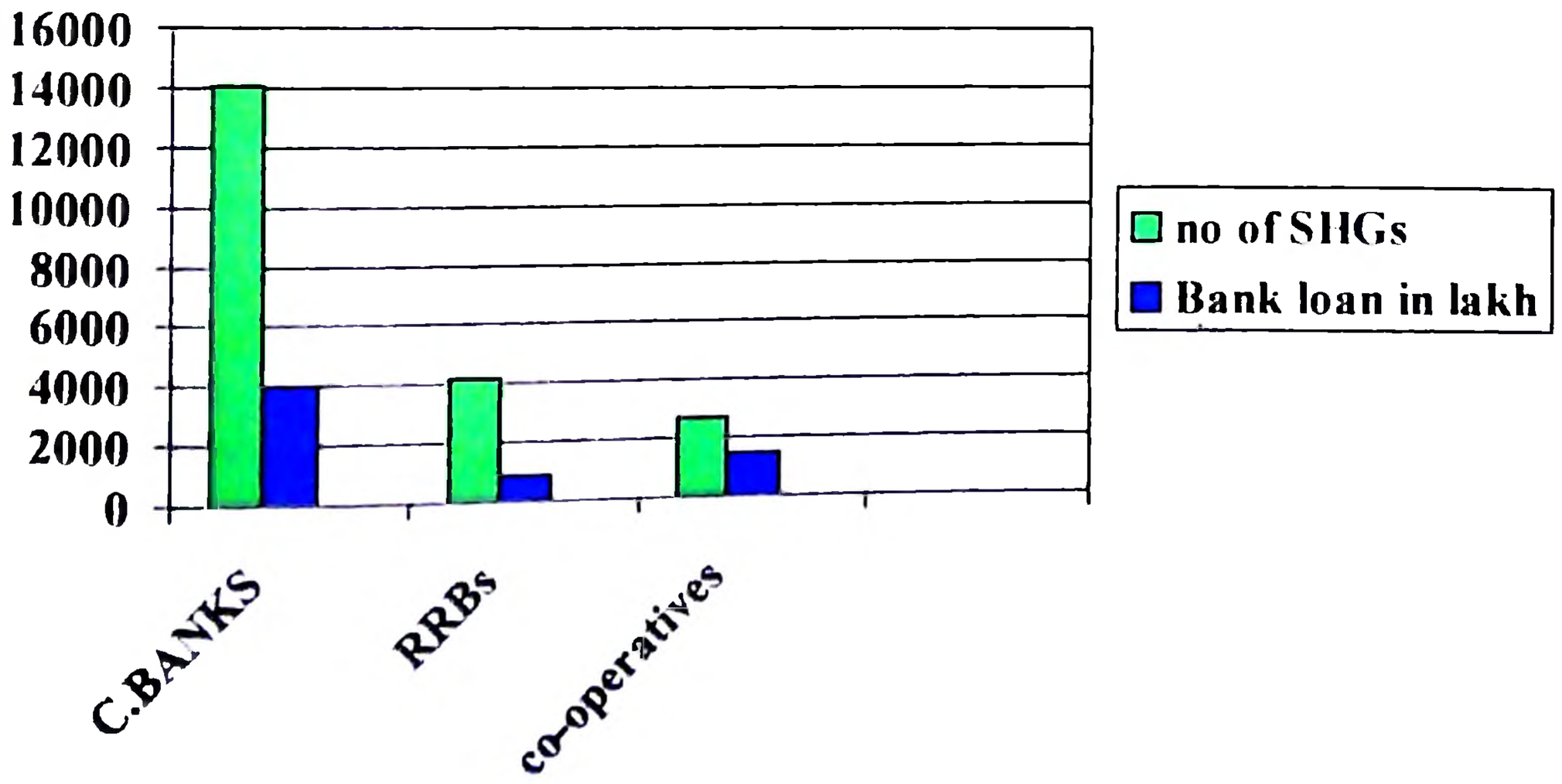
In Kerala SHGs are called Swayam Shaya Sangam have been scripted a successful story. The major Govt sponsored SHGs in Kerala and their no are given below (Economic Review, 2003).

- Kudumbashree-151406
- S.G.S.Y-8555
- V.F.P.C.K-3561 RH

Main NGO sponsored SHGs in Kerala

- Rasta(Rural Agency for Social and Technical Advancement)-1564
- KIDS(Kottappuram Integral Development Samithi)-150

SHG-BANK LINKAGE IN KERALA-2003



Commercial banks accounts for maximum number of SHGs linked 1,40,000, then RRBs ie4,000, then co-operativesie2,300.Bank loans disbursed is also high for commercial banks (Economic Review, 2003).

212

MAJOR CONSTRAINTS OF SHG PROGRAMME IN INDIA

Though the SHG programme was a success overall it has many drawbacks also. The major drawback is that the beneficiaries are nearer to BPL line not absolute poverty line people. The poorest are generally not the members of the SHGs. Some of them are not even aware of their existence.

The second major constraint is the uneven spreading of SHGs.SHG programme got success in only a few pockets of our country especially Southern parts of our country has focused disproportionately more attention on the financing for woman. It may be because they are more disciplined, credit worthy than their opposite counterparts. But until and unless more number of men are brought in to SHGs, there would be gender imbalance. We must rethink whether homogeneity should be the basis of formation of SHGs (Das, 2003).

Jayalakshmi (2001) identified, procedural difficulties faced in getting the society registered, delay in getting funds on time from the funding agency, lack of time due to domestic work, lack of proper marketing system, lack of maintenance of proper records, delay in getting inputs, fear of future when external leadership is withdrawn, heterogeneity among group members, less scope for unanimous decision and no proper leadership as the constraints experienced by SHGs of rural women

Sreedaya (2000) pointed out that the major constraints felt by the SHGs of Kerala Horticulture Development Program were associated with field centers and marketing. Where as the SHGs of Intensive Vegetable Development Program, faced constraints in planning, production, marketing and organization.

Impact of SHG programme in rural house holds Economic Impact (NABARD, 2005)

Increase in savings

- Before joining SHG the average savings wasRs460 per household
- After joining SHG, it has improved toRs1444 per household

LEVEL OF GRADUATION

The following results showed increase in level of graduation.

- **60% members cleared old debts in 3yrs**
- **Average net income increased from Rs 20,177 to Rs26,889**
- **Employment increased from 318 days to 375 days per household**

213

Reji (2002) stated that the social impacts of SHGs on beneficiaries are eflected in terms improvement in women's respect and status in family, a greater sense f solidarity, closeness and will to shoulder responsibilities among the group members.

The economic impact of SHGs on beneficiaries are reflected in terms of ncreased saving habit, increased accessibility to credit, increased contribution to ousehold income, acquisition of household assets, increased income and employment eneration.

Puhazhendhi and Satyasai (2001) evaluated the performance of SHGs with pecial reference to social and economic empowerment. The findings of the studies evealed that the SHG, as an institution could positively contribute to the social and conomic empowerment of the rural poor.

Fayas (2003) studied the economic performance and constraints faced by HGs in Thiruvanathapuram district. The results showed that the farmers of SHGs had a etter economic performance.

Conclusion

SHG system not only provides credit , but also aimed for its rural eneficiaries **capacity building**. The phenomenal growth of SHGs in rural areas indicate hat weaker sections of the society are also capable to sharpen their **micro ntrepreneurial skills** with the help of their savings and additional bank credit. romotion and strengthening of self-help groups is a possible route to promote self-mployment. Self-help groups provide, the benefits of economies of scale, cost effective lternative for different financial services, collective learning, democratic and articipatory culture, a firm base and platform for dialogue and co-operation. Moreover, he benefits of Self-help groups are based on cooperation rather than competition. This ollows the real principle of "contribute according to your ability and extract according to our need. The SHG strategy involves forming small cohesive and participative groups of he poor, encouraging them to pool the thrift regularly and using the pooled thrift make mall interest bearing loans to members. Subsequently bank credit also becomes available o the group, to augment its resources for lending to its members.

REFERENCE

Bales, R.F. 1950. Interaction Process Analysis: A method for the study of small groups. Addison- Wesley, Cambridge. 133 p.

Das, S. 2003. Self Help Groups and Micro Credit:Synergic Integration. *Kurukshetra*. 51:25-31

Government of Kerala. 2003. *Economic Review*. Government of Kerala, Thiruvananthapuram.1050 p.

Fayas, A.M. 2003. Viability of Self Help Groups in Vegetable and Fruit Promotion Council Keralam-A Multidimensional analysis. Msc Agriculture thesis. Kerala Agricultural University, Trivandrum. 213 p.

Jayalakshmi, G. 2001. Empowerment Of Rural Women through Self Help Group An Action Research. Ph.D. Thesis. Kerala Agricultural University, Trichur. 168 p.

KHDP. 1995. Kerala Horticultural Development Programme.KHDP, Kochi. pp.6-7

Mc David and Harari. 1968. Individuals, Groups, Societies. *Social Psychology*. (eds.Colins S.). Harper and Raw, New York. pp.237-238

NABARD. 1995. *Linking SHGs with Banks-An Indian Experience*. National Bank for Agriculture and Rural Development, Thiruvanathapuram. 237 p.

Puhazhendhi, V. and Satyasai. 2001. Economic and Social Empowerment of Rural Poor through Self Help Groups. *Indian J Agric Econ*. 56: 450-451.

Reji, E.M. 2002. Impact of micro finance through Self Help Groups in Malappuram District. M.Sc Agriculture thesis. Kerala Agricultural University, Trivandrum. 233 p.

Sherin, K.J. 1999. Dynamics of Self Help Group formation a case study in Thrissur District. M.Sc Agriculture thesis. Kerala Agricultural University, Thrissur. 158 p.

Smith, 1940. Social Situation, Social Behaviour and Social group. *Psychol*. 52:224-229

Sreedaya, G.S. 2000. Performance Analysis of the self Help Groups in Vegetable Production in Trivandrum District. M.Sc Agriculture thesis. Kerala Agriculture University, Trivandrum. 161 p.

DISCUSSION

1. Why modal-2 is most preferred one?

It is because NGOs train the members in this case and most of social responsibility is externalized.

2. Any registration is possible for SHGs?

Yes, SHGs can be registered under NGOact

3. Why the NABARD's definition is used?

It is the most established definition and widely used also.

4. Which is main sector in which SHGs mainly work?

Agro processing is the main field in which most number of SHGs are found.

5. Do you think this SHG programme will be able to eliminate poverty?

Yes. Till now it has shown a greater reduction in the poverty of participating families.

6. Can you name any SHG in Thrissur?

Samridhi, these SHGs work in agro processing sector.

7. The arrows in formation stage diagram, do they reveal anything?

Yes, they are used to show some particular objective. Their convergence shows orientation among groups.

8. Can anyone go out of SHGs when they feel like?

Yes, but there should not be any liability on the moving out members.

9. The major SHGs in Kerala?

The SHGs work under Kudumbashree.

10. Adjourning stage of formation, is it applicable for every SHGs?

No, this is applicable for task force SHGs.

