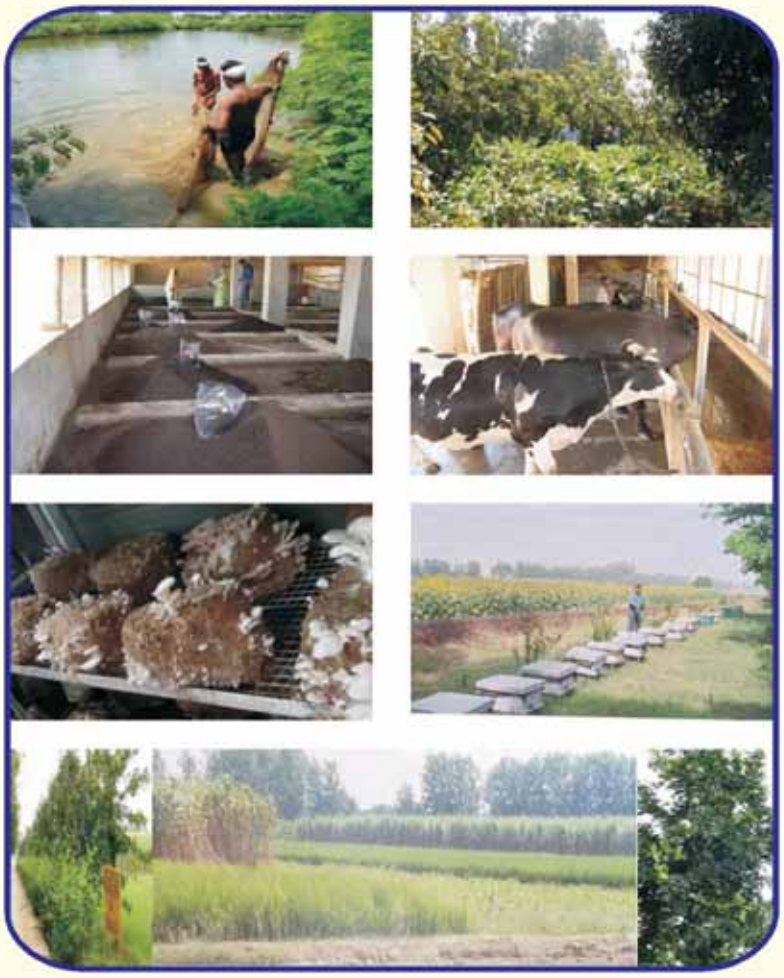
Integrated Farming System Model for Small Farm Holders of Western Plain Zone of Uttar Pradesh



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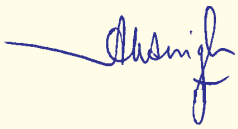
FOREWORD

Marginal and small categories of farmers, representing more than 86% of Indian farm families with holding size below 1.2 ha are living in risk prone diverse production conditions. Small and fragmented land holdings do not allow farmers to have independent farm resources like draught animals, tractors, bore wells/tube wells and other sophisticated farm machineries for various cultural operations. Most of them are illiterate or poorly educated, economically poor and unaware of advancements made in the field of agricultural sciences. In the past, the focus had been on maximization of crop yields only and that to for well-endowed resource rich farmers. To fulfill the basic needs of households including food (cereals, pulses, oil seeds, milk, fruit, honey, fish, meat etc.) for humans, feed, fodder, fuel and fiber, a well-focused attention towards Integrated Farming System Research is warranted.

Scattered experiments based on IFS approach have been carried out in the country over the years but the findings of these research activities could not be converted into recommendations and as such failed to reach the real stake holders. This very fact was realized by the Planning Commission, Govt. of India and ICAR in particular. In fact it is increasingly being recognized that IFS approach is a very strong tool for livelihood improvement of small and marginal farmers. Considering this fact, the PDCSR, Modipuram was renamed as PDFSR, Modipuram with a changed mandate during 2009. The AICRP on CS was also changed to AICRP on IFS for the development of region specific integrated farming system models through 31 on-station, 11 sub centres and 32 on-farm units spread in all the agro-climatic zones of the country.

This bulletin contains research findings of a project on “Development of an integrated farming system model for small land holders of

Western plain zones of Uttar Pradesh", carried out at PDFSR, Modipuram during 2004-10. I am confident that the information provided in the bulletin will serve as a model and guidelines for developing such IFS models in other areas of Western plain zones of Uttar Pradesh in particular, and similar agroclimatic conditions of adjoining states, Haryana and Punjab, in general. The efforts made by the authors in the form of this publication are praise worthy and will be useful not only to the farmers but to other research workers, people engaged in TOT and extension programmes of the states, NGOs and planners too.



(A.K.Singh)

PREFACE

Weakening of the traditional joint family concept combined with unchecked linear growth in human population lead indiscriminate fragmentation of land holdings. More than 85 percent farm families have been converted in to marginal and small categories of farmers having land less than one hectare. Small and fragmented land holdings do not allow a farmer to keep independent farm resources like draught animals, tractors, bore wells/ tube wells and other sophisticated machineries for various cultural operations. Further, most of the inputs have become costly and out of reach of these resource poor farmers which has resulted farming as an uneconomic and unsustainable enterprise. Large scale urbanization, industrial and infrastructural growth - a need of the day has necessitated looking for vertical growth rather than horizontal expansion as far as Indian agriculture is concerned.

In past, the focus had been on maximization of crop yields and that too for well-endowed resource rich farm families. Marginal and small farmers in general are literally illiterate, financially handicapped, their holdings are small and scattered not suited for high-tech agricultural machinery, work in resource poor and risk prone diverse conditions. Lot of efforts have been made aiming at increasing the productivity of different components of farming system but lacking in their integration by following farming system approach. To fulfil the basic needs of household including food (cereal, pulses, oilseeds, milk, fruit, honey, fish meat, etc.) for human, feed and fodder for animals and fuel & fibre for general use warrant an attention about Integrated Farming System.

The preliminary research investigations under IFS approach advocated the benefits of productivity improvement by 30-50% and more than double increase in employment generation than arable farming depending upon the number and kind of enterprises and their management. The integration is made in such a way that product of one component should be the input for other enterprises with high degree of complimentary effects on each other. The fodder fed to the cattle produces milk. The dung, urine and litter produce farmyard manure and energy used for crops and fishpond. The FYM can substitute about 25% of recommended NPK for crops, besides improving the physical and biological properties of soil. Cow dung mixed with crop residues and farm wastes may be converted in to nutrient rich and termite free Vermicompost. The fishpond embankment comprising 20-30% surface area can be used for growing cucurbits and fruit trees and also provide effective soil cover to check the soil erosion. The nutrient rich silt of fishpond is utilized as manure

to crops. The fishpond water can be recycled by gravity and /or lift method as supplemental irrigation at critical growth stages while there is breakdown in electricity supply or long dry spell prevails. Oilseeds provide nectar for honeybee, edible oils for human and oilseed cake for animal feed. Processing of different products enhances the value addition to the extent of 25 to 50% besides generating 50-75-man days/ family/ year of employment.

The results of studies conducted on Integrated farming systems at this Directorate during 2004-10 are synthesized and presented here in the form of this bulletin. Hopefully, it will serve as a model and guidelines for developing such IFS models in other areas of Western Plain Zone of Uttar Pradesh in particular and the similar agro climatic conditions of adjoining states Haryana and Punjab in general.

We feel indebted and extend special thanks to Dr. A.K.Singh, DDG(NRM),ICAR, Dr.I.C.Mahapatra, Ex-VC, OUAT also Ex- Chairman RAC and Dr. Punjab Singh (Ex- Secretary DARE (GOI) & DG ICAR), present Chairman RAC for suggestions from time to time and guidance for mid- term corrections and further improvement of the programme given by them during their field visits to this Directorate. The help rendered by Sh. D.Tripathi (T.O.) is praise worthy. During the process of studies, the help and guidance extended by ex- Directors of PDCSR (New PDFSR) is thankfully acknowledged.

Dated: December,2011 Authors
Modipuram

CONTENTS

SUMMARY

The studies conducted at PDFSR, Modipuram located in western plain zone of Uttar Pradesh for a period of six years (2004-2010) revealed that Integrated Farming System Approach applied on a piece of 1.5 hectare irrigated land, besides fulfilling all the requirement of 7 members household food and fodder demand (animals) inclusive cost of production, could create an additional average annual savings of Rs. 47000/- in first four years of its establishment and more than Rs.50, 000 in subsequent years. This saving could assist the family to meet other liabilities including health, education and social customs and improved the livelihood of small farm holders. Diversified nature of IFS and varied type of farm produces *viz*; milk, fruits, vegetables , fish and green fodders etc. in the system made the human and animal diet more nutritious compared to existing crop based farming system involving crops + dairy. Recycling of all the crop residues, animal and farm wastes and use of leguminous crops as green manure or dual purpose crops and bio-fertilizers could save more than 36% of plant nutrients. In addition, IFS approach generated more than the double man days as compared to crops alone which in turn can solve unemployment problem in rural youths. The analysis made on on-farm production and inter-relationship of different enterprises within the system envisage that more than 57 percent of the total cost on farm production Rs.1,97,883 per annum is met from the inputs (out- put of another enterprise/enterprises) generated within the system itself. This shows the significance of IFS approach in sustaining the farming with more economic gain by adopting it under small farm conditions.Hence, Integrated Farming System Approach to agriculture is a viable approach to solve many problems coming on the way of livelihood of small and marginal land holders in India. The approach encourages organic farming and resource conservation which help in keeping environment clean and safe and agriculture more economic. Further, IFS Model developed at the Project Directorate comprising of a basket of options, will act as a representative model for the farmers of the region and other parts of the country having similar agro climatic conditions and help in choosing enterprise/enterprises as per choice and needs of the family in relation to resource base.

INTRODUCTION

Next to Punjab, western part of Uttar Pradesh rich in natural heritage is considered to be the major contributor to the food bowl of the country. However, linear growth in population and unplanned colonization lead to rapid fragmentation of land holdings and shrinkage in fertile cultivated areas. Due to declining profitability the farmers are considering farming as a secondary occupation which resulted large scale migration of rural mass to the nearby towns and cities. In India, more than 70 percent of the total population of the country still live in villages and mainly depend on agriculture and/or related enterprises. Marginal and small farmers constitute more than 84 percent of the 115 million operational holdings in India which are cultivating only 29 percent of the arable land. Most of them are resource poor and work in diverse, risk prone environment. Further, small farm holders remained deprived of benefits of advancement in the field of agriculture, major beneficiary being resourceful well endowed farmers. The livelihoods of the small and marginal house hold families are the major concern. The improper tapping of the potentialities of each component in the system make the system unviable. Different farming systems have been evolved independently and being practiced by the farmers without any rationale for utilizing the wastes and residues arising out of cropping/animals and other associated enterprises at farm resulting wastage of resources. The income from average farmers from cropping alone is hardly sufficient to sustain his family. Dairy, irrespective of kind of animals and their breeds, has been an integral part of prevailing farming systems across the country. On farm - farming systems' characterization survey of the country as a whole and western plain zone of Uttar Pradesh conducted by the Project Directorate revealed that there is either stagnation or reduction in productivity and profitability of the important crops. The income from the livestock remained fluctuating and also uncertain. Infertility in cows and buffaloes and large scale mortality in poultry and goats are some of the major problems identified for such uncertainty. Because of poverty, the small land holders are reluctant to adopt new technologies and/ or enterprises. Farming system is a resource management strategy to achieve economic and sustained production to meet diverse requirements of farm households while preserving resource base and maintaining a high level environmental quality (Lal and Millu, 1990). Integrated farming system models developed in different parts of the country involving dairy, duckery, poultry , horticulture, apiary, pisciculture and plantation crops viz; coconut, , cocoa, nutmeg, banana, pineapple etc. along with crops, have been found to increase net profit significantly as compared to cropping alone. These IFS systems were also found more sustainable and employment generative. Balasamy et al (2003) obtain net

profit increase from Rs.22971/ha/annum in rice alone to Rs.31788/ha/annum in rice + fish + azolla. In Telangana zone of Andhra Pradesh, the major crops grown are rice, maize, jowar, groundnut, sugarcane and cotton and other components include buffalo, goat, sheep and poultry. The results of a study (Radha *et al;* 2000), conducted on survey based with three agricultural and livestock based farming systems viz., dairy, poultry and sheep rearing clearly revealed that all the farming system generated more than 3 times additional employment over arable farming . The net returns were higher in agriculture + dairy (Rs.35293) followed by agriculture + poultry (Rs.26830) and agriculture + sheep rearing (Rs.14665). Among different farming systems, the agriculture + dairy was proved to be more promising than others. The main reason for high return that stover of maize/jowar for fodder and their grains for feed as well as sugarcane crops to feed cattle buffalo were available at the farm. IFS studies conducted on farmers fields in Punjab conditions, gross profit was found to increase from Rs.81200/ha/annum in cropping (Rice-wheat) alone to Rs.154000/ha/annum in crop+dairy and Rs.113200/- in fish+piggery system of farming (Gill,M.S.,2004). Encouraging results of IFS approach in Uttar Pradesh has also been reported by Gurbachan Singh (2004) and Singh et.al.(2007).

