Market Led Agricultural Extension-Concept & Practices

Model Training Course:2017

Sponsored by : Directorate of Extension
Ministry of Agriculture & Farmers Welfare, Govt. of India

A Training Manual by:

Ujjwal Kumar, Dhiraj Kr. Singh, B.P. Bhatt, Bikash Sarkar,
T.K. Koley & Santosh Gupta

ICAR Research Complex for Eastern Region
ICAR Parisar, P.O.: B.V. College, Patna 800 014


Model Training Course
On
Market Led Agricultural Extension - Concept & Practices
(04 - 11 October, 2017)
Sponsored by : Ministry of Agriculture & Farmers Welfare, Govt. of India
Organizer : ICAR Research Complex for Eastern Region, Patna


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FOREWORD

Food self-sufficiency was a major challenge to the nation particularly during 1950's and 1960's. With the support of technology, policies and extension reforms, food self-sufficiency was achieved. However, very few efforts have been made for higher price realizations for the farmersô produce. After liberalization, privatization and globalization of economy, during the early 1990s, led to the emergence of new market mechanisms and opened new opportunities for the farmers of the country across different agricultural enterprises. Now, markets, not technology, have become the primary driver for agricultural development. Also, there has been a limited success of public agricultural extension systems which gave birth to market-driven approach in India and other countries. This scenario calls for use of new extension approaches involving productivity to profitability, subsistence to commercial agriculture, commodity-oriented to farming systems orientation, local market to export market, seasonal production to round the year production, mono-cropping to multiple cropping and so on. Market-led Extension approach can be the perfect mechanism for reaching the doorsteps of our farmers. Therefore, besides the production technologies, the extension functionaries now have to get equipped with market information on arrival and prices of different commodities which requires imparting new skills to the extension personnel. Farmers also need to be well aware with various aspects on quality, price variation, consumerôs preference and satisfaction, market intelligence, processing and value addition and other marketing information. This will certainly help higher price realization to farmers for their produce, minimize the production cost and improve the product value and marketability.

ICAR Research Complex for Eastern Region, Patna is actively involved in low-cost agricultural technology generation, minimizing input cost, higher profitability to the farmers and mechanism of convergence for higher price realization to the farmers. In this regard, the organization of National Level Model Training Course on ñMarket Led Agricultural Extension: Concept & Practicesò was need of the hour for orientation of farming based on the demand so as fetch better returns.

I compliment the course director, Dr Ujjwal Kumar and his team for compiling this useful training manual. It is expected that this training manual shall prove usefulness to state-level extension functionaries, development departments, policy makers and stakeholders engaged in agricultural development towards market-led extension for increasing farmers income. Directorate of Extension, Ministry of Agriculture and Farmers Welfare, Govt. of India also deserves sincere thanks for financial assistance.

(B P Bhatt)
Director

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IT Based Marketing Information System

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Hon□ble Prime Minister of India, Shri Narendra Modi has called for doubling farmersô income by 2022. Its achieving is not a herculean task if farmers produce is not properly linked to the market. Here, challenges lie in the availability of information tools (knowledge management system, expert system, ICT tools, etc.) to the resource-poor farming community as and when required suited to their own situation. Now, extension or advisory services are more diversified, more technology intensive and more demand-driven, which makes more difficult for the extension worker or the organization working for the vast and diversified farming community without proper networking. India has made remarkable progress in the field of Information and communication technology (ICT) that could be put to effective use for delivering advisory services to the needy farmers. In other word, the information and communication tools are reducing dependency for personal advice and the farmers and extension workers are supposed to use one or other tools of ICT to acquire desired information and services.

The most widely used and available tools of farmersô advisory services are- telephone based Tele Advisory Services, the mobile based Agri Advisory services, television and radio based mass media programmes, web based online portals to get market related information's, video-conferencing, Online Agri video Channel, besides traditional media like, printed literature, newspapers, farmers exhibition/fair etc. The farmers or extension workers can choose any medium to seek the relevant information and advice. Majority of farmers want information with respect to ï crops (varieties, package of practice, plant protection etc.), planting material availability, soil, agrimarket information, weather information, Information on agriculture allied activities like dairy, poultry, beekeeping, mushroom etc. along with information about marketing of the products, credit facility, incentives, Government policies and schemes, supportive measures like subsidies etc.

Most of the agricultural institutes and organizations have their own telephone based advisory services for farmers, which provide telephone based Agri advisory services through a dedicated telephone number to provide real-time information and advice. The online phone based expert advice service, Kisan Call Centers (KCC), launched by the Ministry of Agriculture, Government of India is available for all within the country since January 2004.A toll-free telephone number ñ1800-180-1551ò has been provided that is operational on all day from 6.00 am to 10.00 pm. Beyond these hours the calls are attended in the Interactive Voice Response System (IVRS) mode. The KCC consists of three operational levels. Levelï I is the basic Call Centre interface by local language proficient agricultural graduates who picked up the calls with a short welcome message. In case the level I expert is not able to answer the

question, he forwards the calls to the concerned Level ï II experts. The level ï II experts are the Subject Matter Specialist (SMSs) located at the Resource Centres in SAUs, ICAR institutes/ Departments. Level III is the management group that ensures the ultimate response and resolution of all queries (mainly policy matters) not resolved by either L-II or L-I.

The mobile-based Agri Advisory services offers text, voice and video content based Agri information services through mobile phones. Mobile phones are becoming an essential device for all types of users irrespective of the age group. In India, mobile technology has unleashed a paradigm shift in the communication medium to reach out to the masses. KISSAN Kerala, an integrated, multi-modal agricultural information system, provides several dynamic and useful information and advisory services for the farming community across the state of Kerala. Mobile-based service has been established to provide text, voice, and video-based information services. It offers several services like crop advisory, weather forecast, soil test information etc through farmers mobile. Similarly, ñm KRISHIò developed by Tata Consultancy Services Ltd (TCS), IFFCO Kisan Sanchar Ltd. (IKSL) are also providing mobile based advisory services for the farming community. Advantages of these services are that those are location specific, reliable and cost-effective.

Community radio is one of the important tools of ICT that offer farmers and the people a voice and help the development of the community. Community radio is owned and operated by a community or members of a community. On 16 November 2006, the government of India notified new Community Radio Guidelines which permit NGO and other civil society organizations to own and operate community radio stations.

Television channels like Doordarshan (DD) and Etv are telecasting agriculture-related programs regularly in regional languages. Weekly KISSAN KRISHIDEEPAM. TV programme through Asianet channel is popular in Tamilnadu. Similarly, other satellite channels are also broadcasting useful programmes for the farmers to suit their local needs.

KVK Portal: Krishi Vigyan Kendra (KVK) Portal was launched on July 08, 2016.The portal provides information on different services being provided by different KVKs. Weather and Market related in formations can also be accessed by the farmers and others.The forthcoming programmes will also be available on the website which will benefit farmers and youth in joining different training programmes being organized by KVKs. Question and answer facility will also be available for the farmers. Agriculture related information of the districts is also available on the portal. The farmers and the Agricultural Officers may register themselves and seek different information's related to KVKs.

e-NAM: e-NAM is envisaged as a pan-India electronic trading portal which seeks to network the existing APMC and other market yards to create a unified national market for agricultural commodities. NAM is a ñvirtualò market, but it has a physical market (mandi) at the back end. The NAM Portal provides a single window

service for all APMC related information and services. This includes commodity arrivals & prices, buy & sell trade offers, provision to respond to trade offers, among other services. While material flow (agriculture produce) continues to happen through mandis, an online market reduces transaction costs and information asymmetry.

Agriculture marketing is administered by the States as per their agri-marketing regulations, under which, the State is divided into several market areas, each of which is administered by a separate Agricultural Produce Marketing Committee (APMC) which imposes its own marketing regulation (including fees). This fragmentation of markets, even within the State, hinders the free flow of agri commodities from one market area to another and multiple handling of agri-produce and multiple levels of mandi charges ends up escalating the prices for the consumers without commensurate benefit to the farmer.NAM addresses these challenges by creating a unified market through the online trading platform, both, at State and National level and promotes uniformity, streamlining of procedures across the integrated markets, removes information asymmetry between buyers and sellers and promotes real time price discovery, based on actual demand and supply, promotes transparency in the auction process, and access to a nationwide market for the farmer, with prices commensurate with the quality of his produce and online payment and availability of better quality produce and at more reasonable prices to the consumer.

Objectives of NAM

- A national e-market platform for transparent sale transactions and price discovery initially in regulated markets. Willing States to accordingly enact suitable provisions in their APMC Act for promotion of e-trading by their State Agricultural Marketing Board/APMC.
- Liberal licensing of traders / buyers and commission agents by State authorities without any pre-condition of physical presence or possession of shop /premises in the market yard.
- One license for a trader valid across all markets in the State.
- Harmonization of quality standards of agricultural produce and provision for assaying (quality testing) infrastructure in every market to enable informed bidding by buyers. Common tradable parameters have so far been developed for 69 commodities.
- Single point levies of market fees, i.e on the first wholesale purchase from the farmer.
- Provision of Soil Testing Laboratories in/ or near the selected mandi to facilitate visiting farmers to access this facility in the mandi itself. M/s. Nagarjuna Fertilizers and Chemicals Ltd. is the Strategic Partner (SP) who is responsible for the development, operation, and maintenance of the platform. The broad role of the Strategic Partner is comprehensive and includes writing of the software, customizing it to meet the specific requirements of the mandis in the States willing to integrate with NAM and running the platform.

Success Cases

ITCôs Agri Business Division launched **"e-Choupal** ñ in June 2000 in which village internet kiosks managed by farmers - called *sanchalaks* - themselves, enable the agricultural community access ready information in their local language on the weather & market prices, disseminate knowledge on scientific farm practices & risk management, facilitate the sale of farm inputs (now with embedded knowledge) and purchase farm produce from the farmers' doorsteps (decision making is now information-based). Real-time information and customized knowledge provided by 'e-Choupal' enhance the ability of farmers to take decisions and align their farm output with market demand and secure quality & productivity. The aggregation of the demand for farm inputs from individual farmers gives them access to high-quality inputs from established and reputed manufacturers at fair prices. As a direct marketing channel, virtually linked to the 'mandi' system for price discovery, 'e-Choupal' eliminates wasteful intermediation and multiple handling. Thereby it significantly reduces transaction costs. ǿe-Choupal', has already become the largest initiative among all Internet-based interventions in rural India. 'e-Choupal' services, today reach out to over 4 million farmers growing a range of crops - soybean, coffee, wheat, rice, pulses, shrimp - in over 40,000 villages through 6500 kiosks across ten states (Madhya Pradesh, Haryana, Uttarakhand, Karnataka, Andhra Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Kerela and Tamil Nadu.

***e*-Sagu**, an ICT based personalized agro-advisory system is being developed since 2004.The word 'Sagu' means 'cultivation' in the Telugu language. It aims to improve farm productivity by delivering high quality personalized (farm-specific) agro-expert advice in a timely manner to each farm at the farmerôs doorsteps without farmer asking a question. The advice is provided on a regular basis (typically once a week) from sowing to harvesting, which reduces the cost of cultivation and increases the farm productivity as well as the quality of agri-commodities. In e-Sagu, the developments in IT such as (database, Internet, and digital photography) are extended to improve the performance of agricultural extension services. The e-Sagu system offers next generation agro-advisory tool, and supplements and integrates into the existing agricultural extension system. In e-Sagu, rather than visiting the crop in person, the agricultural scientist delivers the expert advice by getting the crop status in the form of digital photographs and other information. The e-Sagu system contains the following parts: (i) Farmers (ii) Coordinators (iii) e-Sagu local center (iv) Agricultural information system and (v) Communication system. The farmers are the end users of the system and can be illiterate. A coordinator is an educated and experienced farmer who is stationed in the village. Each coordinator is attached to the e-Sagu local center, which contains few computers and a computer operator. Agricultural Experts possess a university degree in agriculture and are qualified to provide expert advice. The Agricultural Information System is a computer based information system that contains all the related data. The communication system is a mechanism to transmit information from farms to agricultural experts and vice versa. If enough bandwidth is not available, photographs from the village to the main system

can be transmitted through courier service. However, the advice (text) can be transmitted from the main system to the local center through the dial-up Internet connection.

AKASGANGA (Meaning ñmilky wayò in Hindi) was established in 1996 under the banner of Shree Kamdhenu Electronics Private Ltd. (SKEPL) by a group of young entrepreneurs. It was established at a time when information technology was almost unknown in the villages of India. AKASHGANGAôs success demonstrates the potential of information technology to impact livelihoods in poor, rural communities. AKASHGANGAôs experience indicates that even illiterate or semi-literate people can adopt IT-based systems when they see substantial benefits and when the systems are deployed in purposeful, easy-to-use ways. SKEP Lôs experience also indicates that providing direct benefits and expanded opportunities to poor communities in developing countries can be profitable. AKASHGANGA, in tying its future to improving the productivity of its customers, will succeed to the extent that it can help transform the fortunes of rural dairy farmers, demonstrating the synergies between business and development goals. All the members (farmers) (members) of the Dairy Cooperative Society DCS congregate twice a day at its premises to sell milk. Previously, all the milk collection activities were performed manually. Due to the climatic conditions, milk would often get spoilt, as the producers had to wait in long queues. Secondly, the payment for the milk sold would get held up. The simple technology used in this product has enabled the timely collection of milk and thus, generated higher earnings for the producer, now paid well in time. A basic milk collection transaction done by AKASHGANGA comprises of automatic milk collection system, an electronic weighing scale, a dairy information system kiosk, and a milk analyzer that tests for levels of fat and non-fat milk solids. Capture of unique member ID by the PC software, Multilingual printing of payment slip. SKEPL also offers accounting and milk procurement software, as well as consulting and maintenance services, to its customers. The companyôs products and services are competitively priced, keeping in mind the limited purchasing power of its customers. Currently, the majority of the companyôs customer base is in the states of Gujarat and Maharashtra.

KISSAN (Karshaka Information Systems Services and Networking) **Kerala** ï is an integrated, multi-modal Agricultural information system, which provides several dynamic and useful information and advisory services for the farming community across the state of Kerala. The core deliverable and achievements of the project is an integrated multi-component, multi-modal delivery of Agriculture Information Services system that is accessible anywhere anytime by all concerned. The project adopted a strategy of providing the right information to the right people in the right context and empowers the farmers with adequate knowledge, which helps them to take better decision. The project solves the problem of content gaps by providing the authentic agricultural information, through various delivery methods like Television, Internet, Telephone, and Mobile. The farmers may choose any medium to seek the relevant information. The project offers the following major services: (A). Online

Agri advisory service: The dynamic portal based online Advisory services for the farmers (www.kissankerala.net) (B). Kissan Krishideepam: Agriculture based weekly Television program - in local language through Satellite channel (C). Online Agri video Channel: The project has launched the countryôs first online video channel in Agriculture in collaboration with YouTube (D). Tele Advisory Services : The project also provides telephone based Agri advisory services through a dedicated telephone number (E). The mobile based Agri Advisory services : The project offers text, voice and video based content and Agri information services through mobile phones. The project has answered more than 18000 questions of farmers through online using the query management service of the portal. The project has generated 32225 online soil test based fertilizer recommendation advisory for farmers and distributed to the farming community during the last one year. The project has completed the production and telecast of 348 weekly episodes of television based agricultural program through Satellite channel. The program reaches to more than 46 lakhs regular viewers every week. The project has produced more than 1000 hours of digital quality video materials on best farming practices, success stories of farmers, womenôs groups, technical information, method demonstration, organic farming, etc. The digital archive is made available to the farming community as part of knowledge sharing. Launched country`s first dedicated online video channel on Agriculture in collaboration with Google/YouTube and uploaded more than 150 videos. It has launched an integrated mobile based Agri advisory service by integrating text, voice and video based content. The project has won several awards and recognitions during the last several years. Some of the major recognitions are. (1). e-India National Award 2009: Best ICT enabled the Agriculture Initiative of the Year (Jury Choice Award) (2). Manthan Award South Asia - 2008 for Design and development of integrated, multi-modal agricultural information system for Kerala (3). First Kerala State e-Governance Award: 2009 for effective online services.

Table: A list of Major ICT initiatives

Name	Implementing Agency	Sponsoring Agency	Target groups/Area	Year of Starting	Mode of Information
Government/ Public Sector initiatives					
ASHA	National Informatics Centre	Dept. of IT, Govt. of India	North east	2001	Internet
Agriculture Technology Information Centre (ATICS)	ICAR,SAUs	ICAR	India	2001	Internet, Mobile/telephone
AGMARKNET	National Informatics Centre (NIC) (GOI)	Directorate of Marketing and Inspection (DMI) - Ministry of	India	2001	Internet

		Agriculture			
AGRISNET (Agricultural Informatics and Communications Network)	NICNET	Indian Council of Agricultural Research ICAR	Rural areas of India	2002	Internet
Bhoomi	Revenue department, Government of Karnataka	Government of Karnataka	Farmers of Karnatka	2004	Internet
Bhu-bharti (Integrated Land Information System)	Revenue department, Government of Andhra Pradesh	Government of AP	Farmers of AP	2005	Internet
Bhu-rekha (Land records information system)	Revenue department, Government of Kerala	Government of Kerala	Farmers of Kerala	2006	Internet
Community Information Centres (CICs)	National Informatics Centre(NIC) and National Informatics Centre Services Incorporation(NIC SI	Ministry of Development of North Eastern Region	Rural population of Arunachal Pradesh, Manipur, Assam, Meghalaya, Mizoram, Sikkim, Tripura, Manipur and Nagaland	2002	Internet
Community Radio - Deccan Development Society	Deccan Development Society	UNESCO	Dalit women of Medak District, AP	1998	Radio
Digital Mandi	Media Lab Asia	Media Lab Asia & IIT Kanpur	India	2003	Internet
e-Sagu	International Institute of Information Technology, Hyderabad	Ministry of Communicati on and Information Technology, Govt. of India	Farmers India	2004	Internet
e-Arik	College of Horticulture and Forestry, Central	Department of Scientific and Industrial	Tribal farmers of India	2007	Internet, TV, Telephone/mo

	Agricultural University (CAU)	Research (DSIR), Ministry of Science and Technology, Govt. of India			bile
e-KRISHI VIPANAN	Madhya Pradesh Agricultural Marketing Board (Mandi Board) and Madhya Pradesh Agency for Promotion of Information Technology (MAP_IT)	Govt. of Madhya Pradesh	Madhya Pradesh	2003	Internet
E-gram	Govt. of Rajasthan/Gujarat	Govt. of Rajasthan/ Gujarat	MP/Gujarat	2009	Internet
Entegramam	KSITM	UNESCO	Kerala	2008	Internet
Gender Resource Center (GRC)	Women Cell of Directorate of Extension, Department of Agriculture & Cooperation, Ministry of Agriculture (GoI)	Govt. of India	India	2004	Internet
Gram Vani	IIT Delhi	Govt & Knight Foundation	North India	2008	TV, Radio Internet, Mobile
Gramin Gyan Kendra	Media Lab Asuia & Institute Of Technology BHU Varanasi	Media Lab Asia, Ministry of Information Technology, Govt. of India	North India	2006	Kiosk
Grasso PCO Project	GRASSO	GRASSO, Dept. of IT - Govt. of West Bengal	West Bengal	2003	Mobile, Kiosk
Gyandoot	Govt. of MP, NIC	Govt. of MP	MP	2000	Internet
I Kisan	Nagarjuna fertilizer & chemical Ltd, Hyderabad	NFCL	India	2004	Internet

IFFCO Kisan Sanchar	Airtel & IFFCO Kisan Sanchar	IFFCO Kisan Sanchar Ltd.	India	2008	Mobile
Kisan Soochana Kendra (KSK)	Jai Kisan/IIT Roorki	UNDP, Dept. of IT ï Govt. of Uttaranchal, NIC Uttaranchal	Farmers of Uttarakhand	2005	Internet/ mobile
Kisan Call Centres	Department of Agriculture & Cooperation (DAC), Ministry of Agriculture, Govt. of India	DAC	Farmers India	2004	Telephone/mobile
KISSAN-Kerala	Indian Institute of IT and Management (IIITM-K)- Kerala	Dept. of agriculture, Govt. of Kerala	Farmers of Kerala	2003	Internet, TV, Telephone/mobile
Village Resource Centres (VRCs)	Satyabama Universit;Chennai, Indian Space Research Organisation (ISRO)	Indian Space Research Organization (ISRO), M S Swaminathan Research Foundation (MSSRF)	Tamilnadu	2004	Internet
Kisan Subhidha	CDAC, Mumbai/ Ministry of Agriculture & Farmers welfare	Ministry of Agriculture & Farmers welfare	All India	2016	Mobile app
Private Sector initiatives					
Agriwatch Portal	Indian Agribusines Systems Pvt. Ltd. (IASL)	IASL	Farmers, traders, processors of agricultural outputs, suppliers of agricultural inputs etc	2001	Internet
AKASHGANGA	Shree Kamdhenu Electronics Pvt Ltd	Shree Kamdhenu Electronics Pvt Ltd	Dairy farmers of Gujarat & Maharashtra	1996	Internet
i-Shakti	Unilever, e-Seva and other NGOs	Hindustan Unilever Ltd.	Women & Youth of Andhra Pradesh	2004	Kiosk , Internet
ITC eChoupal	ITCôs International Business Division (IBD	ITCôs IBD	Farmers of Madhya Pradesh, Haryana,	2000	Internet

			Uttarakhand, Karnataka, Andhra Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Kerela and Tamil Nadu		
mKRISHI	Tata Consultancy Service (TCS)	TCS	Maharashtra	-	Mobile
Nokia Life Tools	Nokia	Nokia	India	2008	Mobile
OSCAR (Open Source Simple Computer for Agriculture in Rural Areas)	IFP (French Institute of Pondicherry	Rice-Wheat Consortium for Indo-Gangetic Plains, India, French Agricultural Research Centre for International Development (CIRAD),	India	2006	Internet
Tata Kisan Kendra	Tata Chemicals Limited (TCL)	Tata Chemicals Limited (TCL)	Farmers of Haryana, Punjab & UP	2003	Internet
NGO-initiatives					
Ashwini (v-Agri v-Aqua)	Byrraju Foundation	NISG-(National Institute for Smart Government)-UNDP	AP	2005	Internet
Creating Rural Entrepreneurs through ICT enabled Enterprise Development Services	Development Alternatives (Tarahaat Informational & Marketing Services Ltd.)	UNDP-NISG	UP & MP	2005	Internet
information Village Centers of MSSRF	M S Swaminathan Research Foundation (MSSRF)	International Development Research Centre (IDRC), Canada	12 villages in Pondicherry region	1998	Internet

Jagriti e-Sewa	Jagriti-eSewa	Jagriti	Punjab	2003	Internet
Jamset Ji Tata National Virtual Academy for Rural Prosperity	M S Swaminathan Research Foundation (MSSRF)	Sir Dorabji Tata SchoolWelfare Trust	Pondicherry	2003	Internet
Rural Knowledge Center (RKC)	Microsoft Corporation India Private Limited, NASSCOM (National Association of Software and Services Companies) Foundation and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT	Microsoft (Nasdaq "MSFT")	Nine coastal states of India ï West Bengal, Orissa, Andhra Pradesh, Tamilnadu, Kerala, Karnataka, Goa, Maharashtra and Gujarat.	2004	Internet
Swayam Krishi Sangam (SKS) Microfinance	Swayam Krishi Sangam	Women's World Banking, CGAP, Grameen Foundation USA, American India Foundation	Rural poor, landless laborers or marginal farmers, women and Dalits of Andhra Pradesh, Karnataka, Maharashtra, Orissa and Madhya Pradesh	1998	Internet
Warna Wired Villages Project	National Informatics Centre (NIC), Directorate of Information Technology, Government of Maharashtra (GoM) and Warana Sahakari Dudh Utpadan Prakriya Limited (WSDUPL)	National Informatics Centre (NIC) and Farmers and rural population of Warna Nagar Directorate of Information Technology, Government of Maharashtra (GoM	Farmers and rural population of Kolhapur and Sangli district, Warna Nagar, (Maharashtra)	1998	Internet

ICT is helpful in providing accurate, timely, relevant information and advice to the farmers, thereby facilitating a favourable platform for more remunerative agriculture. In context of Indian agriculture, the ICT movement is still evolving. Except for few ICTs based projects- Kisan Call Center of DAC which covers entire country, e-soil health card programme that covers state of Gujarat and KISSAN Kerala, most of ICTs project for farming community have been implemented in very limited geographical area and covering few thousand of population. The common problems in adoption of ICT for greater farming community are ICT illiteracy, availability of relevant and localized contents in their own languages, poor electricity supply in rural areas, poor tele-density in rural areas (4.92 against overall 59.63) easy and affordable accessibility and other issues such as awareness and willingness for adoption of new technologies among the rural peoples etc. For effective information delivery, traditional extension methods (personal contact methods, print media, radio, and TV) should be supplemented with new ICTs tools involving research institutions, government agencies, NGOs, private sectors in public- private ï participatory(PPP) mode.

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Market Led Agricultural Extension: Concept, Prospects and Challenges

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Concepts of Market Led Extension

A market led extension can be defined as a tool for effective delivery of adequate and quality information to farmers for an effective decision on production and marketing issues so as to realize an optimum return for their investment without jeopardizing the need of the future generation. With the globalization of the market, farmers need to transform themselves from mere producers-sellers in the domestic market to producers cum sellers in a wider market sense to best realize the returns on their investments, risks, and efforts. Besides the production technologies, the extension workers now have to get equipped with market information which requires imparting new training skills to the extension personnel. This calls for a transfer of new extension approaches involving productivity to profitability, subsistence to commercial agriculture, commodity-oriented to farming systems orientation, local market to export markets, mono-cropping to crop diversity and so on. The focus of the extension functionaries needs to be extended beyond production. Farmers should be sensitized on various aspects of quality, consumerôs preference, market intelligence, processing, value addition and other marketing information. This will help the farming community realize high returns for the produce, minimize the production cost and improve the product value and marketability.