ABSTRACT

Self Help Groups are homogeneous gathering of usually not more than 25 persons who join in a voluntary basis, in order to undertake some common activity through mutual help and mutual trust (NABARD, 1995). These groups promote savings among members and use the pooled resources to meet the emergent needs of their members, including consumption needs.

There are five stages of SHG formation. They are forming, storming norming, performing and adjourning stages. SHGs can be classified on the basis of the SHPIs promoting them NGOs, Banks, VVVs, Govt. agencies and Self employed individuals are main SHPIs. It is observed that Govt. agencies promoting SHGs out number other SHGs.

SHG-Bank linkage programme helps to promote financial transactions between the formal banking systems in India with the informal SHGs as clients. In India there are 7,17,360 SHGs linked with the banks through this programme, which provide better accessibility to credit for the SHGs.

Among Indian states A.P. has highest number of SHGs. In Kerala Kudumbashree have a good number of SHG successful stories. This federated network has a membership to 30,98,011 poor families. The thrift mobilized by NHGs amounts to Rs.432.34 crores.

An impact study conducted by NABARD revealed that the participating SHG households have achieved significant economic growth. A study showed that participating women's respect and status in family have improved (Reji, 2002).

SHGs not only provide credit, but also aimed for the rural beneficiaries' capacity building. The phenomenal growth of SHGs indicates that rural people are also capable to sharpen their micro-entrepreneurial skills with the help of their savings and additional bank credit. Thus, SHGs helps in achieving prosperity among rural people.

217

FUNCTIONING OF VEGETABLE AND FRUIT PROMOTION COUNCIL KERALAM

By
GRACE SARALA.S
(2004-11-04)

SEMINAR REPORT

Submitted in partial fulfillment for the
requirement of the course
Agrl.Ext.651 – Seminar

DEPARTMENT OF AGRICULTURAL EXTENSION
COLLEGE OF HORTICULTURE
KERALA AGRICULTURAL UNIVERSITY
VELLANIKKARA – 680656
THRISSUR

218

CERTIFICATE

This is to certify that the seminar report titled "FUNCTIONING OF VEGETABLE AND FRUIT PROMOTION COUNCIL KERALAM" has been solely prepared by Ms. Grace Sarala.S (2004-11-04), under my guidance, and has not been copied from any seniors, juniors or fellow students seminar reports.

Vellanikkara
Date

Dr. Sreevalsan J. Menon
Major advisor
Assistant professor
Department of Agricultural Extension

219

DECLARATION

I, Grace Sarala.S (2004-11-04) hereby declare that the seminar entitled "Functioning of vegetable and fruit promotion council keralam" have been prepared by me, after going through various references cited at the end and has not been copied from any of my fellow students.

Vellanikkara

Date: 15-10-2005

Grace Sarala.S

2004-11-04

220

Contents

INTRODUCTION

Agriculture continues to be the most important and single largest sector of the state's economy accounting for the State Government, the state will recognize and develop agriculture as a worthwhile occupation capable of ensuring a decent living, dignity and social status to agriculture through judicious utilization of scarce resources of land, water, manpower and technology with focus on increasing production and productivity in a planned manner.

Group formation is a pre-requisite for participatory approach (Mukherjee. 1997) Farmer participation comes when the farmers have an organization to manage their resource at some level Participation naturally flows from the farmer's organization when it is effective (Maloney and Raju, 1994). Extension management by group brings out the best among the individuals of the institution by promoting democratic decision- making and interaction in its day-to-day management. Farmers groups enable extension workers to work directly with farmers with the objective of understating better the farmer's circumstances and influencing the research and extension policies and practices in order to come up with more effective research and extension programmes

For an sustainable development of agricultural sector, farmer has to be the focus and the system should be built around them. Here come the relevance of Self Help Groups A Self help group is a homogenous gathering of usually not more than 25 persons who join on a voluntary basis in order to undertake some common activity through mutual trust and mutual help

The concept of SHGs was initiated by quasi-governmental and governmental agencies in Kerala a few years back The core concept used by Vegetable and Fruit Promotion Council Keralam (VFPCK) for promoting the development of farmers is the 'Self Help Group' a voluntary unit of 15-20 cultivating farmers.

Vegetable and Fruit Promotion Council Keralam is a company having majority of farmer share. It's headquarters is in Ernakulam district a place by the name– Kakkanad . Its branch offices are present in all fourteen districts of Kerala.

Parent organisation:

VFPCK parent organisation is Kerala Horticulure Development Programme (KHDP). It started its field activities in the year 1993, with the financial support of the European Union and the GOK. The total project outlay was Rs.131.95 crores. KHDP (1995) in their programme identified guidelines for the formation of self helf groups are three stages.

a. Group initiation/formation stage
b. Building up/ stabilization stage
c. Self-helping stage.

The broad aim of programme was

1. To give farmers in Kerala a supplementary income by raising the production of high value horticulture crops
2. To ensure that farmers incomes are improved by value addition through development of a modern processing factory and by strengthening the link with existing marketing institutions for fresh fruits and vegetables.
3. Provide a replicable methodology to make fruits and vegetable crops an important sector in Kerala's agriculture production pattern.

It was a six-year project that would culminate in the formation of an organisation called Kerala Horticulture Development council. Then renamed as Vegetable and fruit promotion council keralam.

After a series of studies seven districts of Kerala were identified for the launch of the pilot project. They were Ernakulam, Kottayam, Trivandrum, Trichur, Palghat, Malappuram and Calicut. Activities were first launched in villages of Trivandrum, Ernakulam and Kottayam and gradually over the years the programme has spread to the other districts. Sreekumar(2001) stated that the self help groups of VFPCK are formed by farmers joining voluntarily with the purpose of improving the income level. They

have common concerns, common problems, and common objectives and also they are willing to collaborate as members of the group. Nanda(2002) reported that the advantages for groups lie in their access to larger quantum of resources as compared to their corpus generated through different schemes of banking sector and a general improvement in the nature and scale of operations that would accelerate economic development and viability.

Mission: To develop and sustain cohesive self help groups of farmers who use participatory approaches and innovative environment friendly practices to produce and market vegetables and fruits, leading to prosperity and gaining social empowerment.

Objectives:

1 The primary objective of VFPCK is to improve the livelihood security and thereby enhance and sustain the income of fruits and vegetable farmers of Kerala.

2 To increase and promote the commercial production of vegetables and fruits and their consumption

3 The optimal and sustainable utilization of technology, human and natural resources

4 To improve the livelihood security of dependent farmers.

5 Ensuring a better share and income from production through cost effective and producer oriented marketing

INSTITUTION

In each district the core concept used by VFPCK for promoting the development of farmers is the formation of Self help group which is voluntary group of 15-20 cultivating farmers. The SHG are expected to have common objectives, tasks, and group identities. It is a system where all members work together cohesively to address problems and utilize opportunities through participatory action, accessing minimal external support, for the overall development of members.

Each SHG is run according to a set of rules and regulations. For instance, they should meet at least once every month to discuss member's problems; minutes of the meeting should be recorded.

VFPCK farmers feel being part of an SHG provides them with multiple benefits. These include opportunities for increased social interaction, increased bargaining power, quality input procurement, improved agricultural practices, improved marketing and credit facilities, problem solving ability etc.,

It has been found that even when members believed in various ideologies, or belong to different caste or religion etc., it had negligible influence on the way of the group functioning. Surendrdan (2000) reported that farmers in NGO groups had shown high levels of cosmopoliteness behaviour as compared to others

To become a member of an SHG there are eligibility requirements

1. Like for instance, the farmer should be permanent resident of the area
2. The farmer should own a minimum 25 cents of land for 3 seasons /50 cents of land for 2 seasons / 75 cent of land for 1 season.
3. The ownership of land is not sufficient. The farmers should cultivate minimum acerage of crops If he is a banana farmer should cultivate at least 300 banana plants in a year.
4. The primary income of the farmer should from agriculture.
5. The farmer should be above 18 years of age.
6. The farmer should be willing to associate as permanent membership of a group.

ORGANISATIONAL STRUCTURE

The board of directors consists of 11 members.

1. Chairperson -1 (Agriculture Minister)
2. Agricultural Production Commissioner-1
3. Secretary to government-1
4. Chief Executive officer-1
5. Farmer representatives – 4 persons
6. Nominee of Participating Banks -1
7. Nominee of National Agency on Horticulture-1
8. Nominee of European Union-1

This ensures that a large number of people are trained to spread awareness and knowledge among the farming community. Rotation also prevents vested interests from developing in the functioning of the Self help groups

FIELD CENTRE

A group of 10-12 SHGs form a field centre. Under VFPCK strategy field centres are the central points for the 10-12 SHGs to market their produce together. According to Girija et al., (2001) the linkage between banks and self help groups works out to the advantage of both the bank and the borrower.

In each FC there is VFPCK extension staff called Assistant Manager. This manager plays a facilitating role in organising SHG meetings and farmer training in his area of operation. He also works with the local farmers to implement different policy interventions of VFPCK at the SHG level and to ensure that field centre run according to prescribed norm

All SHG farmers do not automatically become members of the FC. Those who wish to be members are required to contribute a sum Rs.500. This money is used as the capital for running their FC

For the first year of FC operation VFPCK provides basic furniture, a weighing balance, accounts registers, rent for the premises, salary for the secretary and audit fees to a Charted Accountant who check the accounts of FC on a monthly basis.

Field centres which are able to meet the performance criteria set by VFPCK are further assisted to acquire land to erect a permanent building for running the farmer's market. About 5-7% of the sales value is retained by the FC's as a commission and this is used to pay for all the overhead expenses. At the end of the year the surplus commission after meeting all overheads are returned to members of the FC as a bonus.

All "master farmers-marketing" in individual SHGs are members of the FC committee- the body that runs the FC. Each committee elects a Convener who liaises with the markets, traders and VFPCK. The master farmer (marketing) of each SHG is responsible for liasoning between the FC and the SHG members.

PROJECT AREA

All the FCs in a particular district forms a project area. A VFPCK staff called Project Area Manager. This person coordinates the activities of all Assistant Managers heads each project area. All Assistant Managers are called for a fortnightly meeting where their work for previous 15 days is reviewed and their activities for the next 15 days is planned. In each project area (i.e. each district) there is a training centre where the training activities of the district are coordinated. These include the master farmer trainings as well as apart of the project staff.

A resource group comprising of four assistant managers in charge of production & technology, training, credit and marketing respectively also assists each project area manager.

All the district level project area managers report to the team of Specialists/consultants at the VFPCK headquarters in Ernakulam. There is also a monthly project review meeting.

ACTIVITIES

Training:

VFPCK's training programmes are all need based. Except for introductory trainings., it is the SHG members who decide what they need to learn or understand. Only then VFPCK staff organise a field-oriented farmer training to provide them the required information. All VFPCK's training programmes are sill oriented like new ways to control a disease or a new cultivation practice and not academic bookish knowledge. There is active participation of farmers in the training session. Training is by doing, seeing and with the use of audiovisual training aids. Most importantly VFPCK trains master farmers who in turn train the other farmers. Sreedaya(2000) reported that experience in vegetable cultivation was positively and significantly correlated with need satisfaction among VFPCK self help groups. Meera (2001) reported that training improves skill of members to do any particular work, leading to employment and

increase in income. Training had a positive and significant relationship with increase in income.