Keeping in view the importance of Integrated Farming Systems in substantial increase in profitability of households an attempt was made to integrate best possible enterprises to study the feasibility and develop appropriate model for western plain zone of Utter Pradesh. The results obtained during the period of study (2004-2010) are discussed here for ready reference of researchers, planners and farmers.

METHODOLOGY

Before start of the IFS project on, “Development of Integrated Farming System Model” at PDCSR, Modipuram, a multi disciplinary team of scientists and technicians of the Project Directorate conducted detailed survey to characterize the existing Farming Systems in Meerut district assuring as a most representative district of western plain zone of Uttar Pradesh. Based on the information generated during the survey, the dominant farming system identified was crop + dairy representing 80 % house hold of small farm group. As the small and marginal farmers in general were resource poor and economically weak, more realistic additional enterprises in phases and not at a time were introduced & evaluated. Further, to get maximum possible returns from different component enterprises with available farm resources of the small holders, low cost - cost effective and also environmentally safe technological modules were prepared in consultations of the experts of different disciplines. To get set objectives and wide adaptability among small farm holders, a piece of one and half hectare cultivated land with assured irrigation was taken during summer season of 2004. The allocation of land resource for accommodating different enterprises was done as per needs of the family (Calculated for a family of 7 members as per standard given by Dr. M.S. Swaminathan 1998) and size/numbers of individual components of the system. Out of 1.5 hectare of area, 0.72 hectare was used for cultivation of cereals, pulses, oilseeds, potato, flowers and sugarcane. An area of 0.22 hectare was allotted for a multistoried unit of horticulture containing a mixed plantation of perennial fruits mango, guava, pear , citrus species and short duration fruit papaya as intercrop in between the rows of perennial fruits. A number of short duration vegetables and fodder crops were also grown under the canopy cover of these fruit trees. This orchard unit was surrounded by live hedge plantation of bushy crop *Carisa carendis* (Karonda) at a plant to plant distance of one meter. The third component diary was included in 2005 initially comprised of Murrah breed of buffaloes (two) + Sahiwal cow (one) and this unit was further strengthened by inclusion of one Holestein Friesian cow and one buffalo in subsequent years. However, the extra animals were sold in subsequent years to keep the unit size as per norms. To ascertain supply of green fodders round the year, green fodders in an area of 0.32 hectare were rotated with other field crops in different crop sequences and not on separate land. Moreover other enterprises included in to the IFS were apiary (A unit of ten bee boxes) in 2004, fresh water fish production (pisciculture) in 2005 (a mix of rohu, katla, mirigal and grass carp & common carp etc.) in fish pond of 0.10 hectare, vermicomposting in 2006 (0.01 hectare) and goat unit with 15 female & 1 male goat animals in 2007. The fruit species with less

shade effect and of common use (Jamun, bel, jackfruit and seedless nimboo) were also planted all around the field boundaries of the IFS Model. All the cow dung, goat excreta, farm wastes and crop residues were properly recycled either by composting (FYM and vermicompost) or directly incorporated in to the soil . Even the animal wash and urine was mixed directly in to the fish pond. In this way every product and by products including farm wastes and crop residues all were fully utilized and nothing allowed as waste. To keep the farm environment clean and output of one enterprise / enterprises worked as input for other. To know the comparative performance of integrated approach over traditional farming and its impact on livelihood of a farming family, all the parameters of economics were taken in to account. The net saving was calculated after deducting total value of family consumption from the net returns. Cost of production includes all fixed and variable costs including inputs, labour, bank interests and land value.

FARMING SYSTEMS SCENARIO IN THE REGION

Crop production along with rearing of milch animals **(crops + dairy)** is the prevailing farming system in the western plain zone of utter Pradesh as about 96 per cent farmers of the area adopt this system. As component of farming systems sugarcane–wheat and rice-wheat are the major cropping systems in the region. Based on the prevailing market rates of different inputs and outputs during the year 2004 – 05, the net return under sugarcane–wheat and rice–wheat cropping system estimated to be Rs.39689/- and 24048/- /ha, respectively showing that sugarcane-wheat system is more advantageous than rice-wheat cropping system. The economic analysis based on farm holding size revealed that in sugarcane–wheat net returns increased with increase in farm holding size but in case of rice- wheat it was inversely related. Highest net returns (Rs. 41133/-/ha) were realized by large farmers under sugarcane-wheat system. Whereas in case of rice-wheat, highest returns (Rs.26558/- /ha) were recorded with sub-medium farmers. With regard to dairy animals average number of milch animals per family were found to be 0.56, 1.16, 1.99 and 2.57 for small, sub medium, medium and large farmers respectively with an overall average of 1.53. The combined economics of this system indicates that rearing of dairy animals with crop production may further increase income of different categories of farmers ranging from Rs. 760 to Rs.1712/ per family per year.

Data pertaining to comparative economics of different farming systems/ enterprises are predicted in fig.1 below.

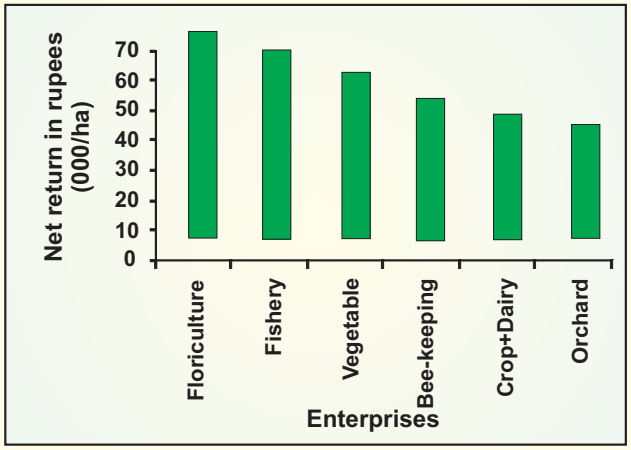


Fig.1. Economics of different enterprises

It was observed that except orchards, farmers earn higher incomes per unit area by adopting enterprises other than crops + dairy, a prevailing farming system of the area. The marginal increase in economic profits over existing farming system (crops + dairy) ranged from 40 percent under vegetable cultivation to 75 percent with floriculture. However, risk is more because of high fluctuations in demand and price of these commodities.

Table1. Economics of prevailing cropping / farming systems

Cropping/ Farming System	Economics (Rs. / ha/year) based on category of farmers				
	Small	**Sub- medium**	**Medium**	**Large**	**Mean**
A. Sugarcane –wheat system					
Variable cost	29422.02	30553.68	30261.76	30117.21	30088.67
Gross cost	43822.03	44953.68	44661.76	44517.21	44488.67
Gross income	82436.05	83779.75	84846.45	85650.4	84178.16
Gross margin	53014.03	53226.07	54584.69	54034.7	53714.87
Net income	38614.02	38826.07	40184.69	41133.19	39689.49
B. Rice -wheat system					
Variable cost	NA	23069.61	23683.84	21603.69	22785.71
Gross cost	NA	37469.61	38083.84	36003.69	37185.71
Gross income	NA	64027.5	61165	58510	61234.17
Gross margin	NA	40957.89	37481.18	36906.33	38448.47
Net income	NA	26557.89	23081.16	22506.31	24048.45
C. Farming system (Crop+ dairy based farming system)					
Variable cost	36691.53	37823.18	39109.62	43250.71	39218.76
Gross cost	52493.28	53624.93	55252.96	58470.03	54960.3
Gross income	91855.2	93198.9	96601.38	101314.8	95742.57
Gross margin	55163.68	55375.72	57491.76	58064.09	56523.81
Net income	39361.93	39573.97	41348.42	42844.78	40782.27

Observations also suggested that backyard poultry (1000 birds per family), Apiary(50 boxes per family) , floriculture and vegetables may add considerably to the income of a farmer (Table 2) with higher B: C ratio however, it requires market link. The study thus suggested that farmers of the region can think of diversifying their farming system with inclusion of the other enterprises. However, adoption of new enterprises should depend upon farmer's skills, resources, availability of credit, future demand, and availability of market channels in the area.

Table 2. Economic analysis of different farming systems

Farming system	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	Benefit-cost ratio
Crops + Dairy (Existing system)	54960	95742	40782	1.74
Orchard (Mango)	122500	160000	37500	1.31
Floriculture (Marigold)	43919	112629	68710	2.56
Vegetables	44752	99599	54847	2.23
Fishery	95180	157500	62320	1.65
Bee-keeping*	125000	171250	46250	1.37
Poultry*	65045	132927	67842	2.04

***Economic analysis of bee-keeping is based on 50 boxes and of poultry on 1000 birds per family based on prevailing market rates of inputs and outputs during 2004-05**

Yield gaps:

The survey of existing farming systems of western Uttar Pradesh revealed that there is wide gap between farmer yield and achievable yield of different farm commodities. The farmer yield, achievable yield and gap in the yield of some farm commodities are given in table 3 below;

Table 3. Gaps between farmer yield and achievable yield of the component enterprises

Farm commodities	Farmer yield (Av.) q/ha	Achievable yield(Av.) q/ha	Gap (%)
Sugarcane (Plant)	540	1100	103.0
Sugarcane (Ratoon)	740	1300	75.7
Wheat	46	65	41.3
Rice	42	65	54.8
Milk (Improved cow)	7.36 kg/animal/day	20 kg/animal/day	171.7
(Buffaloes)	5.22 kg/animal/day	12 kg/animal/day	129.9

Similarly, the production of other enterprises such as horticultural crops, bee keeping and fishery etc. is also much less than potential yield of different commodities.

Constraints responsible for yield gaps

The constraints analysis is most important exercise in order to find out or suggest specific solutions to specific problems. With the help of survey following problems/ constraints were analyzed to identify researchable issues/interventions to make the different enterprises more profitable:

A. Crop production

- Late planting of crops, especially of sugarcane and wheat.
- Use of higher seed rates in wheat
- Poor seed management almost in all the crops
- No seed treatment
- Improper sowing methods mainly broadcasting in wheat
- Excess use of N, imbalanced use of nutrients and improper application methods
- Use of poor quality FYM
- Lack of knowledge about disease and pests management in respect of application methods, time of application, rates of pesticides and use of right pesticides.