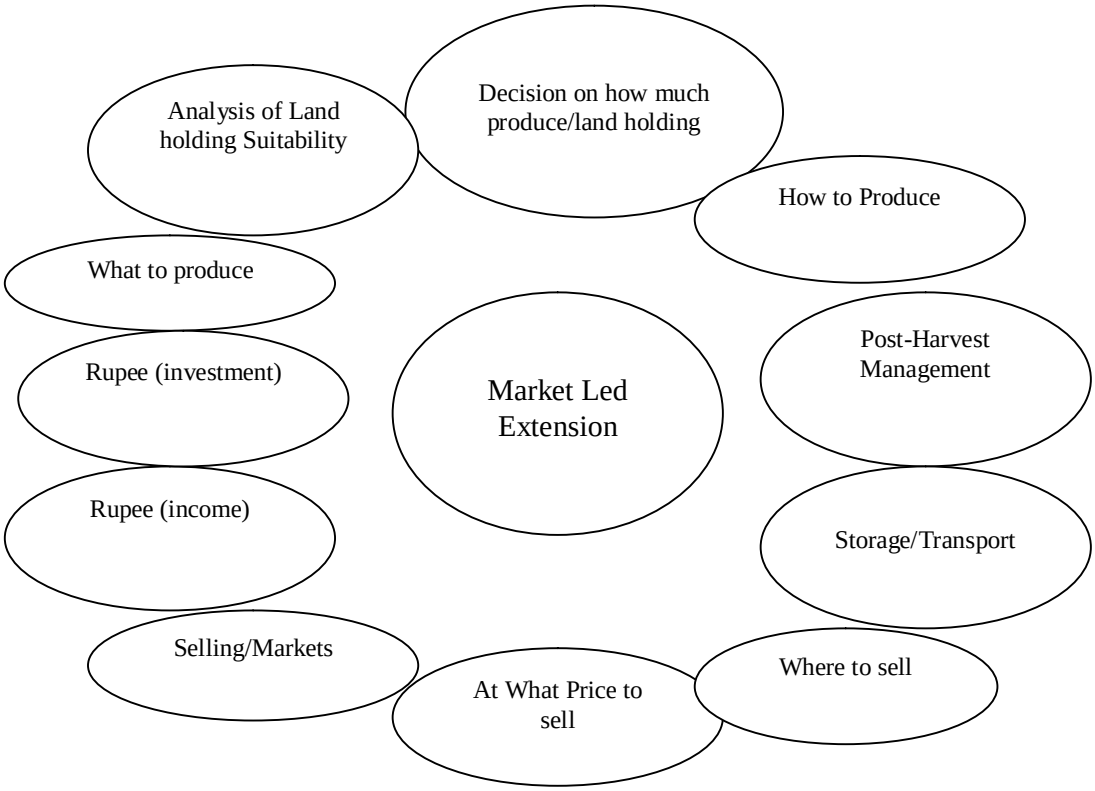
Paradigm Shift

The paradigm shift of present Agricultural Extension scenarios, especially in the Indian context from óProduction Led Extensionô to the óMarket Led Extensionô approach spurs for all hands to be on desk to transform Agriculture and allied sector into worthwhile and profit-oriented business through the needed intervention on the basis of market intelligence. In this era of the open market economy, globalization and liberalization, a farmer will have to change his role from mere óproducerô in the domestic market to óproducer-cum-sellerô in order to best realize the returns for his investments.

Indian Agriculture has been characterized by high input cost, lack of access to quality information, especially information about markets, lack of labour as a result of rural urban migration, lack of infrastructure facility, large number of market functionaries, lack of grading and standardizing, lack of good storage facilities, lack of market intelligence which resulted in high marketing cost and minimum share in

consumerôs rupee. Adequate information is needed by the farmers from the point of making investment in farming to the point of making returns. Extension agents who are trained as an agent of disseminating information should get involved in all stages of farmerôs decision making to guide them in making the right decision at the right time with regard to production and marketing of the agricultural produce. Do farmers need answers to questions like what to produce? Where to sell? In what from to sell? What channels to sell his produce?

The Flow chart of Market Led Extension.



Extension Strategies for Market Led Intervention

Market-led Extension is perfect blend and synergy between Extension Education, Agricultural Economics, and Agricultural Marketing. Market Led Extension is designed for transforming a top-down extension system into bottom-up, farmerï centered and demandï driven system by organizing farmers into groups/organizations like Farmers Interest Groups (FIGs) and Self Help Groups (SHGs) through agencies like the Agricultural Technology Management Agency (ATMA). The focus should be turned towards high quality produce, low cost of

production and high productivity. Innovative strategies for market led extension should be embedded in extension principles and practices to provide the farmers a assured market for their agricultural produce and access to market intelligence. One of these strategies is the timely initiatives of marketing agricultural produce through FIGs, Commodity Interest Groups (CIGs) as well as unitization of other group approaches. This will ultimately enable the participation of various stakeholders in marketing agricultural produce thereby maximizing their potential for maximum profit. Also, another profitable extension strategy is the utilization of principle of e-extension for marketing purposes. This can be done through the initiation of the online marketing system through farmers-traders-wholesalers and monetary transaction. Also, the introduction of subsidy provision for post-harvest management practices as well as value addition can go a long way in minimizing the challenges of post-harvest loss. Public-Private Organizations should also give emphasis on forward linkages of both crop and animal enterprises in addition to non-farm activities at villages. Moreover, there should be adequate provision of credit facilities for storage, transportation, grading value addition, packaging activities for farmers/ farm women/rural youth with proper and strategic monitoring and evaluation of the extension functionaries.

In this context, the extension system may face a crisis in the form of knowledge, efficacy, credibility, reorganizational structure etc. Extension personnel will have to be ready to perform some additional roles like SWOT analysis of the market, organizing Farmers Commodity Interest Groups, supporting and enhancing the capacities of locally established group like Water Users Associations, Self-Help Groups Watershed Committees etc, creation of websites of successful farmers besides establishing marketing agro-processing linkages and market intelligence for motivating our farmers to shift from ósupply drivenô to market drivenô mode.

Prospects of Market Led Extension

The agricultural Extension System has to transform from the transfer of production technologies to enable the farmers to get optimum returns out of the enterprise and in part from ensuring adoption of the package of practices, to ensure the high returns to the farming communities by promoting the agriculture as a an agri-business enterprises. Market-led Extension has a great potential in paving way for optimum production on a sustainable basis, considering the current trend of challenges in the process of food production globally. Over the years ólab to landô had been much emphasized in our country now it is high time to focus on ófarm to forkô. Due to WTO, the countries around the world are no longer confined to domestic production alone. The countries with competitive advantage are looking forward to selling their output anywhere in the world. However, with the new changed role of extension personnel under the market led extension, future success can be guaranteed for agricultural development in our country.

Challenges in Market Led Extension

Market size is large in the agriculture and allied sector and continuously expanding, but the agricultural marketing system is not in a position to keep pace with the ever-increasing agricultural market. 85 percent of the 27,294 rural periodic market facilities for efficient trade is still almost absent and 7161 market yards are inadequate, ill-equipped and mismanaged. On an average Rs. 50,000 corers/year is lost due to poor marketing chain and inadequate storage facilities. Lack of risk-bearing capacity of the farmers in terms the production and marketing of the agricultural produce, lack of storage facilities and cold chain for the farm produce and the absence grading and standardization and lack of agro-processing facilities restrict the development of effective and efficient marketing system.

Extension system is gigantic in size and heavily burdened with multifarious activities. Adding to it is the ever-widening gap in communication between the research system and the client system. Developing good market intelligence/information is yet another challenge. Good market intelligence should be comprehensive, accurate, relevant, confidential, trustworthy, and equally accessible and timeliness. Agricultural goods are quite different from other marketing goods as they are perishable in nature. Supply is not regular because of seasonality in production. Farmers have small land holding which gives scattered production and variability in the quality of the products. Besides our country is not in a position to reap the benefits of the WTO through export on account of unrealized opportunities in agricultural marketing and underexplored export opportunities for agricultural products in our country.

Three Dimensional challenges of Market Led Extension

Production Dimension	Market Dimension
Seasonality of production Supply not uniform	Lack of information about the market
Perishability of produce as a result of poor storage facility	(Market Intelligence) Existence of middleman
Bulkiness of production	Inferior quality of

Extension Dimension
Lack of communication skills
Lack of credibility
Insufficient information

Conclusion

Market Led Extension is perfect blend and synergy between Extension Education, Agricultural Economics, and Agricultural Marketing. Extension functionaries need to work more in the area of marketing through the use of extension strategies in order to disseminate not only production but essentially marketing related information for holistic sustainable agricultural development. This can be achieved through capacity building of farmers to realize optimum returns for their produce. This will in turn help minimize the production costs as well as improve their products through value addition. Sustainable Agriculture can, therefore, be realized by the intervention of the market-led extension system. The focus of the extension functionaries needs to be extended beyond production. Farmers should be sensitized on various aspects of quality, consumerôs preferences, market intelligence, processing and value addition and other marketing information. This will help the farming community realize high returns for the produce, minimize the production costs, and improve the product value and marketability.

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Role of Dairy processing Technology for Increasing Income of Rural Households

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Introduction

Dairying has been an integral component of Indiaôs rural economy, which has contributed significantly to the social and economic development of the rural people. The role of milk in the provision of food and nutrition, particularly in the predominantly vegetarian countries like India, is well-recognized. Despite changing food habits, milk and milk products assume significant importance in Indian dietary systems. India is the worldôs largest milk producer with 156 million tons of milk (2016), which accounts for about 18.5 % of world production. The milk production is growing at the rate of 6.26% and the per capita availability is milk is also considerably higher (337 gm) than the worldôs average (229 gm). Evidence indicate that a significant amount of milk in India is being traded and consumed as liquid milk only. Despite good coverage of dairy cooperative societies, the extent of value addition in this sector is trailing at around 34%. In Bihar, the value addition in dairying is hardly 14%. Growing income, rapid urbanization and increasing awareness about the advantages of milk consumption have instigated the demand for the milk and milk products. The demand for milk is expected to touch 200 million tons by 2021-22. But, in the changing economic environment, there is an increasing concern about the interaction between the economic competitiveness of livestock production and social factors like poverty, unemployment and food and nutritional security. It is apprehended that the poor livestock keepers may be displaced in the marketplace by the commercial producers. For maintaining the pro-poor nature of livestock, the key lies in improving efficiency and sustainability of smallholder livestock production systems. Evidence indicate that majority of farm-households rear dairy animals for their domestic milk consumption requirements and source of regular income. As a matter of fact, the nature of dairy farming is, by and large, subsistence. To improve the situation and make dairying economically viable, it is imperative that it is practiced as a profitable business proposition.

Small-scale dairy processing technologies provide a variety of plausible solutions for increasing the farm-income.

Indian Dairy Sector: An Overview

Although the Indian dairy sector has successfully been transformed from a milk-deficient (17 million tons in 1950ôs) phase to top most producers (156 million tons in 2014) that is anticipated to reach at 170 million tons by 2020 the potential of

the dairy sector could yet not been fully exploited. It is to note that milk is the largest agricultural commodity in India followed by rice, wheat, and other food grains. Some of the facts about the Indian dairy sector are presented below:

There are approximately 13.9 million farmers which are linked through a strong network of more than 1 lakh village dairy cooperative societies spreading across 346 districts of the nation. About 50% of the milk is consumed at the producerôs level itself. Due to the dominance of smallholder dairy producers and low animal productivity, producers generate very small surpluses of milk. Producers lack awareness and skill about effective utilization of available surplus. Remaining 50% is sold in the domestic market of which 50% is sold as liquid milk, 35% as traditional dairy products and 15% for the manufacture of western or industrial dairy products (such as baby food, whey protein concentrate, lactose, casein). Selling of loose milk by milk vendors, *dudhiyas* is a major safety issue. Indian dairy industry with an estimated size of 70 billion US$ contributes to about 18.5% of global milk production is growing at the rate of 3-4%, per annum, however, last few years have witnessed a growth rate of around 6.9%. Level of processing is around 34%, highest among all food categories. Estimates suggest about 15% growth in the processed dairy segment in next five years. Increasing consumer demand is also witnessing diversification of product profile towards value added products such as yoghurt, dairy beverages, ice creams & cheeses. Organized sector processes only 20% of total milk produced in the country. Establishment of 532 private dairies in comparison to 254 owned by cooperatives and 46 government milk processing units indicate the inclination of private organizations towards milk processing. Cooperatives are mainly engaged in liquid milk operations & consumer goods and lesser emphasis is given to other dairy products, whereas private dairies are engaged mainly in the production of value added products such as powder, ghee, dairy whiteners, and butter and whey products.

Table-1. Household expenditure on food items

Area	Household Income Profile	Monthly food expenditure (Rs.)	Milk (Rs.)	Chicken, fish, mutton (Rs.)	Eggs (Rs.)	Milk expenditure (%)
Urban	High	15,000	4000	1500	90	26
	Low	8,000	2500	400	100	31
Rural	High	7,500	2500	400	90	33
	Low	4,500	900	900	60	20

Milk is an important food item and a considerable amount of food expenditure is being made on milk by the Indian households. Table-1 depicts that about 20% to 33% of the food expenditure is made for the consumption of milk. Even, the low-income group of households accords considerable importance to milk consumption, particularly in urban areas where the expenditure on milk is more than that of high-

income household. It accounts for 31% total of food expenditure in comparison to 26% by high-income households. It is obvious that rural households also spend one-fifth (low-income households) to one-third (high-income households) on milk.

Processing technologies for increasing farm income in dairy sector

These trends are unlikely to subside in the near future, suggesting further increases in demand for milk food products. There are a number of technologies, which can be conveniently applied by the rural mass to increase farm income. Sometimes the scale of production impedes the success of a business, but it can be effectively tackled.

For instance, SHGs may be formed to start preparation of Paneer (cottage cheese) from cow milk or goat milk. There is a common perception that cow milk and goat milk contain therapeutic values and thus may be placed in the market at relatively higher prices with proper branding/ marketing strategy. Around this core activity, several supporting activities may be initiated by the enterprising rural youths. They may find opportunities ranging from supply of basic inputs to services, information, market integration, and marketing, *etc*.

Traditional dairy products like sweets, dahi, lassi, etc. are other products, which can be undertaken as small viable businesses and produced hygienically by customized small-scale machines and technologies. However, lack of hygiene and safety measures, the absence of cold chain (often leads to malpractices), less returns to dairy farmers, problems in weights & measures, the existence of middlemen who often play exploitative roles and lesser emphasis on value addition at the producerôs level are some of the shortcomings in milk marketing.

Traditional dairy processing sector maximizes household milk use. It processes 54 MT milk that valued at about Rs. 1,00,000 crore and it is three times bigger than the liquid milk business. The level of value addition is almost 100-200% with an annual growth rate of 15-20%. However, modernization and technological development in the sector is the need of the hour. Rural entrepreneurs/ youth can take advantage of modern technologies and machines to manufacture standardized, hygienic, better quality traditional milk products to find better markets and fetch better prices.

Important traditional milk products, which can be undertaken to start a business by the rural youth, are listed below:

- *Khoa:* a heat desiccated product with the market valued at Rs. 6500 crores. In the absence of standardized protocol quality of khoa is often found poor. Adopting standardized khoa making protocol, rural youth may make their fortunes by starting this business.
- *Paneer*, a heat-acid coagulated dairy product with high demand among urban consumers could be adopted as another business. The manufacturing process

of paneer is simple and small-scale processing equipment like kettle & *paneer* press are available. The only limiting factor is its short shelf-life.

- Utilization of whey: It is a major byproduct, which is nutritionally rich. However, it is usually drained out in open drains that pose an environmental threat. Utilization of whey by value addition will maximize the profit. Technologies for ready-to-serve whey based fruit beverages, dairy drinks, soups, could be adopted for enhancing the income. There are simple manufacturing technologies that can be adopted at small scale. However, emphasis should be on appropriate processing and packaging.
- Fermented milk products: Dahi is one of the fermented milk products which has round the year consumption. It is nutritious and considered good for health. There is growing trend for packaged *dahi.* It is a low cost business, which needs investment in culture propagation and incubation. Short set cultures could be used to minimize space and time of processing. Among the cheeses, Mozzarella cheese could be an attractive option.
- Kulfi: It is the Indian counterpart of Ice Cream. Kulfi is a popular traditional frozen dessert of Indian origin that closely resembles Western Ice Cream. It is also known as Kulpha, Kulphy or Kulfy in different parts of the country. Its production process has been standardized using dairy byproducts (buttermilk/whey solids). Low-calorie kulfi has also been developed to meet the requirements of health conscious consumers, which provides a unique business opportunity to the rural youth.

Conclusion

Production of milk products may be undertaken by the rural youths to start economically viable business activities across dairy value chains. Based on market demand ideas may be adapted to generate innovative business models and arrangements to start new dairy-based business enterprises. Traditional dairy products offer enormous opportunities to the rural youth to start core and subsidiary businesses activities to generate a better income with making and targeting quality milk products to the markets.

Paradigm Shift from Production led Extension to Market-led Extension

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Agricultural Extension has four paradigms namely: Technology transfer; advisory work; human resource and development; and facilitation of empowerment. Based on My Agricultural Information Bank (2011), these paradigms differ in the way communication takes place and why it takes place. Technology transfer is characterized by a persuasive and paternalistic approach in communicating with farmers. It requires persuasive or convincing power because, here, the extension is designed to recommend practice and technology for the specific needs of farmers and move the farmers to adopt such practice and technology while, it is paternalistic in a sense that it uses the top-down approach. Advisory work, on the other hand, uses a persuasive but participatory approach. It needs the persuasive capacity to encourage the farmers to adopt the pre-determined packages of technology based on the stated needs of the farmers. Moreover, the advisory will not take place unless farmers raise questions or consulted extension worker about a particular problem, thus, it is participatory. As for the human resource paradigm, an educational and paternalistic approach is used. This paradigm originated from the universities doing extension works for those who cannot afford to study at the universities, hence providing knowledge and skills through education. It also allows the students to make their own decisions based on the knowledge they acquired. However, this paradigm still uses a top-down approach, thus it is still paternalistic in nature. The last paradigm, facilitation of empowerment, is educational and participatory in nature. It is educational because it provides new information, practice, and skills on how to increase the production and environmental protection while it is participatory because it involves farmers-to-farmers communication and interactive process to educate farmers.

As agricultural extension progress and shifts from one paradigm to another, the role of farmers or stakeholders also increases. In technology transfer, development is achieved by transferring modern research results to the traditional farmer. Farmers are treated as just mere recipients of programmed technology. In advisory works, on the other hand, farmersô capacity to identify their problems and to inquire for solutions to such problems is acknowledged. However, solutions provided by the extension worker are based on pre-determined packages. Hence, farmers still have no other choice but to adopt the prescribed solutions by the extension worker. While in human resource development, extension worker decides on the knowledge, skills and technology to be taught on the farmers, but farmers are being equipped to be able to

ñknow what to ask for evaluate the appropriateness of technical informationò and to be ñresponsible decision makers. Then, in facilitation for empowerment, extension worker is ñno longer seen as the expert who has all the useful information, and technical solutions.ò Here, farmersô knowledge, skills and creativity are acknowledged as major resources. Searching for solutions to problems is a collaborative work between extension worker and farmers.

Causes of Paradigm Shift

Major agricultural development goals have direct connection to the different extension functions. The paradigm for agricultural extension shifts from one function to another as a response to the emerging needs of the rural community based on governmentôs efforts on achieving the national agricultural goals. When one goal is achieved, the government focuses its efforts in achieving the next goal. Along the process, extension paradigms also change to meet the changing needs of the rural community.

The national food security, which is the ultimate goal of a government, is achieved and maintained through technology transfer of research outputs from researchers to farmers. Thus, extension worker plays a critical role in delivering these research results from researchers to farmers. However, achievement of the first goal produces more complex rural issues leading to the next national goal which is to improve rural livelihood. To be able to achieve this goal ñthe focus must shift toward the intensification and/or diversification of farming systems.ò With this, the extension must also move its function from technology transfer to advisory work wherein pre-determined packages of technology could be provided to the farmers based on their specific needs. But, again, achievement of this second goal leads the way to the bigger problems such as ñavailability of land, labor, capital, local agro-ecological conditions and access to markets,ò hence the birth of the third goal which is to ñget interested farmers organized into producer groups for different high value crop and livestock products, so they can increase their access to both inputs and markets for those enterprises.ò To assist the government in meeting this goal, extension must start ñshifting more of its focus to resources and expertiseòð the human resource and development function of extension. Finally, for the sustainable supply of food, farmers should be ñindividually and collectively know how to maintain their soil fertility, stop land degradation, and to make efficient use of increasingly scarce water resources.ò This is where the fourth national goal rises promotion of sustainable natural management practices.

With the above reasons for shifting of paradigms, it is clear that paradigms change as a response to the changing needs of the government and rural communities. Moreover, the shifting is the extensionôs answer to its emerging roles as the government meets one of its national goals and move forward to another goal, which is usually a by-product of the issues brought by the achievement of the previous goal. Hence, agricultural extension paradigms should continue to evolve to ensure its relevance to the community and country, as a whole.

There is a clear cut indication of the shifting paradigm of extension towards the facilitation for the empowerment. Current extension efforts in the country are into equipping the farmers and involving them in the planning and decision-making phases. ñIn the present scenario, the role of extension is much wider and it needs to change its focus from safeguarding national food security to commercialization and export crop production; to equip themselves with traditional skills understand the clients and the local situation; train farmers in management skills and decision making skills; help the rural people develop leadership and organizational skills enabling them to organize better and participate fully in the development programmes; and develop their skills in marketing, selling, negotiating, delivering and using the knowledge of latest communication technologyò.

Prospects of market led extension

Market Led Extension has a great potential in paving the wave for optimum production on a sustainable basis, considering the current trend of challenges in the process of food production globally. Over the years ólab to landô had been much emphasized in our country now it is time to focus on farm to fork. Due to WTO, the countries around the world are no longer confined to domestic production alone. The countries with competitive advantages are looking forward to dump their output anywhere in the world. However, with the new functional role of extension personnel under Market Led Extension, future success can be guaranteed for Indian Agricultural Development. The following are some of the expected functionary roles of extension personnel. This includes SWOT analysis of the market, Organizing commodity based farmersô interest groups and farm management capacity building, Backward and forward linkage, Farmerôs exposure to market intelligence and guidance for the quality decision about the market. Therefore, the key answer to the above questions will empower farmers in both production market oriented knowledge which is the sole responsibility of Extension functionaries through Market Led Extension.

Challenges in market led extension

Extension system is gigantic in size and is heavily burdened with multifarious activities. Adding to it is the gap in communication between the researcher and the farmer. Developing good market intelligence/ information is yet another challenge. Good market intelligence should be comprehensive, accurate, relevant, confidential, trustworthy, and equally accessible and timeliness. Agricultural goods are quite different from marketing goods because they are perishable in nature. Supply is not regular because of seasonality in production. Farmers here have small land holding which gives scattered production and variability in the quality of the products.

Main components of paradigm shift in agricultural extension

ÅProductivity to Profitability

ÅSubsistence to commercial Agriculture

ÅCommodity oriented to farming systems orientation

ÅLocal Market to Export market

ÅMono cropping to crop diversity

ÅExploitative Agricultural-Sustainable Agricultural

A market-oriented agricultural extension (MOAE) service approach is being promoted by various actors in India, including the state public system, the private sector, and NGOs, although the depth and extent of change vary quite markedly between states. The focus of extension and marketing systems is changing rapidly in the light of globalization and market integration. The gradual attainment of food self-sufficiency, government promotion of crop diversification and commercialization has motivated farmers to produce location-specific, high-value commodities. The public extension system in India started with a unified National Extension Service in the early 1960s, and then there was a shift to a specialized crop technology centered, contact-farmer centered ñtraining-and-visitò (T&V) system during the 1970s and 1980s. It has now been transformed into a more participatory, diversified extension delivery system as a result of extension reforms. The Indian Council of Agricultural Research (ICAR), through its network of agricultural universities, also participates in the extension service delivery. In response to market demand, the private sector has also diversified to undertake a range of functions including value-addition, agriculture trade, extension advisory service etc. Many private sector companies, namely e-Choupal, Tata Kisan Kendra, Haryali Kisan Bazaar etc. are involved in providing extension services to farmers. Such private sector investments could be accelerated with fiscal incentives. The Agri - Clinics and Agri - Business Centers scheme, which was launched to disseminate information through unemployed agricultural graduates, aims to tap the expertise available and offer professional extension services to the farming community. This encourages the unemployed graduates in agriculture or allied areas to become self-employed by obtaining credit from banks and providing extension services to the farmers. The Directorate of Marketing and Inspection (DMI) is the apex national agency implementing and monitoring the agricultural marketing extension programmes. DMI sponsors training programmes/consultancies/research studies in the area of market-led extension. DMI receives the support of national institutions like the National Institute of Agriculture Marketing (NIAM) and national and major state agriculture universities (SAUs).

Extension reforms in India reached a decisive stage in the formation of the Agricultural Technology Management Agency (ATMA) in all districts with a focus on reforming public sector extension and decentralized decision making at the village and block level. It is a broad based system, which through the involvement of multi-agency extension service providers, enables NGOs, para-professionals and private companies to take part in the extension delivery process. The pluralistic nature of the Indian extension system is reflected in private sector companies being involved in providing extension services to farmers as a part of their business strategy along with other agencies like government departments/agencies/commodity boards, SAUs, and NGOs. Many of these initiatives are moving towards providing multiple services. The

focus of extension and marketing systems is changing rapidly as a result of globalization and market integration. With the increases in education, incomes and urbanization, the demand for high value fresh and processed products has increased. Some of the reforms introduced by the Government of India include the Agricultural Technology Management Agency (ATMA), which focuses on reforming public sector extension, and encourages decentralized decision making by farmers and farmers/commodity groups by involving them in the planning and execution of extension activities at the village and block level. Kisan Call Centers (KCC) are a telephone network which addresses queries in 22 local languages on all aspects of agriculture and allied subjects. Another initiative, the Kisan Knowledge Management System offers a key-word/phrase based instant search and agricultural graduates through AgriClinics and AgriBusiness Centers act as farm advisors for a fee. With a view to supporting extension intervention by the private sector, project based funding with a clearly defined outlay-outcome matrix with a log frame approach should be promoted. It is evident that public extension by itself can no longer respond to the multifarious demands of the farming community. Public funding for sustaining the vast extension infrastructure is also under considerable strain. Therefore, the public-private partnership needs to be promoted for sharing of resources and convergence. To promote private investment in agricultural extension, it is felt essential to provide fiscal incentives. However, there is a need to enhance agricultural marketing infrastructure, clarify institutional mandates and create synergy among key stakeholders, and develop the capacity of national institutions and state departments of agriculture and marketing. FAO could help in capacity building of national institutions and state departments of agriculture and marketing, reform of institutional mandates, support for extension reform, and support for piloting market-oriented extension advisory services.

Improving Farmer's Income from Commercial Fish Culture

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Agriculture plays a vital role in Indiaôs economy. The 54.6% of the population is engaged in agriculture and allied activities (census 2011). The Gross Value Added GVA growth rate for the agriculture and allied sector during 2013-14 was 3.7% and the sub-sectoral growth in agriculture, including livestock was 3.9 %, in forestry and logging was 0.3 % and in fisheries was 5.8 % (at Constant 2011-12 prices) (SoA, 16). This indicates that Fishery is one of the most promising sectors of agriculture and allied activities in India, with a projected overall growth rate of 6 percent for the 12th Five Year Plan. Moreover, totals production of 10.1 million tonnes (2014-15), India is the largest producer of fish in the world, next only to China. Besides this, fisheries support the livelihood of almost 1.5 million people in the country.

Aquaculture is the fastest growing food production sector in the World with annual growth in excess of 10 percent over the last two decades (Little and Edwards, 2003). Total fish production of the world during 2014 was around 167.2 million tonnes (Mt) and inland aquaculture contributed around 28.16% (FAO, 2016). During 2014, aquaculture production in India was 0.49 Mt, contributing around 6.62% of the world aquaculture production. Top few species contributing the bulk of the freshwater fish production in the world are *Ctenopharyngodon idella* (5.54 Mt), *Hypophthalmichthys molitrix* (4.97 Mt) and *Cyprinus carpio* (4.16 Mt), *Catla catla (2.78 Mt)* and *Labeo rohita* (1.67 Mt) (FAO, 2016).