Moreover, the experiences of being a VFPCK master farmer improve the self-confidence of ordinary farmers. This is reflected in the way they tackle day-to-day situations in their personal, social and economic life.

All the farmer-training programmers are held in the village amongst SHG members. Farmers need not go to the town to learn something new. There are at least 2-3 farmer trainings in each SHG every year. After every training session the SHG members to implement what they have learnt draw up an action plan. Very often senior VFPCK staff picks up a copy of these action plans and visit the sites to see if the farmers have actually implemented what they have learnt. This way the effectiveness of training is constantly monitored

Extension:

- Going to the farmers, meeting them at their fields - Office less extension.
- Helping the farmers to appraise their problems and solve them
- Be with the farmers and always accessible to them
- Technology at farmers' door step
- Being one among them

In the pre-VFPCK days farmers would have to visit the local agriculture department office to get any help or advice. Public extension systems were focused on delivering "products" like seeds, fertilisers, etc., to farmers rather than facilitating the flow of knowledge and agriculture information.

In VFPCK there is no subsidy. The only thing it is today giving free to farmers is high quality information o production technology, marketing etc. The extension system is thus designed to effectively transfer information and knowledge rather than commodities to farmers.

To start with VFPCK staff actually go to farmers doorstep to listen to their problems. They literally do not have an office to sit. It is an "**office less extension**" system. It is not just regular visits but also the path breaking work the VFPCK staff does that has made this development project so successful. Young agricultural graduates work are meant solely for the purpose of resource support.

Pest and disease surveillance

Pest and disease surveillance and forecasting system is a service to the farmers, which is aimed at providing information to enable farmers of a particular area to take respective precaution with maximum economical benefit and lowest environmental hazard.
Surveillance units are conveniently fixed so that there are sufficient number of units to represent the major vegetable and banana growing areas. There will be two plots for each fixed plot surveillance units in respect of each crop selected at random. Each plot will be subjected to observation twice in a week. The fixed plot survey is conducted and the information is recorded in the sampling format. The data received will be analysed and the results will be communicated to the farmers.

Farmer Field Schools (FFS)

Farmer Field Schools are conducted for the purpose of helping farmers to discover and learn about field ecology, agronomy and integrated pest management. The training is carried out in the field, which can be called the "class room without walls" and which is close to where the participants have their production field or even in their fields.

Demonstrations

VFPCK demonstrate proven technologies to farmers to convince them the feasibility and efficacy of new practices. Demonstration is a very effective extension method to disseminate new technology. Scientifically proven practices like box method of vermi composting, preparation of organic pesticides like neem oil emulsion, neem oil-castor oil emulsion, safe handling of pesticides, high yielding varieties, improved production technology practices etc are demonstrated to farmers. Neighbouring farmers also present when critical inputs are applied. Harvest festivals are conducted with the participation o of neighbouring farmers where in the demonstrating farmer will explain his experiences especially about economic benefits.

Campaigns : Mass action through mass awareness

VFPCK organise campaigns to create mass awareness and involve collective action. Through campaigns, extension messages reach maximum number of people at the shortest possible time. Need based campaigns are organised on topics such as vermi composting, organic farming, straight fertiliser, Control of Kokkan, Pseudostem borer in banana etc.

Group Marketing:

The concept of group marketing, in simple terms, is marketing managed by farmers groups. As the name implies, the major focus is to empower and facilitate the farmers to take more effective decisions with regard to the marketing of their produce. This Market formed are known as **"Swasraya Karshaka Samithi"**.The concept of group marketing thereby provides the member farmers better access to markets and therefore a greater share in the consumer's rupee Bony (1991) in his study reported that high cost of plant protection chemicals, inadequate marketing, storage and post harvest facilities were the problems of commercial vegetable cultivation.

FAO (1999) reported that the viability of Small farmer group association (SFGA) seems to depend most on its success in improving the economic conditions of individual members through better economic cooperation between member groups and in generating income for the running costs of the SFGA.

Swasraya Karshaka Samithi(Farmer markets)- Major highlights

- A Market fully owned and managed by farmers
- Well trained committee
- Market information and management support from VFPCK
- Transparent accounting system & regular auditing
- Better bargaining power
- Reduced size of marketing chain.
- Quality produce.
- Production centre oriented system

Market Information Centre:

The objective of Market Information Centre is to provide appropriate, accurate and timely market information to the farmers and to the horticulture sector as a whole. Daily wholesale & retail prices and arrivals of 36 vegetables and 3 major fruits from 16 wholesale markets in Kerala and 5 out of state wholesale markets 6 urban retail markets are available in Market Information Centre.

CREDIT PACKAGE

The eligibility requirements for this credit package include:

1 SHGs must attain a minimum age

2 Its member farmers must be permanent residents of the pilot project area

3 Must own at least 200 sqm of land

4 Must cultivate minimum acreage of crops

5 Must follow recommended technical package

6 Must be an active member of SHG

7 Must have no overdue and there must be no revenue recovery initiated against them within the last 3 years

According to Girija et al , (2001) the linkage between banks and self help groups works out to the advantage of both the bank and the borrower. A study sing an ex-post facto research design to investigate on the perception of officials about self help groups involved in vegetable cultivation in Thiruvananthapuram district, Kerala.The study concludes that majority of the officials had a strong positive feeling towards the concept of self help groups

Under this credit package, it is the self-help groups that determine the credit worthiness and credit requirements of the members eligible for finance through a participatory credit planning approach. Birdar and Jayasheela (2000) reported that in the case of agricultural credit many farmers do not get adequate loans for the intended purposes. Proper supervision over the end use of the credit and other personal reminders through frequent field visits can be effective devices for checking mounting of over dues.

Eligibility farmers as a group submit their application for credit. The banks charge farmers the normal interest rates applicable to agriculture loans. VFPCK also earns the

normal bank interest on its deposit. Nagayya(2000) stated that micro credit supply is an informal arrangement for credit supply to the poor through SHG which is fast emerging as a promising tool for promoting income generating enterprise.

Since the farmers are all members of SHGs there is pressure for the borrowers to repay the loans in time since default of even one farmer in the group affects the future credit availability to the entire group. Puhazhendi and Satyasai (2000) defined micro finance as the entire range of financial service rendered to the poor and includes skill up gradation and entrepreneurial development that would enable them to overcome poverty.

Participating banks

- State Bank of India
- State Bank of Travancore
- Union Bank of India
- Canara Bank
- South Malabar Gramin Bank
- Dhanalakhmi Bank
- Indian Overseas Bank
- Vijaya Bank
- North Malabar Gramin Bank
- Bank of Baroda
- Indian Bank

INSURANCE

VFPCK in association with New India Assurance Co. Limited and the participating banks has introduced an innovative insurance cover for banana farmers. The novelty of this insurance is that it covers the loss suffered by banana farmers due to pseudo stem borer and kokkan disease apart from natural calamities. In the event of a crop loss the assessment (up to a certain value) is normally done by VFPCK itself, which in turn sends the report to New India Assurance for settlement through banks. The premium is Rs. 2.40 plus service tax of 12 paisa per plant.

Efforts like campaigns against kokkan and pseudostem borer random checking by technical staff etc., are being taken by VFPCK to make this policy a more sustainable one.

FARMER OWNED AGRO PROCESSING FACTORIES

Fruit processing factory:

Nadukkara Agro Processing Co.(NAPC) Ltd. is a modern factory for commercial processing of pineapple, mango and other fruits. It was
set up to play an important part in VFPCK's strategy to ensure that farmers eventually own a processing factory by becoming shareholder. The factory was also supposed to provide supplementary income to farmers.

NAPC is located in the heart of Kerala's pineapple growing area Nadukkaara in Avoly panchayat near Muvattupuzha (45 minutes drive from Ernakulam). It is established as a public limited company where eventually farmers will become 70% shareholders and government of Kerala 30% shareholders.

The factory was set up at a cost of Rs. 30crores. Much of this money was spent to acquire a world-class fully automated multifruit processing machinery from Italy.

The factory has three product lines:

concentrate line

ready to serve

Candied fruit

For marketing the fruit concentrate NAPC has tied up with National Dairy Development Board (NDDB). Through them they have already exported a few containers to European Union countries. Private sector food companies like Dabur have also bought fruit concentrate from NAPC. It has also recently launched a ready to serve 250ml pineapple juice called "JIVE" in the domestic market.

Difficulty –

Kew variety of pineapple that is ideal for processing purpose is presently not grown in Kerala. The factory is now suing the less suitable Mauritius variety for making concentrates, which are not very popular in the export markets. The size of the factory itself is less than optimal capacity so per unit costs are higher than competition. With a view to compete in the world market arranging the supply of raw materials from farmers is another problem. Farmers are more inclined to sell their fruits in the open market whenever they get higher price. The factory cannot afford to purchase the fruits for processing at such high prices.

Seed processing factory:

VFPCK has also set up a seed-processing factory at Alathur about 20 km near Palghat with the aim to "produce quality vegetable seed to farmers in time, insufficient quantity and at reasonable prices in a commercially sustainable manner"

VFPCK trained farmers multiply parent seeds from Kerala Agriculture University (KAU). The seed-processing factory then buys the seeds from them, processes it and sells it to farmers all over the state. The processing factory was set up at a cost of Rs. 1 crore (machinery from the Italian firm Ballarini Socoma at a cost of Rs. 65 lacs) European Union funded the machinery. Government of Kerala provided 2 acres of land. The unit can process 300-500 Kg of vegetable seeds per hour.

Although the intension of the factory is to supply vegetable seeds to VFPCK farmers more than 70% of its sales is presently to non-VFPCK farmers (mainly through government orders via People's Plan Programme). Many VFPCK farmers still use home saved seeds and find it expensive to buy the hybrid seeds. The factory is presently using only 10% of its capacity. The back ward linkages of the see-processing factory have been noteworthy. Because of "buy back arrangement" farmers acreage under seed production has increased. The average farmer involved in seed production owns over

0.4 hectares of land.

Crop	Variety name	Price per Kg*
Amaranthus	Arun	Rs.425/-
Ash Gourd	KAU(Local)	Rs.490/-
Bhindi	Arkaanamika	Rs.250/-
Bitter Gourd	Preethi	Rs.750/-
Brinjal	Haritha	Rs.490/-
Chilli	Ujjala	Rs.800/-
Cucumber	Kanivellari	Rs.550/-
Cowpea	Kanakamani	Rs.80/-
Cowpea	VS 13	Rs.240/-
Cowpea	Vijayanthi	Rs.240/-
Pumkin	Ambili	Rs.490/-
Snake Gourd	Kaumudi	Rs.600/-
Snake Gourd	Baby	Rs.600/-
Bottle Gourd	Arkabahar	Rs.560/-

PARTICIPATORY TECHNOLOGY DEVELOPMENT

VFPCK counts PTD as one of its key and novel contributions to Kerala agriculture. One of the attractions of PTD is that it involves farmers in the development of new technology. When some problem arises, instead of rushing to the university to fine the solutions in PTD farmers sit down and discuss the problem. Then aided by the VFPCK extension worker they search for various options available to them. A few options are selected and experimented in an individual farmer's field.