B. Animal husbandry

- Rearing of Non-descript animals
- Feeding of animals with poor quality feed and fodder
- Animals are not fed with balanced concentrates
- Incidence of diseases and other problems
- Fertility problem, anoestrus, repeat breeding, low conception rate, improper time of service, service by local and non-descriptive bull

- Little use of minerals, salts and vitamins

C. Horticultural crops

- Mango: The main problems of mango include alternate bearing, malformation, disease like bacterial blight and powdery mildew and pests like hopper and mealy bug, taking orchard by non-traditional farmers, growing unsuitable crops in orchards and lack of processing units.

- Vegetables: In vegetable main problems were non-availability of good quality seed, sowing of seed without proper treatment, lack of suitable varieties and suitable growing techniques and pests and disease problems.

- Floriculture: There is no suitable variety of marigolds, particularly for rainy season and poor plant protection measures.

D. Bee- keeping

- Lack of technical know- how, adoption at small scale, non-availability of desired flower plants round the year for honey bees for feeding, lack of improved honeybees colonies and incidence of pests and diseases.

E. Poultry

- Lack of technical know-how to farmers, poor housing facilities, non-availability of electricity, not taking regular batches of poultry .

F. Fishery

- Social factor, use of small size ponds, theft, poisoning, lack of technical know-how and un- awareness among farmers.

The overall analysis of the various characters observed during the characterization survey revealed the present scenario of demand and supply of different inputs/commodities required for livelihood and/or at least subsistence of a family.

Crops: - The farmers grow selected crops and are dependent on local market mainly for pulses oilseeds and some times green fodder too. – *The annual minimum need of family for food, fodder and fuel are not met out.*

Dairy:- Farmers as well as land less families rear indigenous low yielding (4-6 kg milk/day) breeds of buffaloes and cows. Fodders having very low nutritive value including wheat straw and sugarcane tops are fed as fodder for more than six months. Green fodders are lacking during Sept.-November – *Rearing of uneconomical animals and lack of nutritious green fodders.*

Fruit cultivation:- Mango, guava, peach and pear are major fruit trees. The fruit orchards however are dominated by mango mixed in different ratios of peach/pear or guava. Farmers grow any of the field crops even sugarcane or rice or wheat or sorghum in newly planted orchards – *Lack of technological know-how.*

Bee keeping:- Bee keeping is practiced mainly by the orchard owners or nearby farmers of the orchard as this need regular flowering crops/trees. *Small land holders do not prefer fruit tree plantations and flowering crops.*

Fishery, piggery and poultry:- Few farmers adopted these three socially less accepted enterprises. Maintaining a certain depth of water in fish pond through out the year is the major constraint of fish farming. Likewise, diseases in pig and poultry.

DEVELOPMENT OF FARMING SYSTEM MODEL

To ensure livelihood security of marginal and small farmers and simultaneously, securing agricultural sustainability and environmental safety as well, a research project on Integrated Farming System was initiated at PDCSR, Modipuram in 2004-05. The model developed on 1.5 hectare area comprises of crops (0.72 ha), dairy (0.32 ha), horticulture (0.22 ha), fishery (0.10 ha) and miscellaneous (0.14 ha) which was used for goat, apiary, vermicompost, threshing floor and farm building etc. This model initially was consisting of field crops including fodders, dairy with improved milch animals (Two buffaloes of murrah breed + one cow of sahiwal breed), horticulture (A multistoried fruits and vegetables unit), apiary (10 bee boxes) and pisciculture (A mix culture of fishes including rohu, katla, mrigal, nain and grass carp). This was further strengthened by establishment of a small vermicompost unit (0.01 ha) in 2006 and goat unit (15 goat animals) in 2007. The goat unit however was not found suitable and profitable under stall feeding and was removed from the programme in subsequent years. In addition, fruit plants (Stone fruit "Bel" , jackfruit, aonla , jamun and citrus spp. Kagji Nimboo) were also planted all around the farm boundaries as wind breaks to protect the field crops and add in to income of the farm. At boundary of horticultural unit's *Carisa carendis* locally known as "karonda" was planted which served as live fencing and provided considerably high fruit yield (4-6q/year) as a bonus. All the farm wastes, by products and crop residues etc. were properly recycled in to the system it self so that nothing go as waste and output of one enterprise serves as a input for other enterprise. Under crop production besides food for family consumption, provided green fodders and feed concentrates to the dairy animals and also green biomass as feed of fish and goat. In turn animals' cowdung and urine after proper composting and in the form of FYM and vermicompost was used as a major source of nutrients in field and plantation crops and calves either used as draught animal or sold in open market. Also animal wash directly diverted from animal shed to fish pond to serve as fish feed. In this way IFS is a very complex in nature but a number of complementary as well as supplementary type of interactions within the system itself make the system more viable. The major components/ enterprises of integrated farming system model at PDFSR, Modipuram are as fallows.

COMPONENT ENTERPRISES OF IFS MODEL

Crops + Dairy

(Dominate Farming System of the Region)

+

Horticulture + Fishery

(Most Promising Enterprises for Integration/ Diversification)

+

Apiary + Vermicompost + Boundary Plantations

(Supplementary Enterprises)

FINDINGS AND RECOMMENDATIONS

Performance of various farm components of the system under an IFS approach and their relative contribution in livelihood improvement of small farm holders are described in detail, here.

CROP PRODUCTION

Ensuring household food (*food grains - cereals, pulses, oilseeds and milk & meat for human beings and feed and fodders for animals*) requirements of a family and making farmers less dependent on market, is pre requisite of any of the research and/or developmental programmes carried out for small farm holders. According, 1.04 ha (69%) land out of total area of 1.5 ha under IFS model was allotted for growing different crops/cropping systems consisting cereals, pulses, oilseeds, vegetables, flowers and green fodder crops. Green fodder crops sharing about 30% of total allotted land under crops were raised as an integral part of different cropping systems and no separate area was allocated for the purpose. Further, to have a basket of options a number of crops in different cropping systems were tested for their yield potential and economic returns. The yield (SYE), net returns, B: C ratio and appropriateness of cropping systems for the farmers living in different situations are given in table- 4 . The farmers can choose the crops and allocate area under particular crops according to their needs but first he should give priority to ensure livelihood of the family and then the crops fetching higher incomes for additional income and prosperity.

The data summarized in table – 4 revealed that in rice equivalent terms the crop sequences viz; Rice- potato-marigold (164.5t/ha/annum), Sorghum-rice-berseem (146.42 t/ha/annum) , Rice-potato –wheat – *Sesbania aculeate* (131.01 t/ha/annum) and Rice-berseem **+** mustard - pearlmillet (100.62 t/ha/annum) were found better cropping systems as compared to prevailing sugarcane based cropping systems (87-96 t/ha/annum). The productivity of other two cropping systems were also comparable to the dominant sugarcane based systems. Further, cropping systems Rice-berseem **+** mustad - pearlmillet and Sorghum (F) – rice (hybrid) - berseem enabled to get sufficient amount of green fodders round the year and be chosen by the farmers rearing more number of dairy animals. This shows that farmers besides sugarcane can include cereals, pulses, oilseeds, potato, marigold and even green fodders to satisfy their household needs and get higher income, simultaneously.

Table 4 : Productivity and profitability of different crop sequences (2004-2010)

S. N.	Crop sequences and technological interventions	Yield (SEY**) (t/ha/year)	Net returns (Rs./ha/year)	B:C	Option/ Suitability
1	Sugarcane (Feb) + **onion/ tomato *** –Ratoon (***Two year rotation)***	95.94	63887	1.53	More productivity / profitability from existing sugarcane based cropping systems
2	Sugarcane (May) +**Cowpea (GM)** * -ratoon-wheat ***(Two year rotation)***	86.98	53818	1.28	More productivity / profitability from existing sugarcane based cropping systems
3	Rice – **potato *-** wheat – ***Sesbania aculeate*** * (GM)***(One year rotation)***	131.01	67312	1.56	Diversification of existing Rice-wheat cropping systems
4	Rice-berseem **+ mustad ***- pearlmillet ***(One year rotation)***	100.62	70162	1.73	Better choice for animal based systems
5	Sorghum (SF) – rice **(hybrid)** *-berseem (One year rotation)	146.42	166637	3.14	Better choice for animal based systems
6	Rice (basmati) – **potato *– marigold *** (One year rotation)	164.54	150812	1.57	Most profitable cropping system for the farmers living in near vicinity of cities and towns
7	Maize **(Dual purpose) *+ red gram** * – wheat (One year rotation)	82.23	123343	1.94	A better cropping system with considerably higher net returns and B:C ratio.
8	Sorghum (SF) - rice **(Hyb.) *** - mustard ***(One year rotation)***	88.00	88380	2.40	For the farmers living at far distances of cities

**** Technological interventions for increased efficiency of prevailing systems. However, all the crops included in different cropping systems were grown with improved practices recommended for respective crops.***

***** Sugarcane Equivalent Yield***

1: Maize (green cobs) + red gram –wheat a most promising cropping system for the region

2: Potato in rice-potato-wheat system – A highly productive and profitable cropping system

3: In situ incorporation of cowpea (GM) in summer planted sugarcane (R) and spring planted sugarcane (L)

4: To fetch higher income marigold crop can profitable be taken in Basmati rice – potao – marigold system

Photos 1-4: Potential crops and cropping systems

Further, the data given in table 5- below show that the cropping plan (Photo 1-4) included in the IFS approach not only fulfilled the annual demand of food and fodder for a 7 member Indian family but enabled to produce additional produce for sale in market and earn a sizable cash (Rs.73,430/year) to meet out cost of production and add in to the purse of the family .

Table 5: Production of crops and their contribution in livelihood improvement.

Food Commodities	Periods			Annual food and fodder demand of an Indian family (Tones)	Surplus available for sale in market-calculated based on the harvest of different produces in final year
	Av. of first 4 years; 2004-05 to 2007-08 (Tones)	Fifth year (2008-09) (Tones)	Final concluding year (2009-10) (Tones)		
Cereals	3.10	4.01	3.27	1.55	1.72 ***(Rs. 20,640)****
Oilseeds	0.16	0.29	0.15	0.13	0.02 ***(Rs. 600)****
Pulses	0.46	0.25	0.21	0.20	0.01 ***(Rs. 300)****
Fodders	53.00	90.20	88.00	86.60	1.40 ***(Rs. 1050)****
Sugarcane	27.70	9.68*	26.4	1.60	24.80 ***(Rs. 50,840)****
Total	-	-	-	-	***(Rs.73430)****

*In reported year, the area under sugarcane was reduced to half of the previous four years and was shifted to green fodder crops because of increase (200%) in animal number of the animal unit and hence less cane production as compared to average production of previous years. Further, the cane yield reported in the year is of plant crop of summer planted sugarcane which is always less than the average yield of plant + ratoon crops of sugarcane.

** Figures in bold italics are the values of different farm commodities in term of money.

DAIRY FARMING

Livestock considered to be a valuable and critical asset of the rural poor in supporting their livelihoods particularly during unfavorable times. Mixed (crop-livestock) farming systems provide flexible asset regime and reduce risk and vulnerability of the poor farmers. Characterization survey conducted in western plain zone of Uttar Pradesh revealed that 96% of farmer families rear milch animal's cows and buffaloes. The later however contribute significantly, both in number as well as in production of milk. Further, the average production per day or annual production is low to very low. This was because of low yielding local breeds, poor and imbalanced nutrition, and lack of green fodders mainly during the period of October to February. Not only this, but the fodders too are not adequately mixed with leguminous fodders. A few farmers use salt and mineral mixtures and that too for limited periods. Under better management of animals the high yielding breeds (Photo 5) of the buffalo (Murrah) and cow (Holstein Friesian) were kept in the dairy units which are most common and best suited for the area. Daily feeding of animals with green fodder 30 kg daily, dry fodder 6 kg daily concentrate 2 kg for maintenance of body and 1kg for every 2.5 lit of milk .Clean and fresh water for drinking was provided to animals. Round the year availability of green fodders were ensured by inclusion of season specific fodder crops (Photo 7-9) in different cropping systems

Table 6: Year round green fodder production under IFS model at PDFSR, Modipuram.