Aquaculture in India has got an astounding response from culturists covering various revolutionary episodes and challenges with the use of vast land resources. Our country has 2.4% of the worldôs land area about 17% of the world population with only 4% of the worldôs freshwater resources (Mukherjee *et. al.,* 2014). The inland aquatic resources in India comprise of 2.433 million hectares (m ha) of ponds and tanks, 2.906 m ha of reservoirs, 0.798 m ha of floodplain lakes and derelict water, 0.195 million km of river and canals. With these vast freshwater resources, India stood second in the world in fish production. Fisheries sector together with subsidiary industries also provides employment to a large section of the economically backward population of the country apart from providing the cheap and nutritious protein source for the people. At present per capita fish consumption of fish in India is very low (3.23 kg per year, DAHD, 2014.) compared to the world average of >20.0kg/year (FAO, 2016) as well as nutritional security point of view of 11.0 kg/year as recommended by WHO, Geneva. Fish is a nutritious and easy digestible food item and rich in numerous nutrients like calcium, iron, zinc, iodine, vitamin (A, B12, & D) as well as omega-3 fatty acids and high quality protein that is often missing in diets,

particularly those of the poor and under privilege people. Higher availability of fish will not only help in addressing a frequently overlooked, but extremely important part of world food and nutrition security, but will also help in generating employment to many underprivileged populations. As per the Livestock Census (2003), 14.49 million people were engaged in various fisheries related activities; about 75% are engaged in inland fisheries activities and about 25 percent in marine fisheries activities (Anon, 2012). Off late growth rate of the marine sector has slowed down and production is almost reached to plateau. This creates more emphasis and stress on freshwater sector, especially in the eastern states to improve productivity and production of pond based aquaculture and culture based fisheries from reservoirs and floodplain wetlands to meet the growing demand of fish.

Freshwater pond fish culture:

Freshwater aquaculture, mainly confined to carp culture, has evolved from a household activity practiced in West Bengal and Odisha to that of an industry worth about US$2 billion in recent years (Ayyappan and Jena, 2003). In last one decade, the growth of fish production was very good in all the states compared to many other elite sectors, but still there is a large gap between demand and supply. For example, total fish production of the state of Bihar is around 4.00 lakh tonnes (DAHD, 2014) and demand is 5.20 lakh tonnes leaving a deficit of, 1.20 lakh tonnes in fish production. Similarly, in seed production of the State, there is a deficit of 557.75 million fry. The national mean production levels from still-water ponds has gone up from about 600 kg/hectare/year in 1974 to over 2 900 kg/hectare/annum at present and several farmers are even demonstrating higher production levels of 8ï 12 tonnes/hectare/year (HBFA, 2013). The average aquaculture productivity of the Eastern Region ranges between 2.1 to 3.5 tonnes per ha/yr (Kaushal *et. al.*, 2012) and that of FFDA pond, productivity ranges between 2.2 to 4.4 tonnes (DAHD, 2014). This clearly indicates wide variations in fish productivity across the states. It is as low as 2.2 tonnes/ha in Assam and as high as 4.4 tonnes/ha in West Bengal, but still low as compared to Punjab (around 6 tonnes/ha/yr). One of the most important reasons for variations in productivity in pond fish culture is the application of quality feed. Composite fish culture with major carps and exotic carps in a moderate stocking density and with supplementary feeding has been realising the production of 4-8 tonnes/ha/yr under different management practices. The feed is becoming the single most important components influencing the productivity of a culture pond. As per the estimate around 8 million tonnes of feed has been used by the aquaculture industry in the country with a feed conversion ratio (FCR) of 3.0 in carp culture (Jaysankar, 2011). It is also reported that feed alone constitutes about 60% of the production cost in commercial aquaculture. It is generally accepted that good quality and nutritionally well balanced diet are essential for growth and survival of fish. The inferior quality of feed and feed ingredients are of concern for many farmers, as apart from direct economic losses, low quality, feed ingredients result in elevated FCR, increased culture periods, deterioration in fish health , increase susceptibility to disease, reductions in water quality condition etc. In general, in semi-extensive polyculture systems, six (Indian

major, Chinese and common) carp species *viz.* rohu (25 to 30 %), catla (10 to 15 %), mrigal (15 to 20 %), silver carp (20 to 30 %), grass carp (5 to 10 %) and common carp (10 to 20 %) are cultured together (Veerina *et. al*., 1993). In similar polyculture systems in Andhra Pradesh, generally stock larger stunted yearlings of 50 to 125 g with a stocking densities of rohu and catla range between 5 000 to 6 750 fish/ha and 550ï 800 fish/ha respectively. The fish are harvested at 1 to 2 kg (rohu) and 2 to 3 kg (catla) and produce between 6 600 to 8 400 kg/ha/year. The quantity of feed required to achieve this level of production is 17 160 to 26 880 kg/ha/year, equating to feed conversion ratios (FCR) of 2.6 to 3.2:1. While stocking still bigger size fish (catla: 250-1000g & rohu: 200-500 g) in the cultural practice, which is called zero point culture can further improve fish production to 8-10t/ha/y with a FCR 2.5 to 3.2:1 (Ramakrishna *et. al.* 2013). In another report, Jena (1998) mentioned that utilizing supplementary diet in fish production 3.59-4.1 t/ha/year can be obtained while without supplementary diet 2.0-2.2 t/ha/year. This indicates that supplementary feeding alone can almost double the fish production. However, due to the high cost and poor availability of supplementary fish feed and feed ingredients, the poor and marginal farmer can hardly use supplementary feed in the production processes and that leads to low fish production per unit area. In this regards integrated farming can also play an important role in increasing the employment opportunities, nutrition and income of rural populations and because of which it has been receiving considerable attention in recent years (Pillay and Kutty, 2005). Studies carried out in ICAR Research Complex for Eastern Region, Patna has shown that there is immense potential to increase fish production to around 3.0-4.5 kg/h/yr through manure based livestock-fish integrated farming. Similarly FAO also endorsed that livestock- based aquaculture utilizes wastes (both leftover feed and excreta) from poultry birds, ducks, rabbits, pigs or sheep/goats. Production rates ranging from 3 000 to 6 500 kg/ha/year were registered under different systems (FAO, 2014). Das (1990) reported that the pigï fish, duck-fish and poultry-fish integration can yield fish production to the tune of 6.0-7.0, 3.5-4.5 and 5.2 t/ha/y respectively. The common approach for increasing fish production in ponds is the direct application of fertilizer, which enhances production of plankton, a natural food item for fish. Pond fertilization practices using animal wastes are widely used in many countries to sustain productivity at low cost. Among manure used, chickenôs is preferred because of its ready solubility and high level of phosphorus concentrations. In India, however, cow dung is the most common organic manure applied to fish ponds as it is the most abundant and, in terms of availability and also the most reliable. The purpose of pond fertilization is to augment fish production through autotrophic and heterotrophic pathways. An increase in natural fish food organisms, detritus, and bacteria in fish pond enable filter feeding and omnivorous fish to grow faster.

Resource utilization from open water bodies:

Apart from tanks and ponds, there are floodplain lakes (chaurs, beels, mauns, etc.), constitute around 4.84 lakh ha and predominantly found in Bihar, West Bengal, Eastern Uttar Pradesh and Assam. The floodplain lakes are mostly lentic water bodies

with or without having a connection with the river. Culture-based fishery activities are mostly followed in those water bodies where fish production is very low, in spite of having tremendous potential in fish production. At present, fish production from mauns ranges between 60 and 150 kg/ha/yr although fish production up to 1.5 t/ha/yr is achievable by practicing cage and pen culture practices and by selective stocking (Bhatt *et. al.*, 2012). It has also been reported that culture-based fisheries in flood plain wetlands (which include jheels, beels, chaur, mauns, diyara and pats) of West Bengal, Assam, Bihar, and Manipur can enhance fish yield from 100-400 kg/ha/year to 900-1400 kg/ha/year (Sharma and Katiha, 2011) by selective management practice. Similarly, there are also many small and medium reservoirs where culture-based fisheries can be adopted. Culture-based practices developed by CIFRI for small reservoirs enhanced fish yield in Karnataka, Tamil Nadu, Uttar Pradesh, and Madhya Pradesh from 52 to 300 kg/ha/year (Sharma and Katiha, 2011) and ultimately enhanced the total production significantly. Selective stocking with desirable species at the optimum size and required numbers can ensure high production from these water bodies.

Benefit Cost ratio analysis (BCR) is a practical way of expressing the desirability of projects. If the BCR exceeds one, then the fish farming venture is considered profitable. In the chaur areas of Bihar revealed that aquaculture as most profitable enterprises with BC ratio 1.46 (Kumar *et. al.,* 2016). An estimate by McInnes (2004) showed that BC ratio varied from 2.92 to 4.80 from aquaculture in Mary river wetlands of Australia. However, it varies with system of culture, input applied, management practice followed, species cultured, etc. Thompson and Mafimisebi (2014) recorded that BCR in fish culture varies with size of fish cultured. He reported that enterprise producing fingerling had 1.46 BCR followed by 1.29 for juveniles and 1.26 for full fish and opined that enterprise producing fingerlings is the most profitable fish. Katiha *et. al.* (2005) reported that BCR of high input carp polyculture is 1.22 while for the low input carp culture it is 1.79.

Marketing system

In-spite of having high potential and production of Eastern Region, marketing and trading system of fish and fishery products is not well developed. It is still not an organized sector and running without any proper channel and system. In general, there are serious of transformation or transfer of fish from producer to consumer. There are different marketing channels exist like channel 1 where producer directly sells the products to customers. Here the volume of fish disposed will be less in general around 7-10%. A most common channel is the producer to local vender /baparies and customer. Here the bulk of the product can be transferred to the customer. However, for big producers or corporate producers, there might be two or three interlinks between vendor and customer like the whole seller, primary retailer, etc. It is always better for the producers to have the shortest link to achieve better efficiency. The farmerôs share of the customerôs price is the unit expressed for calculation purpose and it is expressed as the percentage of farm gate price against the retail sale price. On

average, fish farmers get 50-60% of the price paid by consumers. Mia (1996) reported that 56% of the price goes to producer and 44% of the consumer price goes to intermediaries, while Beparies and retailers earn 11% and 17% profit respectively.

Constrains in fish culture:

Fish culture is a profitable venture. Adopting the scientific method of fish culture generally gives the better dividend. However, there are several issues and problems associated with fish culture practice. Commercial fish culture is a capital-intensive enterprise, thus requiring big capital to start the program. However, the government has initiated policies and subsidies to encourage and promote fish culture in a bid way. Now a dayôs several banks also coming forward in the form of a loan and technical help to promote fish culture. Apart from that, non-availability of quality fish seed and feed material as an when required, high macrophytes infestation in open water bodies, poor auto stocking and ranching program, poor technological and extension support, remoteness and poor transportation facilities, disease and health issues are some of the other problems that hinder the pace of development. Moreover, fish being a perishable product and fish landing centers being located in the remote, isolated areas make the establishment of an efficient market chain a big challenge. Development of infrastructure (like hygienic market, cold storage facilities, etc.); transportation, distribution and marketing through the cold chain system; development of market research group for proper pricing are some of the challenges to achieve for marketing high value fish and fishery products to the consumer.

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Integration of Forage Crops in Cropping System for Higher Profitability

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Indian agricultural practice is complex and more or less in a integrated mode of operation. The integration of crops,livestock,fish,bird,forestry,horticulture, etc. is in a complementary way for maximum utilization of unit area for sustainability and dependency on the system without affecting soil health, pollution hazard and more profitability point of view (Gill *et al.* 2009). The long-term trends in household-level consumption pattern also show that per capita direct consumption of food grain has been declining and livestock products, fruits and vegetables have been increasing for a fairly long time. Despite this shift, food grains are of paramount importance for household food and nutritional security because cereals and pulses are a staple and cheapest food sources of energy and protein for low-income group people as well as for the livestock sector. More, importantly, the cropped area is almost stagnant since last 6-7 decades in our country with tremendous increases of about 3 fold population. The pressure on crops agriculture land is very high to fulfill the demand for grain, pulses, and vegetables, etc. Total net sown area of the country is 142 million ha in which net irrigated area of only 55 million ha with average crop productivity of 1.7 t/ha. Similarly, the eastern region of India having 0.34 billion populations that depend on only 31million ha net sown area.

The total livestock population of the country is 530 million, whereas, the eastern region having around 164 million livestock population (GOI, 2014). The total requirement of roughages on the dry matter basis for the eastern region bovine population is almost 142 million tonnes whereas availability is about 84 million tonne only that shows a big gap between demand and availability. As a whole, India having a total fodder area is about 8.81 million ha only with the production of 525 million tonnes against the requirement of 1100 million tonnes that shows a 52.27 percent deficit (Kumar, 2013). The area under annual fodder crop is 7.96 million ha and very nominal area of 0.85 million ha under perennial fodder. Apart from this, permanent and grazing pasture land 10.90 million ha; cultivable wastelands 13.66 million ha and 54 million ha common property resources other than forests (69.41 million ha) area are also available in India to support livestock. The gap between demand and supply (Table 1) of green and dry fodder at the national level is increasing due to increasing in livestock population with almost static net cropping area for the last few decades and it is going to be like this. Similarly, the area under fodder crops has also almost remained static to about 8.3 mn ha.

Table 1: Demand and supply of green and dry fodder

Part.	Supply (mnt)		Demand (mnt)		Deficit (%)	
	Green	Dry	Green	Dry	Green	Dry
1995	379	421	947	526	60.0	20.0
2005	390	443	1025	569	62.0	22.1
2015	400	466	1097	609	63.5	23.6
2025	411	488	1170	650	64.9	24.9

The shortage of quality feed and fodder resources, low land holding, negligible area under cultivated fodder, poor animal husbandry practices are the main reasons for the less production performance of livestock (Gupta *et al*. 2014a). The majority of farmers of our country is small and marginal (80-90%) and their agriculture land varies from 0.5 to 1.0 ha per family only, so why, they are not able to spare their land for fodder production even most of them are having one or two animal species for their livelihood. Now, it is high time to convince our farmers to spare some area for fodder production in a present cropping system or they can utilize the bund area for perennial grass production to increase the profitability of system (Table 2).

Table 2: Carrying capacity of one acre land

Particulars	Cereal	Cereal + Fodder	Mixed	Mixed + Fodder
Crop Area Bund (m^2) Net Sown Area (m^2)	200 C:3800	200 C:3400+F:400	200 C:3000+P:300+ O:300+V:200	200 C:2600+P:300+ O:300+V:300+ F:400
Cereal Yield (q)	19	17	17	15
Pulse yield (q)	--	--	0.23	0.23
Oil Yield (q)	--	--	0.10	0.10
Straw Yield (q)	28.50	25.50	25.82	22.82
Fodder Yield (q)	2(15)	62(77)	2(15)	62(77)
Conc. By-product Yield (q)	1.52	1.36	1.74	1.58

The small acreage farmers having one acre land and if they spare one-tenth area (400m^2) for annual fodder or improved perennial fodder can be produced from bunds without utilizing main crop area to meet the requirement of their cattle round the year up to some extent for balanced feeding and thereby to increase the profitability of the system along with food and nutritional security for livelihood of farm family (Table 3). Considering the above facts, it is essential to produce fodder round the year in existing cropping system for a balanced feeding system to livestock for maximum return as well as to achieve the goal of demand of 45 mnt milk by 2050. Hence, how to move forward in this aspect is discussed below.

Table 3: Requirement of farm family

Family needs	Family Needs (Per/yr)	Cattle needs	Cattle needs (Per/yr)
Cereal@500g/h/d	9.12q	Straw @4kg/d/h	14.6
Pulse @50g/d/h	0.91q	Fodder @10kg/d/h	36.5
Oil @20g/d/h	0.36q	Conc. @2kg/d/h	7.3

Fodder Production

Generally, different types of fodder are grown in various land use pattern. The annual fodder like cereal fodder (maize, sorghum, oat etc.) or legume fodder (berseem, Lucerne, cow pea, rice bean, soybean, pigeon pea, horse gram etc.) is grown in main cropland. However, perennial grass/legume fodders like Napier, Guinea, Deenanath, Para, Stylosanthes etc. are grown on the mainland under the raised bed or at a boundary on bunds. Similarly, fodder trees/shrubs like Moras Alba, Subabul, Tephrosia, Artocarpus, and Ficus etc. can also be planted at the boundary.

Fig 1: Fodder Production under different land uses

Different types of forages can be grown for round the year production in a combination of cereal and legume as per situation for the more nutritive value of forage and balance feeding point of view since the supplementation of legume forage in cereals fodder increased dry matter intake and digestibility of nutrients (Gupta and Dey, 2015). Alternate sowing of cereal and legume fodder practice should be followed for soil fertility point of view. The study also revealed that sowing of

legume crop enriches the soil by adding organic matter 1.22 and nitrogen 14.14 percent, respectively in 160 days crop duration. The different types of fodder crops grown during various seasons are to be grown like multi-cut sorghum, maize and jowar/bajara as cereal and cow pea (Bundel-2), rice bean (RBS-16) and soybeans (NRC-37) as legumes grown during the rainy (*Kharif)* season (Table 4). Cereal fodders shall be grown under 85% area, whereas, legumes could be cultivated under the 15% area for up-land situation only. Cereal fodder oat under 40% area and legume fodder berseem/annual rye in 60% area shall be grown on the same land during winter (*Rabi)* season. By following this method, total 4.5 to 5.0 tonne green fodder available per annum from 400m^2 area only that to be meet the requirement of two adult cattle unit round the year.

Table 4: Different fodder crops grown round the year

Types of Crop	Annual Fodder		Perennial Fodder
	Summer / Rainy Season	Winter Season	
Cereal	Multi cut sorghum: (80-85t.ha) Maize/Bajra/ Jowar: (40-50 t/ha)	Oat: (28-30 t/ha) Maize (45-50 t/ha)	Hybrid Napier: (250-280 t/ha)
Legume	Cow pea: (30-32 t/ha) Rice bean: (25-30 t/ha)	Berseem: (70-75 t/ha) Ann. Rye: (60-65 t/ha)	Stylo /Per. Groundnut: (30-40 t/ha)

Fig 2: Fodder Production under cereal legume combination

Livestock Feeding and Nutrition

Feeding animals as per the requirement and avoiding wastage is the key to exploiting the production potential of livestock for economic viability and sustainability since feed costs are the major part of the production that accounts for 60-80 percent. Mostly livestock is to be fed *in situ* the various available crop residues and forages with supplementation of concentrate feed as per production status. The large dairy animals are required dry matter @ 2.5-3.0 kg/100kg body weight in which 60-80 percent should be supplied by green fodder and straw and remaining 20-40

percent should be supplied through concentrated feed as per requirement and production status to meet especially digestible crude protein (DCP) and total digestible nutrients (TDN). The maintenance requirement of the DCP and TDN are 250-300 g/day and 3.2-3.4 kg/day, respectively for adult cattle. An additional requirement to be also needed as per production status, for example, 45g DCP and 315g TDN per kg milk production having 4 percent fat levels.

Concentrate feed is given @1kg per 2.5kg of milk production in case of cow and 1kg per 2kg of milk production in the case of dairy buffalo in addition to maintenance ration which is 1.5kg for cow and 2kg for dairy buffalo. After 5 months of pregnancy, cow/ buffalo should be given 2kg concentrate in addition to the maintenance requirement. Frequent change in feeding should not be done. The concentrate feed can be prepared by mixing 35 parts of ground maize, 30 parts of wheat bran, 15 parts of pulses by-product, 17 parts of oil cake, 2 parts of mineral mixture and 1 part of common salt. Total Mixed Ration (TMR) feeding system i.e. *Sani* method should be followed which increases feed intake, nutrient digestibility and 13-15% milk production (Gupta *et al.* 2014b). TMR for one milking cow weighing 400kg and yielding 10kg milk per day can be prepared by mixing chopped straw 2kg, green fodder 25kg and concentrate feed 5 kg. The half of the quantity will be fed forenoon and remaining half in the afternoon after mixing with water. Apart from this, dairy cows under average feeding condition require about 27-28 liters of water for maintenance purpose and additional 1 liter water for each 0.5kg of milk produced.

Fig. 3: Total mixed ration feeding system

Hence, integration of forage crop in cropping system is essential to take care of animal health and feeding that in return it not only increase the income from the system over mono-cropping (Channabasavanna *et al*. 2009) but it improves the overall sustainable productivity of system with soil health for the future.

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Raising Farmers' Income through Cultivation and Value Addition of Specialty Corn

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Specialty corn (maize) is cultivated for various purposes other than grain. The various specialty corn types are quality protein maize (QPM), baby corn, sweet corn, popcorn, waxy corn, high oil corn, fodder maize, etc. In India, QPM, baby corn, and sweet corn are being popularized and cultivated by a large number of farmers. The brief summary of different type of specialty corn (Sain Dass *et al*. 2009) are given here-

1. **Quality Protein Maize:** Quality Protein Maize has specific features of having a balanced amount of amino acids with the high content of lysine and tryptophan and low content of leucine & isoleucine. The balanced proportion of all these essential amino acid in Quality Protein Maize enhances the biological value of protein. The biological value of protein in QPM is double than that of normal maize protein. The biological value of milk and QPM proteins are 90 and 80 % respectively. Many QPM hybrids of different grain colours have been developed and released in India for their cultivation in different agro-climatic conditions of the country. The production technology of QPM is same as of normal grain maize except isolation as to maintain the purity of QPM, it should be grown in isolation with normal maize.
2. **Baby corn**: Baby corn is a young finger like unfertilized cobs with one to three centimeters emerged silk preferably harvested within 1-3 days of silk emergence depending upon the growing season. It can be eaten raw as salad and in preparation of different recipes such as chutney, pakora, mix vegetables, pickles, candy, murabba, kheer, halwa, raita, Chinese preparations, etc. The desirable size of baby corn is 6 to 11 cm length and 1.0 to 1.5 cm diameter with regular row/ ovule arrangement. The most preferred colour by the consumers/exporters is generally creamish to very light yellow. Baby corn is nutritive and its nutritional quality is at par or even superior to some of the seasonal vegetables. Besides proteins, vitamins, and iron, it is one of the richest sources of phosphorus. It is a good source of fibrous protein and easy to digest. It is almost free from residual effects of pesticides. It can be cultivated round the year, therefore, three to four crops of baby corn can be taken in a year.

   In general, the cultivation practices of baby corn are similar to grain crop except (i) higher plant population (ii) higher dose of nitrogen application because

of higher plant population (iii) preference for early maturing single cross hybrid and (iv) harvesting within 1-3 days of silk emergence.

3. **Sweet corn**: Sweet corn is one of the most popular vegetables in the USA, Europe and other advanced countries of the world. It is a very delicious and rich source of energy, vitamin C, and A. It is eaten as raw, boiled or steamed green cobs/ grain. It is also used in the preparation of soup, salad, and other recipes. It is becoming very popular in urban areas of the country, therefore, its cultivation is remunerative for peri-urban farmers. Besides green cobs, the green fodder is also available to the farmers for their cattle. Generally, sweet corn is early in maturity. It is harvested in 70-75 days during kharif season. Green cobs are harvested after 18-20 days of pollination during kharif but the duration may vary season to season. At the harvest time, the moisture is generally 70 % in the grain and sugar content varies from 11 to more than 20 %. Sweet corn is generally dull yellow and white but dull yellow colour is preferred.

   Precaution: Its picking should be done in the morning or evening. Green cobs should be immediately transported to the cold storage in refrigerated trucks to avoid the conversion of sugar to starch. It loses flavor if kept at high temperature after picking. Sweet corn with high sugar content should not be planted when the temperature is below 16 ^{o} C.

4. **Pop Corn**: Popcorn is one of the common snack items in many parts of the world, particularly in cities and is liked because of its light, porous and crunchy texture. The popcorn flour can also be used for preparing many traditional dishes. It is consumed fresh, as it has to be protected against moisture absorption from the air. Kernels of popcorn are very small and oval/round in shape. When heated at about 170 ^{0} C, the grains swell and burst, turning inside out. Quality of popcorn depends on popping volume and a minimum number of non popcorn.

5. **Waxy corn**: It is originated in China, but largely used in the USA. The grain gives the wax-like appearance and having 100 % amylopectin starch. While in normal maize, the starch is nearly 30 percent amylose and the remaining 70 percent is amylopectin. Waxy corn is mainly used for food and industrial purposes.

6. **High oil corn**: Most of the normal maize lines have 3- 4 % oil content. In general, lines with more than 6 % oil are considered high oil lines. 95 % of the total oil is in the germ. When the oil percent increases the starch decreases. The wet milling industries are still in advantage with high oil content corn. In the USA the high oil corn is cultivated on a contractual basis and the remunerative price is paid to the farmers. In India, its cultivation is not economical because it is not sold on a premium basis. Generally, in normal maize crop, 15-20 % population of high oil hybrids is used as pollen parent and there is detasseling of the normal corn plant. Due to xenia effect, there is an increase of oil in normal maize and its cultivation is done in isolation. The corn oil has the low content of

saturated fatty acid and is considered to be one of the best quality cooking oil. In India, more than 60,000 tonnes of corn oil is made available for various uses.

7. **Fodder maize**: Maize fodder can be used at any crop growth stage. Its quality is deteriorated after anthesis. To maintain the fodder quality the detasseling is advised to the farmers for better digestibility and palatability. By grazing this fodder to the milch cattle, their milk is increased. The tall, leafy and longer duration cultivars are most preferred for maize fodder cultivation. The cultivation of maize for fodder can be done round the year. The very high seed rate is used. Generally, the farmers grow composite varieties or advance generation of hybrid seed, which is economical to the farmers.

Specialty corn cultivars

Sl.	Specialty corn type	Cultivars
1	Quality Protein Maize	Hybrids: HQPM 1 & HQPM 5 (all states of India), HQPM 7, VQPM 9 (Peninsular India), Shaktiman1,2,3& 4 (Bihar) Composite: Shakti 1
2	Baby corn	Hybrid: HM-4, Syngenta 5414 and 5417 (male sterile lines) Composite: VL Baby Corn 1
3	Sweet corn	Hybrid: Sugar N 75, HSC 1 Composites: Madhuri, Win orange, Priya , Almora
4	Pop corn	Composites: Jawahar, Amber, Pearl &VL pop corn
5	Fodder	Composites: African tall, J 1006 & Partap chari-6

Production Technology:

Maize is a versatile crop that can be successfully grown in varied agro-ecologies ranging from sea level to high altitudes of up to 3000 m.

Soils: Maize can be grown successfully in a wide range of soils ranging from loamy sand to clay loam. However, soils with good organic matter content having high water holding capacity with neutral pH are considered good for higher productivity. Being a sensitive crop to moisture stress, particularly excess soil moisture and salinity stresses; it is desirable to avoid low lying fields having poor drainage and also the field having the higher salinity.

Time of sowing:

The maize can be grown round the year in all seasons viz; Kharif (monsoon), post monsoon, rabi (winter) and spring. For higher productivity, particularly in Kharif season, for the farmers having sufficient irrigation facilities, it is desirable to complete the sowing 12-15 days prior to the onset of monsoon. However, in rainfed areas, the

sowing time should coincide with the onset of monsoon. The optimum time of sowing in different seasons is given below.

Optimum sowing time in different seasons

Season	Optimum time of sowing
Kharif	Last week of June to 15 July
Rabi	Last week of October for inter cropping and first fortnight of Nov. for sole crop
Spring	First week of February

Seed rate and plant geometry:

Optimum plant density is the key to achieving higher productivity and resource use efficiency. The seed rate depends on the purpose, seed size, plant type, season, sowing methods, planter, etc. For different purposes of maize cultivation, the following crop geometry and seed rate should be adopted.