The farmer evaluates the success of the experiments and the SHG evaluates and recommends the most effective option. Since in PTD it is the farmers who are finding

the solutions there is a big motivation for them to adopt the technical recommendations in their fields.

PTD also addresses agriculture problems better because farmers are also involved in developing the solutions. It is cost effective and less dependent on agriculture research institutions. In a typical institutional field research all the costs are paid by the project except the farmers labour. In PTD the farmers themselves normally cover all costs.

Most of the experiments focus on pest and disease management and production of low cost agricultural inputs. Some of the best PTD experiments are taking place in Malappuram district. These include: developing new crop varieties, organic manure trials, harmone application in cow pea/gourds, high density planting in banana, control of PSB in banana, tissue culture banana, IPDM in vegetable, sigatoka management and low cost pandal in bitter gourd.

PUBLICATIONS

Krishiyankanam

It is a bi – monthly publication in malayalam. Farmers are the major subscribers. Each issue covers a specific topic connected to commercial cultivation of fruit and vegetables

Handouts

Handouts are published on both technical and non-technical topics

1 Self help groups of VFPCK
2 Group Marketing
3 Credit Package
4 Plant Protection Chemicals
5 Fertiliser Management
6 Nematode Control in Banana
7 Post Harvest Handling of Fruits and Vegetables
8 Post Harvest Handling of Banana
9 Post Harvest Handling of Bitter Gourd
10 Integrated Pest and Disease Management
11 Cultivation Practices of Cowpea(Yard long bean)
12 Cultivation Practices of Bhindi(Okra)
13 Cultivation Practices of Brinjal(Egg Plant)
14 Cultivation Practices of Coccinia

15. Cultivation Practices of Pumpkin, Ashgourd and Cucumber
16. Cultivation Practices of Bittergourd and Snakegourd
17. Cultivation Practices of Amaranthus
18. Cultivation Practices of Chilli
19. Cultivation Practices of Bottlegourd and Ridgegourd
20. Cultivation Practices of Mango
21. Soil Testing

Books Published:

1. Banana cultivation
2. Quality seed production

Technical bulletins

1 Integrated Pest & Disease Management in Fruits and Vegetables (Malayalam)

2 Principles of Quality Seed Production (English)

National Seminars

1 Proceedings of National Seminar on "Farmer Friendly Technology Transfer.

2 Proceedings of National Seminar on "Participatory Technology Transfer".

3 Proceedings of National Seminar on "Participatory Approaches for Horticulture Development"

4 Abstract Souvenir of National Seminar on Technology Transfer.

5 Abstract Souvenir of National Seminar on PTD.

6 Abstract Souvenir of National Seminar on Participatory Approaches for Horticulture Development

EUREPGAP Certification Programme:

EUREPGAP is a means of certification of agricultural products. It is a system or process certification. Emphasis is given on the good agricultural practices to be followed that contribute to the quality of the produce. EUREPGAP certification

incorporates integrated pest management and integrated crop management practices within the framework of commercial and sustainable agriculture production for long-term improvement and global harmonization. This certification is applicable for all kinds of fresh fruits and vegetables for direct human consumption.

Foodcert is the accredited inspection and certification body and has its base in India at Hyderabad. VFPCK has been identified as the agency to promote the concept and undertake the inspection activities

The main objectives are

- Establish good agricultural practices in the production system of fruits and vegetables
- Promotion of the concept of Eurepgap certification
- Marketing of Eurepgap certified products of SHG farmers

Any farmer in the state of Kerala, who wishes to get certified under Eurepgap can put in their applications through VFPCK. The identified inspectors of the Council will undertake the inspection work of the farm of the applicants and if all the criteria in the check list provided is having compliance, he will be recommended for certification and certificate to be issued by Foodcert

VFPCK concept of retailing:

The Udyanam retail chain has been started to offer consumers a wide variety and range of natural foods, specifically fruits and vegetables. The brand name "Udyanam" has been chosen as it symbolises the pleasant experience of visiting a garden and encouraging the person to come back again

The Unique Selling Propositions (USP) of Udyanam

- **Transparency in prices** : prices will be displayed at the shop to improve credibility among consumers.
- **Transparency in weighments** : actual and correct weights will only be billed
- **Good hygiene** : shop to be clean, neat and well lighted.
- **Farm fresh fruits and vegetables** : as the Kerala grown vegetables reach the shop straight from the farms.

- **Better services**

Export Promotion Cell:

VFPCK has started a new wing with an objective of promoting exports of fruits and vegetables from the state. The cell provides the necessary institutional framework and assistance to the farmers for marketing their produce outside the country by direct exporting or acting as a nodal agency. The Cell operates at the Headquarters of VFPCK. A state level apex body of the farmer vipanies of VFPCK will coordinate the exporting activities. The Cell provides the necessary liaison for bringing together foreign importers with Farmer Vipanies and farmers. The services also include assisting the setting up of export groups and export oriented activities, establishing liaison with agencies which has been set up to establish the standards of quality and packing. exporter's directory to strengthen clientele database for farmer vipanies and the apex body. Suggesting more effective marketing channels and distribution systems and use them for selling their produces. Arrange necessary insurance support for the export. etc.

Product coverage: The products include fresh and value added fruits and vegetables.

Major buyers: The major buyers are Middle East Countries. Steps have been taken to export to Europe for which export oriented production of fruits and vegetables have started under Euro gap Certification practices

Qualitative achievements:

- Promoted the concept of enduring SHGs of horticultural farmers for their economic stability and better farming decisions
- Emerging farmer as farmer trainer and equip them for farm research
- Dissemination of technical know-how through office less extension.
- SHGs equipped to ascertain financial needs and ensuring their prudent use.
- Production centre oriented farmer markets ensuring better producer share of consumer rupee and collective bargaining power.
- MIC- a data bank on market prices and arrivals of vegetables and fruits for market oriented production and improved marketing decisions.

- Production and processing of quality vegetable seeds ensuring purity and varietal preferences to cater farmer needs.
- Exploring export potential and promoting certified products for overseas markets.
- Professionally qualified and experienced extension personnel as the back bone for successful interventions.

Quantitative achievements:(As on 31st March 2005)

No. of districts	14
No. of Farmers	63,687
No. of SHGs	3,561
No. farmer markets (Swasraya Karshaka Samithis)	143
Total Annual quantity of trading (Metric Tons)	40,000 (Approx.)
Total value traded per annum (Rs.)	38 Crores(Approx.)
Total number of farmers availed credit	29,000
Total amount of credit disbursed annually	42.8 Crores
Quantity of vegetable seed processed and marketed per Annum	8300 Kg

Registered Office: Mythri Bhavan, Kakkanad, Cochin, Kerala

Phone Nos +91 484 2427544, 2427455

Fax +91 484 2427570

Email khdprog@sancharnet.in

District contacts of VFPCK

District	Address of district training centres	Phone Nos
Thiruvanathapuram	101.Kalpana, Panavila(Jn), Chembaka Nager, Trivandrum	0471-2334480 0471-3236382(Mobile)
Kollam	Near Kerala Agro Industries,	0474-2451364

	Neelaswaram (PO), Kottarakara, Kollam	0474-3503350(Mobile)
Pathanamthitta	Vadakkenaluthundil, Near Swagath college, Pandalam(Jn),Pathanamthitta	0481-3405613(Mobile)
Alapuzha	Koikkal house, Near TKMM College,Nangiarkulangara(PO), Alapuzha.	0479-2410455 0477-3621498(Mobile)
Kottayam	Pandarasseril Bldg.,Near Village Office, Ettumanoor, Kottayam	0481-2534709 0481-3405613(Mobile)
Ernakulam	Mythri Bhavan, Kakkanad, Cochin	0484-3571936(Mobile)
Trichur	Koodally Arcade, Nenmanikara, Puthukkad(PO), Trichur	0480-2755458 0487-3452127(Mobile)
Palakkad	Seed Processing Plant, Kindimukku, Alathur, Palakkad	0492-2222706 0491-3281711(Mobile)
Malappuram	M M Building, 22nd Miles, Manjeri, Malappuram	0483-2768987 0483-3227445(Mobile)
Kozhikode	Sithara Building, Thamarassery(PO), Kozhikode	0495-2225517 0495-3101231(Mobile)
Wayanad	Sithara Building, Thamarassery(PO), Kozhikode	0495-3101231(Mobile)

Conclusion:

VFPCK is farmer friendly organization. It is strengthening small and marginal farmers by its activities at various levels, which includes credit supply, insurance, input suppy, homestead farming etc.,

REFERENCES

Birdar,R. and Jayasheela, R.2000. Rural finance – A village study. *Kurukshetra* 43: 19 – 25

Bony, B.P.1991. Adoption of improved agricultural practices by commercial vegetable growers of Olukkara block in thrissur District. M. Sc. (Ag.) Thesis, Kerala Agricultural University, Trichur, p. 126

FAO.1999. UN rural institutions and participation services. *Proc. FAO e-mail conf. Small farm Group Associations: Bringing the poor together* 1998, Rome. pp. 10-22

Jayalekshmi, G. 2001. Empowerment of Rural Women through self help groups – An Action Research Ph. D. thesis, Kerala Agricultural University, Trichur. p. 144

KHDP 1995. *Self Help Groups in KHDP*, Kerala Horticulture Development Programme, Cochin, Kerala. Pp. 25-35

Kesavan, P.K. [illegible] Farmer Empowerment through participation. *Proceedings for National Seminar HORTINDIA*, 99, Kerala Horticultural Development Programme, Cochin. pp. 59-64

Maloney,C. and Raju, K.V. 1994. *Managing Irrigation together Practice and Policy in India*. Sage publications, New Delhi, p. 245

Meera, B. 1981. Impact of Farm Women's Training in Agriculture. M.Sc. (Ag.) Thesis, Kerala Agriculture University, Trichur, p.111

Mukherjee, N. 1997. *Participatory Appraisal of Natural Resources*, Prakash publishing company, New Delhi.p. 185

Nagayya, D. 2000. Micro Finance for Self Help Groups. *Kurukshetra*. 48: 10-12

Nanda, Y.S. 2002. *Significance of Establishing Linkages with Self Help Groups and Banks*, NABARD, Mumbai. p.16

Narayanasamy,N., Manivel,S., and Bhaskar,B.2003.Networking SHGs and cooperatives – an analysis of strengths and weaknesses. *J. Rural Dev.* 22(3): 333-344

Puhzhendi, V. and Satyasai,V. 2000. Evaluation study of Self Help Groups in Tamil Nadu, National Bank for Agricultural and Rural Development, Mumbai, p.60

Sreedaya, G. S.2000. Performance Analysis of the Self Help Groups in Vegetable Production in Thiruvananthapuram district. M.Sc. thesis, Kerala Agriculture University, Trichur.p.150

Sreedaya, G S , Sushama, N P. and Nehru, S.M. 2001. Perception of officials about self help groups involved in vegetable cultivation. *J. Trop. Agric.* 39: 87 –88

Sreekumar, K 2001. SHG approach for Rural Development – A case of KHDP – Seminar Report, Tamil Nadu Agricultural University, Coimbatore. p.5

Srinivasan, G. and Satish, P. 2001. Networking of micro credit delivery. *Rural Dev.* 20: 635 – 671

Surendran, G. 2000. Participatory group approach for sustainable development of agriculture in Kerala. Ph.D. thesis, Kerala Agriculture University, Trichur. p.156

DISCUSSION

1. What is the criterion for the selection of mater farmers?

There is no specific criterion for the selection of the master farmers. Generally, knowledgeable and experienced farmers take the master farmer role.