Name of crops	Availability(duration)	Av. annual production of green fodder (q)	Av. annual production of dry fodder (q)
Sugarcane (cane tops)	Oct. to April	-	89
Wheat straw	Round the year	-	22
Maize curvi	August to Sept.	-	5
Maize+cowpea	May to June	44	-
Pearlmillet	June to July	50	-
Sorghum	July to Nov.	241	-
Berseem	Dec. to April	72	-
Oats	Dec. to March	53	
Total		460	116

Note: Fodder crops were a part of cropping systems under crop production programme and no separate area and cost allocated for the purpose in animal (Dairy) enterprise.

5: Cow (H.F.) and buffaloes (Murrah)

6: Hybrid Napier-a perennial green fodder

7: Maize + Cowpea

8: Rabi crops Berseem (L) and Oats (R)

9: Kharif sorghum (L) and bajra (R)

Photos 5-9: Feed and fodder management of dairy animals

followed under crop- production programme (Table 6). Further, to get green fodder during October to December, the months generally lacking in green fodders, sorghum variety Hari Ganga was sown in late September which produced lush green fodder in these months. Hybrid napier (Photo 6) a perennial grass grown on a small area (150 sq. m.) also add in to the green fodder production.

Animals were observed daily for any kind of illness and disease. Regularly deworming of animals was carried out. Observation of heat symptoms in animals and artificial insemination of animals were done. Cleaning of animals, animal shed and surrounding of animal shed to maintain hygiene and prevention of diseases. Daily proper disposal of dung for preparing of farmyard manure and vermi-compost was also done.

Production and profits

The details of milk production, gross and net returns from the animal unit during last five years (March, 2005 to March 2010) are given in table 7. The study revealed that even under small farm conditions a unit of 3-5 milch animals can easily be handled. It may contribute besides home consumption of milk, sufficiently higher profits through milk sale.

Table 7: Annual milk production and gross & net returns from the animal unit

Year of production	Annual MilkProduction (Litre)	Gross returns* Rs./year	Net returns Rs./year
2005-06	5748	51852	22450
2006-07	5667	116333	40705
2007-08	2083	111285	32293
2008-09	11315**	2,91,003**	1,92,673
2009-10	5792	2,48,971	1,47,022
Average	6121	1,63,888	87,029
Annual milk requirement Of a 7 members family	1022	-	-

* Income from the milk and other products and by- products of animal unit along with sale of calves
** The number of milch animals was doubled during the year and hence more production and profits

Beside milk production, the animal unit also produced more than 33.0 tones of cow dung on fresh weight basis which in turn can add about 60 kg N,140 kg P_2O_5,230 kg K_2O and a number of macro & micro nutrients when added in to the soil. This all can save money equivalent to Rs.6935/year. On the other side, when 2/3rd' of cow dung was utilized in preparation of Vermicompost (Photo 10) and rest 1/3 was used as fish feed and FYM, could be produced as much as 15 tones of enriched Vermicompost (2.3%N) and 8-10 tons FYM , annually .

10: Growth of earthworm spp. *Eisina foetida* during the process of vermicomposting

HORTICULTURE - NUTRITIONAL ORCHARD

Horticultural crops are nutritionally rich mainly of essential proteins and vitamins which make human diet complete and help human being physically fit and mentally more sound. Characterization survey of the districts Meerut and nearby areas representing western Uttar Pradesh revealed that fruit orchards generally are being owned by medium to large categories of farmers and most of them are absentee farmers. The orchards are auctioned to professional fruit owners for a certain period and the soil and crop management of these fields are very poor and hence the productivity. As far as vegetables and flowers are concerned, the farmers living in close vicinity of the towns and cities use to grow these crops entirely or as a part of cropping systems but are on the mercy of middle mans and local market as the storage facilities are not adequate and in command of the farmers and the growers are forced to sale their produce on low prices to middle men.

To make the family members' diet nutritionally rich and bring prosperity, horticulture enterprise was considered more appropriate to integrate in to the predominant on-farm farming system (crops+ dairy) of the region. An orchard unit of 0.22 hectare (Photo 11-14) was established in the very first year of the IFS model development. Guava & mango (Photo 11-12) as main fruit, papaya (Photo 14) as an intercrop fruit and citrus, banana and Karonda (*Carisa carendis*) as border fruit trees were planted at recommended spacing and with scientific management practices. vegetables , flowers and legumineous fodders (Photo 13) were raised in between the rows of fruit trees.

During first two years the fruit plantations were maintained and mortality if any was replaced. Intercropping of fruit papaya and vegetables tomato & brinjal could realized an amount of rupees thirty thousand and sixty eight (Rs.30,068/-) by sale of vegetable tomato in first year and by auctioning the whole produces of the unit including intercrop papaya in second year. The yield and income of first two years is given in the table 8. The intercrops enabled to meet the initial establishment cost of the orchard. In addition to this proper care and maintenance of the orchard (hoeing/ weeding and irrigations etc.) could also be possible because of regular interventions related to the intercrops tomato, papaya and brinjal.

During third year (2006-07), floriculture was also introduced by growing marigold and gladiolus flowers along with vegetables tomato, brinjal and capsicum. Gross and net income generated from the horticultural block during the year in term of fruits (citrus, papaya, banana karonda & guava), flowers marigold & gladiolus

11: Guava var.L-49 producing more than 100 kg of fruits per tree during fifth year of plantation

12: Heavy blooming and fruit bearing five year old mango tree in the orchard

13: All the interspaces in between the rows of fruit trees were utilized to grow a number of vegetables (Brinjal in picture), field pea and also leguminous fodders

14: Papaya best suited fruit spp. for intercropping in between spaces of fruit rows was taken in first two years of establishment of the orchard and gave higher initial income

Table 8: Fruits and vegetables yields during first two years of establishment of the orchard

Intercrops	Yield (kg)	Prevailing market rate (Rs./kg)	Gross value (Rs.)	Remark
Tomato	1344	Rs.6/kg	Rs.8064/-	Sold in staff
Papaya & brinjal	63	Rs.8/kg	Rs.504	Sold in staff
Papaya & brinjal	-	-	Rs. 21500/-	Auctioned

and vegetables (tomato, brinjal, capsicum) sold in office staff (Rs.9902) and rest of the produces auctioned (Rs.5600) were Rs.15502/- and Rs.3371/-, respectively. This yield and profit was mainly from boarder plantations and intercrops (Table-9).

Table 9: Production and income details from the horticultural unit -third year (2006-07)

S.No.	Farm commodities Fruits/vegetables/ Flowers etc.	Weight (kg)/ Numbers	Prevailing market rate (Rs.)	Product Value (Rs.)
1	Guava	89.5 kg	8.0/kg	716
2	Papaya	11.0 kg	8.0/kg	88
3	Banana	213.0 kg	8.0/kg	1704
4	Karonda	30.0 kg	20.0/kg	600
5	Citrus	28.0 kg	20.0/kg	560
6	Brinjal	615.5 kg	8.0/kg	4924
7	Marigold	57.5 kg	20.0/kg	1150
8	Gladeolus	160 sticks	1.0 / stick	160
	Total sale	-	-	9902
	Produce auctioned	-	-	5600
	Gross return	-	-	15502

In fourth year (2007-08) of the study a number of seasonal crops including flowers, vegetables and green fodder crop oats were grown under canopy cover of these fruit trees. These seasonal crops along with fruits, could earn money worth Rs. 22678/- (excluding 205 quintal fodder oats) with a net returns of Rs. 13456/ year. Similarly, in fifth year (2008-09), 560 kg fruits and 3207 kg vegetables were produced and sold in open market worth Rs.20800/year with a net profit of Rs.14040/ year. In 2009-10, the unit was auctioned @ Rs.9050/year on one year contract and a sum of rupees seven hundred (Rs.700/-) only was spent in the form of irrigation water as term condition of the contract and rest expenditure was made from the side of the contractor. In this way on an average the gross and net returns from the horticultural unit were Rs.17,402 and Rs.10263 per annum which when calculated on per hectare basis comes to Rs.80,564 and Rs.47513/ha/year with B:C of 2.44. As a matter of fact the major component of the orchard is fruits and most of the fruit species (Mango and Guava in this case) starts fruit bearing only after 4 - 5 years or even later, hence the income during establishment years as above was mainly of the intercrops papaya and vegetables including fruits. The income will increase manifold in succeeding years when fruit trees will produce to its maximum.This way horticultural crops produce round the year high value crops and provide more employment to the family members as compared to crops alone.

FRESH WATER FISH PRODUCTION

Linear growth in human population and decreasing trend in animal population put extra burden on food production and necessitated search of new sources of food . Increased supply of meat and meat products is the next possibility to satisfy the food demand in coming future. Fish production is an emerging field of supply high quality protein and other nutrient rich meat particularly in northern India, southern part of the country being the leading fish production states by habitat. During characterization survey of the area a number of farmers doing fish farming and fetching high income from the enterprise show the future scope of this enterprise in the area. The government of Uttar Pradesh has taken it as a campaign and a number of measures have been taken to popularize the fish production programme in the state including rejuvenation of old village ponds and digging new ones and also establishing seed nurseries and hatcheries.

Management of farm pond:

To standardize cultural practices for small size of fish pond best suited under small farm conditions and raising the income of IFS model, a fish pond with a total living area of 1200 sq.m. and water filling area of 0.09 ha. was constructed in the month of August,2004 and fingerlings of fish species rohu, katla, mrigal and grass carp were introduced @ 10000 fingerlings/ha as mixed seed. Before introducing fingerlings in the pond the pond ground layer was well mixed with silt of old fish ponds and cow dung to reduce the downward and lateral movements of pond water. For proper feeding, the pond water was nourished by cowdung (Photo 15) , mustard cake, rice bran and NPK as per recommendations. Liming of pond was also done as and when required to maintain the pH level normal for better growth of fishes. A level of 1.5 meter depth of water was maintained by regular watering in the pond. Exercise of fishes was also done on regular intervals of one month for good health and rapid growth for good health. The growth of fishes (Photo 16) was watched at a regular interval of three months and the harvest of fish (Photo 17) was done twice a year when fish weight reached in between half to one kilogram.

Fish production:

In very first year comparatively less yield (148 kg) than expected was obtained which was mainly because of less space available for free movement and required exercise of the fishes and high density of fingerlings in the pond. To correct this error, the pond was rejuvenated by removing middle barrier hindering movement of

15: Feeding of fishes with cow dung

16: Scientist observing fish growth

17: Harvested fish - A mix of different fish species

the fishes in to the pond water (initially the pond was divided in to two equal portions) and putting optimum number of fingerlings for less competition for food and space.

As a result the situation improved and the yield of fishes increased from 148 kg in 2005-06 to 280 kg in 2007-08, 472 kg in 2008-09 and 518 kg in 2009-10. The improvements made in the shape and size of the pond and cultural practices made possible to get considerably higher yields and subsequently more gross and net returns (Rs.25900 and Rs.16063, respectively in fifth year 2009-2010) than initial two years of establishment .

Besides fish production, nutrient rich pond silt (de-silted once in every third year) and pond water (recycled as irrigation water for crop production twice a year

in ***kharif*** rice and ***rabi*** wheat) were applied for productive use in crops. A total amount of 18.56 kg N, 6.21 kg P and 74.24 kg K was added by excavation of 15 cm deep ground soil surface of 800 m^2 pond area saving an amount of about rupees nine hundred fifty. The OC% of the soil was as high as 1.20 with an average value of 0.95. Addition of pond silt and water was found to increase the yield of rice and wheat by 3.48 q/ha and 2.41 q/ha, respectively.