Sl.	Purpose	Seed rate (kg/ha)	Plant geometry (plant x row, cm)	Plant population
1	Grain (normal, QPM)	20	60 x 20 75 x 20	83333 66666
2	Sweet corn	8	75 x 25 75 x 30	53333 44444
3	Baby corn	25	60 x 20 60 x 15	83333 111111
4	Pop corn	12	60 x 20	83333
5	Green cob (normal maize)		75 x 20 60 x 20	66666 83333
6	Fodder	50	30 x 10	333333

Seed treatment:

To protect the crop from seed and major soil borne diseases and insect-pests, it is always advisable to treat the seed with fungicides and insecticides before sowing as per the details given below:

Seed treatment for major diseases and pests

Disease/insect-pest	Fungicide/Pesticide	Rate of application (g kg^{-1} seed)
Turcicum Leaf Blight, Banded Leaf and Sheath Blight, Maydis Leaf Blight	Bavistin + Captan in 1:1 ratio	2.0

BSMD	Apran 35 SD	4.0
Pythium Stalk Rot	Captan	2.5
Termite and shoot fly	Imidachlorpit	4.0

Tillage and crop establishment: Tillage and crop establishment is the key to achieving the optimum plant population that governs the crop yield. Though the crop establishment is a series of events (seeding, germination, emergence and final establishment) that depends on the interactions of seed, seedling depth, soil moisture, the method of sowing, machinery etc but the method of planting is the important parameter for proper crop establishment under a set of crop growing situation. Mainly the maize is sown directly through seed using different methods of tillage & establishment, but during winters where fields are not vacant in time (till November), transplanting can be done successfully by raising the nursery. However, the method of sowing (establishment) depends on the season, cropping system, soil conditions, etc. For different situations, the sowing methods are described below:

i. Raised bed (ridge) planting: In general, the raised bed planting is the best planting method for maize during monsoon and winter seasons, both under excess moisture as well as limited irrigation availability conditions. Sowing should be done on the south side of the east-west ridges/beds, which helps in better germination. Preferably, the raised bed planter having inclined plate, cupping or roller type seed metering systems should be used for planting that facilitates in placement of seed and fertilizers in the proper place in one operation that helps in getting a good crop stand, higher productivity and resource use efficiency. Using raised bed planting technology, 20-30 % irrigation water can be saved with higher productivity. Moreover, under temporary excess soil moisture/water logging due to heavy rains, the furrows will act as drainage channels and the crop can be saved from excess soil moisture stress.

ii. Zero-till planting: Maize can be successfully grown without any preparatory tillage under no-till situation with less cost of cultivation, higher profitability, and better resource use efficiency. Under such condition, one should ensure good soil moisture at sowing and seed and fertilizers should be placed in a band using zero-till seed-cum-fertilizer planter with furrow opener as per the soil texture and field condition.

iii. Conventional/reduced till flat planting: Under heavy weed infestation where herbicidal weed management is not economical in no-till and also for rain-fed areas where crop is taken on conserved moisture, flat planting can be done using seed-cum-fertilizer planters.

iv. Transplanting: Under intensive cropping systems where field are not vacated in time for planting of winter maize, the chances of delayed planting exist and under such situation, establishment is a problem due to low temperature. It is advisable to grow nursery and transplant the seedlings in furrows and apply irrigation water for proper establishment. For one hectare, 700 m^2 area is required for nursery and the nursery should be raised during the second fortnight of November. The 30-40 days

old seedlings (depending on the growth) should be transplanted during December-January in furrows as the yield in furrows is always higher than flat.

Nutrient management: The maize in general responds well to organic manures and hence integrated nutrient management (INM) is very important nutrient management strategy in maize production systems. Therefore, for the higher economic yield of maize, application of 10 t FYM ha^{-1}, 10-15 days prior to sowing supplemented with 150-180 kg N, 70-80 kg P_2O_5, 70-80 kg K_2O and 25 kg $ZnSO_4$ ha^{-1} is recommended. Full doses of P, K and Zn should be applied as basal preferably drilling of fertilizers in bands along the seed using seed-cum-fertilizer drills. Nitrogen should be applied in 5-splits as detailed below for higher productivity and use efficiency

S. No.	Crop Stage	Nitrogen rate (%)
1	Basal (at sowing)	10
2	V_4 (four leaf stage)	20
3	V_8 (eight leaf stage)	30
4	V_T (tasseling stage)	30
5	GF (grain filling stage)	10

Water management: The water management depends on the season as about 80 % of maize is cultivated during monsoon season particularly under rain-fed conditions. Young seedlings, knee high stage (V_8), flowering (V_T) and grain filling (GF) is the most sensitive stages of water stress and hence irrigation/ moisture should ensure at these stages. In general, the irrigation should be applied in furrows up to the $2/3^{rd}$ height of the ridges/beds. For winter maize, it is advisable to keep the soil wet (frequent & mild irrigation) during 15 December to 15 February to protect the crop from frost injury.

Weed Management: Weeds are the serious problem in maize, particularly in monsoon season that competes with maize for nutrient and causes yield loss up to 35 %. Pre-emergence application of atrazine @ of 1.0-1.5 kg a.i ha^{-1} in 600 liter water is an effective way for control of weeds. While spraying, the person who is doing spray should move backward so that the atrazine film on the soil surface may not be disturbed. Preferably three boom flat fan nozzle should be used for proper ground coverage and saving time. One to two hoeings is recommended for aeration and the uprooting of the remaining weeds if any. While doing hoeing, the person should move backward to avoid compaction and better aeration. For areas where zero tillage is practiced, pre-plant application (10-15 days prior to seeding) of non-selective herbicides viz., Glyphosate @ 1.0 kg a.i. ha^{-1} in 400-600 liter water or paraquat @ 0.5 kg a.i. ha^{-1} in 600 litre water is recommended to control the weeds.

Crop protection:

Insect-pest management: *Chilo partellus*, popularly known as stalk borer that occurs during the monsoon season is a major pest throughout the country. *Chilo* lays eggs 10-25 days after germination on the lower side of the leaves. The larva of the *Chilo* enters in the whorl and cause damage to the leaves. Whereas, *Sesemia inference*

occurs during the winter season, particularly in peninsular India, where winter maize is an important crop. The moth of the *Sesamia* is nocturnal and lays eggs on lower leaf sheath. The larvae of the *Sesamia* enter the plant near the base and cause damage to the stem. For control of *Chilo and Sesamia*, foliar spray of 85 % W.P. Carbaryl @2.5 gm/litre water 10 days after germination is effective. The *Chilo* can also be controlled by the release of 8 Trichocards (*Trichogramma chilonis*) per hectare at 10 days after germination. Intercropping of cowpea with maize is an eco-friendly option for reducing the incidence of *Chilo* on maize. Termite is also an important pest in many areas. For control of this fepronil granules should be applied @ 20 kg ha^{-1} followed by light irrigation. If the termite incidence is in patches, fepronil should be applied spot application @ 2-3 granules/plant. Clean cultivation delays termite attacks.

Disease management: Estimated losses due to major diseases of maize in India is 13.2% of which foliar diseases (5 %), stalk rots, root rots, ear rots (5 %) cause major yield losses. The major diseases and their management practices are described as below:

i. Turcicum leaf blight (TLB): In its appearance, it shows long, elliptical, grayish-green or tan lesions ranging from 2.5 to 15 cm in length on the leaves. For control of TLB, spray Zineb/Meneb @ 2.5-4.0 g/liter of water (2- 4 applications) at 8-10 days interval. The crop debris should be ploughed down. Also, the resistant cultivars should be grown.

ii. Maydis leaf blight (MLB): It shows the symptoms as lesions on the leaves elongated between the veins, tan, 2-6 x 3-22 mm with limited margins with buff to brown borders. For effective control of this disease, spray of Dithane Z-75 or Zineb @ 2.4 ï 4.0 g/liter of water (2-4 applications) at 8-10 days interval after the first appearance of symptoms of the disease. In addition, the crop debris should be ploughed down. Also, the resistant cultivars should be grown.

iii. Polysora Rust: The main symptoms of the disease show the appearance of circular to elongate light cinnamon brown, circular to oval 0.2-2.0 mm long densely scattered lesions on the upper leaf. The uredospores are yellowish to golden in color. For effective control of polysora rust, three sprays of Dithane M-45 @ 2-2.5 gm/liter beginning from the first appearance of symptoms at 15 days interval are required. It is always advisable to use resistant varieties.

iv. Banded leaf and sheath blight (BLSB): At the appearance of the disease, white lesions develop on leaves and sheath. Purplish or brown horizontal bands present in white lesions characterize the disease. Seed treatment with peat based formulation (*Pseudomonas fluorescence)* @ 16 g/kg of seed or as soil application @ 7g/liter of water (soil drenching) or foliar spray of Sheethmar (Validamycin) @ 2.7 ml /liter water provides effective control of the disease. Stripping of 2 lower leaves along with leaf sheath also gives effective control of the disease.

Harvesting and post harvest management: Harvesting of QPM and popcorn grain should be done at optimum moisture content (20%) in grain to avoid post harvest losses due to store grain pests and diseases. The harvested cobs should be sun dried before shelling and should be shelled at 13-14 % grain moisture. Shelling can be done manually or by power operated maize Sheller. For proper storage of the grain, drying should be done till the moisture content is reduced to 8-10 % and should be kept in aerated jute bags. The average grain yield of QPM is at par with normal maize. All India average maize grain yield is approximately 25 q/ha.

Economics of baby corn: Average yield of baby corn (without husk) is 15-20 q/ha. In addition, 200-400 q/ha green fodder is also obtained. Economics of baby corn cultivation are as follows:

Cost of cultivation: Rs.20,000/- to Rs.25,000/- per ha

Gross income (including green fodder): Rs.95,000/- to Rs.1,00,000/- per ha

Net Income: Rs. 75,000/- per ha

Baby corn may be grown 3-4 times in a year on the same piece of land. Therefore, Rs.2,25,000/- to Rs.3,00,000/- may be earned from a unit hectare of land in a year.

Economics of sweet corn: Average yield of green cobs and green fodder per hectare are 110-13 q/ha and 250-400 q/ha respectively. Economics of sweet corn cultivation in one season is as follows:

Cost of cultivation: Rs.45,000/- per ha

Gross income (including green fodder): Rs.1,00,000/- per ha
Net Income: Rs. 55,000/- per ha

Value addition:

Products based on normal/QPM Maize

Traditional products - Ladoo, halwa, kheer, chapati, sev, mathi, pakora and cheela

Baked products-	Bread, nan khatai and cake
Extruded products-	Vermicelli and pasta;
Convenience foods-	Instant idli mix, instant dhokla mix and porridge mix,
	sprouted products-sprouted chat, QPM vada, QPM sevian, QPM flour
Infant food-	Infant food-I, Infant food-II, Infant food (flavored), Infant food (enriched with vitamin A), Infant food (flavored and enriched with vitamin A)
Health food-	QPM Mix-I, QPM Mix-II, QPM ladoo, honey maize

	Chocolate, maize coconut chocolate, maize coconut toffee, maize groundnut toffee, choco maize bar, honey maize water
Snacks and savoury item-	QPM biscuit salted, QPM biscuit sweet, choco maize biscuit, honey maize chikki, maize matthi, namak para, sev, shakarpara, QPM burfi, QPM halwa, suji upama, suji kheer, sevian (sweet), sevian (upama), QPM chatni powder-I, QPM chatni powder-II, QPM chatni powder-III
Specialty foods-	High quality protein mix, low quality protein mix, quality protein mix for elderly, QPM honey liquid, honey maize water (Singh. 2006)

Fig. Value added products developed with baby corn

Traditional products-	Pakoda, cutlet, chat, salad, dry vegetable, kofta, mixed vegetable, raita
Sweet products-	Halwa, kheer, burfi
Preserved Products-	Jam, chutney, pickle, candy, murraba
Chinese products-	soup, manchurian, baby corn chili,
	chowmein, sweet & sour vegetable

All the products have good acceptability and can be easily prepared at home (Kawatra and Sehgal. 2007).

Value added products of sweet corn


Sweet Corn Soup

- Thai basil and sweet corn
- Salted green beans with shallots and sweet corn
- Oganic speedchef- Pizza with garlicky greens and sweet corn
- Sweet corn cake
- High summer scallops with sweet corn and couscous
- Sweet corn and tomato salad

Value added products of pop corn

- Apple popcorn brittle
- Ballpark popcorn crunch
- Beach party popcorn
- Boston tea party popcorn
- Caramel corn crunch
- Caramel nut popcorn crunch
- Cherry almond popcorn clusters
- Chilli corn
- Red cinnamon popcorn

- Swiss onion popcorn
- Pina colada popcorn
- Patchwork popcorn party mix
- Kettle corn (Rakshit *et al*. 2003)

Industrial products of corn

Corn is used in more than three thousand products that include adhesives, antibiotics, automobiles, baby food, breakfast cereals, canned vegetables, cheese spreads, chocolate products, printings, cosmetics, crayon and chalk, dessert powders, dyes, edible oil, finished leather, insecticides, ketchup, livestock feed, malted products, paper manufacturing, pharmaceuticals, rugs & carpets, shoe polish , soft drinks, textiles, wheat bread, yogurts etc. Corn is subjected to wet and dry milling to separate the grain into its components that are used as food ingredients (Venkatesh *et al*., 2003).

Conclusion

The cultivation of specialty corn and development of value added products will not only diversify the uses of maize, but also will be beneficial for human health and raising farm income. There is a need to popularize specialty corn and develop value added products based on quality protein maize and baby corn among housewives so that they include these preparations in their daily dietaries. The increased utilization of maize will encourage farmers in improving the production of maize, which may indirectly help in improving economic standards of farmers. Efforts for commercialization of the maize-based value added products through self help groups, food industries etc. are also required.

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Market Development for Organic Products

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Organic products in India are still a small niche market, hence; at present there is not a sufficient number of producers to meet the growing demand in the cities. Coupled with inadequate transport infrastructure, lack of storage facilities and high losses, this brings up the cost of organic produce. At the same time, many organic farmers do not have access to organic markets and are forced to sell their produce in conventional outlets, losing out on the premium. The organic market development sector needs major thrust for development of supply chain and related infrastructure to ensure a competitive price of organic produce to the grower in domestic and international markets.

With recent development of supermarkets in several cities of India and few showrooms in Organic India, Ecofarms, Fabindia and Navdanya etc. the marketing of processed organic produce got accelerated. However, it is not sufficient for the large chunk of the raw organic produce of India.

Fig.1. Vegetables are not often found in the stores, but in this supermarket well

Fig.2. Raw organic produce (Linseed) and SGS- National Programme for Organic Production (NPOP) in Fabindia, Patliputra

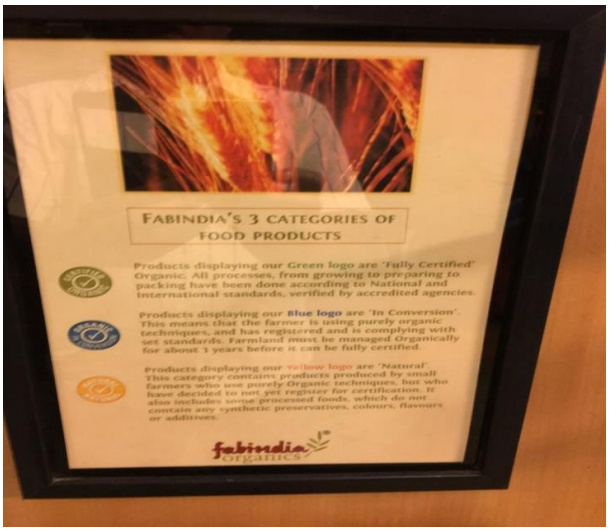

Fig.3. Fabindia's three categories of food products

SGS (formerly Société Générale de Surveillance (French for *General Society of Surveillance*)) is a multinational company headquartered in Geneva, Switzerland which provides inspection, verification, testing and certification services. It has more than 90,000 employees and operates over 2,000 offices and laboratories worldwide. The core services offered by SGS include the inspection and verification of the quantity, weight and quality of traded goods, the testing of product quality and performance against various health, safety and regulatory standards, and to make sure that products, systems or services meet the requirements of standards set by governments, standardization bodies or by SGS customers.

Current status regulatory mechanism in India

National programme for Organic production

There is tremendous scope for cultivation and export of a wide range of organic in India (NPOP 2000). A national organic logo ñIndia Organicò was also developed that has been in use for certified organic products. During July, 2002, Ministry of Agriculture, Government of India has also circulated guidelines for promotion of organic farming (Bhattacharyya and Gehlot, 2004). India produced 58,597 tonnes of certified organic products, including cereals, pulses, honey, tea, spices, coffee, oilseed, fruits and vegetables and also their value added products. The production is not limited to the edible items, but also cotton fibre, garments, cosmetics, functional food products, body-care products, etc. India exported 35 items last year (2007-08) with a total volume of 19,460 tonnes. The export realization was around US $78 million, registering a 200 % growth over the previous year. Organic products are mainly to export to the EU, US, Australia, Japan, Switzerland and Middle East. Basmati rice leads among the products exported (5,139 t).

Accreditation agencies

As of 2004, Agricultural and Processed food Product Export Development Board, Spice Board, Tea Board, Coconut Development Board and Cocoa and Cashewnut Board were authorized by Ministry of Commerce, Government of India as accreditation agencies for organic agriculture (Bhattacharyya and Gehlot, 2004).

Certifying agencies

At present there are 16 accredited certification bodies (www.apeda.com) in India (Table 1). In 2001, a group, organization and corporate bodies took the initiative to set up the Indian Organic Certification Agency (INDOCERT). It has become an important element of the organic movement in India and mobilize new forces and partnerships. In 2003, together with other partners, INDOCERT created the International Competence Center for Organic Agriculture (ICCOA), a service provider for networking, capacity building and market development in the organic sector in India. Among other activities, ICCOA implements the Indian Organic Market Development Project (2005-2007), the activities of which were focussed on awareness raising, market intelligence, develop organic market initiatives, and India Organic Trade Fair.

Table1. List of accredited certification bodies under National Program for Organic Production.

Name of the certifying agency	**Validity of current accreditation**	**Scope of accreditation**
Bureau Veritas Certification India Pvt. Ltd. (Formerly Known as BVQI (India) Pvt. Ltd)	14-September-2009	NPOP;USDA;NOP
ECOCERT India Pvt. Ltd	22-August 2008	NPOP;USDA;NOP
IMO Control Pvt. Ltd.	27-September-2010	NPOP;USDA;NOP
Indian Organic Certification Agency (INDOCERT)	24-October- 2008	NPOP;USDA;NOP
Lacon Quality Certification Pvt. Ltd	31-September-2008	NPOP;USDA;NOP
Natural Organic Certification Agency (NOCA)	23-May-2009	NPOP;USDA;NOP
OneCert Asia Agri Certification Pvt. Ltd.	26-October-2009	NPOP;USDA;NOP
SGS India Pvt. Ltd.	01-May-2011	NPOP;USDA;NOP
Control Union Certifications [Formerly known as SKAL International (India)]	28-May-2008	NPOP;USDA;NOP
Uttrakhand State Organic Certification Agency	13-November-2017	NPOP;USDA;NOP

APOF Organic Certification Agency (AOCA)	09-January-2010	NPOP
Rajasthan Organic Certification Agency (ROCA)	09-October-2010	NPOP
Vedic Organic Certification Agency	30-September-2011	NPOP
ISCOP (Indian Society for Certification of Organic Products)	30-November-2011	NPOP
Food Cert India Pvt. Ltd.	30-September-2011	NPOP
Aditi Organoc Certifications Pvt. Ltd	30-September-2011	NPOP

Source: www.apeda.com , USDA- United States Department of Agriculture, NOP-National Organic Programme

The certification of organic produce is essentially a marketing strategy to procure a higher value from a minority of conscious consumers- offended in distant places- who afford it. The expensive ôbuying and sellingô of certificates, which only a small section of farmers may be able to afford. Rather, ófarmer-consumer organic cooperativesô, mediate by local or regional/state organic farming association, may be a better option than impersonal certification of allegedly organic produce from anonymous suppliers. Product lebelling should actually be required of hazardous industrial junk-food, not safe food.

The Organic Farming Association of India (OFAI)

The association, registered under the Indian Societies Registration Act, - was formed in 2005 with the objective to produce OFD for Indian consumers and to maintain the living fertility of Indian soils. Its memorandum of association was written and approved after a wide consultation with organic farmers. Indian agriculture continues to remain a source of livelihood for mostly small farmers and peasant: it is the organization of the country having grassroots organic farmers, which includes active involvement of women farmers in decision-making structures of the association. Such involvement is mandatory and reflected in the associationôs bye-laws. The primary objective of the association is to promote from within the country and to take all such means that are available to achieve this purpose. OFAIôs labelling scheme is meant to provide an assurance of guarantee of organically grown produce exclusively for domestic consumers and not for export. Unlike other organic farm certification systems, OFAI certification is done through the agency of trained organic farmers themselves and does not accept farm inspector, who do not themselves

practice OA. OFAI firmly opposes to the introduction of GMOs in agriculture and campaigns against it.

The Organic Farming Association of Bihar

Farmers cooperative societies like Bihar State Organic and Herbal Development cooperative society Ltd. Was registered since 2007 for promotion and marketing of organic produce. Through such cooperative societies organic product of farmers may be sold directly to the consumers without any middlemen. This will facilitate farmers to get proper price of their produce. During 2010 in Bihar State level workshop, ECOCERT facilitated certification for organic produce for a group of small and medium farmers at subsidized rate. Such effort will promote marketing of organic produce within domestic market

Green facilitates farming certification using a participatory Guarantee System (PGS) is a collaborative approach which involves farmers and other stakeholders in verifying the authenticity of organic produce. PGS replaces expensive third party audits, making organic farming certification possible for the small scale and marginal farmers that make up nearly 70% of Indiaôs agricultural sector. The government, private sector and producer association each have a necessary role to play in organic produce. How the various pieces fit together to increase value and marketability of farmersô produce is a challenge and will require additional work to make the system function properly.

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Stake of Vegetable Crops in Improving Farmers Access to Market

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India is the worldôs largest producer of many vegetable crops like peas, brinjal, cabbage, cauliflower, onion, gourds, potato etc. Table 1 shows the percent share of India in worldôs production and rank of India in world for major vegetables. Indiaôs vast geographical area and varied climatic conditions facilitate to grow a variety of vegetables. India produces 168 million tons of vegetables (which accounts for 14% of worldôs production) from an area of 9.5 million hectares (NHB, 2015). Although, more than 70 types of vegetables are grown in our country, higher emphasis is given to more popular vegetables like tomato, brinjal, chilli, cauliflower, cabbage, peas, potatoes, onions and few common cucurbits and leafy vegetables. Among the vegetables, potato is cultivated over large area followed by onion, tomato and brinjal whereas, in the case of production potato ranks first followed by tomato, onion and brinjal. During the last decade, there was increase in the contribution of potato, onion, tomato, peas and cauliflower. However, there was visible decline in the contribution of tuber crops like tapioca and sweet potato. Vegetable cultivation generates high income and employment, particularly for small farmers. Benefit cost ratio of vegetable crops is much higher than that of field crops. Also the water use efficiency is higher for vegetables.

Table1. Production share and ranking of India in production of vegetables in the world

Vegetable crop	Share % in world production	Ranking in world
Brinjal	8.3	2
Cabbage	5.3	2
Cauliflower	4.9	2
Onion	10.4	2
Peas	2.5	1
Tomato	11.2	6
Potato	28.0	3
Sweet Potato	0.7	9
Cassava	8	8

Indian Scenario of Fruits and Vegetables Production

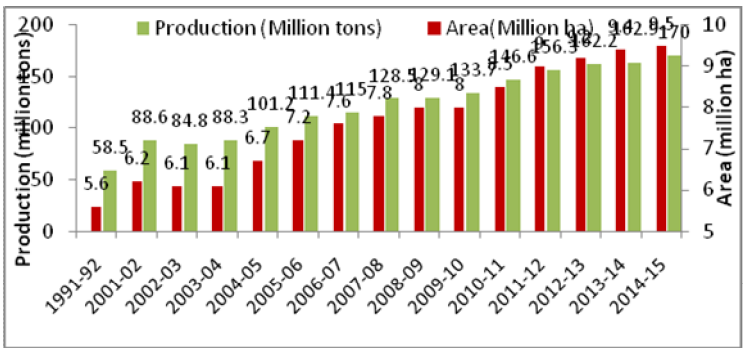
There had been a remarkable increase in the area during 2001-10 although the rate of increase in production remained same as that of 1991-2000. Fig 1 shows the growth trends in the total production of various vegetables in India along with the area of production. This is attributed to the low rate of growth in productivity of vegetable crops. If we look at the growth rate of productivity during the last five years, it is

markedly lower than the previous two decades. So this indicates a trend towards plateauing of productivity of vegetable crops. Hence this warrants newer approaches for increasing the growth rate of productivity of vegetable crops. In India per capita availability of fruits and vegetables is quite low because of postharvest losses which account for about 25% to 30% of production. Table 2 shows the projected domestic demand of fruits and vegetables in India for the years 2010, 2015 and 2020 with 2010 as base year. Besides, the quality of a sizable quantity of produce also deteriorates by the time it reaches the consumer. Most of the problems relating to the marketing of fruits and vegetables can be traced to their perishability. Perishability is responsible for high marketing costs, market gluts, price fluctuations and other similar problems. There is a rise of about 4% in the production of fruits and vegetables, but there is significant increase in production area also which results in low per hectare production. This phenomenon is caused due to various factors in which economic and technological factors lead the race. State needs to educate the producers of the latest technology available and also help them by granting support to acquire them and proper supply chain management should be there in the country which would help prevention of exploitation of farmers and help increase their income.

Table 2. Projected domestic demand of vegetables in India

Year	Total demand (million tonnes)	Per captia demand (kg)
Base year 2010	103.16	87.51
2015	119.12	94.28
2020	137.25	102.00

Fig 1. Area and production growth trends of vegetables



Eastern Region: Major share of vegetable production in India

With respect to vegetable production, the region contributes nearly 44% of total production of India from 45.81% of total area under vegetable cultivation in India. This indicates the importance of eastern India in total vegetable production in the country. The increase in area at national level (47.28%) was much higher than that recorded under eastern India conditions (4.89%). However the eastern region has witnessed marked increase in production during 2001-02 to 2013-14 (259.3%) as compared to that at national level (72.82%). Vegetable productivity of eastern India was lower (16.89t/ha) than that at national level (17.625). This warrants for concerted efforts for increasing the vegetable productivity in eastern India.

Marketing vegetables

Marketing vegetables is complex due to

- Perishable nature : wastage/spoilage, high marketing costs, price fluctuation, market gluts
- Seasonable production : continuous demand
- Bulkiness: difficulty in maintaining quality

Two major channels of vegetable marketing were identified as shown below:

- Channel I: Producer ï Wholesaler -Retailer- Consumer
- Channel II: Producer -Consumer

Factors affecting supply chain management

- **Availability of cold storage facilities**: Estimated cold storage in India is 24.4 million tons. Uttar Pradesh stands first holding 29.5% of total cold storage capacity (Rais M and Sheoran A, 2015).
- Government policies: Market reform and market system management are integral part of government policy and strategy.
- **Connectivity**: Country is also lacking in appropriate technology & infrastructure in many aspects of modern storage and shipping methods, post harvest handling, value addition etc.
- **Sorting & grading technology**: Traditional method of weighing, grading, sorting and packing fetches low prices for the produce.
- **Marketing intelligence**: Relevant information is gathered and analyzed specifically for the purpose of accurate and confident decision-making in determining strategy in areas such as market opportunity, market penetration strategy, and market development. Eg. Exports of okra, chilli, tomato, onion etc.