2. Why the seed production unit is located in palakkad?

Humid climate is required at the time of flowering and dry climate at the time of seed formation stage.

3. In what way VFPCK differ from KHDP?

VFPCK has started export promotion cell, kitchen gardening, tissue culture units in addition to the activities of KHDP.

4. What is 'office extension'?

Extension concentrated on office activities. There is no much emphasis on field activities

KERALA AGRICULTURAL UNIVERSITY

COLLEGE OF HORTICULTURE
DEPARTMENT OF AGICULTURAL EXTENSION

Ag. Ext. 651 – Seminar

Topic: Functioning of Vegetable and Fruit Promotion Council Keralam

Name of the Student: Grace Sarala. S
Admission No. : 2004-11-04

Venue: Seminar Hall
Date : 15-10-2005
Time : 11:00-11:45

ABSTRACT

Agriculture continues to be the most important and single largest sector of Keralas' economy accounting for over one-third of the state's income at present. According to the Agricultural Policy of the State Government, the intention is to improve the vitality and dynamism of Kerala's agriculture through judicious utilization of scarce resources of land, water, manpower and technology with focus on increasing production and productivity in a planned manner. The emphasis is on creating and restructuring infrastructure and strengthening input delivery, extension and research system to meet the requirements of small farmers who constitute the majority of the farming community.

Group formation is a pre-requisite for participatory approach (Mukherjee, 1997). Farmer participation comes when the farmers have an organisation to manage their resource at some level. Participation naturally flows from the farmers' organisation when it is effective (Maloney and Raju, 1994).

Vegetable and Fruit Promotion Council Keralam (VFPCK) is a company, in which majority of share holders are farmers.

For the sustainable development of the agricultural sector, farmer has to be the focus and the system should be built around them. Kesavan (1999) stated that philosophy of Vegetable and Fruit Promotion Council Keralam (VFPCK) is based on organization of farmers in SHGs that are informal, voluntary and on neighbourhood basis integrating all activities of the project area. They take up roles beyond cultivation and this will result in farmer empowerment. In this situation the role of developmental intervention will be that of facilitation only. The core concept of VFPCK for promoting the development of farmers is the Self Help Group, a voluntary unit of 15-20 cultivating farmers. Each SHG runs according to a set of mutually agreed norms. They form the base target group for all the council activities like transfer of technology, rural credit, group marketing and participatory technology development. Dissemination of information is routed through the novel concept of 'master farmer'. The master farmers selected by the SHGs are trained and take a lead role in constituting a stabilised SHG. 'Officeless extension' promoted by the organisation provides the opportunity for the farmers to get the technology at their doorstep.

PRACTICAL UTILITY OF PRINCIPAL COMPONENT ANALYSIS

By

JOSHY.C.G
(2004-19-01)

SEMINAR REPORT
Submitted in partial fulfillment of the course Ag.stat.651.seminar
2005

DEPARTMENT OF AGRICULTURAL STATISTICS
COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR-680656
KERALA, INDIA

DECLARATION

I, Joshy C G (2004-19-01) hereby declare that this seminar script entitled **'Practical Utility Of Principal Component Analysis'** has been prepared by me independently after going through the various references cited, without copying from any of my senior students seminar report

Vellanikkara
Date 13-12-05

Joshy.

Joshy C G
(2004-19-01)

CERTIFICATE

Certified that the script entitled "Practical utility of principal component analysis" is a report submitted independently by Mr. Joshy C.G for the partial fulfillment of the credit seminar (Ag stat 651) under my guidance and supervision and that it has not previously been duplicated

Vellanikkara
Date 15-10-15

S.Krishnan
(Chairperson, Advisory committee).
Assistant professor (sel. Gr.).
Department of agricultural statistics.
College of horticulture.
Vellanikkara, Thrissur

CONTENTS

INTRODUCTION

Inferential statistics deals with extracting maximum information about a data set coming out of an experiment, conducted according to basic principles of experimentation. The data that is coming out of an experiment is not only the yield data that one may consider most crucial in most of the cases, but the different parameters that depicts the growth of an organism. In an agricultural experiment the data may be height, girth, number of primary and secondary branches, weight of fruits, number of fruits, days to flowering, days to harvesting etc. Usually the observations may be recorded in a row-column form that is known as matrix with individuals along the rows and different parameters that represent a particular individual along the columns. Suppose there are n individuals and p variables, then the matrix is said to be order of nxp. With this representation the recording of observations is completed and it is in form of multivariate data. After having recorded all these data, the researcher would like to interpret the data.

With a univariate set of observations the analysis usually begins with the calculation of two summary statistics namely mean and standard deviation for each variable and in addition correlation coefficient for each pair of variables. These summary statistics gives preliminary information about the data

The mean of j^{th} variable is given by

$$\overline{X} = \Sigma_r X_{rj} / N$$

Standard deviation of the jth variable is given by

$$S_j = SQR\ (\Sigma_r (X_{rj} - \overline{X}_j)^2) / (n-1)$$

Correlation coefficient of ith and jth variable is given by

$$r_{ij} = \Sigma_r (X_{ri} - \overline{X}_i)(X_{rj} - \overline{X}_j) / (n-1)S_iS_j$$

Where S_i and S_j are standard deviation of i^{th} and j^{th} variables

Geometrically correlation coefficient is the cosine of the angle between the two standardized vectors. If for example two vectors are close together in an n-dimensional space then the angle between the vectors will be very small and its cosine will close to one, indicating high positive correlation. The correlation coefficient can be conveniently assembled in a correlation matrix R. which is given by

$$R = \begin{pmatrix} 1 & r_{12} & r_{13} & \cdots & r_{1p} \\ r_{21} & 1 & r_{23} & \cdots & r_{2p} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{p1} & r_{p2} & r_{p3} & \cdots & 1 \end{pmatrix}$$

Note that diagonal elements are all unity because correlation coefficient between the same variable is always one.

The correlation matrix simply speaks of the linear relationship between two variables. When we want a simultaneous evaluation of all the variables, we may have resort to multivariate technique. A wide variety of multivariate techniques are available, but generally there are two types of multivariate techniques.

1.Variable directed technique:- It is primarily concerned with the relationship between the variables

2.Individual directed technique:-It is primarily concerned with the relationship between the individuals

The choice of appropriate multivariate technique depends on type of data, the type of problem, and the sort of objectives which are envisaged for the analysis. The underlying theme of much multivariate technique is simplification. In other words we want to summarize a large body of data by means of a relatively few parameters.

According to Chatfield and Collins, with just two variables, researchers simply look at the correlation between them. With more than two variables, a technique called principal component analysis (PCA) may be appropriate. This is a variable directed technique and aims to transform the observed variables which are correlated to a new set of variables which are uncorrelated and arranged in decreasing order of importance. The principal aim is to reduce the dimensionality of the problem and to find new meaningful variables which make the data easier to understand.

Important practical applications of Principal Component Analysis are

1 Clustering of individuals

2 To solve multicollinearity problem in regression analysis

253

PRINCIPAL COMPONENT ANALYSIS

Principal Component Analysis is useful to examine the relationship among a set of 'p' correlated variables. It is a variable directed technique for analysing the interdependence of the variables. The principal aim is to reduce the dimensionality of the problem and to make the data easier to understand. PCA finds orthogonal linear combinations of a set of variates that maximize the variation contained within them, there by displaying most of the original variability in a smaller number of dimensions. The main objectives of PCA are

1.To reduce the dimensionality of the problem without significant loss of much information

2. To identify new meaningful underlying variables

PCA transforms a set of correlated variables into a set of uncorrelated variables called principal components. The first principal component accounts for as much of the variability in the data set as possible and the succeeding principal components accounts for as much of the remaining variability as possible and so on.

The mathematical technique used in Principal Component Analysis is called eigen analysis, which constitutes eigen values and eigen vectors.

Eigen value - Let 'A' be a square matrix. Then the equation $|A - \lambda I| = 0$ is called the characteristic equation of a matrix 'A' and its roots are called characteristic roots or eigen values.

Eigen vectors:- Let 'X' be any nonsingular column matrix. Then the equation $(A - \lambda I) X = 0$ is a characteristic vector of the matrix 'A' corresponding to characteristic root λ, where λ is any scalar quantity and 'I' is the unitary matrix.

Eigen analysis plays an important role in PCA because it finds the principal components That is the eigen vector associated with the largest eigenvalue has the same direction as the first principal component The eigen vector associated with the second largest eigenvalue determines the direction of second principal component. In a similar way the eigen vector associated with the least eigenvalue determines the direction of last principal component. Maximum number of principal component is equal to the number of variables in the matrix. Traditionally PCA is performed either on a covariance or a correlation matrix.

Derivation of principal components

Suppose $X^T = (x_1, x_2, \text{---------- } x_p)$ is a 'p' dimensional random variable with mean μ and covariance matrix Σ Our problem is to find new set of variables namely $y_1, y_2, \text{----------} y_p$ and whose variance decreases from first to last and each Y_j is taken to be a linear combination of the x's, so that $Y_j = a_{1j}X_1 + a_{2j}X_2 + \text{----------} + a_{pj}X_p$ subject to the constraint that $a_i^T a_i = 1$, which means over all transformation is orthogonal

The first principal component Y_1, is found by choosing a_1 so that Y_1 has the largest possible variance subject to the constraint that $a_1^T a_1 = 1$

Now Var $(y_1) = V(a_1^T x)$

$= a_1^T \Sigma a_1$

The aij's are estimated from the relation

$L(a_1) = a_1^T \Sigma a_1 - \lambda (a_1^T a_1 - 1)$ Differentiate this with respect to a_1,

to get $\partial L/\partial a_1 = 2 \Sigma a_1 - 2 \lambda a_1$, Setting this equal to zero, we have

$$(\Sigma - \lambda I) a_1 = 0$$

We have to find a solution for a_1, So $(\Sigma - \lambda I)$ must be a singular matrix. So that

$$|\Sigma - \lambda I| = 0$$

This is a polynomial in λ of degree p .so we get p eigen values which are denoted by $\lambda_1, \lambda_2, \text{———} \lambda_p$ and assume that $\lambda_1 > \lambda_2 > \lambda_3 > \text{———} > \lambda_p$

Now $V(a_1^T X) = a_1^T \Sigma a_1$

$$= a_1^T \lambda I a_1 = \lambda$$

As we want to maximize this variance, we choose λ to be the largest eigen value namely λ_1. Then the first principal component must be the eigenvector of Σ corresponding to the largest eigenvalue.