In addition to this bund dykes was also utilized for raising fruits like banana (Photo 18), citrus, guava and also many other crops including short duration vegetables and green manure crops *Sesbania aculeate, Lucenea lucocephala* (Photo 19). These crops not only add in to production but save bund slops from soil and water erosion.

18: Utilization of pond dykes for raising valuable fruits Banana on pond dykes

19: Planting of Subabool (*Lucenea lucocephala*) on pond dykes for checking erosion of slopes and using it as GM and GF

BEE KEEPING

Bee keeping is an enterprise which is being practiced mainly by the orchard owners and landless families residing near vicinity of the orchards. Besides producing honey and wax, they play an important role in the pollination of various crops. It has been stated that for every rupees worth of honey and wax produced, honey bee works worth rupees ten as pollinator. To fetch higher profits from this enterprise round the year availability of flowers is essential which is not possible at a single place and hence shifting of bee colonies from one place to another is essential. This however, is not feasible by the small farm holders. To diversify the existing farming system and make the enterprise within reach of the small farm holders, a small unit (Photo 20) of apiary with 10 boxes was initiated in March , 2004 which enlarged to 20 boxes (Photo 21) in subsequent year 2005 .

Photos 20-21: Small unit of 10 bee boxes started in 2004-05 (L) was extended to 20 boxes in subsequent years (R)

Management of bees

To maintain the apiary unit following measures were adopted;

1. *Artificial feeding:* The bee colonies were fed with sugar syrup in the dearth period, especially in winter. The sugar syrup is prepared by dissolving 100 g of sugar in 150-200 ml of hot water, boiled and cooled. The syrup is offered in containers with their mouth covered with cloth. The bee colonies are fed on alternate days in the evening.

2. *Provision of drinking water:* Fresh water within a short distance of colonies was provided. Water is require to blend the food and to lower the temperature of the hives during hot weather.

3. *Swarming and its prevention:* The hives were examined regularly (Photo-24) every week during the swarming season, and all newly formed queen cells cut out. The beehives were kept in shade of trees to avoid direct sunshine. All care was taken to avoid over crowding in the brood chambers. To ensure a vigorous queen and minimize the swarming tendency Queen was renewed every year.

4. *Round the year availability of flowers:* Round the year availability of flowers is a pre-requisite to get maximum production from apiary unit. The owner of large units generally use to shift the bee unit to other places during the periods when sufficient flower crops are not available. However, this is not feasible as well as economic for such a small unit. Therefore, the provision of additional feeding is required. Even then crop selection in cropping sequences was made in such a manner so that availability of flowers could be maintained for a longer period (Table 10).

Table 10. Ensuring round the year availability of flowers

Source of Nectar	Rainy season June-Aug	Autumn Sept-Nov	Winter Dec-Feb	Summer Mar –May
Crops	Maize	Maize,Pigeonpea, Cut end of Sugarcane	Mustard, Sunflower, Sugarcane	Sugarcane Marigold
Fruits	Citrus ,	Gauva	-	Citrus, guava, peach, litchi
Vegetables	Cucurbitaceous	-	-	Cucurbitaceous family
Timber tree	-	-	-	Eucalyptus

Production of honey: An average honey yield of 195 kg/year was recorded during first two harvest seasons (2004-05 and 2005-06) with a net profit of Rs.8103/year from the unit. During third year (2006-07) considerably low yield (90.5 kg) was produced. The production was badly affected because of large scale mortality of bee flies by attack of a parasite insect **Varao mite** on the larvae and pupae of the bee flies damaging more than 70% of the bee colonies. The insect attack started in June, 2006 was so incidental and wide spread which not only effected production in

IFS unit at PDFSR, Modipuram but more than 50% business was completely lost in most of the northern states including Haryana, Punjab, Rajasthan, Himachal, Uttaranchal and western Uttar Pradesh; HINDUSTAN (Hindi) Daily edition,September,6,2006. Under all even and odds, the bee keeping was still beneficial and a net returns of Rs.3815 and Rs.3717 was obtained in 2006-07 and 2007-08, respectively. The production further increased and it reached to 160 kg or more in subsequent years. The average values of different constituents in honey are given in table-11.

Table 11 : Composition of honey

Sr.No	Nutrients	Percentage
1	Fructose	38.2%
2	Glucose	31.3%
3	Sucrose	1.3%
4	Maltose	7.1%
5	Water	17.2%
6	Higher sugars	1.5%
7	Ash	0.2%
8	Other/undetermined	3.2%

BOUNDARY PLANTATIONS

To counteract the ill effect of winds during summer and making productive use of field boundaries and vacant land, plantation of fruit species and perrinianl bushy fruit plants (Photo 22-27) having no or little adverse affect on the field crops was done all around the farm boundaries . These perennial types of fruits will provide nutritionally rich diet to the family, fuel and fodders and also fetch additional income in long run. Such plantations also help to create cool and clean microclimate and healthy environment as well.

22: Aonla (*Phyllanthus emblica*)

23: Jamun *(Eugenia jambolan)*

24: Jack fruit *(Artocarpus hetrophyllus)*, Bel (*Aegle marmelos*) and citrus

25: Subabool (*Lucenea lucocephala*)– A multipurpose perennial leguminous bush

26: Carisa carendis (Karonda) – A bushy fruit tree, beside producing valuable fruits also serve as live fencing

27: Citrus spp. Kagji Nimboo was also planted on field boundaries as well as pond dykes

ECONOMICS AND LIVELIHOOD IMPROVEMENT

Gross and net returns:

Gross and net returns under IFS averaged over the year (Table 12) were Rs. 3,29,400/ha / year and 1,35,820/ha/year, respectively, which were 165.2% and 82.5% more than crops alone (Rs.1,24,230 and Rs. 74,430 /ha/year. This probably was because of inclusion of more enterprising vegetables and flower crops, strengthening of livestock & fishery units, optimum recycling of farm wastes and crop residues and better management of all the enterprises of the model maintaining higher level of production.

Table 12: Gross and net returns under IFS since start of the project (2004-05 to 2009-10) from an IFS model of 1.5 hectare cultivated land.

S.No.	Enterprises	(Av. 2004-06) Initial years	2006-07	2007-08	2008-09	2009-10	(2004-10) Average
			Gross Returns (Rs 000/year)				
1	Crops	88.84	149.33	134.92	149.70	98.37	124.23
2	Animals (Dairy*+Goat**)	51.85*	116.33*	111.28*	291.03**	275.46**	163.88
3	Horticulture	18.98	15.50	22.67	20.80	9.05**	17.40
4	Fishery	2.22	11.20	14.16	15.75	25.91	13.84
5	Apiary	15.61	7.360	7.75	15.40	4.00****	10.02
	Total IFS	177.50	299.73	290.79	492.65	412.79	329.40
			Net Returns (Rs 000/year)				
1	Crops	45.02	104.05	80.35	89.66	53.07	74.43
2	Animals (Dairy*+Goat**)	22.45*	40.70*	32.29*	192.67**	146.13	87.02
3	Horticulture	12.14	3.37	13.45	14.04	8.30	10.26
4	Fishery	-4.21	0.79	4.29	7.80	16.06	4.94
5	Apiary	8.10	-1.54	3.71	9.95	0.80	4.20
	Total IFS	83.51	147.37	134.11	314.12	224.37	135.82

*Income from dairy animal alone ** Income from Dairy+ goat animals *** The orchard unit was auctioned for one year and the income from intercrops raised are not included in gross and net returns. **** Apiary unit was badly affected by insect ***Baravo which*** damaged almost all the bee hives, resulting in poor honey production in the year.

Livelihood Improvement:

Overall monitoring and livelihood analysis of the IFS model (Table 13) revealed that by removing the constraints responsible for yield gaps and optimum integration

Table 13: Impact of IFS approach on the productivity of a farm and household food security

Farm commodities	Production year			Annual demand of an Indian family (Tones)
	(Av. of first 4 years) (Tones)	Fifth year (2008-09) (Tones)	Final concluding year (2009-10) (Tones)	
A. Crops (0.72ha)				
Cereals	3.10	4.01	3.27	1.55
Oilseeds	0.16	0.29	0.15	0.13
Pulses	0.46	0.25	0.21	0.20
Fodders	53.00	90.20	64.0	86.60
Sugarcane	27.70	9.68*	26.4	1.60
B. Horticulture (0.22ha)				
Fruits	1.80	0.56	1.35	0.20
Vegetables	3.10	32.7	4.02	0.90
C. Live stock (0.32ha)				
Dairy animals (Milk)	4.50	11.57*	5.79	1.12
Meat animals (Goat meat)	NA	0.18	0.19 (Rs. 19100)	Goat & fish not consumed by a vegetarian family
D. Pisciculture (0.10ha)				
Fishes	0.15	0.45	0.52	
E. Apiary& others(0.14ha) (Honey)	0.19	0.16	0.04**	0.02
Gross value (Rs.) (All the farm produces)	315300	502655	4,12,799	(104196)*** 119560****
Cultivation cost (Rs.)	164441	305163	2,24,375	
Net returns (Rs.)	150859	197492	1,88,424	
Net saving (Rs.)	46663	77932	68,865	

***In reported year, the area under sugarcane was reduced to half of the previous four years and was shifted to green fodder crops because of increase (200%) in animal number of the animal unit and hence less cane production as compared to average production of previous years. Further, the cane yield reported in the year is of plant crop of summer planted sugarcane which is always less than the average yield of plant + ratoon crops of sugarcane. Similar is in the case of milk production. Higher the number of milch animals , higher is the milk production.**
****The *Varao* an eight legs insect badly damaged the bee hives and a very low yield particularly in sixth year of the model.**
*****Household consumption in term of money value (Av. Of first four years)**
****** Household consumption in term of money value (5th and 6th year of production)**

of farm & eco friendly enterprises in existing on – farm farming system, the farmers can earn 82.47% more profits (Rs.135.82 thousands/ha/year) than crops alone (Rs.74,435/ha/year). As regard to livelihood security, the IFS approach adopted in the model met almost all the domestic family needs of food, fodder, fuel etc. and saved a sizable amount of money ranging from an average value of Rs. 46.66 thousands/- in first four years to as much as Rs. 77.93 thousands in fifth year, respectively, to meet the other liabilities of the family including education, health etc. This saving was exclusive of all the fixed and running cost of IFS model and money required (Rs.119.56 thousands) for household food and fodder requirements of a family.

NUTRIENT RECYCLING

Recycling of farm wastes and crop residues has been found to economize farm production as well as safe environment. Korikanthimath and Manjunath (2004) working in Goa conditions found that adoption of intensified cropping systems helped to recycle the crop residue more efficiently than the rice alone crop. The organic manure FYM, poultry manure, mushroom residue smeared fully intact for reuse but the crop residue available under different system is about 62% and rest is used for dry or other purpose. In IFS model at PDFSR, Modipuram, all the farm wastes and crop residues were recycled either ***in situ*** incorporation in to the soil (green manure crops, cowpea intercropped in sugarcane , cane trash, leaves of potato and redgram , roots of berseem and other leguminous crops and green biomass added after picking of pods etc.) or by composting (Vermicompost, FYM) of cow dung & urine mixed with farm wastes (Photos 28-31). A detail account of recyclable farm resources and nutrients availability is given in table-14 .