Measures to improve market access: Government role

- **Demand forecasting:** Prediction of future demand on the basis of past events and prevailing trends in the present.
- **Creation of infrastructure:** roads, transport, information, communication technology, cold storage
- **Vertical coordination:** Process of ensuring that each successive stage in the production, processing, and marketing of a product is appropriately managed and interrelated to the next, so that decisions about what to produce, and how much, are communicated as efficiently as possible from the consumer to the producer**.** Agricultural economists believe that vertical coordination of markets is particularly important in the food industry because of its complexity, the large number of firms that participate in one or more stages, and the relative perishability of the products involved. Eg. cooperatives, contract farming, retail chains, public private partnerships
- **Customized logistics:** Management of flow of goods between point of origin to point of consumption. It involves integration of information flow, material handling, production, packaging, inventory, transportation, warehouse etc.
- Incentives to Agro food industry, Food and technology parks

Measures to improve market access: Farmers & Researcher role

- Improved management & production technologies to increase productivity
- **Off season cultivation:** Using structures like low tunnel, shade net etc. vegetables can be produced during off season fetching the farmer higher market price
- **Protected cultivation:** Round the year cultivation of vegetables can be accomplished using fully automated protected cultivation or naturally ventilated polyhouses.
- **Round the year cultivation**: Photo insensitive/ biotic & abiotic stress tolerant varieties for round the year supply of vegetables
- **Exploring ecological niches for off season production**: Exploring cultivation of some high value vegetables is possible due to varying climatic conditions of the country
- **Introduction of new crops**: New crops like vegetable soyabean, vegetable pigeon pea etc. can be successfully introduced in to new markets by creating awareness among the consumers.
- **New markets for under utilized crops**: Creating awareness about their nutritional potential for health conscious consumers
- Cropping system

- **Post harvest technologies**: Shelf life extension, minimal processing, value addition, improved packaging, processed foods etc. definitely increase the income

Improved Management & Production Technologies developed at ICAR RCER, RC, Ranchi for vegetable crops

Release of improved varieties/hybrids of vegetables

A total of 52 varieties/hybrids of different vegetables which are high yielding, biotic and abiotic stress resistance were released by ICAR RCER Research Centre, Ranchi fulfils the needs of the farmers of the eastern region.

Improved production technologies standardized

- Formulations for correction of Boron and molybdenum deficiencies in vegetables in Jharkhand
- Use of plastic mulching in vegetable crops
- Drip irrigation of vegetable crops
- Fertilizer and spacing requirement in cabbage
- Vegetable based cropping systems
- Management of bacterial wilt in solanaceous vegetables
- Management of powdery mildew in peas and cucurbits
- Production of healthy vegetable seedlings in nursery
- Staking for rainy season cultivation of tomato

Off season cultivation

Cultivation of French bean during summer using shade nets

Out of 12 lines evaluated under shade net cover during Feb.-May, 2005, the round & stringless podded Contender (75.17 q/ha), EC-350940 (70.45 q/ha) and EC-350939 (70.35) and the flat podded Arka Suvidha (75.57 q/ha) performed well with market availability of pod from 1st April to middle of May. When the same entries were evaluated under similar shade net cover during March-May, the round & stringless podded Contender (111.25 q/ha), CH-913 (67.52 q/ha) and EC-350939 (66.54 q/ha) and the flat podded Arka Komal (82.41 q/ha) & Swarna Priya (65.47 q/ha) were found promising and the green pods were available from 21st April to 31st May.

Cultivation of cucurbitaceous crops during winter using poly tunnels

Poly tunnel technology was used to cultivate cucurbits like bottle gourd which can be made available in the market earlier than the main crop. The maximum income

by Sh. Malik Murmu of Karela, Jama, Dumka - Rs.1012/- from 1.0 decimal (40m2) area. Yield of fruits (152.33 kg) & sold @ Rs.10-5/- in the local market.

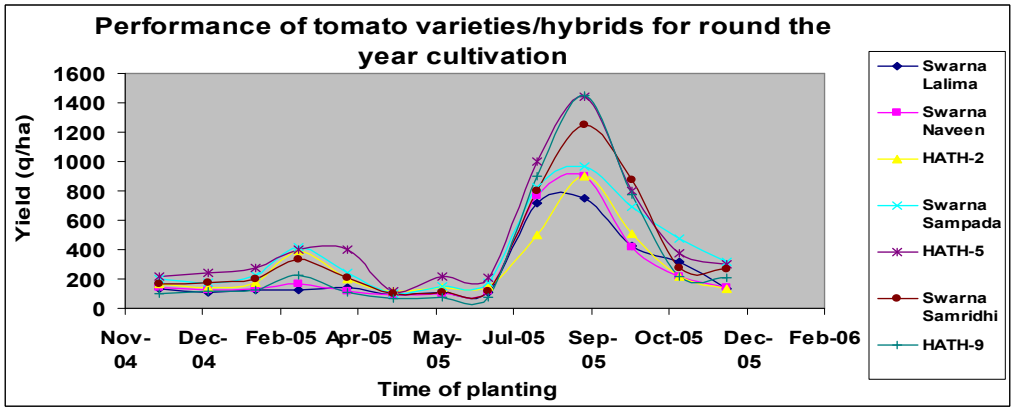
Protected cultivation

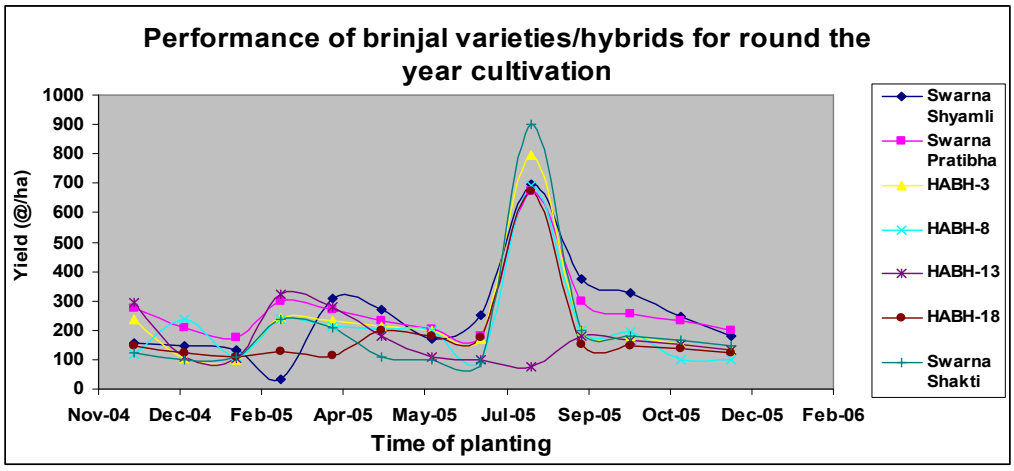
Total area under protected vegetable production is not more than 10,000 hectares (Devi & Thakur, 2013). Area under protected cultivation is 0.23% of the total horticultural area of India (2012). This technology can be used for year round & off-season production of high value, low volume vegetables. Cultivation of indeterminate tomato variety/hybrid was standardized in naturally ventilated saw tooth design polyhouse at ICAR RCER Research Centre Ranchi.

Round the year cultivation

Evaluation of promising F_1 hybrid and varieties of tomato indicated the hybrids HATH-5 and Swarna Sampada to be suitable for round the year cultivation. Variety Swarna Shyamali, (50-60t/ha) and F1 hybrid Swarna Ajay (70-80t/ha) were found suitable for round the year cultivation of brinjal. How ever, Swarna Pratibha and hybrid Swarna Shakti, HABH-8, HABH-13 and HABH-18 were found suitable for transplanting in August, September and October (Fig 2).

Fig 2. Performance of tomato and brinjal varieties/hybrids for round the year cultivation





Exploring ecological niches for off season production

In order to prolong the availability of peas, efforts were made to study the performance of pea genotypes under high altitude condition of Netarhat hills. Out of 12 lines/varieties evaluated under sowing on 3.1.2008, mid season and powdery mildew resistant var./lines viz., Swarna Mukti (147.21 q/ha), CHP-1 (139.56 q/ha) and Swarna Amar (103.23 q/ha) and the powdery mildew resistant edible podded snowpea variety Swarna Tripti (97.56 q/ha) proved their worthiness in respect of pod yield, quality and resistance to powdery mildew and suitability for off-season cultivation with market availability of green and disease free pods during first to third week of April. The same lines/var when evaluated under sowing on 15.1.2008, Swarna Mukti (109.72 q/ha), CHP-1 (90.50 q/ha) and CHPMR-2 (81.51 q/ha) and the snow pea variety Swarna Tripti (131.40 q/ha) performed well with market availability of pods during 1st to 3rd week of April. When evaluated under sowing on 31.1.2008, CHP-1 (84.64 q/ha), Swarna Mukti (79.05 q/ha) and CHPMR-2 (77.05 q/ha) and the Snowpea variety Swarna Tripti (131.60 q/ha) exhibited their superior performance with market availability of pods during 2nd fortnight of April.

Introduction of new crops

Promising lines/varieties of vegetable soya bean (Swarna Vasundhara 15-20t/ha), vegetable pigeonpea (HAVPP-1), snow pea (Swarna Tripti 25-30t/ha) were introduced and cultivated by the farmers of Jharkhand, Bihar, Orissa, Karnataka.

New markets for underutilized crops

Underutilized crops like leafy vegetables, tubers can be introduced into new markets among health conscious consumers by making aware their nutritional potential. They are inexpensive, easily available and can be a good source of unconventional foods. Nutritive and antioxidant potential of thirty underutilized leafy vegetables of Jharkhand have been characterized. The leafy vegetables were found to be a rich source of various minerals (calcium 125.8 to 1737.8 mg/100g, iron 7.2 to 61.3 mg/100g, phosphorus 26.7 to 525.3 mg/100g, magnesium 254.3 to 1233.7 mg/100g, potassium 98.5 to 4516.1 mg/100g, zinc 1.5 to 9.9 mg/100g), vitamin (vitamin C 2.41 to 156.92 mg/100g), fiber (0.72 to 5.93 g/100g) and protein (1.23 ï 9.57 g/100g). The high antioxidant potential of these leafy vegetables was indicated by high total antioxidant activity (17.43 to 2158.7 mg AEAC/100g), phenolic content (0.40 to 11.71 mgGA/100g) and total carotenoids (1.59 to 77.56 (mg/100g) that helps to reduce the oxidative stress and thereby plays a role in health management.

Among tuber crops, 256 germplasm were collected througha survey in Jharkhand, Chhattisgarh, Nagaland, Odisha and West Bengal and were multiplied in the field for characterization and evaluation. These include germplasm of Dioscorea spp. (56), Ipomoea batatas (12), Maranta arundinacea (3), Colocasia spp. (112), Amorphophallus spp. (47), Alocasia spp. (7), Manihot spp. (7), Xanthosoma spp. (5) and Cucumis melo var agrestis (7). The best genotypes in terms of yield and nutrition are being multiplied for introducing into farming systems.

Cropping system

In rice-legume cropping system under rainfed upland situation in kharif season, the upland rice (variety Anjali) and legumes like soybean (variety Swarna Vasundhara), groundnut (variety Birsa Bold), black gram (variety Uttara), green gram (variety CN 9-5) and cowpea (line EC 452) were grown both as sole crops (each of 12 rows) and in combination of (6 row rice + 6 rows of each legume). The sole crop of soybean recorded the maximum rice equivalent yield of 8.26 t/ha which was at par with that of groundnut (8.10 t/ha). The rice equivalent yield of the treatment of (6 row rice + 6 row soybean)(5.89 t/ha) was at par with that of (6 row rice + 6 row groundnut) (5.81 t/ha), sole crop of rice bean (5.57 t/ha) and a sole crop of black gram (5.22 t/ha). The result indicated that growing of sole crop of soybean or groundnut in the rainfed upland situation during kharif season would be more profitable in respect of rice equivalent yield.

Post harvest technologies

Shelf life extension of vegetables can be done using cold storage on a large scale, zero energy cool chamber at farmers level. Improved packaging like Modified Atmospheric Packaging can be used to extend the shelf life. Minimal processing, dehydration, pickling, canning, freezing, brining, processing can be done at cottage level by forming cooperatives among farmers to increase the revenue generation

Conclusion

Vegetables play a significant role in the agrarian economy. Adoption of improved technologies on vegetable production can enhance the overall profitability in farming system and farmers access to the market.

Entrepreneurship Development in Agricultural Sector

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In order to enhance agricultural productivity/profitability, the option of adoption of modern agricultural technology is already there from the very beginning, and the same has got the adequate, direct or indirect support of the Government, NGOs, and other concerned agencies in various ways aimed at improving the socio-economic conditions of the farmers. However, considering various types of constraints including those of labour, capital, irrigation water, farming risks and uncertainties, etc. confronted by farmers in food production and sale processes, having an adverse impact on farm income, adoption of modern agricultural production technology as such, though claimed to be cost reducing and yield/income augmenting, is left with the limited capacity to enhance farm income, if farmers choose to remain confined to their operation in the agricultural production sector alone.

This has resulted in their gradual relative marginalization, compelling them to partially or fully leave this occupation and migrate to some other places in search of economically attractive avenues yielding greater returns needed to satisfy their increasingly growing needs, via exposure and demonstration effect, caused by techno-information led changing times towards consumerism and materialism witnessing the onslaught of the plethora of modern and fancy technological consumer goods in the market. All these lead to raise a very serious and pertinent question how working in the agriculture sector can be made attractive, profitable, and employment augmenting so as to meet the rising expectations of the farming community, and retain them in this very occupation of the production of food required for their own families and also for the growing population of the nation.

The answer lies in the adoption of the multi-pronged approach to deal with this pressing problem of low agricultural profitability resulting into the waning charm of agriculture among rural youths. So far as approaches/strategies to deal with low agricultural profitability are concerned, these should be adopted and executed seriously from both government and farmersô sides on equal footing, and these from both the sides should be considered equally important. Non-seriousness and laxity from either side may not yield the desired result. However, the article focuses more on those to be adopted from the farmersô side with the active support of the Government, as the sustainable development of an individual/economy is not a unilateral process. It has always been a bilateral phenomenon, developer (government) and farmers being two parties, working together in symbiosis. Indifference from either side is detrimental to a solution to the problem of low agricultural profitability. Therefore, realizing the fact and significance of bilateralism of efforts towards agricultural

development, farmers must not remain in confusion that it is only the governmentôs responsibility to meet their expectation of making agriculture profitable and improve their livelihood, but the onus lies equally on them also to make it more productive and profitable.

Adoption of, *inter alia*, agri-entrepreneurship in agriculture by farmers, may prove effective in both developments of the agricultural economy in general and bring about farmersô prosperity in particular. But before that to happen, first of all, the farmers, particularly youths, must learn and imbibe basics of entrepreneurship concept and factors affecting its development/inculcation. After that, they must think of acquisition/upgradation of some gainful skills according to their taste, interest, and strength.

What is agri-entrepreneurship?

This refers to an individualôs characteristic by virtue of which he has an intense desire and will power to achieve the goal of earning most benefit by undertaking innovative activities of agriculture (crop production) and allied enterprises (livestock, poultry, fishery, duckery, bee keeping, horticulture, etc. together in symbiosis) including the work of agri-value addition in order to improve oneôs livelihood/ lifestyle by dint of actively engaging oneself in profitable and innovative agricultural enterprises warranting consistent hard work and adequate risk bearing ability. One, who is filled with this characteristic of entrepreneurship, remains loaded with the urge and capability to make the most by working in the domain of agriculture. In short, agri-entrepreneurship is all about building a bright idea which can be transformed into a successful business opportunity.

How to bring about agri-entrepreneurship in agriculture?

There are many ways to bring about agri-entrepreneurship in agriculture. Broadly, three of them are given below.

1. Changing the method (do how) of agriculture: given below are a few ways

- Having willed/commitment to change the method (do how) of agriculture.
- Learning and use of modern agricultural technologies Use of learnt modern agricultural technologies
- Undertaking market led agriculture
- Borrowing from institutional sources
- Maintenance of farm records

2. Changing the dimension of agriculture: given below are a few ways

- Market led crop diversification

  Following popular and proven norms of agronomy, crop diversification refers to the addition of new crops or cropping systems of agricultural production on a particular farm taking into account the different returns from value-added crops with complementary marketing opportunities. This gives

individuals and households more capabilities to improve livelihood security and to raise living standards.

Market led farm diversification

Farm diversification consists of taking up of multiple agricultural production enterprises together, such as crop, horticulture, livestock, poultry, fishery, beekeeping, etc., on a piece of land, allocating suitable separate areas for each enterprise, so that the output of one enterprise acts as input for the other one, as far as possible. There are many literatures/reports advocating IFS as agricultural technology capable to significantly enhance the income of farmers in general, and that of small ones in particular. However, giving due consideration to household consumption requirement, if the adoption of IFS is market led as far as possible, it would be more profitable.

Occupational/Role diversification

Undertaking different diversified roles by farmers between the point of production to that of final consumption, such as the transporter, processor, value adder and marketer, etc. may be referred to as occupational/role diversification. Farmers should be sincere and painstakingly willing to shun their production-centric occupational rigidity, work beyond the boundary of agricultural production, learn skill sets of innovative production, processing and marketing, and practise them gainfully, either locally or outside.

3. Changing the mindset/attitude (self reform) of agriculturists: given below are a few ways

- Developing/creating an intense urge to earn more and more by dint of consistent hard/smart work.
- Minute observation of the activities of those agriculturists of the village or nearby areas, who remained successful in their occupation and lives, and learning from and emulating them, and also learning factors of failure from those who could not succeed in their endeavour. The composite knowledge of factors of success and also those of failure, which we normally disregard, will help a farmer learn, improve and gain confidence and march ahead on the path of progress with ease and less risk of failure.
- Breaking oneôs socio-psychological and personal barrier to undertaking any profitable enterprise irrespective of its apparent social recognition/non-recognition.
- Learning, inculcation and application of characteristics of entrepreneurship in oneself.
- Inculcating belief in participatory/collective development rather than individual standalone development.
- Building self help/interest group (SHG/SIG) for a common cause, if going ahead singly becomes difficult and burdensome. But while building SHG, one has to be very careful and cautious. In the absence of a cohesive SHG, it

is likely that the membersô spirit may be dampened and achievement of the set goal may remain elusive.

Characteristics of an agri-entrepreneur

Health conscious (health is wealth); money centric, goal setter and goal committed; right user of time, money and energy (TME); hard/smart working; risk bearer; courageous; willing to work; work enjoyer; enthusiastic; service-motivated to society, focused; self confident; market led; determined; well behaved; non-aggressive in nature, but aggressive in work; innovative; aware; active; opportunity seeker; passionate; persistent; persevering; patient; polite; punctual; progressive; pluralistic; pragmatic; positive; planner; professional; far-sighted(dreamer); optimistic; disciplined; honest; competitive; non-quarrelsome; frugal; saver investor; good fund manager; non-superstitious; tolerant; open minded with sharing attitude; help seeker and giver; non-blaming; tendency to learn (knowledge and skill, etc) and implement it in life profitably; occupationally, spatially and attitudinally mobile; temperamentally flexible; receptive and adjusting/accommodative, i.e., adaptability to new changes (environment, policies, etc.); non-defeatist; belief in and capable of team work; social, but not over-emotional, over-social and over-religious; no intoxication habit which is time, money and energy consuming and infectious, debilitating, health deteriorating, socially and environmentally unfriendly; no hesitation in borrowing for undertaking the gainful enterprise, but also a sincere loan repayer (non-defaulter); harnesser of women power; family planner, i.e., Short family (two children only irrespective of sex, proper spacing between children, i.e., 3-4 years, marriage at appropriate age i.e. after 25 or attaining economic independence); good family manager ensuring that family aspirations are also taken care of, and it remains free from conflict.

Barriers to agri-**entrepreneurship development**

- Physical/infrastructural: Lack of rural infrastructure such as all weather motorable road and telecommunication connectivity, electricity, irrigation/water facility, credit and market availability, etc.
- Individual/personal: Problem of farmersô and their familiesô health, tend to participate more in unproductive social and religious activities, leisure loving, lassitude (laziness), occupational rigidity, i.e., unwillingness to work hard to undertake some unconventional work of profit, lack of risk and responsibility bearing capacity, lack of change proneness, failure phobia, etc.
- Family: There is lack of support/encouragement from family members to take up some enterprise beyond production sector, which is historically not family occupation and perceived as social esteem eroding. In the event of such situation of non-support, it becomes difficult for one to venture into agri-value addition and marketing sector, which is undoubtedly more remunerative.
- Social: There is lack of support/encouragement from the members of society, which the entrepreneur is associated with, to take up some non-traditional

enterprise despite its being profitable. Many times, following entrepreneurship is considered forbidden to the individual, as per societal protocol. ñLog Kya Kahenge (what people would say)ò syndrome is negatively predominant in the minds of individuals, resulting into their doing away with works of profit.

- Economic: There is a lack of apparent adequate capital for initial fixed investment and meeting operational expenditure of enterprises.
- Religious/cultural: There are many religious/cultural restrictions or inhibitions to take up some enterprise, despite its being profitable.
- Educational: Lack of proper education, exposure and training reduces risk and responsibility bearing capacity, self-confidence/faith restrict farmers to take up some unconventional, though remunerative, enterprise.

Conclusions

Adoption of, *inter alia*, agri-entrepreneurship in agriculture by farmers, may prove effective in both developments of agricultural the economy in general and bring about farmersô prosperity in particular. But before that to happen, first of all, the farmers, particularly rural youths, must learn and imbibe basics of entrepreneurship and factors affecting its development/inculcation. After that, they must think about the acquisition of some gainful skills according to their taste and interest. For this, they should gear up themselves to attend some focused need-based training programs aimed at exposure and inculcation of characteristics of agri-entrepreneurship. The government should also dutifully endeavour to provide them such kind of training opportunity through any institution oriented towards farmersô welfare to improve their entrepreneurial capacity. In order to improve the effectiveness of the training, it must also utilize local successful agripreneurs, their innovativeness and experiences in promoting modern agriculture. Besides, it should also make efforts towards providing a progressive and employment augmenting economic environment, such as agro-processing, storage facilities including cold ones, rural infrastructure, agricultural markets to sell farm produce, input delivery mechanisms, etc., wherein the created entrepreneurial skills among the farming community may be productively absorbed.

For bringing about agri-entrepreneurship, farmers must adopt strategies such as (1) changing the method (do how) of agriculture by the sustainable adoption of technology, (2) changing the dimension of agriculture through the strategy of market led crop diversification or farm diversification or occupational/role diversification or a feasible and convenient combination of all the three strategies, and (3) changing their mindset/attitude (self reform). However, there are a few barriers to agri-entrepreneurship development, such as physical, individual/personal, family, social, economic, religious/cultural, educational, etc., which must be somehow overcome by the farmers through self-understanding and realization with the support of governmentôs focused capacity building (training) programmes as far as possible to make agriculture reasonably profitable and bring about farm prosperity.

Production of Quality Marketable Produce through Adoption of Integrated Farming Systems

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Indian economy is mainly agriculture oriented where small and marginal farmers are the core of the Indian rural economy constituting 85% of the total farming community, but possessing only 44% of the total operational land (GOI, 2014). The average size of operational land holdings has reduced by half from 2.28 ha in 1970-71 to 1.16 ha in 2010-11. The operational farm holding in India is still declining. In Bihar and Kerala, the average size of holding fell by more than three times during the last four decades, whereas in Andhra Pradesh, Karnataka, Madhya Pradesh and Maharashtra, it has reduced by more than two times. This is reflective of the immense population pressure on the limited land resource available for cultivation (NABARD, 2014). The declining trend of per capita land availability poses a serious challenge to the sustainability and profitability of farming (Siddeswaran*et al*., 2012). Due to ever increasing population and shrinking land resources in the country, practically there is hardly any scope for horizontal expansion of land for food production. Only vertical expansion is possible by integrating appropriate farming components that require lesser space and time to ensure reasonable periodic income to farm families (Gill *et al*, 2005). From green revolution onwards farmers are mostly concentrating on single enterprise based agricultural systems that lead to deterioration of soil health, increased risk of crop failure and downward trends of productivity (Rahman and Sarkar, 2012). Rapid population growth, urbanization and income growth in developing countries like India, the demand for food of animal origin is increasing, while also aggravating the competition between crops and livestock (increasing cropping areas and reducing rangelands). A systematic approach is the need of the hour for fulfilling the demand of ever increasing population without disturbing the ecological balance. Integrated farming system seems to be the possible solution to the continuous increase of demand for food production, stability of income and nutritional security particularly for the small and marginal farmers with limited resources. It is not only a reliable way of obtaining a fairly high productivity with substantial fertilizer economy, but also a concept of ecological soundness, leading to sustainable agriculture. Further, modest increments in land productivity are no longer sufficient for the resource-poor farmers. Hence, intelligent management of available resources, including optimum allocation of resources, is important to alleviate the risk related to land sustainability. Planning and implementation of different enterprises in Integrated farming system in our country lack scientific and systemic approach. Moreover, proper understanding of interactions and linkages between the components would improve food security,

employment generation as well as nutritional security. This approach can be transformed into a farming system that integrates crops with enterprises such as ï agro forestry; horticulture; cow, sheep and goat rearing; fishery; poultry and pigeon rearing; mushroom production; sericulture; and biogas production ï to increase the income and improve the standard of living of small and marginal farmers.

Integrated farming system provides an opportunity to increase the economic yield per unit area per unit time by virtue of intensification and diversification of crops and integration of allied enterprises. It also offers enough scope to nutrient recycling within the system to economize and sustain the system and minimizes the dependence on chemical fertilizers for crop production to earn more profit. This may also generate more employment for the family members throughout the year. An integrated farming system fulfil the multiple objective of making farmers self sufficient by ensuring the family members a balance diet improving the standard of living through maximizing the total net returns and provide more employment, minimizing the risk and uncertainties and keeping harmony with environment. Simultaneous production of fish in ponds, with pigs, duck or chicken rearing in pens, beside or over the ponds constitutes a continuous organic fertilization of the pond by the livestock. This practice increases the efficiency and rentability of both livestock farming and fish culture through the profitable utilization of animal and feed wastes.

Declining of per capita availability of land in India is an important issue and there is hardly any scope for horizontal expansion of land for food production. Only vertical expansion is possible by integrating appropriate farming components that require lesser space and time to ensure periodic income to the farmer. Further, modest increments in land productivity are no longer sufficient for the resource-poor farmers. Hence, intelligent management of available resources, including optimum allocation of resources, is important to alleviate the risk related to land sustainability. Moreover, proper understanding of interactions and linkages between the components would improve food security, employment generation as well as nutritional security. This approach can be transformed into a farming system that integrate crops with enterprises such as ï agro forestry; horticulture; cow, sheep and goat rearing; fishery; poultry and pigeon rearing; mushroom production; sericulture; and biogas production ï to increase the income and improve the standard of living of small and marginal farmers.