The second Principal Component, namely $Y_2 = a_2^T x$ must be the eigenvector of Σ corresponding to the second largest eigenvalue namely λ_2, subject to the constraint that $a_2^T a_2 = 1$. Further these two principal components should be uncorrelated. Now

$$\text{Cov}(y_2, y1) = \text{var}(a_2^T x, a_1^T x)$$

$$= E(a_2^T (x-\mu)(x-\mu)^T a_1)$$

$$= a_2^T \Sigma a_1 = 0$$

In a similar way the last principal component namely $y_p = a_j^T x$ must be the eigenvector of Σ corresponding to the least eigenvector λ_p , subject to the constraint that $a_j^T a_j = 1$. Note that all the principal components must be uncorrelated.

The eigenvalues can be interpreted as the corresponding variances of the different components. Now the sum of these variances is given by

$\Sigma_{j=1}^{p} \lambda_j = \text{trace}(A)$

Thus we have the important result that the sums of the variances of the original variables and of their principal components are same. It is therefore convenient to make statements such as the i^{th} principal component accounts for a proportion $\lambda i / \Sigma \lambda j$ of the total variation in the original data. We will also say that the first 'm' components together accounts for a proportion $\Sigma_{j=1}^{m} \lambda j / \Sigma \lambda j$ of the total variation

Illustration with an example

Here 15 individuals and 8 variables are used for the purpose of the problem. The variables used are

x_1-Tree height
x_2-Number of branches
x_3-Leaf length
x_4-Leaf breadth
x_5-Number of fruits
x_6-Fruit length
x_7-Fruit width
x_8-Fruit weight

Table 5.11represents the data used for each variable which are the secondary data obtained from a study conducted on puemello.
Table 5.12 and 5.13 represents the mean and standard deviation for each variable
Table 5.14 represents the eigen roots which are obtained from the variance-covariance matrix and are arranged in decreasing order of importance.

Table 5.15 represents the percentage of variation explained by each root. From the table we can see that the largest eigen value explains maximum information in the data set as possible and the succeeding principal components accounts for as much of the remaining variability as possible and so on. All the eigen vectors together explains 100% variation.

Table 5.16 represents the eigen vectors (column vectors) obtained from the corresponding eigen values. First 6 components explain 97.85 Percent variation. Table 5.17 shows the first 6 principal component scores, which are obtained by multiply the original data with corresponding eigen vectors. The first principal component scores are computed as
$0.326*x_1+0.235*x_2+$----------$+0.091*x_7+0.113*x_8 = -2.404$, similarly the subsequent principal component scores are computed.

Figure 5.a is a graphical representation of first two principal component scores which explains 62% variation together. The graph is drawn by taking first principal component score on X axis and second principal component score on Y axis and the points are named as v_1, v_2----------v_{14}, v_{15} .With this graphical representation we reduced the dimensionality of the problem by two.

PRACTICAL UTILITY OF PRINCIPAL COMPONENT ANALYSIS

Principal component analysis analyses interdependence of variables with its principal aim of reducing the dimensionality of the problem. The other important applications of PCA are

1. Clustering of individuals

2. To solve multicollinearity problem in regression analysis

1.Clustering of individuals

The basic aim of cluster analysis is to find the 'natural groupings, if any, of a set of individuals This set of individuals may form a complete population or be a sample from some larger population More formally, cluster analysis aims to allocate a set of individuals to a set of mutually exclusive, exhaustive groups such that individuals within a group are similar to one another while individuals in different groups are dissimilar.

If observations are taken on only two variables, the simplest and probably the best, way of finding any natural groupings is to plot the data on a scatter diagram and examine the graph visually. This is possible only when the first two components explain a large proportion of variation.

Figure 5 b represents a scatter diagram of bivariate data. It is obtained by plotting first two principal component scores (from table 5.17) on X and Y-axis. Three clusters are evident in the figure, which are encircled. The contiguous points give rise to clusters.

2 To solve multicollinearity problem in regression analysis

Regression analysis is a measure of the average relationship between two or more variables in terms of original units of data One of the important assumptions in regression analysis is that all the explanatory variables are not perfectly linearly correlated (which means correlation coefficient should not be equal to 1) According to Kautsoyiannis (1977) the term multicollinearity is used to denote the presence of linear relationship among explanatory variables. If the explanatory variables are perfectly linearly correlated, that is, if the correlation coefficient for these variables is equal to unity, the parameters become indeterminate. It is impossible to obtain numerical values for each parameter separately and the method of least squares breaks down.

Consequences of multicollinearity

If the Intercorrelation between the explanatory variables is perfect then

a. The estimates of the coefficient are indeterminate

b. The standard errors of these estimates become infinitely large

The problem of multicollinearity in regression analysis can be solved by the application of principal component analysis. We transform the multicollinear variables to a new set of variables using principal component analysis and the transformed variables are uncorrelated to each other. We can find the regression coefficients for the transformed variables. Thus the transformation provides a feasible solution to multicollinearity problem

TABLES AND FIGURES

Table 5.11 Observed data used for each variable

x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
5	23	14.02	6.39	75	17.84	19.02	498
5	17	12.65	5.25	55	18.82	20.16	1166
6	19	10.24	5.56	85	28.4	30	1486
6	23	13 74	5.69	45	35.4	32	1960
5	23	12 09	6.8	85	26.3	25	710
6	29	9 61	4.65	55	27.5	22.8	980
8	33	10 1	6.73	77	32.1	29.1	1230
7	37	13 85	5.73	45	27.4	25.1	946
5	28	10 75	6 21	55	30 4	29	1700
4	22	9 5	3 4	45	22	21 2	590
5	27	9 92	5 02	46	29 1	30 44	1460
6	23	12 29	6 75	75	20 8	24	870
6	33	10 29	5 49	55	18 84	20 6	570
5	35	14 64	6 12	110	25 14	26 4	910
5	35	11 66	5 56	45	23	24	860

Table 5.12 Means Of Variables

5 50	27 13	11 71	5 69	63 53	25 54	25 25	1062 40

Table 5.13 Std. Dev. Of Variables

0 99	1 76	6 31	0 90	19 82	5 23	4 12	432 47

Table 5.14 Eigen Roots

2 945	2 035	1 258	0 748	0 565	0 278	0 116	0 055

Table 5.15 % Variation Explained By Each Root

36 81	25 44	15 73	9 35	7 06	3 47	1 45	0 69

Table 5.11 Observed data used for each variable

x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
5	23	14.02	6.39	75	17.84	19.02	498
5	17	12.65	5.25	55	18.82	20.16	1166
6	19	10.24	5.56	85	28.4	30	1486
6	23	13 74	5.69	45	35.4	32	1960
5	23	12 09	6.8	85	26.3	25	710
6	29	9 61	4.65	55	27.5	22.8	980
8	33	10 1	6.73	77	32.1	29.1	1230
7	37	13 85	5.73	45	27.4	25.1	946
5	28	10 75	6 21	55	30 4	29	1700
4	22	9 5	3 4	45	22	21 2	590
5	27	9 92	5 02	46	29 1	30 44	1460
6	23	12 29	6 75	75	20 8	24	870
6	33	10 29	5 49	55	18 84	20 6	570
5	35	14 64	6 12	110	25 14	26 4	910
5	35	11 66	5 56	45	23	24	860

Table 5.12 Means Of Variables

5 60	27 13	11 71	5 69	63 53	25 54	25 25	1062 40

Table 5.13 Std. Dev. Of Variables

0 99	1 76	6 31	0 90	19 82	5 23	4 12	432 47

Table 5.14 Eigen Roots

2 945	2 035	1 258	0 748	0 565	0 278	0 116	0 055

Table 5.15 % Variation Explained By Each Root

36 81	25 44	15.73	9.35	7.06	3 47	1 45	0.69

Table 5.16 Corresponding Eigen Vectors (Columns Are Vectors)

	1	2	3	4	5	6	7	8
1	0.326	-0.010	0.101	0.191	0.014	0.547	0.550	0.494
2	0.235	0.213	0.478	0.583	0.515	-0.122	-0.070	-0.216
3	-0.459	-0.735	0.215	0.111	0.315	-0.015	0.137	0.269
4	-0.272	0.234	0.766	-0.098	-0.489	0.031	-0.018	0.184
5	-0.601	0.506	-0.086	-0.241	0.444	0.177	0.270	-0.124
6	-0.413	0.150	-0.344	0.718	-0.368	-0.165	0.075	0.067
7	0.091	0.244	-0.064	-0.141	0.199	-0.658	0.007	0.659
8	0.113	-0.111	0.094	-0.090	-0.152	-0.438	0.771	-0.385

Table 5.17 First 6 Principal Component Scores

1	-2.404	1.662	0.776	0.401	-0.515	0.087
2	-1.729	-0.543	1.299	0.484	-1.158	-0.230
3	1.916	-0.463	1.318	-1.39	-0.021	-0.514
4	3.001	-0.768	1.003	1.490	-0.572	-0.367
5	-0.373	1.257	1.055	-0.616	0.312	0.479
6	-0.270	-1.267	-1.063	-0.645	0.024	-0.501
7	2.517	1.133	-1.406	-1.368	-0.478	-0.144
8	0.845	0.809	-1.911	1.326	-0.508	-0.473
9	1.663	-0.757	0.497	0.218	0.380	1.045
10	-2.549	-2.726	0.077	-0.209	0.617	-0.533
11	1.175	-1.892	0.124	0.055	0.575	0.434
12	-0.587	1.324	0.531	-0.514	-0.816	0.347
13	-1.709	0.038	-1.645	-0.509	-0.233	0.299
14	-0.027	2.469	0.459	0.467	1.886	-0.645
15	-0.778	-0.276	-1.113	0.811	0.508	0.715