Table 14: Nutrient budgeting under Integrated Farming System at PDCSR, Modipuram

Source of nutrients and per centnutrient content (N:P:K) on dry wt. basis	Available quantity at farm (kg)	Approx. released nutrient N (kg)	Approx. released nutrient P (kg)	Approx. released nutrient K (kg)	Total NPK released/ required in the IFS
Green manure crops					
Sesbania spp. (1.29:0.36:1.64)	8800	18.9	5.3	24.0	48.2
Cowpea (1.29:0.36:1.64)	8500	18.3	5.1	23.2	46.6
Crop residues (dry wt.)					
Sugarcane leaves (0.4:0.18:1.28)	900	3.6	1.6	11.5	16.7
Arhar leaves (1.29:0.36:1.64)	232	3.0	0.8	3.8	7.6
Potato leaves (0.52:0.21:1.06)	1450	7.5	3.0	15.4	25.9
Cow dung (dry wt.) (0.4:1.2:1.9)	17600	70.4	211.0	334.0	615.4
Total nutrients added in to soil	-	121.7	226.8	411.9	760.4
% of total requirements	-	42.6%	>100%	>100%	
Nutrient requirement/year (field + plantation crops)	***-***	***285.3***	***116.3***	***109.9***	***511.5***

NOTE: Nutrients from silt and water of fish pond is not included in the table.

28: Intercropping of cowpea in sugarcane and *in situ* incorporation in to soil

29: *Sesbania aculeate* green manuring in rice-wheat- *sesbania* system

30: Biogas unit in FSR project of PDFSR – Efficient use of cow dung for kitchen gas, lightning and slurry as fertilizer

31: About half of the cowdung is used for preparation of Vermicompost

This nutrient budgeting indicate that through recycling of all the available farm resources, plant nutrients equivalent to 121.7 kg N, 226.8 kg P and 411.9 kg K could be added in to the soil. Considering a realizable amount of 30% of the total nutrient incorporated in to soil through recycling , a saving of 228 kg of NPK (44.6% of 511 kg of NPK – annually required for field and plantation crops) was observesd . The average annual requirement of NPK however, was 285.3kg, 116.3kg and 109.9kg, respectively). In addition to this, nutrient rich pond silt and pond water recycled for crop production also add a total amount of 18.56 kg N, 6.21 kg P and 74.24 kg K with a market value of rupees nine hundred fifty or more. The OC% of pond silt was as high as 1.20 with an average value of 0.95. Addition of pond silt and water was found to increase the yield of rice and wheat by 3.48 q/ha and 2.41 q/ha, respectively. Organic source of nutrients are rather cheap than chemical fertilizers and also help in maintaining soil health and keep environment safe.

EMPLOYMENT GENERATION

Comparatively diversified and rather intensive nature of multifarious activities related to different enterprises included in the IFS model provide a lot of opportunities of employment (Photo 32-33) and keeps farmers and their family members engaged whole the year and as such can help in solving unemployment problem of the country mainly in rural youths. The man days required for the production of crops alone was 182/ha /annum wherein under IFS this number was 2.91 times more (795 man days) than crops alone (Table 15). Similar were the findings of Jayanthi et al (2001), Radha et al (2000), and Singh et al (2007).

Table 15: Effect of IFS approach on employment generation

Component enterprises of IFS	Man days
1. Crop alone (1.04ha)	189
2. Dairy (5 Milch animals and their young ones)	365
3. Fishery (fish pond of 0.10ha)	52
4. Apiary (10 bee boxes)	38
5. Goat (15 animals)	91
6. Vermicomposting (0.01ha)	60
Total IFS (1.5 ha)	795 man days (530/ha)

32: Human labour caring of cucurbits and papaya taken as intercrops in fruit orchard

33: Green fodder cutting from the fields, it's transportation to animal unit, chaff cutting and feeding, all engage a significant part of labour in IFS

LESSONS LEARNT

Learning is a continuous process and no system is perfect itself and there is always scope of correction and or perfection in it. Development of IFS model at PDFSR, Modipuram was first effort made in the direction of farming system research and that too in an integrated manner in western plain zone of Uttar Pradesh. No doubt, the IFS studies generated significant findings but even then there were so many limitations which if corrected can make the programme in future more effective and remunerative. Some of the important lessons learnt from the study are given below.

Crops

- The farmers are advised to allocate the land under crops in such a way that all the family needs of food (cereals, pulses, oilseeds, sugar) and year round availability of green fodders can be ensured from their own fields and farmer do not depend much on market.

- The left out land can either be allotted under high value low volume cash crops and/or other low cost enterprises considered or found feasible and viable under small farm conditions.

- For sustaining soil fertility, inclusion of legumes and green manure crops in crop sequences is a must and due consideration may be given to fit them in different crop sequences.

Horticulture

- To enrich nutritional standards of family food and regular income, establishment of a nutritional orchard unit is strongly recommended for small farm holders.

- Ensure procurement of planting/seed materials from reputed firms only. Under small farm conditions, growing of vegetables and flowers are not desirable because of market and high labour requirement. However, regular home requirements of vegetables can be met by promoting kitchen gardening and intercropping vegetables in between the row spaces of fruit trees under nutritional orchard.

- The farmers should also ensure timely gap filling caused by mortality of plants (if any).

- To get regular fruits and income, the farmers are advised to grow a mix of different type of fruit species.

Dairy

- Irrespective number and breed of the animals, dairy is an integral part of any of the farming system adopted by the farmers in India. Regular supply of milk from the animal unit is a pre requisite. To maintain this purchase of animals should be made in phases and not at a time.

- Small farm holders should purchase a better adaptive breed with high milk yield only so that he can escape danger of several diseases and disorders.

- To economize the production of milk, round the year green fodder availability should be ensured.

- Balanced feed and mineral mixtures etc. should also be provided to avoid irregularity in production as well as reproduction.

- The milch animals should be inseminated three to four months after parturition to avoid longer dry period. It is also advised to take preventive measures against infectious diseases.

Goat

- Rearing of goat at small land holdings was not found desirable because of poor health and high mortality in goat animals under stall feeding. This was because of less space and no grazing which caused high infestation of internal and external parasites resulting in weakness, indigestion and high mortality.

- Under stall feeding, the animals could not get desired environment and varied type of vegetation as in grazing conditions which are most ideal for rearing goats.

Bee Keeping

- The bee keeping is also not found a suitable enterprise for small farm holders. The enterprise required round the year availability of flowers for optimum growth and production and suits well for horticultural areas which generally are owned by large farmers.

- It is not possible to grow crops with flowers round the year at a location and the farmers maintaining large number of bee boxes transport the bee boxes to different places for getting regular supply of nectar. This is not possible with small land holders.

- The enterprise was badly suffered due to heavy attack of a eight legs insect called Baravo mite. A blanket recommendation therefore, cannot be given in this regard.

- The bee colonies are very much sensitive to application of insecticides in field and plantation crops used by the farmers of nearby fields, if not by the owner of the apiary unit.

- The bee boxes are attacked by ants, lizard and so many insects and need regular cleaning.

General

Farming systems under small farm holders can only be made profitable if farmers adopt a conservative approach at all stages of farming. For this he has to utilize each and every inches of land for raising suitable field and plantation crops, select low cost viable enterprises for diversification, recycle all farm wastes and crop residues within the system itself and make productive use of farm boundaries and waste lands if any. Further, farmers are also advice to make use of renewable sources of energy such as solar and biogas etc.

CONCLUSION

IFS approach not only fulfils the household needs but enrich diet of human being and animals both and simultaneously keep the people away from the hazards of residual toxicity of the chemicals being used in agriculture on a large scale. Further, diversified nature of the model provides huge employment opportunity for unemployed rural youths. Economic and livelihood analysis of the system revealed that beside household food and fodder security, the system generated a sizable amount of rupees ranging from Rs.46, 663 in first four year to as much as Rs.77, 932 in fifth year of the study as net savings which will assist to meet other liabilities of the family including education, health and social obligations and overall improvement in livelihood of small farm holders. Further, based on input output scenario of last six years of the study envisage that a major part (57% or more) of inputs for farm production was met through proper recycling of farm wastes and crop residues and inclusion of legumes in different cropping systems. This shows the soundness of the IFS approach and its utility for small and marginal land holders of the region. The IFS model developed at PDFSR, Modipuram will serve as a basket of options and farmers can choose appropriate combinations of enterprises as per their resources and family needs. The farmers having sufficient land and other farm resources can prefer for integration of horticultural crops viz; fruits, vegetables and floriculture as an additional enterprise along with prevailing ones. Whereas, marginal farmers or land less farmers living nearby fruit orchards can integrate apiary and mushroom in to their existing farming systems. Farmers having sufficient irrigation water or living in low lying riverbed areas can choose fishery as an additional enterprise. Similarly, farmers living in near vicinity of the towns and cities can grow vegetables and green fodders as per market demand and availability.

SYNTHESIZED EFFICIENT IFS MODEL FOR SMALL FARMERS OF WESTERN PLAIN ZONE OF U.P.

Area of the IFS model — One Hectare

Family Size — Seven members

Components of Proposed IFS Model

Prevailing Farming System — Crops + Dairy animals

Next best most accepted and profitable enterprise — Horticulture (Fruits & Vegetables)

Supplementary enterprising component — Fishery +Apiary + Mushroom

Complementary enterprises — Vermicompost +Boundary plantations

Allocation of farm land

To meet minimum essential annual requirements of food and fodder of a household with 7 family members and overall improvement in livelihood, it is must to allocate farm land and other resources appropriately. Based on the IFS study conducted at PDFSR, Modipuram, resource allocation for 1.0 ha irrigated land area representing marginal and small farmers both is given in table –1 below.

Table 1: Allocation of one hectare irrigated farm land for livelihood improvement

Farm commodities	Minimum family needs (kg/ton)	Land allocation for basic food & feed commodities (ha)	Distribution of left out land area under high value crops/enterprises (ha)
Cereals	1550 Kg	0.35	-
Oilseeds	130 Kg	0.11	-
Pulses	200 Kg	0.17	-
Sugarcane	1600 Kg	0.03	0.14 **(Main cash crop of the region)**
Green fodders	40 Ton	0.67	A part of cropping systems followed
Fruits	200 Kg	-	0.20 **(Fruit orchard of mango and guava)**
Vegetables	900 Kg	-	No separate area allocated. Vegt. will be grown as intercrops in fruit orchards and kitchen gardening .
Milk	1120 Kg	-	No separate area allocated for green fodders as these are integral part of cropping systems.
Meat/Fish etc.	160 Kg	-	0.10 **(Under fish pond)**
Mushroom	-	-	0.01
Apiary	-	-	0.01

NOTE: To meet minimum basic food and fodder requirements of the family a farmer need 1.33 ha gross cultivated area. Under irrigated conditions , more than two crops per year are taken from the same piece of land. Considering an average 250% cropping intensity the net cultivated area required comes to 5320 sq.m. or say 0.54 ha only. Now the remaining land area (0.46 ha) out of 10000 sq.m. (1.0 ha) is available for diversification of the prevailing on – farm farming systems either with high value crops(Sugarcane in this case) or by integrating some additional more paying enterprises (Fruits & vegetables and fishery to make the system holistic and also more profitable and sustainable too. Vermicompost and boundary plantations are mandatory and most essential for all type of IFS models.