IFS Concepts

ñIntegrated Food and Waste Management Systemsò (IF&WMS) which was developed by Prof. Chan is one of the best versions of an IFS (CARDI, 2010). He introduced this concept at the Montfort Boy Farm in Fiji, a vocational school that now serves as a model for the students to replicate in their villages (A Primer on Integrated Farming Systems). IFS systems combine livestock, aquaculture, agriculture and agro-industry with an expanded symbiotic or synergistic system, so that the wastes of one process become the input for other processes, with or without treatment to provide the means of production, such as energy, fertilizer, and feed for

optimum productivity at minimum costs. The concepts associated with IFS are practiced by numerous farmers throughout the globe. A common characteristic of these systems is that they have a combination of crop and livestock enterprises and in some cases may include combinations of aquaculture and trees. It is a component of farming systems which takes into account the concepts of minimizing risk, increasing total production and profits by lowering external inputs through recycling and improving the utilization of organic wastes and crop residues. In this respect, integration usually occurs when outputs (usually by-products) of one enterprise are used as inputs by another within the context of the farming systems. The difference between mixed farming and integrated farming is that enterprises in the integrated farming systems interact eco-biologically, in space and time, are mutually supportive and depend on each other.

Prevalent IFS models

IFS is a multidisciplinary whole farm approach and very effective in solving the problems of small and marginal farmers. The approach aims at increasing income and employment from small-holding by integrating various farm enterprises and recycling crop residues and by-products within the farm itself. Rapid destruction of forest due to shifting cultivation appears to be the prime cause of degradation of land mass in NEH Region. A micro-watershed based agro-pastoral system in a hilly slope holds promise for small and marginal farmers for sustaining their family and soil fertility on low input basis.

Northern part of India comprises of fertile land, rivers, dams, canals, hills and plateau land with sub-humid to temperate climatic condition and considered as a basket for temperate fruits like apple, almonds, pear, scented rice and wheat etc. A study conducted by Sheokand*et. al.* (2000) involving 300 landless (no land), marginal (0.1- 1.0 ha), medium (2.1-3.0 ha), and large (>3.0ha) farmers in Haryana, to compare the economics of different farming systems in a rice-wheat cropping sequence. Expenditure and income of arable farming, buffalo rearing, and mixed farming units were determined. The results showed net returns of Rs. 6326, Rs 3904 and Rs. 89966/ha, respectively. The net return per Rs.1000 invested was Rs. 223, Rs. 241and Rs.250, respectively. The percentage net returns over gross expenditure were 22.29, 24.10 and 24.99%, while the percentage returns over other variable costs were 39.69, 33.87 and 39.99%, respectively. The expenses incurred for labor were 12.90, 18.99 and 25.36% of the total expenditure, respectively. The results showed higher gross and net returns per Rs.1000 invested, as well as higher per cent return over gross investment, in mixed farming compared with other farming systems. Mixed farming also generated more income and human labor employment than arable and dairy farming.

In a study conducted at Umiam, Meghalaya on an area of 0.50 ha having a slope of 32 %, which was converted into 60 numbers terraces and perennial grass species planted on terrace risers and combined with livestock (two number of cows and their calves). The 1500 m^2 lower terraced area was assigned with rice ï toria -

frenchbean, middle area for maize ï mung ï toria (1200 m^2) and groundnut ï toria (300 m^2) while upper terraced area ginger + cucumber (500 m^2), ginger + bottle gourd (500 m^2) and turmeric + bottle gourd (1000 m^2) were planted. The terraced risers of 3700 running meter (rm) area were planted guinea grass (2500 rm) and broom grass (1200rm). He found that integration of these crop sequences with animal component improved the system profitability in totality as maintaining milch cow on a small farm of 0.50 ha was one of the important components, which contributed more than 55 % of the total farm income and make the system more remunerative. The inclusion of animal component in the system had set a positive link on sustainability by generating cash income, improving family nutrition and recycling crop residues and livestock refuse into a valuable nutrient source for crops.

Southern states of India have plenty of midlands and plateau lands and coconut and banana are the dominant crops in the south. Study conducted in Uttara Kannada district of Karnataka with an overall objective of identifying and analyzing the optimality under different situations for different farming systems and it was concluded that, with the introduction of integrated farming system with suitable enterprises, the net farm return would increase in the range of 25 to 150 per cent over existing plan. Further, with the availability of additional resources for inclusion of new technologies, the net farm return would enhance by 40 to 170 per cent (Naik, 1998).

With rice based IFS in Kerala, Mathew and Varughese (2007) fetched major returns by79 % from coconut- banana intercropping in the dykes and field bunds. The intervention of green manure husk burial and vermicompost with banana pseudo stem provided a major share of nutrients in the farm (Table 2).

The seven selected sesame based cropping systems were diversified with companion crops of *rabi* season. Further, each sequence was integrated with one ôMurrahô buffalo for maintaining cash flow of resource poor farm families of Bundelkhand reeling below poverty line (BPL). Among the tested, integrated farming systems, the maximum net income (Rs. 65819/ha) was obtained from sesame-lentil + mustard + one ôMurrahô buffalo and was closely followed by sesame-lentil + linseed+ one ôMurrahô buffalo (Rs. 64,004/ha) in ravines degraded soils of Bundelkhand. The lowest net returns of Rs 35,999/ha was recorded from sesame-wheat + mustard + one ôMurrahô buffalo farming. An Integrated Fish Farming model involving fishery, poultry and vegetable farming was developed and evaluated by Bisht, 2011, for two consecutive years on participatory approach at farmerôs field in the Indian Central Himalaya region. Fast growing hybrid *layer* broiler was housed beside fish pond (264 m^2) at 3000 birds/ ha. Fingerlings of Chinese carps (30,000/ha) and combinations of silver carp 45%, grass carp 35% and common carp 20% were stocked. On an average 98 gm dropping/bird/day was recycled into the pond. After one year composite carp culture yielded an average of 120 kg, which corresponded to 4545 kg/ha/yr. Average egg production per female bird was 143 eggs/bird/year and an average of 118.5 kg chicken (live weight) was obtained annually. Besides, 2115 kg vegetables were

produced annually in the associated fields (600 m^2), generating a handsome amount of Rs 20,958/-. Beside protein rich food for household consumption, an average net gain of Rs 36,823 was obtained annually from IFS with an investment of Rs 11,925 by the farmer. Economic analysis of technology clearly showed an advantage over conventional systems of cropping under rain-fed conditions. A net profit of about 200% of the total cost indicates the economic viability of the technology. It has considerable potential to provide food security, nutritional benefits, employment generation and providing additional income to resource poor small farmers.

Kumar *et al*. (2012), developed seven integrated farming systems for efficient utilization of available farm resources and to increase the income per unit of land, different combinations of crop, animal, fish and bird were evaluated at three locations of Eastern India, *viz*. Patna, Vaishali and Munger districts, to sustain productivity, profitability, employment generation and nutrient recycling for lowland situations from 2007- 2008 to 2009-10. Among the tested different Integrated Farming System (IFS) models, crop + fish +cattle model recorded higher rice grain equivalent yield (RGEY) (18.76 t/ha) than any other combinations, but in terms of economics and employment generation, crop + fish + duck + goat model supersedes over all other combinations. The highest average net returns of Rs.1,64810 (USD 2655/yr) only were recorded from crop + fish + duck + goat system over all other systems tested here. Higher average employment of 752 man-days/ year were also recorded by crop + fish + duck + goat system because of better involvement of farm family labors throughout the year. Based on a sustainability index (SI) derived from different models, crop + fish + duck + goat system was found superior with a maximum sustainability for net returns (83.9 %), apart from the addition of appreciable quality of nitrogen, phosphorus and potassium into the system in the form of recycled animal and plant wastes (Table 1). The wastes/by- products of crop/animals were used as input for another component to increase the nutrient efficiency at the farm level through nutrient recycling. Results on integration of different

Table 1**:** Productivity (RGEY) t/ha and economics and income sustainability indices of different farming systems models (mean value of four years, 2010-14)

Farming Systems	**RGEY (t/ha)**	**Capital cost (Rs./ha)**	**Total Production cost (Rs./ha)**	**Gross return (Rs./ha)**	**Net return (Rs./ha)**	**ISI**
Crop alone	10.01	---	58,337	1,18,400	60063	39.4
Crop + fish + poultry	17.04	1,10,000	1,00,720	2,04,240	1,03,388	79.8
Crop + fish + Duck	13.72	1,00,625	86,988	1,65,880	77,845	56.1
Crop + Fish + goat	16.65	1,13,500	96,528	1,98,600	1,02,256	78.7
Crop + fish+ duck + goat	18.20	1,35,125	1,10,130	2,17,280	1,07,828	83.9
Crop + fish + cow	18.60	1,45,000	1,40,963	2,25,160	84,197	62.0
Crop + fish + mushroom	13.38	1,04,000	81,149	1,61,360	80,211	58.3

Note: ISI: Income sustainability index

Components with crop depending upon sustainability and preferences were found encouraging, and to enhance the productivity, economic returns, generating employment for farm families and maintaining soil health of the farm, the crop + fish + duck + goat combination could be adopted in the eastern part of India than cultivating the crop alone on the same piece of land under irrigated conditions. Addition of organic residues in the form of animal and plant wastes could also help in improving the soil ï health and thereby productivity over a longer period of time with lesser environmental hazards.

Success story:

IFS model with half acre of land in Vaishali district

Sri Lalisahni, a farmer of Chakramdas village in Vaishali district is practicing family farming in his half acre of land with a family size of seven members (fig.4). This model includes crop, livestock (buffalo) and backyard duck ï cum ï fish integration to obtain a sizeable income for the farm family having a small area of 2000m^2. Out of 2000m^2 area, different crops like rice/wheat/ vegetable were grown in an area of 1400 m^2 and a pond was constructed in an area (low lying wasteland) of 200 $m^2$for aquaculture purpose. The pond dike, about 1 m wide, was used to grow vegetable and fruit crops. For better recycling of nutrients within the system, ten ducks and two buffaloes were also integrated in the model from which vermicompost and FYM prepared and applied into the crops again which enriched the soil in turn. Based on data collected from farmersô field and cost-benefit analysis, showed seven to eight-fold increase in income (Rs.55,578/annum) from the same land area (Table 2). In addition to profit, the model also provided nutritional security to the dependent farm families.

Table 2. Economics of half acre model at Vaishali district

Traditional System	**Income from different Components (Crops+Fish+Duck+Livestock)**	**Rice Equivalent Yield (REY)**	**Gross Income (G.I.) (in Rs)**	**Cost of cultivation (C.C.) (in Rs)**	**Net Income (N.I.) (in Rs)**
Rice-Wheat (0.2 ha) Gross Income = Rs.11400 Cost of Cultivation = Rs. 3872 Net Income = Rs. 7528 Labour employed = Family labour (58 mandays)	**Crops** Rice-Wheat-Moong (0.07ha) Rice-Potato+Maize (0.07 ha) **Total** **(LR – 58 md)**	 9.8 q 12.0 q 21.8 q	 9800 12000 21800	 4200 5100 9300	 5600 6900 12500
	Veg. & Fruits (Pond's bund) **(LR – 8 md)**	Lady finger equivalent yield (L.F. E.Y.) 2.2 quintal	 2200	 1144	 1056

Note: LR= labour requirement	**Fish pond (0.04 ha)** Rohu+Common Carp + Silver Carp+Mrigal (300 fingerlings) **(LR – 15 md)**	140 kg	9800	204	7736
	Duckery (9+1) on ponds dike 9 female duck & 1 male duck. **(LR – 23 md)**	2250 egg.	9000	4300	4700
	Livestock (2+2) Area=0.01 ha 2 Buffalos & 1 calf **(LR – 74 md)**	Milk Yield 2160 lit.	 52,840	 22,254	 29,586
	Total	--	95,640	39,062	55,578



Before intervention After intervention

IFS model with half acre of land at Vaishali district in the farmers' field

Constraints:

Depending on the type and size of independently owned operation, some limiting factors are:

- **Economies of scale**: Larger farms are able to bargain more competitively, purchase more competitively, profit from economic highs, and weather lows more readily through monetary inertia than smaller farms.
- **Cost of inputs**: fertilizer and other agrichemicals can fluctuate dramatically from season to season, partially based on oil prices; a range of 25% to 200% is common over a few year periods.
- **Oil prices**: Directly (for farm machinery) and somewhat less directly (long distance transport; production cost of agrichemicals), the cost of oil significantly impacts the year-to-year viability of all mechanized conventional farms.
- **Commodity futures**: the predicted price of commodity crops, hogs, grain, etc., can determine ahead of a season what seems economically viable to grow.

- **Technology user agreements**: a less publicly known factor, patented GE seed that is widely used for many crops, like cotton and soy, comes with restrictions on use, which can even include who the crop can be sold to.
- **Wholesale infrastructure**: A farmer growing larger quantities of a crop than can be sold directly to consumers has to meet a range of criteria for sale in the wholesale market, which include harvest timing and graded quality, and may also include variety, therefore, the market channel really determines most aspects of the farm decision making.
- **Availability of financing**: Larger farms today will often rely on lines of credit, typically from banks, to purchase the agrichemicals, and other supplies needed for each growing year. These lines are heavily affected by almost all of the other constraining factors.
- **Government economic intervention**: In some countries, notably the US and EU, government subsidies to farmers, intended to mitigate the impact on domestic farmers of economic and political activities in other areas of the economy, can be a significant source of farm income. Bailouts, when crises such as drought or the "mad cow disease" problems hit agricultural sectors, are also relied on. To some large degree, this situation is a result of the large-scale global market farms have no alternative but to participate in.
- **Government and industry regulation**: A wide range of quotas, marketing boards and legislation governing agricultural impose complicated limits, and often require significant resources to navigate. For example, on the small farming end, in many jurisdictions, there are severe limits or prohibitions on the sale of livestock, dairy and eggs. These have arisen from pressures from all sides: food safety, environmental, industry marketing.
- **Real estate prices**: The growth of urban centers around the world, and the resulting urban sprawl have caused the price of centrally located farmland to skyrocket, while reducing the local infrastructure necessary to support farming, putting effectively intense pressure on many farmers to sell out.

What is to be done?

Policy can be, and is, extremely important for the fate of family farming. Although family farming can survive highly adverse conditions, positive conditions can help family farming reach its full potential. Precisely here resides the enormous responsibility of policy, that is, of state apparatuses, multinational forums (like the FAO, IFAD and other UN organizations), but also of political parties, social movements and civil society as a whole. By securing rights and by investing in infrastructure, research and extension, education, market channels, social security, health and many other aspects, investments by family farmers themselves can be triggered. Strengthening rural organizations and movements is equally of utmost importance. We have to keep in mind that family farmers, wherever in this world, are trying to find and unfold new responses to difficult situations. Thus, identifying successful responses, building on novel practices, communicating them to other places and other family farmers and interlinking them into strong processes of change must be important items on our agenda. In

short: a lot is to be done. The good news, though, is that every step, including every little step, is helpful.

Challenges

- Require initial investment
- Require more manpower
- Land consolidation
- Social problems: Tradition, value and belief
- Timely availability of required inputs
- Lack of technical knowledge
- Location specificity and lack of confidence among the farmers

Ways out

- Running of awareness programmes such as farmerôs fare, workshops and trainings.
- Build-up of confidence towards adoption of recent scientific development through laying out of a demonstration of the technology in a farmerôs field.
- Assured irrigation facility and timely supply of inputs.
- Lucrative subsidies for purchase of solar panel, fish fingerlings, animal breeds and pond construction and livestock purchase.
- Needs attention to the state agricultural departments.
- Steps required for the land consolidation program.

Conclusion

Addition of organic residues in the form of animal and plant wastes helps in improving the soil ï health and thereby productivity over a longer period of time with lesser environmental hazards with increased profit margin. IFS model comprising of crop components, dairy, poultry and fishery is the most suitable and efficient farming system model giving the highest system productivity for the irrigated agro-ecosystem of North eastern plain zone while suitable IFS model for the Indian Central Himalaya region is fishery + poultry + vegetable farming which has considerable potential to provide food security, nutritional benefits, employment generation and providing additional income to resource poor small farmers. In general, IFS enables the agricultural production system sustainable, profitable (3-4 folds) and productive on long term. About 90percent of nutritional requirement is self sustained through resource recycling, which curtails the cost of cultivation and increases profit margins and employment. Therefore, it is imperative to state that to sustain food and nutritional security, IFS approach is promising and will conserve the resource base through efficient recycling of residues and wastes within the system. IFS models developed for different ecological ecosystems and subsystems can be tuned through farmersô participatory trials with multilevel interventions itself in the farmersô fields.

Commercial Poultry for Rural Youth

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Poultry farming is a good occupation for the rural masses for economic sustainability and nutritional security. Chickens are grown for their egg and meat. Likewise, they are classified as egg-type chicken and meat-types chickens. Egg-type chickens are composed of stock that has been developed for egg production and is maintained for the principal purpose of producing chicks for the ultimate production of eggs for human consumption. Breeds of meat-type chickens primarily include broilers, fryers, roasters, and other meat-type chickens. Here broilers and other chickens are raised for their meat. Broilers are genetically selected for fast growth and raised for meat rather than egg. The chickens developed and reared for egg production are termed as a layer. At the hatchery itself, day-old layer-type chicks are sexed mostly by vent sexing and only female chicks are retained for egg production or sale to farmers for layer farming. Transformed from rural farming to poultry has developed full-fledged industry within a short span of 30-35 years. Today, poultry is one of the fastest growing segments of the agricultural sector in India and many other countries.

Commercial broiler breeds: Caribro, Babcobb, Krishibro, colour broiler, Hy-bro, Vencobb etc.

Dual Purpose: Kuroiler dual, Rhod Island Red, Red Vanaraja, Gramapriya etc.

Commercial Layer Strains: BV-300, Bowans, Hyline, H & N nick, Dekalb Lohman etc.

Following guide is an illustration of requirements of commercial poultry:

Different types of poultry houses

- *Brooder/chick house*: It is used to brood and rear egg-type chicks from 0 to 8 weeks of age.
- *Grower house*: It is used to grow egg-type birds from 9 to 18 weeks of age.
- *Brooder cum grower house*: Here, the birds are reared from 0 to 18 weeks of age (entire brooding and growing period of egg-type chicken).
- *Layer house*: In which birds over 18 weeks of age are reared, usually up to 72 weeks of age.
- *Broiler house*: In which broilers (meat-type birds) are reared up to 5-6 weeks of age.

- *Breeder house*: In which both male and female breeders are maintained at appropriate sex ratio.
- *Environmentally controlled (EC) house*: In which, the entire environment is manipulated in such a way that is optimum for the birdôs growth.

Location of poultry shed

- Poultry house should be located away from the residential and industrial area.
- It should have proper road facilities
- It should have the basic amenities like water and electricity.
- Availability of farm labourers at relatively cheaper wages.
- Poultry house should be located in an elevated area and there should not be any water-logging.
- It should have proper ventilation.
- The poultry house should be in the east-west orientation to protect from summer wind and cold stress and also for direct sunlight in winter months. During summer direct sunlight should be avoided to reduce the summer stress in birds.

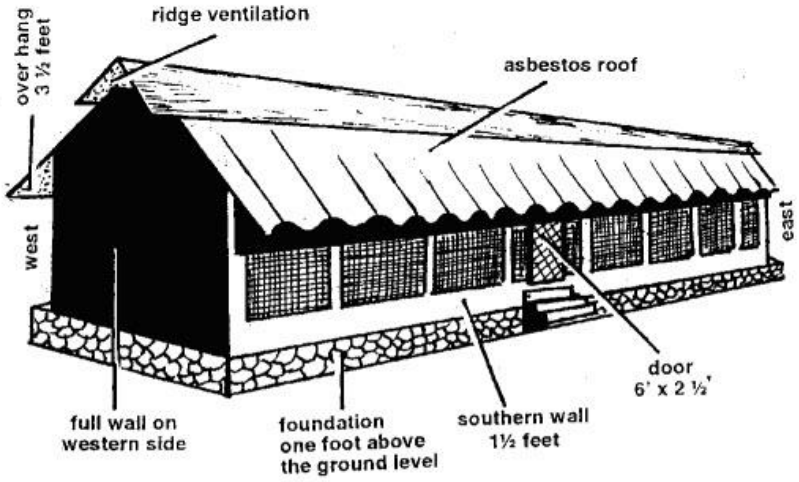
Layout of Poultry farm

- A small size poultry farm doesnôt require any special layout as it involves a construction of only one house.
- The medium and large size farms require special considerations for placement of building on the farm premises.
- The basic principles to be observed for layout are,
    - The layout should not allow visitors or outside vehicles near the birds.
    - The sheds should be so located that the fresh air first passes through the brooder shed, followed by grower and layer sheds. This will prevent the spread of diseases from layer houses to brooder house.
    - There should be a minimum distance of 50-100 feet between chick and grower shed and the distance between grower and layer sheds should be of minimum 100 metre.
    - The egg store room, office room, and the feed store room should be located near the entrance to minimize the movement of people around the poultry sheds.
    - The disposal pit and sick room should be constructed only at the extreme end of the site.

Details of poultry house construction

House Orientation (Direction)

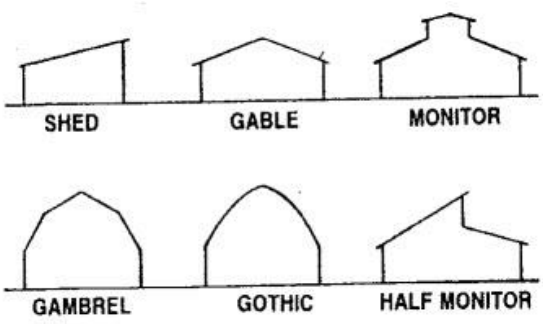
- The poultry house should be located in such a way that long axis is in the east-west direction. This will prevent the direct sunshine over the birds.



A model poultry house

- Each broiler requires one square foot of floor space while a layer requires two square feet of floor space under the deep-litter system of rearing.
- So the size of the house depends on the number of birds to be reared.
- The length of the house can be of any extent. The number of birds reared and availability of the land determines the length of the poultry house.
- The open-sided poultry houses in tropical countries should have a width not more than 22 to 25 feet in order to allow ample ventilation and aeration at the mid-portion.
- Sheds wider than this will not provide adequate ventilation during the hot weather.
- If the width of the shed is more than 25 feet, ridge ventilation at the middle line of the rooftop with proper overhang is a must.
- The height of the sides from foundation to the roof line should be 6 to 7 feet (eaves height) and at the centre center10 to 12 feet.
- In case of cage houses, the height is decided by the type of cage arrangements (3 tiers or 4 tiers).
- A good foundation is essential to prevent seepage of water into the poultry sheds.
- The foundation of the house should be of concrete with 1 to 1.5 feet below the surface and 1 to 1.5 feet above the ground level.

- The floor should be made of concrete with the rat-proof device and free from dampness.
- The floor of the house should be extended 1.5 feet outside the wall on all sides to prevent rat and snake problems.
- The door must be open outside in case of deep-litter poultry houses.
- The size of door is preferably 6 x 2.5 feet. At the entry, a foot bath should be constructed to fill with a disinfectant.
- The side wall should be of 1-1.5 feet height, and generally at the level of birdôs back height.
- This side wall protects the bird during rainy days or cold weather and also provides sufficient ventilation. In case of cage houses, no side wall is needed.
- The roof of the poultry house may be thatched, tiled, asbestos or concrete one depending upon the cost involvement.
- Different types of roofs are Shed, Gable, half-monitor, full-monitor (Monitor), Flat concrete, Gambrel, Gothic etc. Monitor type is mostly preferred in tropical countries like India.



- The overhang of the roof should not be less than 3.5 feet in order to prevent the entry of rainwater into the shed.

Lighting

- The light should be provided at 7-8 feet above the ground level and must be hanging from the ceiling.
- If incandescent bulbs are used, the interval between two bulbs is 10 feet. In case of fluorescent lights (tube lights), the interval is 15 feet.

Poultry housing system

- Broadly, poultry housing systems are classified into three systems:

- Free range or extensive system
- Semi-intensive system
- Intensive system: Deep-litter system, Slatted floor system, Slat cum litter system & Cage system

Free-range system

- This system is adopted only when adequate land is available to ensure desired stocking density by avoiding overcrowding.
- We can rear about 250 adult birds per hectare.
- A range provides shelter, greens, feed, water, and shade.
- Foraging is the major source of feeding for birds. The shelter is usually provided by temporary roofing supported by ordinary poles.
- The fields are generally used on rotational basis after harvesting of crops by moving of birds from one field to another depending on cropping programme.
- All categories of birds can be reared in this system. This system is most preferred for organic egg production.

Semi-Intensive system

- As the name indicates birds are half-way reared in houses and half-way on ground or range, i.e. birds are confined to houses in the night or as per need and they are also given access to runs.
- The houses are with solid floors while runs are fields only.
- The success of rearing depends on maintenance condition of runs to reduce the contamination.
- Runs can also be used on a rotation basis. The stocking density rate on an average for adult birds is 750 per hectare. This system is usually adopted for duck rearing.
- The feeding and watering facilities are provided in the pen.

Intensive system

- Birds are totally confined to houses either on ground/floor or on the wire-netting floor in cages or on slats.

- It is the most efficient, convenient and economical system for modern poultry production with huge numbers.

Deep litter system

- In this system, the birds are kept inside the house all the time.
- Arrangement for feed, water, and nest are made inside the house.
- The birds are kept on suitable litter material of about 3ò to 5ò depth.
- The word litter is used for fresh litter material spread on the floor.
- Usually, paddy husk, sawdust, ground nut hulls, chopped paddy straw or wood shavings are used as litter materials.
- This arrangement saves labor involved in the frequent cleaning of fecal matter (droppings), however, it needs periodical stirring.
- The litter is spread on the floor in layers of 2ò height every fortnightly till the required depth is achieved.

Slatted (slotted) floor system

- In a slatted floor, iron rods or wood reapers are used as floor, usually 2-3 feet above the ground level to facilitate fall of droppings through slats.
- Wooden reapers or iron rods of 2ò diameter can be used on lengthwise of the house with interspaces of 1ò between rods.

Slat (slot) cum litter system

- This system is commonly practiced for rearing birds for hatching eggs production, particularly meat-type breeders. Here, a part of the floor area is covered with slats.
- Usually, 60% of the floor area is covered with slats and rest with litter.
- Feeders and waterers are arranged in both slat and litter area.
- In case of breeder flock, nest boxes are usually kept on litter area.

Cage system

- This system involves rearing of poultry on raised wire netting floor in smaller compartments, called cages, either fitted with stands on the floor of the house or hanged from the roof.
- It has been proved very efficient for laying operations, right from day-old to till disposal.
- At present, 75% of commercial layers in the world are kept in cages.
- Feeders and waterers are attached to cages from outside except nipple waterers, for which pipeline is installed through or above cages.
- Auto-operated feeding trolleys and egg collection belts can also be used in this rearing system.
- The droppings are either collected in trays underneath cages or on belts or on the floor or deep pit under cages, depending on the type of cages.
-

Floor space requirement			
Type	**Age (in weeks)**	**Deep-litter (ft^2)**	**Cages (ft^2)**
Egg-type chicken	0 - 8	0.60	0.30
	9 - 18	1.25	0.50
	> 18	1.50	0.65
Meat-type chicken	0 - 3	0.50	-
	4 - 6	1.00	-

Brooding Management

Brooding of chicks is very important operation in the early age of the chicks (0-4 week). Chicks are provided with required temperature by artificial means. Chicks need brooding during initial 6 weeks of age to maintain the required body temperature and to protect from predators. Metal, wooden or any other low-cost brooding materials can be used for the purpose and electric bulbs (2 Watts/ chick) can be used as a heat source. The movement of the chicks can be restricted nearby the heat source with the help of chicks guard. Initially about 7-10 sq. inches space is recommended per chick under brooder.