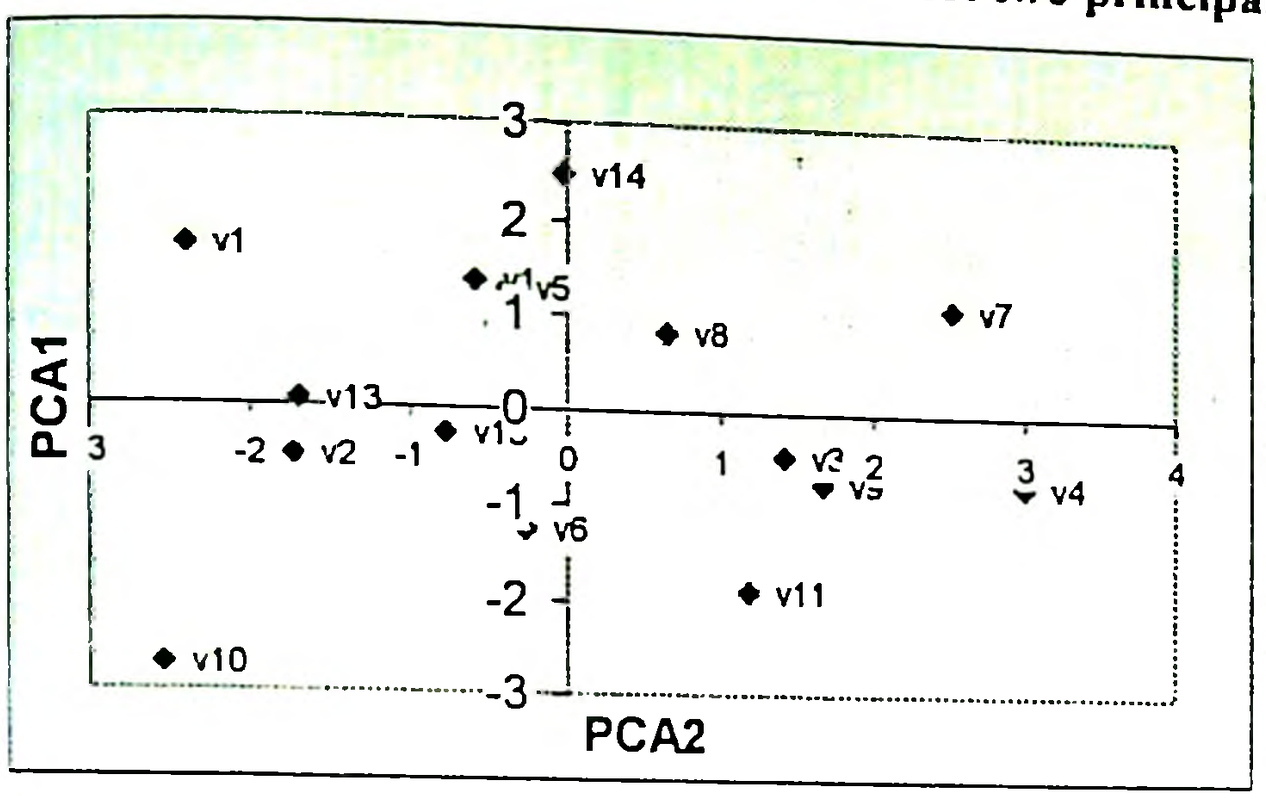
Table 5.16 Corresponding Eigen Vectors (Columns Are Vectors)

	1	2	3	4	5	6	7	8
1	0.326	-0.010	0.101	0.191	0.014	0.547	0.550	0.494
2	0.235	0.213	0.478	0.583	0.515	-0.122	-0.070	-0.216
3	-0.459	-0.735	0.215	0.111	0.315	-0.015	0.137	0.269
4	-0.272	0.234	0.766	-0.098	-0.489	0.031	-0.018	0.184
5	-0.601	0.506	-0.086	-0.241	0.444	0.177	0.270	-0.124
6	-0.413	0.150	-0.344	0.718	-0.368	-0.165	0.075	0.067
7	0.091	0.244	-0.064	-0.141	0.199	-0.658	0.007	0.659
8	0.113	-0.111	0.094	-0.090	-0.152	-0.438	0.771	-0.385

Table 5.17 First 6 Principal Component Scores

1	-2.404	1.662	0.776	0.401	-0.515	0.087
2	-1.729	-0.543	1.299	0.484	-1.158	-0.230
3	1.916	-0.463	1.318	-1.39	-0.021	-0.514
4	3.001	-0.768	1.003	1.490	-0.572	-0.367
5	-0.373	1.257	1.055	-0.616	0.312	0.479
6	-0.270	-1.267	-1.063	-0.645	0.024	-0.501
7	2.517	1.133	-1.406	-1.368	-0.478	-0.144
8	0.845	0.809	-1.911	1.326	-0.508	-0.473
9	1.663	-0.757	0.497	0.218	0.380	1.045
10	-2.549	-2.726	0.077	-0.209	0.617	-0.533
11	1.175	-1.892	0.124	0.055	0.575	0.434
12	-0.587	1.324	0.531	-0.514	-0.816	0.347
13	-1.709	0.038	-1.645	-0.509	-0.233	0.299
14	-0.027	2.469	0.459	0.467	1.886	-0.645
15	-0.778	-0.276	-1.113	0.811	0.508	0.715

Figure 5.a Graphical representation of first two principal component scores



-2.404	1.662	v1
-1.729	-0.543	v2
1.416	-0.463	v3
3.001	-0.768	v4
-0.373	1.257	v5
-0.27	-1.267	v6
2.517	1.133	v7
0.645	0.809	v8
1.663	-0.757	v9
-2.549	-2.726	v10
1.175	-1.892	v11
-0.587	1.324	v12
-1.7	0.038	v13
-0.027	2.469	v14
-0.778	-0.276	v15

Figure 5.b clustering group of individuals

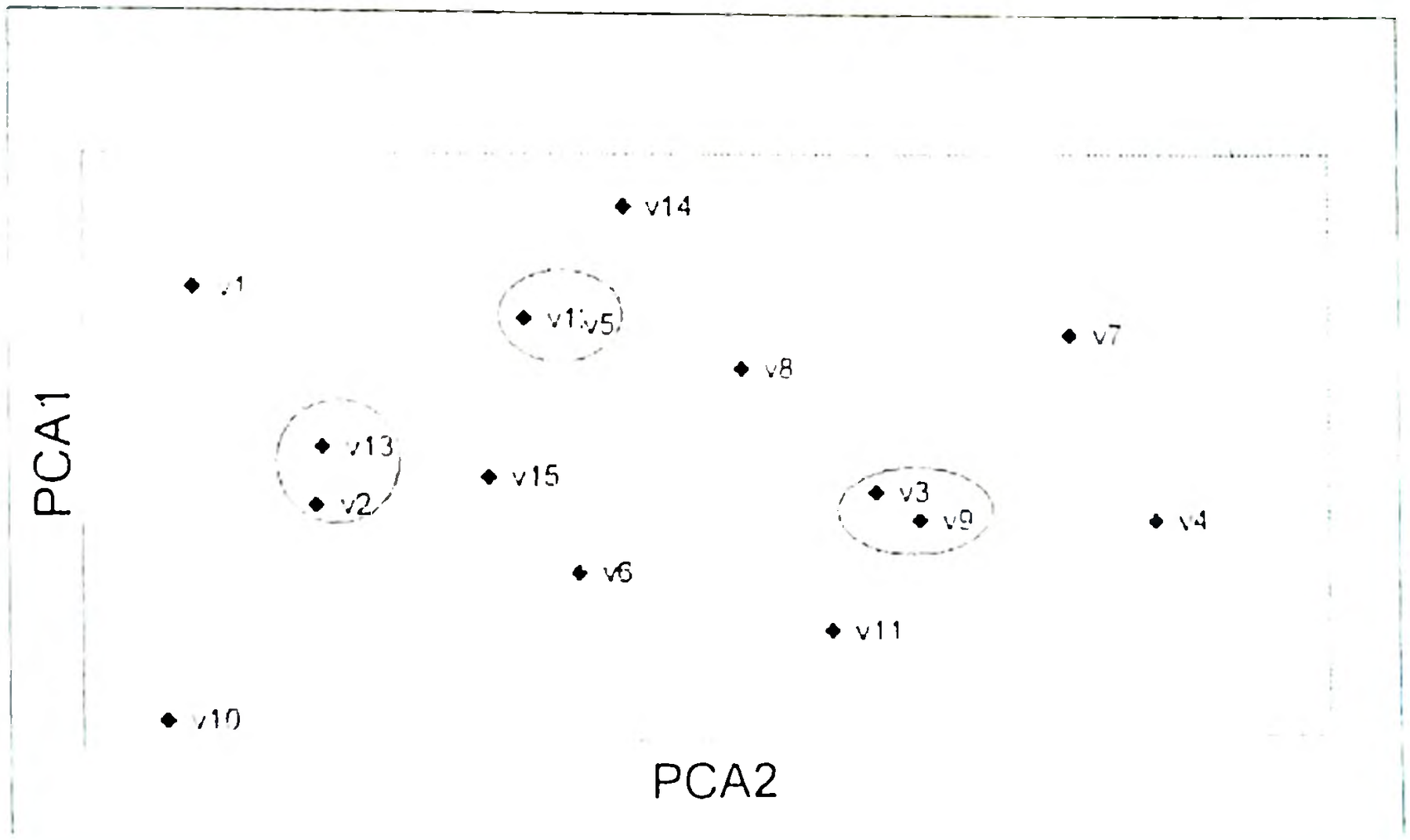
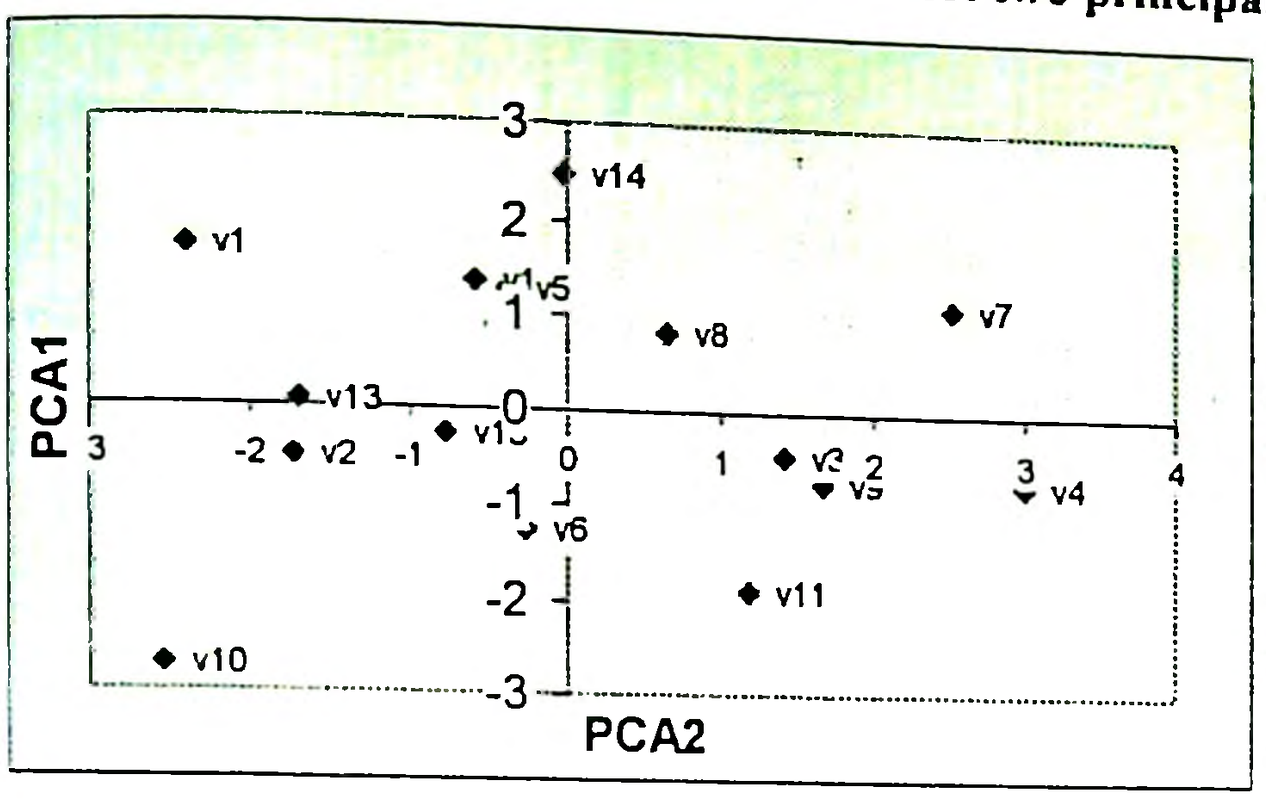
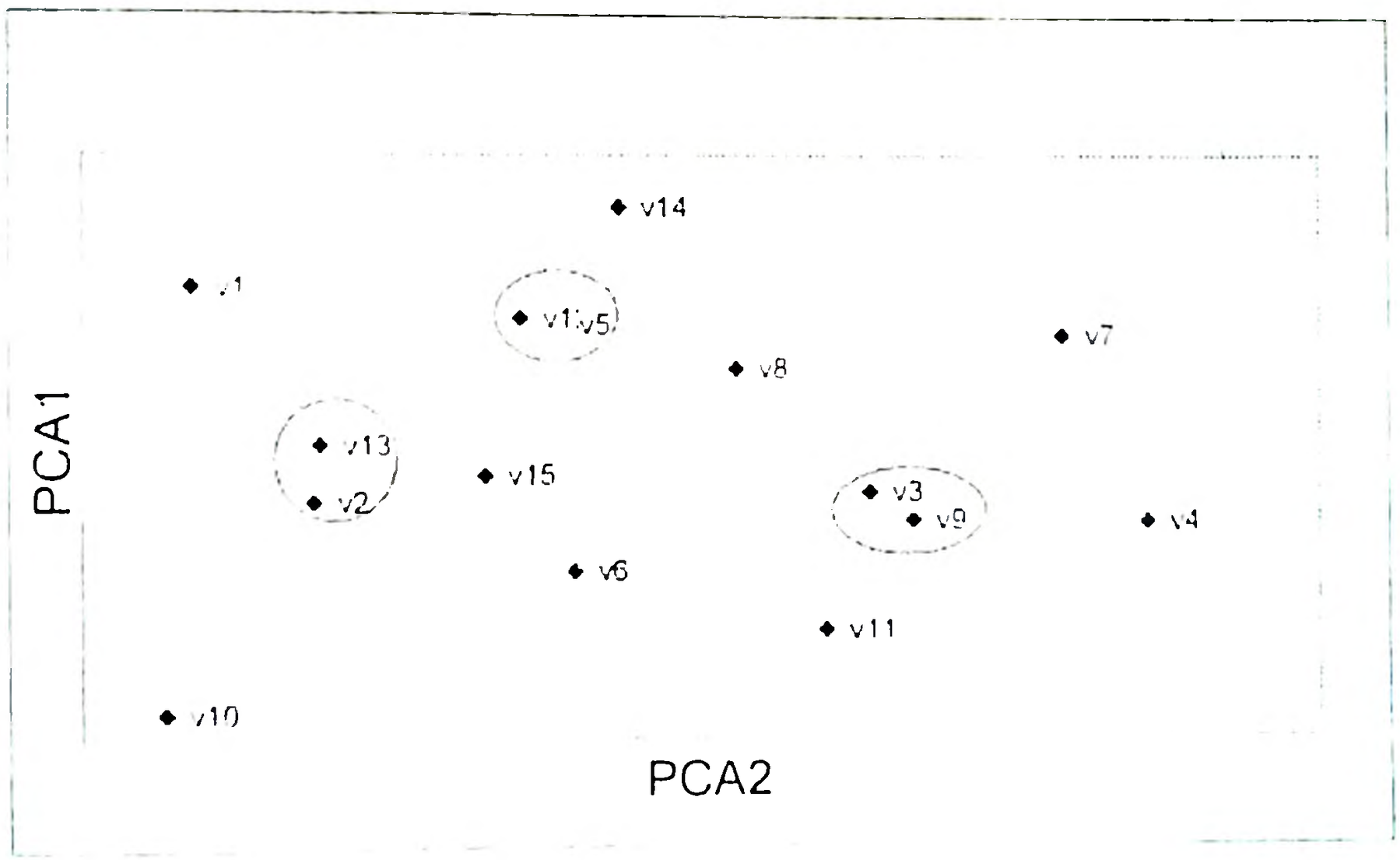