A. Crop module for household food and feed security

Major Farm commodities	Household Needs, Farm production and market value of produces	Crop sequences proposed and expenditure involved (Rs./seqence)	Net area alloted (Sq.m.)	Farm Commodities Produced	Expected Production (kg/q)
Cereals (Rice, Maize, wheat)	1550 Kg***** **(3340 kg) Rs.40,080**	Rice (Hyb.) – potato - wheat – Sesbania aculeate (GM) (Rs.16500)**	1200	Rice, Wheat GM (Fresh wt.) Dry fodders (Rice husk + Wheat straw)	720 kg 660 kg 42.00 q 325.00 q 15.45 q
Oilseeds (Mustard)	130 Kg **(216 kg) Rs.6,480***	Sorghum-mustard- Maize+ cowpea (Rs.7320)**	1200	Mustard Sorghum (GF) Maize+cowpea	216kg 84.0 q 66.00 q
Pulses (Red gram, black gram)	200 Kg **(268 kg) Rs.8,040***	Maize + red gram– wheat Sorghum-blackgram-wheat (Rs.10880)**	800 800	Maize Red gram Black gram Wheat Sorghum (GF) Dry fodders (Wheat straw + Maize curvi)	360 kg 148 kg 120 kg 880 kg 56.00 q 16.0 q
Sugar crops (Sugarcane)	16.00 q **(128.0 q) Rs.23,040***	Sugarcane (Feb) + onion – Ratoon (Rs.20000)**	1600	Sugarcane Onion Green fodder (Sugarcane tops)	128.0 q 10.0 q 51.0 q
Green fodders Sorghum Berseem Oats	400.00 q **455.0 q (Rs.34,125***	Sorghum (GF) – rice (hybrid) - berseem/oats (Rs.8520)**	1200	Rice Sorghum (GF) Berseem (GF) Oats (GF) Dry fodder	720 kg 84.0 q 66.0 q 48.0 q 7.20 q

Contd/-.....

Major Farm commodities	**Household Needs, Farm production and market value of produces**	**Crop sequences proposed and expenditure involved (Rs./seqence)**	**Net area alloted (Sq.m.)**	**Farm Commodities Produced**	**Expected Production (kg/q)**
Sugarcane tops				(Rice husk)	
Dry fodders (Wheat straw, Rice husk, maize curvi etc.)	38.0 q **(38.6 q) Rs.11,580***	-	-	-	-
Vegetables Potato Onion	5.60 q **(42.0q) Rs.42,000** **(10.0q) Rs.10,000**	-	-	-	-
Net area 6800 sq.m.	**Gross return** Rs. 1,65,345	**Cost of cultivation** Rs.63,220	6800	**Net profit** Rs.1,02,125/ 6800Sq.m. area	-

Yield levels

Rice; 60q/ha, Wheat;55q/ha, Maize ; 45q/ha, Mustard; 18 q/ha, Potato;350q/ha, Red gram;18.6q/ha, Onion;250q/ha, Green fodders: Sorghum; 700 q/ha, Maize + cowpea ; 550q/ha, Berseem;1100q/ha, Oats; 800q/ha

Prevailing market rates: Cereals; Rs. 12/kg, Pulses and oilseeds; Rs. 30/kg, Potato and onion; Rs. 10/kg

Technological package (Crops):

- Selection of season specific HYVs
- Use of RCTs (Zero tillage, BBF and residue recycling)
- SSNM
- INM –Increased use of organic sources of nutrients along with chemical fertilizers
- In situ and ex situ green manuring
- Use of Vermicompost in place of cow dung/FYM

B. Dairy (Milk production):

Size of the animal unit –

2 milch animals (1 buffaloes + 1 cow **or** 2 buffaloes as per choice of the family) & their young ones

Economics of milk production:

1. Animal unit production costs (Fixed + Recurring)

a) Fixed cost :

i) Purchase cost of the animals:

One buffalo @ 55,000/buffalo = Rs.60,000/-

One H F crossbred cow **=** Rs.45,000/-

Total cost of animals = Rs.1, 05,000/-

ii) Miscellaneous expenditures including milking utensils and other petty items during initial establishing phase = Rs.5,000/-

Total (a) **= Rs. 1,10,000/-**

b) Recurring expenditure:

i) Concentrate mixtures = Rs.36,160

@ 4kg/day/animal x two animals x265 days @ Rs 18/kg

ii) Dry period ration = Rs.7,200

@2kg/day/animal x two animal x 100 days x Rs.18/kg

iii) Dry fodder/straw = 38.0q x Rs.300/q = Rs.11,400

@ 5kg/day/animal x two animal x365 days

iv) Green fodder =Rs.19,875

@25kg/day/animal x two animals x365days x Rs.0.75/kg

v) Mineral mixture = Rs.2375

@50 gm/day/animal x two animals x 365 days x Rs.65/kg

vi) Medicines and other miscellaneous = Rs.5, 000

vii) Cost of vermicompost preparation = Rs.10,800

Total b) : **= Rs.** Rs.92,810

Total cost of production **= Rs.1, 08,310**

(Depreciation value of animals@10% of purchase value Rs.10, 500 + Miscellaneous expenditure Rs.5000 + Recurring cost Rs.92, 810)

2. Production from dairy animals:

i) Milk production

Buffalo – At an average milk production of 8.0 liter per day = 2120 liter
X 265 days milk period
Market value @ Rs.28.0 per liter = Rs.59, 360

H.F.Cow - At an average milk production of 12.0 liter per day = 3600 liter
X 300 days milk period
Market value @ Rs.25.0 per liter = Rs.90,000

ii) Young ones of animals –Two @ Rs.5000/calf = Rs.10,000

iii) Vermicompost 60.0 q @ Rs.500 per quintal = Rs.30,000

3. Gross returns from dairy unit = Rs.1,89,360

4. Net Profit (Gross returns Rs.1,89,360 **-** = Rs.81,050/year
Cost of production Rs.1,08,310)

C. Horticulture (Fruits and vegetables production)

Total area under fruits = 2200 sq.m.

Fruit species

i) Mandarin var. kinnow (Papaya and vegetables as intercrops) = 1000 sq.m.

ii) Banana var. Grain Nain(Fodder /vegetables as intercrops) = 1200 sq.m

Economic evaluation of horticultural unit

1. Cost of cultivation: ***(Considering average age of the orchard as 15 years)***

a) Establishment year *(Cost of pits, plants , plantation and input costs etc.)*

Banana plantations (280 plants) = Rs.11, 250

Kinnow plantations (66 plants) = Rs.8800

Guava plantations (50 plants) (A*s boundary plantation)* = Rs.3,000

Karonda plants (244) in between guava (A*s boundary plantation)* = Rs.3660

Total cost = Rs.26,710

Considering the average age of fruit plant as 15 years, the fixed cost = Rs.1,536

b) Recurring expenditures during subsequent years

@ Rs.50/tree/year for 396 tree/plants = Rs.19,800

@ Rs.9/tree/year for 244 Karonda plants = Rs.2196

(Pruning and harvesting etc)

c) Labor cost – 4 hours per day @ Rs.150/mandays of 8 hours = Rs.27,375

d) Annual expenditure (Fixed + running costs) = Rs.50,907

Interest on borrowed money @7% = Rs.3565

e) Total expenditure / year to be incurred = Rs.54472

2. Annual expected income

From banana unit (1st Year onward) Rs.35,000/year

From Kinnow (4th.year and onward) Rs.31,000/year

From guava (4th. year and onward) Rs.22,000/year

From Karonda (4th. year and onward) Rs.6000/year

Gross Returns/ year ***(Averaging production years of 14 for banana, 12 each for kinnow and guavaand kinnow)*** Rs.94,000/year

3. Net returns

(Gross returns Rs.94,000**– cost of cultivation** Rs.54,472) Rs. 39,528/year

D. Fresh water fish production – Composite fish culture

Major fish species and number & ratio to be cultivated in the pond

A composite mixed fish culture has been found ideal under fresh water fish production in small pond for optimum utilization of all the water depth layers. The farmers can choose the species as per market need and seed availability among the following fish species;

Local ***IMC*** fish species: Bhakur (Catla), Rehu (Rohu), Nain (Mrigal)

Exotic carps: Silver Carp or Grass Carp

Seed rate (Number of fingerlings): 1000

Fish ratio: Catla, Rohu, Mrigal and Grass carp (30:20:20:30)

1. Cost of production

a) Fixed cost:

Cost of pond construction for an area of 1000 sq.m. = Rs. 45,000 (Approx.)

Considering total age of fish pond as 20 year, depreciation valueof fish pond = Rs.2250/-

(About 50% subsidy on pond construction and fish cultivation is given in most of the states)

b) Recurring cost

Average Cost of fish production/ha/year in a scientifically managed fish pond to get maximum production is given in table 2 below.

Table 2: Recurring expenditure for fish production/ha/year

Sr.No.	Iteams	Quantity	Approx. cost (Rs.)
1.	Lime	250 kg	1250/-
2.	Cow dung	20 tonnes	5000/-
3.	Ammonium sulphate	450 kg	3150/-
4.	Single Super Phosphate	250 kg	1750/-
5.	Murrete of Potash	40 kg	280/-
6.	Broken rice (Kanni)	500 kg	4000/-
7.	Mustard cake	500 kg	4000/-
8.	Fish seed cost	10000 in Nos.	4000/-
9.	Water charges	Maintaining desired water level whole the year	3000/-
10.	Mahi /harvesting of fishes	-	2000/-
11.	Miscellaneous expenditures	-	2000/-
	Total per hectare cost on fish production/year		30430/-

Total running cost on fish production/year from an area of 1000 sq.m= Rs.3043

Depreciation cost of fish pond = Rs.2250/-

2. Annual Fish Production: Av. Fish yield 400 kg/year/1000 sq. m. pond area

3. Expected Gross Returns from 1000 sq.m. fish pond:
Total income taking fish value@Rs50/-per kilogram = Rs.20,000 per year

4.Net Profit per year (Rs. 20,000 - (Rs.2250 + Rs.3043)=Rs.14707/1000 sq.m.

E. Vermicompost:

Animal unit with two buffalos or one buffalo and one H.F. cow with two young ones produces more than 200 quintal of fresh cow dung. If 3/4th'of this cowdung is used for Vermicompost preparation and 1/4th' used for fish pond and FYM etc. than more than 60 quintal vermicompost can be prepared for fulfilling the need of field and plantation crops of the model. Vermicompost content of macro and micro nutrients N(%),P(%),K(%),Zn(ppm),Cu(ppm),Mn(ppm),Fe(ppm)is about 1.68, 0.23,

1.26, 112, 48, 397, 3323 as compared to respective values 0.70, 0.19, 1.37, 75, 34, 222, 3134 found in FYM.

Method of Vermicompost preparation

Component of Vermicompost:

Pit size and depth of the pit : 1.5 to 3.0 meter length, 1.0 to 1.5 meter wide and 0.9 -1.5 feet deep pit size is ideal for Vermicompost preparation. Farmers can prepare as many as required such pits.

Farm products: Cow dung, Grain straw, Crop residues and other farm wastes

Value addition: Press mud from sugar mills, Spent Mushroom Substrates and or any other nutrient rich by products

Earthworm species: *Eisina faetida, Lumbricus rubellus and Perionyx excavator*

Weight of earthworm: For one quintal mixture of cowdung etc 250g to 500 gm

Composition of different constituents of Vermicompost mixture:

50-75% cow dung + 25-30%% Crop residues/straw etc +SMS/Pressmud alone or in combinations

Precautions:

- Proper shade on Vermicompost material is essential to save it from direct sunshine and rainy water
- The mixture should well moisten and loosen fortnightly for proper moisture (70-80%) and aeration which is a pre requisite for fast growth of the earthworms.
- Use neem cake time to time to save earthworm from ants etc.

Note: Input output details of Vermicompost preparation has been included in dairy unit.