Floor Brooding:

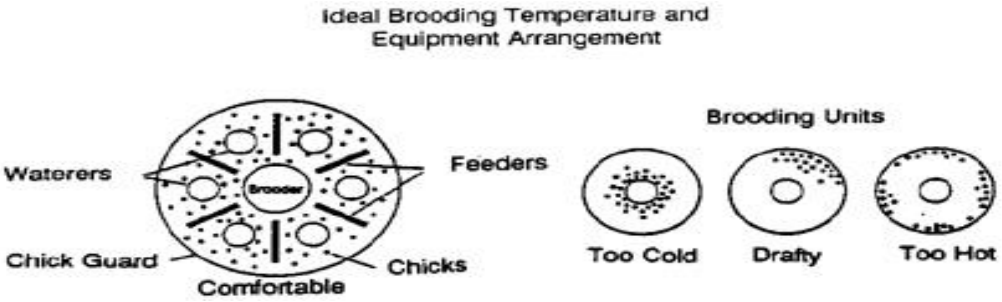
Spot brooding: This conventional method of brooding depends overhang on spot heating either by using electrical bulbs or gas brooders. In this system, one overhanging or standing is provided for every 300-600 chicks. Hovers are reflectors which provide warmth to chicks using electrical bulbs or gas brooders. The air temperature under the hover is kept at a required level. Hovers are made up of metal, wood or bamboo baskets fitted with electrical bulbs, infrared bulbs or heating elements and gas heaters.

Brooder guard: 2 to 2½ foot away from the hover, brooder guard is provided to prevent chicks straying away from heat source, feed, and water. Brooder guards are generally made up of G.I sheet with foot height. For first 2 days, the feed is sprinkled on the paper. After that chick feeders are provided. Chick waterers should be provided first day onwards. Feeders and waterers are arranged in cartwheel manner, so that chick need not have to walk a long distance to access feed and water. Temperature: The temperature is regulated by adjusting the height of the hover with the number of bulbs/flame. During the first week, brooding temperature under hover (2 inches above litter at the top of the hover) should be 32 -34°C (90-95°F) with a weekly reduction of 5 till it reaches 21-22°C (70°F).

Table: Brooder temperature for chicks at different ages:

Age of chicks	Brooder temperature	
	°F	°C
1st Week	90	32.2
2nd Week	85	29.4
3rd Week	80	26.7
4th Week	75	23.9
5th Week	70	21.1
6th Week	70	21.1

The correct temperature of brooder is known by the behavior of the chicks. When the chicks are comfortable, they will spread out evenly within chick guard area. If the hover temperature is too low the chicks will huddle together under hover, whereas when the brooder temperature is high they tend to move away from the hover. The brooder should be started 8-10 hours before arrival of the chicks.



Feeders: During the first day, the feed may be sprinkled or provided in the trays/newspaper for encouraging the newborn chicks to pick up the feed. From day two onwards feed is provided in trough type of feeders. As the chicks grow bigger suitable feeders are used. The feeders should be at a proper height for the birds to eat properly. As chicks grow the feeder should be lifted up by adjusting their height to the back level of the bird. The level of feed in feeder has a direct correlation with feed

wastage. As a thumb rule, 10 percent feed is wasted if the feeders are two thirds full compared to 3 percent wastage if they are half full and only 1 percent if they are one-third full. Therefore, feed should be offered more frequently with small quantity at each time and helps to gain weight more uniformly. Feeder space allowance: Trough feeders 2.5cm ï up to 2 weeks and 5cm ï up to 6 weeks.

Waterer space: Clean and fresh water should be provided to the chicks waterers from day old chicks should be conveniently placed close to the hover and alternatively to feeders. Water may be provided using troughs, bell-shaped drinkers, and caps. With these drinkers, 0.75 inches (2 cm) of water space per bird is recommended. Water should be provided before the chicks are released under the brooders. Bell type chick drinkers are essential during first three days of brooding irrespective of the type of brooding. In deep litter brooding drinkers should be evenly distributed. The height of the drinkers needs to be adjusted according to the chick height. One chick drinker is enough for 100 chicks up to 2 weeks of age and regular bell drinker is sufficient for 50 birds from third week onwards

Chick feed: Grounded maize should be provided 2 hours after chicks are placed under the brooder. During the first week, frequent feeding of small quantity should be practiced to stimulate feed consumption.

Floor space: The chick should be provided sufficient hover and floor space. Growth and feed conversion ratio (FCR) is proportionate to floor space available for chicks, apart from the genetic potential of the bird. Overcrowding results in stress and mortality, chick requires 8 square inches of hover space. In deep litter brooding 0.3 sq. ft. floor space per chick is to be provided during the first week. During the 6 weeks, 1 sq. ft. floor space per chick is essential.

Relative humidity: During the first week of brooding, the relative humidity should be 65.70% when the relative humidity drops below 50% it results in dehydration of chicks, which may affect growth, uniformity, and livability of chicks. In houses where gas brooders and nipple drinkers are used, relative humidity can drop down to as low as 25%. To maintain the required humidity frequent spray of sanitized water is advised.

Ventilation: Supply of fresh air to the chicks is highly essential. Brooding will cause depletion of oxygen and build up of carbon dioxide, ammonia etc., the airtight curtains should be avoided. It is recommended to keep a gap of 3.5 inches between

the ceiling and side curtains to facilitate gas exchange between the house and environment. In extreme weather conditions curtains, windows, doors, and fans need to be effectively used to maintain optimum ventilation.

Beak trimming: Trimming of the beak is an important management practice. This is done to prevent cannibalism and wastage of feed. Beak trimming is a sensitive operation and it should be done by trained people. The beak trimming is done at 3rd-week one-third of the beak should be trimmed. There are different methods of cutting and cauterization with the hot iron is the popular method. Cauterization helps in arresting and destroys the tissue responsible for generating beak growth. Proper care should be taken not to burn the tongue of the chick. Use electrolytes and vitamin (K and C) in the water two days before and after beak trimming. Deeper feed should be provided for several days.

- Preparation of poultry shed/house: After marketing of old flock the following operations are required to be created for clean and healthy environment in the poultry house.

- Remove all the movable equipment from the shed. Soak in water and clean thoroughly in tap water and finally dip in disinfectant solutions. Finally, wash in clean water, sundry and store.
- Litter should be removed from the shed and transported away from the farm in closed containers or in gunny bags and disposed of properly.
- Lightings and feed and water pans should also be taken out of the shed and cleaned properly.
- Accumulated dust and cobweb formed on the wall, ceiling, mesh, etc., should be removed.
- Insecticide is to be sprayed over the litter, walls, mesh, roof, etc., Shed should be washed using a pressure washer.
- All the repair work of the shed including cages, equipment, and mesh should be carried out.
- Flame guns should be used inside and outside of the houses. Walls should be white washed and metal surfaces should be painted if needed. The equipment and fitting should be re-assembled and the curtains be tied. Spray an insecticide to kill the insects.

- Shed should be kept under lock (shed rest) for a minimum of one-two weeks.

***One day before arrival of chicks*:**

- Set heating system (switch on brooders) at 29-32^{0}C (85-90^{0}F) for cage brooding or at 32-35^{0}C (90-95^{0}F) at chick level for floor brooding.
- Cover the floor (litter) of the brooder with newspaper and arrange feeders, waters etc.,
- Check water system and adjust to the proper height of chicks
- Disinfect and flush water lines.

***On arrival of chicks*:**

- While placing chicks in the brooders, count the number of chicks placed in each portion cell to ensure proper stocking density.
- Fill waterers with clean water or operate water systems.
- During the first six weeks, operate feeders to provide feed more than twice daily.
- Check brooder temperatures.
- On placing chicks, trigger water cups to encourage drinking.
- Provide the feed in mash or crumble form. Crumble/pellet feed will ensure more uniform growth.
- Provide adequate light continuously during the first two days.
- After two days one hour darkness may be provided to train the chicks in case of any power failure.
- Medication program: First and Second day ï Electrolytes and vitamins.
- 3rd to 7th day ï Antibiotics. (Other medications as and when required)

Litter Management

Litter management place a vital role in controlling the disease in the flock. When birds are housed on deep litter system, proper attention is required to keep the litter dry. It can be achieved through placement of waterers in the proper place and their maintenance. Suitable litter materials like sawdust, rice husk, pieces of hay and straw can be spread up to 5-10 cm thickness and that should be stirred frequently and treated with slaked lime to avoid caking. In case of humid coastal areas, add about 0.5 kg of superphosphate/hydrated lime may be thoroughly mixed up with litter spreading in 15 sq.ft. floor area. Birds are allowed to feed ad libitum during the first few weeks

of age. To ensure proper development of feathers skeletal growth and immune system birds should be provided feed all through the initial 4 and 5 weeks.

Grower Management

- Proper cleaning and disinfection of grower house is needed before introduction of grower birds.
- Provide sufficient floor space, feeding space and water space.
- Spread litter material to a height of 4ò in case of deep-litter system.
- Arrange feeder and waterers in the grower house.
- Change the feeder and waterer according to the need.
- Adopt restricted feeding programme during growing period to prevent fattening of pullets and early sexual maturity and thus to improve egg production.
- Follow good litter management to avoid diseases like coccidiosis.
- Only 12 hours lighting programme is sufficient in case of open-sided houses. No artificial light is needed.
- Aim for the uniformity of the flock. Sample weights are taken once in a week to find out the average body weight as per the breeder suggestions.
- Follow strictly the recommended vaccination, medication and other management programs like deworming, debeaking etc for the growers. It is adopted during growing period of layers or breeders.

Layer Management

- Proper cleaning and disinfection of layer house.
- Provide proper floor space, feeding space and watering space both in deep-litter and cage system
- In deep-litter system, floor space of 2 sq.ft. per bird and feeding space of 5ò per bird are provided
- In cage system 3 birds/box of 18ò x 15ò cage floor space is provided (0.63 sq. ft per bird)
- 6 feet linear feeders can be used for every 30 layers or 18ò diameter circular feeder of 4-5 no for every 100 birds.
- Provide 18ò diameter plastic waterer of 2 numbers for every 100 birds.
- Spread litter material, in case of deep-litter system up to 6ò thickness.
- Arrange feeder and waterer in the poultry house to the height of birdsô back.
- Grill size may be changed according to the size of the birdôs head.

- In deep-litter system, the litter material should be racked in the evening daily after egg collection is over.
- The litter should be treated chemically at least once in a month or whenever necessary in case of wet litter problem to prevent ammonia emission in the house.
- Provide 16 hours light during the laying period.
- Provide well-balanced layer mash. Phase feeding may be followed for layers according to age, level of production and climatic factors.
- The average feed consumption during the laying period ranges from 100-110 gram.
- Feed consumption during winter increases and during summer, feed consumption decreases.
- Summer and winter management should be followed for better flock percentages.
- Deworming should be done regularly at an interval of 6-8 weeks depending on the worm load, especially when reared under the deep-litter system.
- Collect the eggs at least 5 times a day in a deep-litter system and twice a day in cage system.
- Cull the unproductive layers regularly.

Disease prevention and control

- Clean sanitary conditions of poultry sheds and equipment, balanced feed, fresh clean water, healthy chicks are essential to prevent diseases.
- Avoid entry of visitors to farm, especially inside the sheds. If visitors come, ask them to dip their feet in a disinfectant solution wash and clean hands and to wear apron/boots provided by the farm.
- Use proper vaccination schedule. Use high quality vaccines purchased from reputed manufacturers. Keep vaccines in cool, dry conditions away from sunlight. Any leftover vaccine should be properly disposed off. Vaccines should not be used after their expiry date is over.
- Any bird showing advanced signs of a disease, should be removed from the shed and culled. It can be sent to a laboratory for diagnosis

- Birds showing advanced signs of a disease should be shown to a qualified veterinarian and suitable medication/treatment be given as per his/drug manufactures recommendations.
- Any dead birds should be immediately removed from the shed and sent to a laboratory for diagnosis or buried/buried/burnt suitably away from the poultry sheds. The waste of farm should be suitably disposed off.
- Poultry manure, if infected, can spread disease, from one batch to another. Keep the litter dry, remove it after the flock is sold and dispose the manure properly and quickly.
- Keep proper records on mortality and its causes and the treatment given to birds. The dates of vaccination for each flock should be properly recorded.
- Rats are important carriers of poultry disease. Use suitable rat poisons/rat traps
- Many poultry medicines can be given in drinking water. When medication is to be given, remove the waterers in poultry sheds on the previous evening. Next morning give medicine in measured quantity of water, so that the entire medicine will be quickly consumed and there will be no wastage of medicines.
- Mild infection of a disease may not cause mortality, but it will reduce growth. Keep a sample record of body weight and mortality rate. Study the possible causes, if weight is low take steps to improve the management of the subsequent batches. A Constant vigil and analysis of records/results are necessary to keep up the efficiency in farming.

Table: **Vaccination schedule layer birds**

Age	Name of the vaccine	Strain	Dose	Route
1st day in the hatchery	Mareks Disease	HVT	0.20 ml	S/C injection
5 th day	Newcastle Disease	Lasota	One drop	Eye drop
14th day	Infectious Bursal Disease	Georgia	One drop	Oral drop
21st day	Pox Fowl	pox	0.20 ml	IM/SC injection
28th day	Newcastle Disease	Lasota	One drop	Eye drop
9 th week	Newcastle Disease*	R2B	0.5 ml	S/C injection
12th week	Pox*	Fowl pox	0.20 ml	S/C injection

*Repeat these two vaccines at every 6 months interval (Pathak and Nath, 2013)

Role of Contract Farming in Market Led Production

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With the rapid transformation of agriculture in India, new systems and models of farming are emerging which promised farmers for assured market and remunerative price for their products. There is growing evidence that Contract Farming will have an important role in this transformation. The Government of Indiaôs **National Agriculture Policy** also envisages that ñPrivate sector participation will be promoted through contract farming and land leasing arrangements to allow accelerated technology transfer, capital inflow and assured the market for crop production, especially of oilseeds, cotton, and horticultural cropsò.

To link production agriculture to market, the concept of Contract Farming has emerged, which promises to provide a proper linkage between the ófarms and marketô. It can be a means to bring about a market focus on Indian farming. The essence of such an arrangement is the commitment of the producer/seller to provide an agricultural commodity of a certain quality, at a time and price, and in the quantity required by a known and committed buyer. The basic elements of contract farming are pre-agreed price, quality, quantity and timely delivery of produce. Contract Farming (CF) can be defined as a system for the production and supply of land-based and allied produce by farmers/primary producers under advance contracts, the essence of such arrangements being a commitment to provide an agricultural commodity of a type, at a specified time, price, and in specified quantity to a known buyer. According to FAO, Contract farming can be defined as an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices.

Elements of Contract Farming

Sl. No.	
1.	Purpose/Reason (quality and quantity of material not available for company)
2.	Time of Contract (pre and post harvest)
3.	Minimum size of contractual acreage
4.	Registration process
5.	Partners in consortium
6.	Insurance supplied
7.	Inputs provided

8.	Services provided
9.	Quantity specification
10.	Harvesting time
11.	Price fixation criteria
12.	Procurement strategy
13.	Packaging
14.	Handling
15.	Transport
16.	Mode of payment
17.	Time of payment

Why contract farming?

Contract farming fulfills several needs of Indian agriculture, which is very diverse in nature. Some of the important reasons for promoting contract farming are:

- To reduce the load on the central & the state level procurement system.
- To increase private sector investment in agriculture.
- To bring about a market focus in terms of crop selection by Indian farmers.
- To generate a steady source of income at the individual farmer level.
- To promote processing & value addition.
- To generate gainful employment in rural communities, particularly for landless agricultural labour.
- To flatten as far as possible, any seasonality associated with such employment.
- To reduce migration from rural to urban areas.
- To promote rural self-reliance in general by pooling locally available resources & expertise to meet new challenges.

Key preconditions for successful contract farming

Contract farming involves several actors to work in synergy for its successful implementation at ground level. Several important factors play role in it, of which some are listed below:

1. **A profitable market:** The sponsor must have identified a market for the planned production and it must be sure that such a market can be supplied profitably on a long-term basis.

The farmer must find potential returns more attractive than returns from alternative activities and must find the level of risk acceptable. They also should have potential returns demonstrated on the basis of realistic yield estimates.

2. The physical and social environment

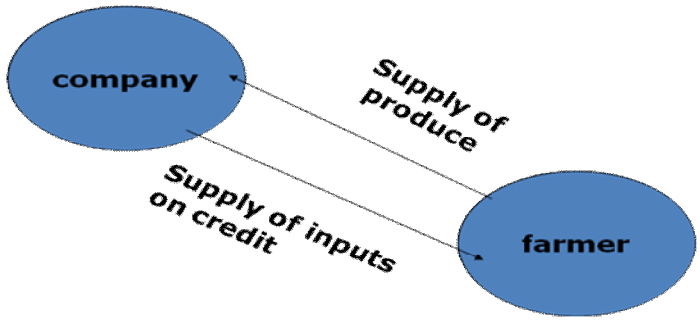
- The physical environment must be suitable in general and in particular for the product to be produced.
- Utilities and communications must be suitable for both farming and for agro-processing. e.g. water and electricity.
- Input availability ï sources of inputs need to be assured.
- Social considerations ï cultural attitudes and practices should not conflict with farmers obligations under the contract and managers must develop a full understanding of local practices.

3. **The Governent Support:** Govt should play regulatory and developmental role to support contract farming.
   - Suitable laws of contract and other laws are required as well as an efficient legal system.
   - Governments need to be aware of the possible unintended consequences of regulations and should avoid the tendency to over regulate.
   - Governments should provide services such as research and sometimes, extension.
   - Governments can take steps to bring together agribusiness and suitable farmers.

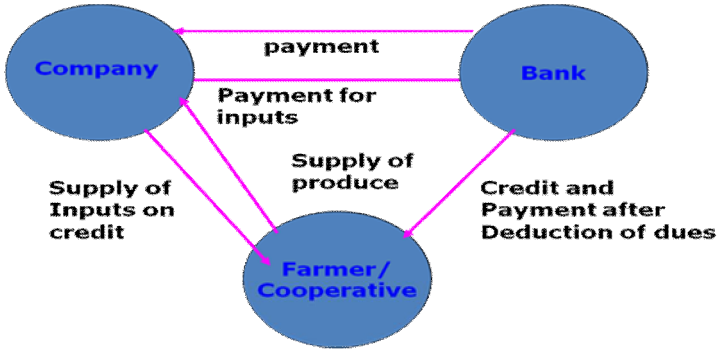
Models of Contract Farming

There are several models of contract farming working in India. These models are based on number of stakeholders involved in CF. The models vary from crop to crop. The pictorial representation of these models are given below.

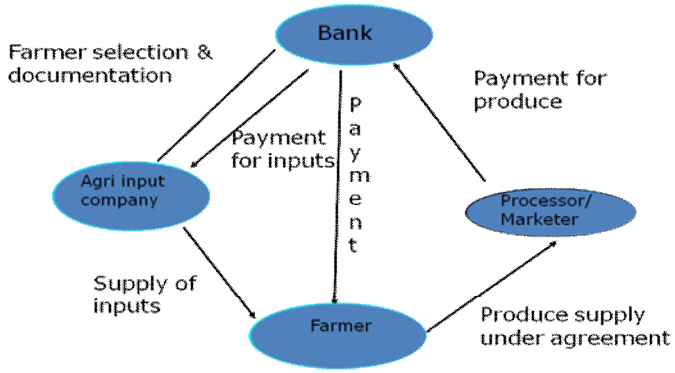
1. Bi-partite model



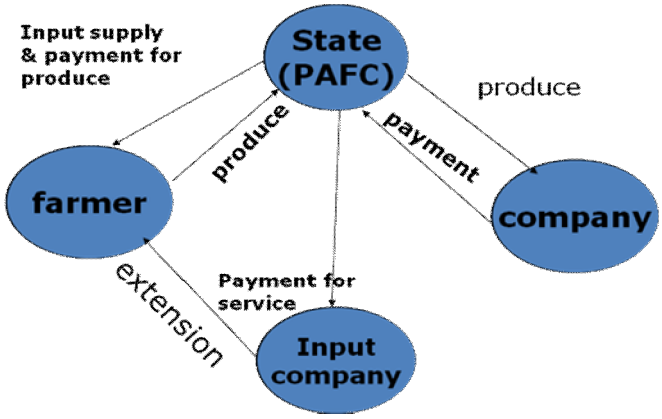
2. Tri-partite Model



3. Quad-partite model



4. Multi-partite model



Advantages of Contract Farming

For farmers

- Inputs and production services are often supplied by the sponsor.
- This is usually done on credit through advances from the sponsor.

- Contract farming often introduces new technology and also enables farmers to learn new skills.
- Farmers price risk is often reduced as many contracts specify prices in advance
- Contract farming can open up new markets, which would otherwise be unavailable to small farmers

For Sponsors

- Contract farming with small farmers is more politically acceptable than, for example, production on estates.
- Working with small farmers overcomes land constraints.
- Production is more reliable than open-market purchases and the sponsoring company faces less risk by not being responsible for production.
- More consistent quality can be obtained than if purchases were made on the open market.

Limitations of Contract Farming

For Farmers

- Particularly when growing new crops, farmers face the risks of both market failure and production problems.
- Inefficient management or marketing problems can mean that quotas are manipulated so that not all contracted production is Purchased.
- Sponsoring companies may be unreliable or exploit a monopoly position.
- The staff of sponsoring organizations may be corrupt, particularly in the allocation of quotas.
- Farmers may become indebted because of production problems and excessive advances

For Sponsors

- Contracted farmers may face land constraints due to a lack of security of tenure thus jeopardizing sustainable long-term Operations.
- Social and cultural constraints may affect farmers ability to produce to managers specifications.
- Poor management and lack of consultation with farmers may lead to farmer discontent.

- ❖ Farmers may sell outside the contract (extra-contractual marketing) thereby reducing processing factory output.
- ❖ Farmers may divert inputs supplied on credit to other purposes, thereby reducing yields.

Contract Farming Generally Works Quite Well under following conditions

a) The contracted commodity does not have significant direct consumer market, as in case of plantation crops (tea, coffee etc.), sugarcane or seeds.

b) The company offers fair price and adequate risk cover;

c) The company ensures timely payment since ñfarmers are loyal to moneyò.

d) The produce is new, exclusive, unique, not normally cultivated in the region (for example poplar in case of WIMCO; Gherkin production).

e) Company provides needed planting materials and inputs;

f) Both parties believe in mutually beneficial relations.

g) Trust relationship is built up over a long period of time.

h) There are strong self-regulatory social systems (social control) among the growers.

i) Contract is properly designed, clearly understood by grower farmers and sincerely Implemented.

Conclusion

In the present world of liberalization, privatization and globalization contract farming is a viable option for large as well as small farmers. Contract farming system should be viewed as a partnership between agri-business and farmers. This is more important in potato since prices of potato are highly volatile and farmers incur heavy losses. Through contract farming, they can get assured market and price for their crop. The government has to play a very active role to protect interests of, especially small farmers. Present legal framework and contract laws need reforms and a Contract Farming Regulatory Agency can be established at the district level to govern and regulate CF.

Development of Agri-preneurs through Fruit Processing

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Introduction: In the present scenario of shrinkage of agricultural land, land fragmentation, and climate uncertainty, agriculture alone becomes less profitable venture. As results, a large proportion of rural youth has been migrating towards town or cities. This phenomenon has lead to imbalanced economic growth between rural and urban area. This condition can be mitigated though generate alternative employment opportunity in rural areas. Establishing an agro-processing industry could change the economy of rural areas. Among various agro-processing sectors, fruit processing received special attention. Since India is the second largest producer of fruits and wide ranges of fruits are available throughout the year, the establishment of fruit processing industry can generate a new window of opportunity to agri-preneurs. In the present article some basic aspect of the establishment of fruit processing is discussed.

Prerequisite of fruit processing: Practically any fruit can be processed, but some important factors which determine whether it is worthwhile are:

a. The demand for a particular fruit in the processed form;

b. The quality of the raw material, i.e. whether it can withstand processing;

c. Regular supplies of the raw material.

A particular variety of fruit which may be excellent to eat fresh is not necessarily good for processing. Processing requires frequent handling, high temperature, and pressure. For example, a particular variety of mango or pineapple may be very tasty eaten fresh, but when it goes to the processing centers it may fail to stand up to the processing requirements due to variations in its quality, size, maturity, variety and so on. In addition to this, after selection of variety for processing, their availability must be ensured. Even when a variety can be processed, it may not be available at large scale. An important processing center or a factory cannot be planned just to rely on seasonal gluts; although it can take care of the gluts it will not run economically unless regular supplies are guaranteed. To operate a fruit processing center efficiently it is of utmost importance to pre-organise growth, collection, and transport of suitable raw material, either on the nucleus farm basis or using out growers.

1. **Site selection:** Fruits are perishable in nature, therefore it is better to locate a processing unit in the area where they are grown. This reduces transport costs and

also reduces the amount of handling, which means that crops are more likely to be in good condition when they arrive at the processing unit. If they are in good condition, they can be stored for a few days before they have to be processed.

Besides, there are following other basic facilities should be present in the processing area

a) Continuous supply of electricity
b) Adequate supplies of potable water.
c) Availability of skilled and unskilled labor
d) Accessibility for the workers and staff (public transport, distance down an access road)
e) Presence of metallic road
f) Presence of basic facilities for the staff (e.g. schools, medical facilities, ATM, shops and entertainment).

2. Processing systems

*Small-scale Processing***:** This is done by small-scale farmers for personal subsistence or for sale in nearby markets. In this system, processing requires little investment: however, it is time consuming and tedious. Until recently, small-scale processing satisfied the needs of rural and urban populations. However, with the rising rates of population and urbanization growth and their more diversified food demands, there is a need for more processed and diversified types of food.

Intermediate-scale Processing: on this scale of processing, a group of small-scale processors pools their resources. This can also be done by individuals. Processing is based on the technology used by small-scale processors with differences in the type and capacity of equipment used. The raw materials are usually grown by the processors themselves or are purchased on contract from other farmers.

*Large-scale Processing***:** Processing in this system is highly mechanized and requires a substantial supply of raw materials for economical operation. This system requires a large capital investment and high technical and managerial skills. Because of the high demand for foods in recent years, many large-scale factories were established in developing countries.

3. Production planning: Production planning involves thinking ahead to make sure that everything is in place to produce the required amount of product. Inadequate planning causes stoppages in production. The short harvest season for fruits means that everything must be in place and working properly at the start of the harvest so that enough fruit can be processed to produce sufficient product for the following year. The amount of less perishable ingredients, such as sugar, salt or spices and packaging materials should be sufficient in stock.

If production stoppages happen too frequently, the amount of product available for sale falls to a level where the business cannot afford to pay the bills and it fails. Successful business people manage their cash flow, so that enough money is available to buy the inputs needed for production, before income is received from the sale of products. To do this they plan their production carefully.

4. **Processed products:** Fruit can be processed to various kinds of product. Some of them are enlisted bellow.