Figure 5.a Graphical representation of first two principal component scores



-2.404	1.662	v1
-1.729	-0.543	v2
1.416	-0.463	v3
3.001	-0.768	v4
-0.373	1.257	v5
-0.27	-1.267	v6
2.517	1.133	v7
0.645	0.809	v8
1.663	-0.757	v9
-2.549	-2.726	v10
1.175	-1.892	v11
-0.587	1.324	v12
-1.7	0.038	v13
-0.027	2.469	v14
-0.778	-0.276	v15

Figure 5.b clustering group of individuals



CONCLUSION AND DISCUSSION

Conclusion

In most of the agricultural experiments data are multivariate in nature. We can make valid conclusions by reducing dimensionality of the problem by applying principal component analysis and also we can make a graphical representation of individuals.

Discussion

Other areas in which PCA can be used in agriculture?
PCA can be used in AMMI model (additive main effect and multiplicative interaction) for studying Genotype x Environment interaction

Which are the characters or attributes used for clustering in the graph?
Tree height, Number of branches, Leaf length, Leaf breadth, Number of fruits, Fruit length, Fruit width, fruit weight, all these characters are used for clustering

What is the criterion for clustering?
Contiguous points come under a cluster group and the individuals within a cluster have some common features

What is the use of PCA in multicollinearity problems?
We transform the multicollinear variables to new set of variables by using principal component analysis and the transformed variables are uncorrelated to each other. We can find the regression coefficients for the transformed variables. Thus the transformation provides a feasible solution to multicollinearity problem

267

REFERENCE

References

Chatfield, C. and Collins, A.J.1986.Introduction to multivariate analysis. Science paperbacks, England. 249P.

Kautsoyiannis, A.1977.Theory of Econometrics. The Macmillan press ltd. London.453p.

Rao, C.R.1965.Linear Statistical Inference and its applications. Wiley publications in statistics, New Delhi.504p.

Surendran,P.U. and Saxena, H.C.1985.Statistical Inference.S.chand and company ltd, New Delhi. 345p.

Gupta, s.p.1982. Statistical methods. Sultan chand and Sons Company limited, New Delhi. 450p.

Rao, C.R. 1964.The use and interpretatation of Principal component analysis in applied research. *The Indian J. of statistics*:56-85.

Bartlett, M.S 1947. Multivariate analysis. *J.Roy.Stat.Soc.(2)*:176-197.

Orcoli, L.1978. Multivariate analysis in vegetation research.Dr.w.junk B.V publishers,Hage.450p.

Bryant,E.H and Atchley, W.R. 1989.Multivariate statistical methods, Hutchinson and Ross, Inc.Dowden 435p

Girshic, M.A.1936 Principal components.*J.Amer.Stat.Assoc.31*: 519-529

Hotelling,H 1933 Analysis of a complex of statistical variables in to principal component *J.Educ.Psychol.24*: 417-441

Johnston,R.J 1978 Multivariate statistical analysis in geography. Longman Inc, New York. pp:127-182

Mahajan, R.K., Rao,A.V. and Dindsa,K.S.1981 Principal component analysis in some late maturing varieties *Indian J.Agric.Sci.(51)*:9-12

Watton,P.D.1972. Factor analysis in spring wheat. *crop. sci.12*:731-733

Thurstone, L.L. 1931 Multiple factor analysis. *Psychol.rev.38*:406-427

Asawa,B.M.1981 Factor analysis in chick pea. *Indian J. agric.scie.51*:156-159

Geetha,U. 1985. A comparison of path coefficient analysis and principal component analysis in turmeric Msc(Ag) thesis,Kerala agricultural university.124p.

Ramey,T.B., and Rossillie, A.A.1983. Hass cluster analysis: a new method of grouping genotypes orenvironments in plant breeding.*Thoery appl genet 66*:131-133

Singh, S.K.2003.Cluster analysis for heterosis in wheat. *Indian J. of genetics and plant breeding,63(3)*:49-251.

Raju,B.M.K.2002.A study on AMMI model and its biplots.J Ind. *Soc.Ag. statistics 55(3)*:323-347.

Gauch,H.G.1998.Model selection and validation for yield trials with interaction *Biometrics(44)*: 705-715

PRACTICAL UTILITY OF PRINCIPAL COMPONENT ANALYSIS

By

JOSHY.C.G
(2004-19-01)

ABSTRACT OF SEMINAR REPORT
Submitted in partial fulfillment of the course Ag.stat.651.seminar
2005

DEPARTMENT OF AGRICULTURAL STATISTICS
COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR-680656
KERALA, INDIA

KERALA AGRICULTURAL UNIVERSITY
College Of Horticulture, Vellanikkara
Department Of Ag. Statistics

Ag.stat 651-Seminar

Topic: Practical Utility Of Principal Component Analysis

Name of the student: Joshy .C.G
Admission no. : 2004-19-01
Major advisor : S.Krishnan

Venue: seminar hall
Date :03-09-05,
Time 11.30-2.15pm

ABSTRACT

The results ensuing from an agricultural experiment is usually multivariate in nature. These results can be tabulated in a raw-column form with individuals along the rows and variables along the columns (Surendra and Saxena, 1985). Then the ultimate aim before an experimenter is to elucidate valid conclusions. Reduction in dimension will help to arrive at such conclusion more rapidly. Principal component analysis (PCA) is one of the techniques by which we can attain the above objectives

PCA is a variable directed technique and it analyses interdependence of variables. PCA finds orthogonal linear combinations of a set of variates that maximize the variation contained within them thereby displaying most of the original variability in a smaller number of dimensions. Objective of PCA is to reduce the dimensionality of the problem and to identify new meaningful underlying variables (Rao, 1965)

PCA transforms a number of correlated variables to a number of uncorrelated variables called principal components (PC). The first PC accounts for as much of the variability in the data set as possible and each succeeding PC accounts for as much of the remaining variability as possible.

The mathematical technique used in PCA is eigen analysis. It constitutes the extraction of eigen values and eigen vectors either from a covariance or a correlation matrix. The eigen vector associated with the largest eigenvalue has the same direction as the first principal component. The eigen vector associated with the second largest eigenvalue determines the direction of the second principal component. This first and second principal component should be uncorrelated. Maximum number of principal components is equal to the number of variables in the matrix and each PC is a linear combination of original variables (Collins and Chatfield, 1986)

Important practical applications of PCA are

1.clustering of individuals

2.It used for solving multicollinearity problem in regression analysis (Kautsoyiannis,1977).

References:

Chatfield, C. and Collins, A.J.1986.Introduction to multivariate analysis. Science paper backs. England. 249P.

Kautsoyiannis, A.1977.Theory of Econometrics. The Macmillan press ltd. London.453p.

Rao, C.R.1965.Linear Statistical Inference and its applications. Wiley publications in statistics, New Delhi.504p.

Surendran,P.U. and Saxena,H.C.1985.Statistical Inference.S.chand and company ltd,New Delhi. 345p.