F. Mushroom

Yield and economics of Button Mushroom

Size of mushroom unit = 500 bags per crop

Number of harvests in a year - 4

Total production @ 500 g per bag = 1000kg/year

Cost of production per bag –Rs.10

Total cost of unit (2000 bags) / year = Rs.20,000

Value of mushroom produce – 1000 kg x Rs. 60 /kg = Rs.60,000

Net return = Rs.40,000

G. Apiary:

Unit size = 20 boxes

Fixed Costs = Rs.60,000

Running cost = Rs.200/box per year = Rs.4000

Labour (Man days) = 40 man days/year @ Rs.150/man days = Rs.6000

Total cost of production = Rs.16000/year
(10 % of fixed cost (Rs.6000) + Running cost (Rs.4000)+labour costRs.6000)

Production = 14kg honey per box x 20 boxes =280kg honey@ Rs.150/kg

Gross return = Rs.42000/-

Net return = Gross return – Cost of production = Rs.26,000

H. Boundary Plantations:

All the field borders should invariably be planted with either perennial fruit tree species or grasses having little or no shade effect on companion crops and that will be a source of permanent income in long run. The plant and grass species tried at PDFSR, Modipuram for boundary plantations were jack fruit, bel, jamun, citrus species nimboo and karonda and aonla. *Cenchrus ciliaris* (Subabul) was also planted on pond dykes and field boundaries produced huge amount of green leguminous fodders and fuel wood. In addition to this guava and banana can also be planted on

boundaries of crop fields as well as fruit orchards. They will save the crops from winds and hot waves besides income to the farmers.

Economic viability of the proposed IFS model

The expenditure involved in IFS development and outputs in term of gross and net returns given in table-3 below envisage the economic viability of the suggested IFS model which not only provide sufficient feed and fodder for the household but after meeting production cost create an additional saving of Rs.75,060/ha/year to assist the family in other liabilities including health and education etc.

Table 3: Expenditure and gain details of the proposed IFS model

Enterprises	Size of the unit	Gross returns (Rs.)	Cost of production (Rs.)	Net returns (Rs.)
Crops including fodders	6800 sq.m.	1,65,345	63,220	1,02,125
Dairy animals +Vermicompost	Two milch animals & young ones	1,89,360	1,08,310	81,050
Horticulture	2200 sq.m.	94000	54472	39528
Fishery	1000 sq.m.	20,000	5293	14707
Mushroom	500 bags x 4 harvests/year	60,000	20,000	40,000
Apiary	20 bee boxes	42,000	16,000	26,000
Total	**10,000 sq.m.**	**5,70,705**	**2,67,295**	**3,03,410**

Note: Income from farm boundary plantations will be an additional advantage in subsequent years.

Total cost of production = Rs.2,67,295/ha/year

Gross returns = Rs.5,70,705/ha/year

Net returns = Rs. 3,03,410/ha/year or say Rs.25,284/ monthy

The project proposal suggested and production and economic values/figures (achievable) included show the soundness of the IFS approach. However, it takes two to three years to achieve the targeted goals because the project involve enterprises like fruit plantations, boundary plantations etc. which start giving returns from third or more than third year of establishment of the project.

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ANNEXURE-I

On-farm production and inter-relationship of different enterprises included in the IFS model at PDFSR, Modipuram

(Average; 2004-10)

S.No.	Intermediate inputs generated at farm	(Quantity (kg or liters)/Nos.)	Value (Rs)	Home consum-ption Quantity and (Value in parenthesis) (Rs.)	Farm produces and / or by products of one enterprise used as inputs for other enterprise/enterprises within the system (kg or lit.)/Nos.)						Value of the inputs used/ recycled within the system	Marketable surplus (kg or lit.)/Nos.)
					Crops	Dairy	Horti-culture	Fishery	Vermi-compost	Total		
1	**Crops**											
	Cereals (Kg)	3280 @Rs.9/kg	29,520	1550(13950)	48	900	-	-	-	948	8532	782
	Pulses (kg)	380 @Rs.30/kg	11,400	200 (6000)	5	-	-	-	-	5	150	175
	Oilseeds (kg)	180 @ Rs.30/kg	5,400	130 (3900)	2	-	-	-	-	2	60	48
	Sugarcane (t)	24.48 @ Rs.1500/t	36,720	1.6 (2400)	3	-	-	-	-	3	4500	19.88
	Green fodders (t)	61.03 @ Rs.600/t	36,618	-	-	44	-	0.36	-	44.36	26616	16.67
	Dry straw/stalks (t)	9.20 @ Rs.3500/t	32,200	-	-	8.20	-	-	1.0	9.20	32200	-
	Green manure (t)	17.30 (94.8 kg NPK)	1346	-	13.00	-	4.00	0.30	-	17.30	1346	-
	Crop residues/litter fall (t)	2.58 (50.2 kg NPK)	712	-	2.00	-	-	-	0.58	2.58	712	-
	Weeds (t)	2.10	- **(1,53,916)***	-	-	2.10		-	-	2.10	- **(74116)***	-
2	**Horticulture**							-	-			
	Fruits (kg)	1520 @ Rs.15/kg	22,800	200 (3000)	-	-	-	-	-	-	-	1320
	Vegetables (kg)	3280 @ Rs.8/kg	26,240	900 (7200)	-	-	-	-	-	-	-	2380
	Crop residues (t)	2.10 (40.86 kg NPK)	580	-	2.00	0.10	-	-	-	2.10	580	-
	Fuel wood (t)	2.50 @ Rs.1500/t	3,750 **(53370)****	2.50 (3750)	-	-	-	-	-	-	- **(580)****	-
3	**Dairy**							-	-			
	Milk (lit.)	5890 @ Rs.28/lit.	1,64,920	1120 (31360)	-	-	-	-	-	-	-	4770
	Vermicompost (t)	15.00 @ Rs.5000/t	75,000	-	5.00	-	2.00	0.05	-	7.05	35250	7.95
	FYM (t)	5.80 @ Rs.250	1,450	-	5.00	-	0.80	-	-	5.80	1450	-
	Urine (lit.)	14235	NA	-	-	-	-	4235	10000	14235	-	-
	Calves (Nos.)	3 @ Rs.3000/ calve	9,000 **(2,50,370)*****	-	-	-	-	-	-	-	- **(36700)*****	3

(table contd.)

S.No.	Intermediate inputs generated at farm	(Quantity (kg or liters)/Nos.)	Value (Rs)	Home consum-ption Quantity and (Value in parenthesis) (Rs.)	Farm produces and / or by products of one enterprise used as inputs for other enterprise/enterprises within the system (kg or lit.)/Nos.)						Value of the inputs used/ recycled within the system	Marketable surplus (kg or lit.)/Nos.)
					Crops	Dairy	Horti-culture	Fishery	Vermi-compost	Total		
4	**Fishery**				-	-						
	Fish (kg)	261 @ Rs.50/kg	13,050	-	-	-	-	-	-	-	-	261
	Pond silt (Cu.m.)	120 (18.56 kg N+ 6.21 kg P+74.24 kg K)	950	-	120	-	-	-	-	120	950	-
	Pond water(Cu.l.)	2400	NA	-	1800	-	600	-	-	2400	-	-
	Fodder from pond dykes (t)	2.10 @ Rs.600/t	1,260 **(15260)******	-	-	2.10	-	-	-	2.10	1260 **(2210)******	-
5	**Apiary**							-	-			
	Honey (lit.)	160 @ Rs.150/lit.	**24,000*******	20 (3000)	-	-	-	-	-	-	-	140
6	**Border plantations**							-	-			
	Green fodder (t)	0.90 @ Rs.600/t	540	-	-	0.90	-	-	-	0.90	**540********	-
	Fruits (kg)	200***	-	-	-	-	-	-	-	-	-	-
	Fuel wood (t)	3.50 @ Rs.1500/t	5,250 **(5790)********	3.50 (5250)	-	-	-	-	-	—	-	-
Total			**5,02,706**	**79,810**							**1,14,146**	

ANNEXURE-II

INFORMATION GENERATED IN THE FORM OF PUBLICATIONS (2004-2010)

1. Singh, J.P., Gangwar. B. and Pandey, D.K. (2011). Nutrient Management in Farming System Perspective. ***Indian J. Fert.,*** Vol. 7(11), pp. 16-21.

2. Singh, J.P., Gangwar, B., Pandey, D.K. and Sanjeev, K. (2011). Samanvit Krishi Pranali Aapnayen – Adhik Labh kamayen (Hindi): ***Khad Patrika***; 52(8):6-10.

3. Singh, J.P., Gangwar.B and Pandey, D.K. (2011). Farming Systems Scenario of small farm holders and measures to diversify On - Farm Farming Systems for sustaining farm productivity and livelihood. – Presented in the National Symposium on Integrated farming Systems for Sustainable Agriculture – Challenges and Opportunities, held at Institute of Agricultural Sciences, Bundelkhand University , Jhansi during 19-21 Feb.,2011. **The paper was awarded best research paper presentation of the symposium.**

4. Singh, J.P. and Gill, M.S. (2010). Livelihood Security and Resource Conservation through Integrated Farming System. ***Indian Farming***, September, 2010 pp: 03-07.

5. Kochewad, S.A., Singh, J.P., Langer, R.K. and Pandey, D.K. (2010). Role of dairy animal in Integrated farming Systems. In Souvenir & Abstract –National Symposium on Emerging Trends in Agricultural Research –Organised by Hi-Tech Horticultural Society,Meerut, Sept.,11-12,2010, pp:117.

6. Singh J.P., Kochewad, S.A., Langer, R.K. and Pandey, D.K. (2010). Integrated Farming System – A Multipurpose farming System for sustainable production. In Souvenir & Abstract –National Symposium on Emerging Trends in Agricultural Research –Organised by Hi-Tech Horticultural Society,Meerut, Sept.,11-12,2010, pp:49.

7. Gill, M.S., Singh, J.P. and Gangwar, K.S. (2009). Integrated Farming System and Agriculture Sustainability. ***Indian Journal of Agronomy*** 54 (2):128-139.

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9. Singh, J.P., Gill, M.S., Tripathi,D. and pandey, D.K. (2008). Household food and fodder security through Integrated Farming System Approach. Extended Summaries: National Symposium on New Paradigms in Agronomic Research. Held at Navsari, Gujrat. November 19-21,2008, pp: 295-296.

10. Singh, J.P., Gill, M.S. and Tripathi, D. (2007). Development of Integrated farming System Model for Marginal and Small Farmers. ***Awarded with best research paper in poster session –I of National Symposium on Integrated farming Systems & It's Role Towards Livelihood Improvement., held at ARS Durgapura-Jaipur, Rajasthan,October 26-28,2007.***

11. Singh, M., Singh, J.P., Singh, S.P. and Kamta Prasad (2005).Characterization and constraint analysis of farming system of Meerut district. ***Journal of Farming System Research and Development***. pp: 1-11.

12. Singh, M., Singh, S.P. and Singh, J.P. (2004). Farming systems characterization-problems and prospects. Extended summaries. Second National Symposium on Alternate Farming Systems: Enhanced Income and Employment Options for Small and Marginal Farmers. Held at PDCSR, Modipuram. September, 16-18, 2004. pp:25-26.

13. Singh, M., Singh, S.P., Singh, J.P. and Kamta Prasad. (2005). Farming Systems Characterization – A Case Study of Meerut District. Technical Bulletin, PDCSR, Modipuram : 1-65.

NOTES

NOTES

HUMAN RESOURSE DEVELOPMENT

TRAININGS AND VISITS

Dr. B. Gangwar, Project Director, PDFSR appraising the FSR activities carried out at PDFSR, Modiopuram to Dr. N.K. Tyagi, member ASRB, New Delhi

Dr. B. Gangwar, Project Director, PDFSR, explaining the IFS approach and appropriate model for the farmers of western U.P. before Meerut and Delhi based press reporters

Farmers of villages covered under an institute project "Chalo Gaon Ki Aur" are being trained on IFS activities

Subject matter specialists of KVKs Zone I and Zone III were given extensive training on IFS during 6-10 days short courses /trainings

Farmers visiting IFS model at PDFSR, Modipuram

Farmers discussing the process of vermicompost preparation