- ✓ Fruit pulp/puree (mango pulp, guava puree)
- ✓ Dried fruit (Fig, pineapple and banana)
- ✓ Fruit wines (Grape, cashew apple)
- ✓ Fried snacks (banana chips)
- ✓ Juices (mango, litchi, apple, pineapple)
- ✓ Squashes and cordials
- ✓ Frozen fruit (mango dice, papaya dice, pomegranate arils)
- ✓ Jams, jellies and marmalades
- ✓ Candy and preserve (aonla, karonda, bael)
- ✓ Bottled fruits
- ✓ Chutneys and pickles

Domestic market: India is second largest populated countries. Therefore, there are huge marketing opportunities. A major fruit product which have domestic market demands are ready to drink beverage, particularly fruits from mango, litchi, guava, pomegranate, etc. Besides this, demand of candied fruit is also good. Demand of dried fruit products such as banana chips, jackfruit chips, dried fig, dried nut have been increasing in domestic market. Pickle of karonda, lime; jam and jellies from various fruits have a good demand.

Export market: India has huge scope in international market. Mango pulp is the major processed product which is exported to various countries like Saudi Arabia, Netherland, Yemen Republic, United Kingdom and United Arab Emirates. The main varieties of Mango Pulp are Alphonso Mango Pulp, Totapuri Mango Pulp, Kesar Mango Pulp. Two main clusters of Mango Pulp are there in the country, which has around 65 processing units with a good backward linkage of Alphonso and Totapuri variety of mangoes. These clusters are Chittoor in the state of Andhra Pradesh and Krishnagiri in the state of Tamil Nadu. Some of the processing units are in the state of Maharashtra and Gujarat. India has exported 135621.22 MT of mango pulp to the world for the worth of Rs. 864.97 crores / 129.29 USD millions during the year 2016-

17. Beside mango pulp, other various processed products are exported to various countries are apple juice, dried apricots, grapefruit juice, jam and jellies of apple, jam, jellies of other various kinds of fruits, lemon juice, pineapple juice, cherries, dried apples, nuts, grape juice, mango juice, olives, etc. They are exported mostly to the United States, Netherland, United Kingdom, Saudi Arabia, and United Arab Emirates. Apart from these products, fruit wine also has good scope of export. In this regards Maharashtra has emerged as an important state for the manufacture of wines. There are more than 35 wineries in Maharashtra, and around 1,500 acres of grapes are under cultivation for wine production in the state.

5. Processing equipment: The equipment required for fruit and vegetable processing is described in the following section. A summary of the spare parts, maintenance and cleaning requirements is shown in Table 1.

Table 1 Details are given below for individual items of equipment.

Equipment used	Spare parts kept in stock	Maintenance required	Cleaning
Airlocks	None	None	After use with detergent and clean water, followed by sterilization using dilute bleach
Blanchers	None	None	Daily after use with detergent and clean water
Boiling pans/ pasteurisers	None	None	Daily after use with detergent and clean water
Bottle coolers	None	None	Weekly wipe with damp cloth
Bottle washer	None	None	Weekly wipe with damp cloth
Bottlebrush	None	None	None
Corers	Replacement of blade	None	Daily after use with detergent and clean water
Corkers	None	None	Weekly wipe with damp cloth
Crown cappers	None	None	Weekly wipe with damp cloth
Cutting boards	None	None	Daily after use with detergent and clean water
Deep fat fryers	Electric heating Element (electric	Periodic check of temperature and	Periodic (monthly) removal of oil and

	versions)	thermostat setting	cleaning

Dicers	**Replacement blade**	**Periodic blade sharpening**	**Daily after use with detergent and clean water**
Dryers	Plastic covers, Preferably UV resistant	Replace polythene cover each year or replace polyester cover every 3-5 years	Cleaning trays after use with detergent and clean water
Energy saving Charcoal stove	None	None	Clean out ashes daily
Fermentation tanks	None	None	After use with detergent and clean water, followed by sterilisation using dilute bleach
Fillers	None	None	After use with detergent and clean water
Filters (wine, juice)	Filter cloths or pads	None	After use with detergent and clean water, followed by sterilisation using dilute bleach
Food grade drums	None	None	After use with detergent and clean water, followed by sterilisation using dilute bleach
Freezer	None	Periodic de-icing	Periodic cleaning with detergent and clean water after de-icing
Fruit crushers	Motor drive belt, bolts, fuse	Monthly check belt tension, bearings, condition of wiring and bolt threads	After use with detergent and clean water
Fruit presses	None	Periodic check for wear on screw and bearing	After use with detergent and clean water
Gas burners, Gas cylinder	None	None	After use with detergent and clean water
General tools, work tables	None	None	After use with detergent and clean water
Heat sealers	Heating element	None	Weekly wipe with damp cloth. Remove any burned-on plastic immediately

Hosepipe and spray gun	**Washer for spray gun**	**None**	**Weekly wipe with damp cloth.**
Hydrometers – alcohol and brine	None	None	After use with detergent and clean water
Insect proof door	None	None	Weekly wipe with damp cloth.
Insulated filling tank	None	Periodic check on accuracy of temperature gauge	After use with detergent and clean water, followed by sterilisation using dilute bleach
Jam thermometer	None	None	Carefully wipe with a clean cloth
Labellers	None	Daily, check guide position	Daily - wipe down surface with damp cloth
Laboratory glassware & equipment	None	None	After use with detergent and clean water, rinse with distilled water
Liquidisers	Fuse	Monthly, check bearing tightness.	Periodic blade sharpening. After use with detergent and clean water
Motor, isolator, and starter	None	Weekly check on wiring and bearings	Weekly wipe down with clean cloth
Packing table	None	None	After use with detergent and clean water
Pasteurising kettle	None	None	After use with detergent and clean water
Peelers	Replacement blade	None	After use with detergent and clean water
pH meters	Buffer solutions, probe	Monthly standardisation	Wipe carefully with damp cloth after use
Pot sealers	Heating element	None	Weekly wipe with damp cloth
Preparation table	None	None	After use with detergent and

			clean water
Pressure cooker	None	None	After use with detergent and clean water

Protective gloves, hats, hairnets, coats, boots	**None**	**None**	**Weekly laundry for coats, daily washing of boots. Others laundry as required**
Pulper finishers	Motor drive belt, bolts, fuse	Monthly check belt tension, bearings, condition of wiring and bolt threads	After use with detergent and clean water, with particular attention to the screen
Reamers	None	None	After use with detergent and clean water
Refractometer	None	None	Wipe carefully with tissue paper and rinse with distilled water
Scales	None	Monthly standardisation with known weights	Weekly wipe with damp cloth
Sulphuring cabinet	None	None	Clean trays after each batch with detergent and clean water

6. Quality assurance: All fruit products should have a marketable quality and also be safe for consumers to eat. Even at the smallest scale of production, the processor should develop a Quality Assurance (QA) system to ensure this. The following steps are needed to develop a system:

1. Look at every stage of the process, from raw material selection to distribution of products and identify the factors that could affect either product quality or safety
2. Develop procedures to monitor and control these factors so that they do not cause a

Problem

The basis of QA is to prevent problems from arising, rather than trying to cure them afterwards. Factors that should be examined include the ingredients, particularly any spices that might be contaminated with micro-organisms, the acidity or moisture content of the product and the amounts of any preservatives that are used. Additionally, any sources of contamination from buildings or water supplies should be included (Section 2). The stages in a process where an error could affect the safety of a product are known as

Critical Control Points (CCPs) and these are the stages that should be given more attention.

It is important to train all staff to operate the QA procedures that are devised. They should know the limits that are put on any variation from the specified processing method and everyone should understand his or her responsibilities for ensuring that high quality products are made. It is also important to develop reporting procedures and keep records. There should be a plan of what must be done if the process limits are exceeded. Workers should know who has the authority to make decisions and who is responsible for checking that the correct action is taken.

7. **Government schemes & policies:** Several schemes have been formulated by the Government of India to provide financial support and aid for establishing modern infrastructure, FPUôs, research & development support and human resource development and other promotional measures to encourage the growth of the industry. Below mentioned is a glance on selected schemes:

Food Park Scheme*:* A total financial assistance of US$ 23 million has been given by the Government of India to implement Food Park Scheme. Across India, it has approved 50 food Parks to boost the overall food industry.

Packaging Centers*:* This Scheme aims to provide packaging facilities for enhancing the shelf life of the product. In Jammu & Kashmir, Rs 1450 million has been approved for one packaging center in Jammu & Kashmir.

Integrated Cold Chain Facility*:* During 10th Plan, financial assistance of Rs. 4010 mn have been approved for 3 cold chain facilities in Maharashtra, 1 each in U.P., Kerala, Manipur, A.P., Haryana, Delhi and Goa.

Value Added Centre*:* The intention of the value added center scheme is to enhance value addition leading to enhanced shelf life. 3 Value Added Centers, 1each in Maharashtra, H.P., and Punjab have been established.

Focus on Infrastructure*:* Around India, ***60*** Agri Export Zones have been set up. The Ministry of Food Processing Industry has formulated Vision 2015; Government of India plans to establish 30 mega food parks in public- private partnership mode.

Incentives for development of storage facilities*:* For establishing and operating cold chain facilities and storage facilities, investment linked tax incentive of 100 per cent deduction of capital expenditure has been done.

Focus on R&D and modernization: Setting up / up gradation of Quality Control/ Food Testing Lab, R&D and promotional schemes are the initiatives launched by the Government of India.

Production: Agriculture Ministry, Government of India, has launched The National Horticulture Mission (NHM) with the objective of the objective of doubling the production of horticulture by 2001-12 by end to end approach covering research, post harvest management, processing and marketing in a mission mode for smallest & marginal farmers.

Food Safety and Standards Act (Integrated Food Law, 2006): The objective of this law is to gain the consumer confidence in the quality and safety aspect of the product.

Excise Duty Reduction: Excise Duty reduction on fruits & vegetables, export of fruit product are allowed freely, for establishing a fruit processing industry, no industrial license is required.

Conclusion: Diverse climatic condition enables India to grow wide ranges of fruit. Huge quantities of fruits are wasted during post harvest handling and marketing. Processing of these fruits into various kinds of product not only stabilizes the fresh fruit market, it also creates opportunity for employment of rural youth. Government of India has various programs for processing of fruits. Educated youth should come forward to harness the opportunity and make India developed.

Role of Farm Mechanization in Reference to Market Led Extension

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Introduction

Tools, implements, and machines are essential and major inputs to agriculture. Mechanizations generally used an overall description of the application of these inputs. Three sources of farm power viz. manual (human), animal draft and motorized power are utilized for these tools, machines, and equipment. In many developing countries up to 80% of farm power is provided by human beings. However, in developed countries mostly machines are used as the source of power.

In Indian scenario, where the expansion of agricultural land is limited, advanced crop husbandry inputs such as improved seed, fertilizer, and pesticides, as well as increased use of irrigation water cannot be realized without the use of implements and machines. The average farm size in India is small (1.16 ha) and small and marginal land holdings (less than 2.0 ha) account for 85% of land holdings (Mehta *et al.,* 2014). In situations where land is not a constraint, increased farm power can lead to direct increases in production by simply increasing the land area or animal numbers that one man can handle.

The changes in population growth, urbanization, and market dynamics, impact directly on farming making it more market-oriented and competitive. These trends have an effect on farmers who need to develop their skills and competencies to cope with these changing farming scenarios. Farmers need assistance from extension workers to better manage and run their farming businesses for profit. For many extension workers, however, business management is often a challenge as their experience and practice have largely been focused on agricultural production and technology transfer. To provide support to farmers it is critical that extension workers understand some of the concepts and practices of farm business management which is now market oriented and apply to their day-to-day extension work.

Market Led Extension and its purpose

Market Led Extension is the Market ward (towards market) orientation of Agriculture through Extension. Most of the decisions regarding the profitability of any cropping system are based upon market indices viz. market price of the product, their price in different *mandis*, availability of the product in offseason etc. Earlier extension approach was production driven.

Though the production has increased dramatically, small and marginal farmers are generally prone to sell their produce on ñas is where basisò due to several constraints like lack of market, lack of transport facilities, perishability of raw product, repayment of personal hand loans and to meet domestic needs. With the

globalization of market, farmers have to transform themselves from producers-sellers in the domestic markets to producer cum seller in a wide market. To achieve this, farmers need to know answers to questions like what to produce, when to produce, how much to produce, when and where to sell, at what price and form to sell his produce. This is known as market oriented farming.

Market-oriented farming is driven by making profits through selling farm products in the market on a regular basis. Market-oriented farms can still be strongly linked to a farm household, but the goals and decisions for the farm are less directly influenced by the goals and decisions of the farm household. They are more influenced by markets, prices of produce and the costs of farm inputs.

Purpose of market led extension:

a) Availability of inputs at the door steps of our farmers
b) Transforming farmers from producer to producer cum seller
c) Reorienting the farming community to market driven agricultural practices
d) Sensitizing farmers on various aspects on quality, consumerôs preference, market intelligence, processing and value addition and other marketing information
e) Increasing the horizon of extension worker from production knowledge to market information.
f) Increasing farm efficiency and enhancing profitability

Status of Farm Mechanization in India

Crop cycle requires different types of machinery for activities such as seedbed preparation, sowing/planting, fertilizer application, irrigation, and harvesting. There are a lot of machineries/implements/tools to be used for a single crop. Seed bed preparation and harvesting operation are fairly mechanized while seeding and planting are less mechanized (Fig. 1 & Table 1)

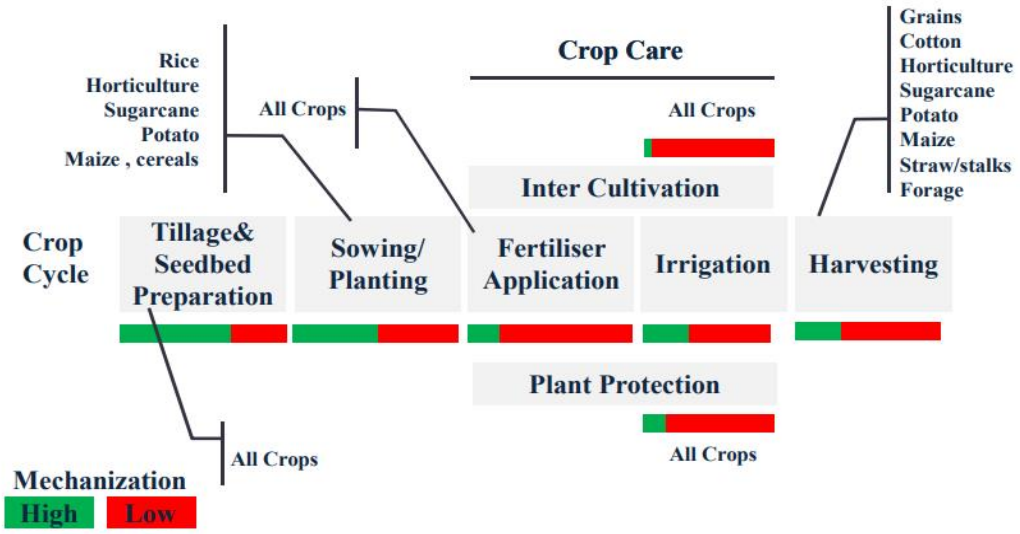

Fig 1. Status and need extent of mechanization

(Source: Singh, 2014)

Table 1 Level of mechanization in India

Sl. No.	Operation	Percentage
1	Soil working and seed bed preparation	40
2	Seeding and planting	29
3	Plant protection	34
4	Irrigation	37
5	Harvesting and threshing	60-70 % for wheat and rice >5% for others

(Source: Singh, 2014)

The sale of tractors in India has grown at a CAGR of 10.64 % from 217,456 in 2001-02 to 661,431 in 2012-13 during the last 11 years. The power, sale of tractors in India during the last 13 year is shown in Fig. 2.The trend shows that sale of more than 37 kW tractors increased from 7.3 % to 13.8 % during the last thirteen years (2000-2013). Similarly, the sale of tractors in the range of 31-37 kW increased from 14.1 to 36.4 % during the same period (Table 2). It indicates that requirement of higher power category tractors in India increased. During the same period, the sale of medium power tractors (23-30 kW) decreased from 55.0 to 40.4 % and low power tractors (15-

22 kW) from 23.0 to 6.3 %. The sale of less than 15 kW tractors was only 3.13 % during 2012-13(Mehta *et al.,* 2014).

Table2: Percentage of Tractor sales according to their power

Year	Tractor Power (kW)				
	>37 kW	31-37 kW	23-30kW	15-22 kW	<15 kW
2000-01	7.3 %	14.1%	55.0%	23.0%	-
2012-13	13.8 %	36.4%	40.4%	6.30%	3.10%

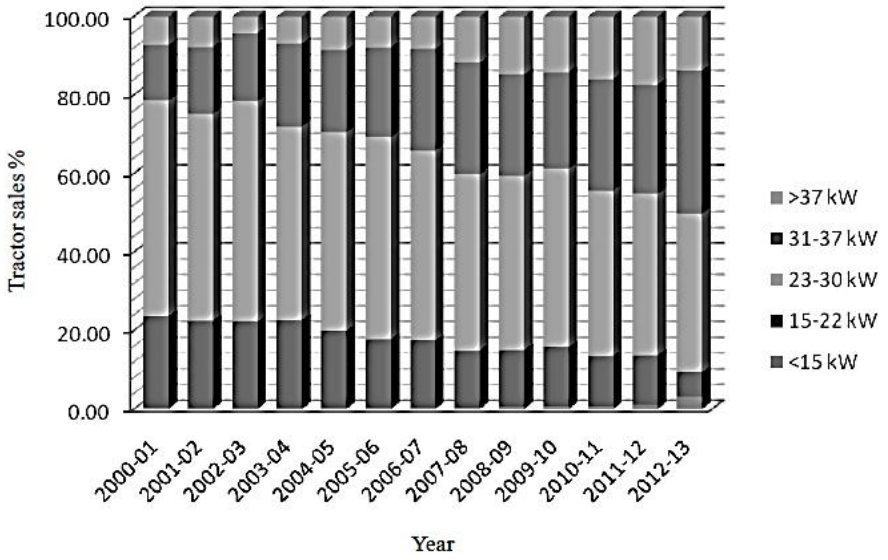

Fig. 2: Power wise sale trend of tractors in India

The current market for power tillers in India is estimated at 56,000 numbers during 2013-14 (Fig. 3). The market for power tillers in India is mainly concentrated in the eastern and southern parts of the country owing to the small land holdings per farmer in these regions and high cultivation of rice crops.

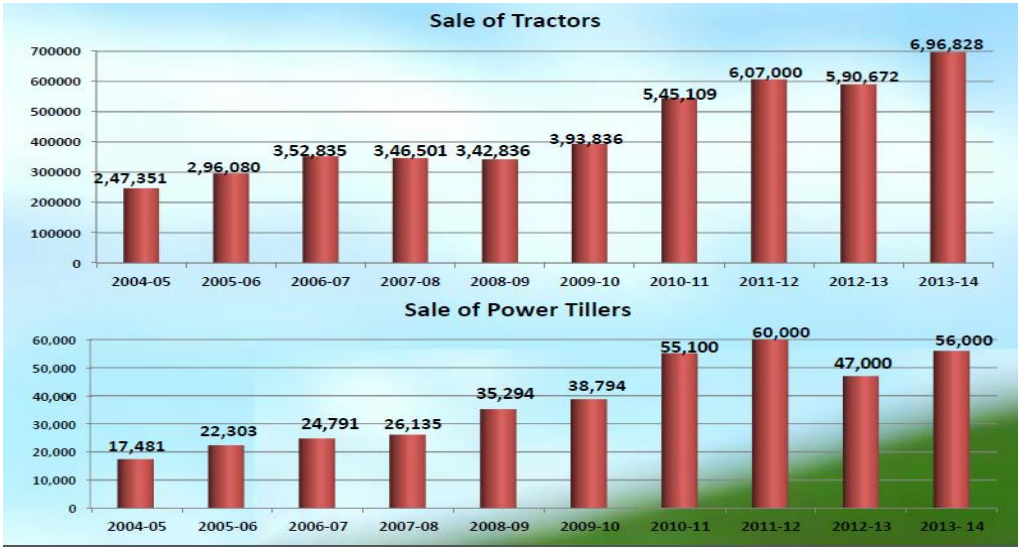

Fig. 3Sale of tractors and power tillers in India

(Source:http://www.un-csam.org, 2015)

It is very strange that power tillers, which are essentially mini-tractors should logically be preferred over tractors by Indian farmers, given that almost 85 percent of them have farm holdings of less than two hectares in size. But the scenario is totally different (Fig. 3). Even small and marginal farmers prefer to own or hire a tractor rather than the more affordable power tiller. While the annual market for tractors is roughly around 600,000 units, the market for power tillers is well below 60,000 units and that too mostly in the southern and north-eastern states. The main limitation in a power tiller is that someone needs to walk behind it to guide its movement. Also, it cannot be used for transport purpose as a tractor can be.

Table 3 presents the market overview of the major agricultural machinery used in India. From the table, it is estimated that the highest annual requirement is 100,000 for threshers and followed by 60,000-80,000 for rotavators, and 25,000 for power weeders. Light weight power weeders are also required for hilly terrains.

Table 3 Market Overview of the major farm machinery used in India

Sl. no.	Name of machinery	Market size annually
1	Tractor	6,00,000
2	Power tiller	56,000
3	Combine harvester	4,000-5,000
4	Thresher	1,00,000
5	Rotavator	60,000-80,000

6	Rice transplanter	1,500-1,600
7	Self-propelled vertical conveyer reaper	4,000-5,000
8	Zero till seed drill	25,000-30,000
9	Multi crop planter	1,000-2,000
10	Laser land leveler	3,000-4,000
11	Power weeder	25,000

(Source: Mehta *et al.,* 2014)

Major Constraints in Farm mechanization in India

Land size, cropping pattern, the market price of crops, availability of labour and cost of labor are the major factors deciding the agricultural mechanization. These challenges pose a serious obstacle to the growth of the industry and agriculture. The key challenges faced by the farm mechanization in India (Mehta and Pajnoo, 2013) are as follows:

i) The average farm size in India is small (1.16 ha) as compared to the European Union (14 ha) and the United States (170 ha). Due to small size of land holdings, it is difficult for the farmers to own machinery. As a result, the benefits of mechanization are enjoyed by only a section of the farmers who have large farm holdings.

ii) Mechanizing small farms is against ǿconomies of scaleô especially for operations like land preparation and harvesting. With continued shrinkage in average farm size, more farms will fall into the adverse category thereby making individual ownership of agricultural machinery progressively more uneconomical.

iii) Matching equipment for tractors, power tillers and other prime movers are either not available or farmers make inappropriate selection in the absence of proper guidance, resulting in fuel wastage and high cost of production.

iv) The high cost and energy efficient farm machinery are capital intensive and the majority of Indian farmers are not able to acquire these assets due to the shortage of capital with them.

v) Cropping pattern decides the extent of mechanization required for timely operations and achieving optimum results. The scope of mechanization increases with intensivecropping pattern.

vi) The quality of farm implements and machinery manufactured by small scale industries in the country is generally not of desired standard resulting in poor-quality work, longer down time, low output and high operational cost.

vii) The after sales service of farm machinery is the other main concern in India as the majority of farmers are cost conscious. There are inadequate service centers for proper upkeep of the machinery.

Role of Farm Mechanization in Market Led Extension

Just like various agriculture inputs farm machines are also an important input which led towards farm efficiency and enhancing profitability. A farmer receives most of the production technologies from extension system. Both farmer and extension worker must know the appropriate choice and subsequent proper use of mechanized inputs into agriculture as they have a direct and significant effect on achievable levels of land productivity, labour productivity, the profitability of farming, the environment (Clarke, 2000).

In the past, inappropriate selection and use of certain mechanization inputs (mainly tractors and heavy machinery) have, in many parts of the world, led to heavy financial losses and lowered agricultural production as well as contributed to environmental degradation and soil compaction. Despite the high cost, mechanization is an input like any other such as fertilizer, seed and crop protection chemicals. It is one of a number of management tools a farmer has available to maximize production and profit. In many developing countries, politically motivated tractor schemes have often become a burden to the national budget and the farming community rather than being a productive input (Clarke, 2000).

Basics of Market Led Extension

a) *Product oriented implements/tools*: It is very important to know what are the different tools/implements/machineries are available in the market. There is some specialized machinery for specific crop viz. sugarcane planter, potato planter/harvester etc.

b) *Updated knowledge of market*: Updated knowledge of different machineries/implements will help in wisely choosing them and using them for their crops.

c) *Market intelligence*: Today many service providers are available which provide implements on need basis. So Instead of owning a costly machine, a machine can be hired.

d) *Use of technology*: Many technologies are now helpful in increasing the efficiency of the system viz. an irrigation pump can be stopped/started remotely by using a mobile phone. It is necessary that farmers as well extension persons should know that such technology even exists.

e) *Appropriate extension approaches*: Extension persons should guide farmers in taking the decision regarding purchasing/hiring of any implement or machine. They should evaluate the economics of using them.

Roles of Agricultural Extension Personnel in light of Market-Led Extension

Extension personnel plays a vital role in dissemination the technology and their know-how which are available in the market. They have played their role tirelessly in the transfer of production technologies from lab to land beside the agricultural scientists, farmers, and marketing network.

a) SWOT analysis of the machinery purchase: They must do SWOT analysis of the machine before they are being suggested by them to the farmers. Should this be purchased by a single farmer or a group of farmers?

b) Supporting and enhancing the capacities of locally established groups under various schemes/programmes.

c) Enhancing the interactive and communication skillsof the farmers.

d) Collateral requirements should be realistic and physical access to sources of credit should be facilitated.

e) Establishing marketing and agro-processing linkages between farmersô groups, markets and private processors.

f) Educating the farming community. Different farms require different types and sizes of machines. One farmer may wish to purchase hand and animal draft equipment and rely on these for his farming; another may wish to purchase a tractor for both i.e. his own use and to carry out contracting services for his neighbours. As long as both are viable there is no reason why they should not have the choice.

g) Capacity building of Farmers groups in terms improved production, post-harvest operations, storage and transport and marketing.

h) Acquiring complete market intelligence by keeping in touch with engineering colleges of different Agricultural Universities, different government websites regarding implements etc.

i) Regular usage of internet facility through computers to get update on market intelligence.

j) Production of video films of success stories of community specific farmers

Required information to extension system and farmers

a) The present agricultural scenario and land pattern: Land pattern helps in choosing the right size of machinery for a farmer.

b) Suitability of land holding to various crops: Crop should be selected on the basis of its market price, land holding size and type of machineries available.

c) Knowledge of different machines used for different operations.

d) Different dealers of tractor and other machineries available in local market.

e) Repair and maintenance facility for implements

f) Credit facilities- Implements/machinery is very costly. Hence Credit from bank helps farmers to arrange quality of input required for production. Extension personnel should know the basic criteria for getting credit from financial institutions.

g) Subsidies on farm machines provided by different Government agencies.

h) Desired qualities of the products desired by consumers- needed for competitive marketing.

i) Harmful effect of mechanization viz. use of combine harvester leads to burning of the straw by the farmer.

j) Market network of the local area and the price differences in various markets.

k) Proper storage and warehouse facilities for machines.

l) Post-harvest management like processing, grading, standardization of produce, value addition, packaging, storage, certification, etc. with reference to food grains, fruits and vegetables, eggs, poultry, fish, etc. value addition is the process of changing or transforming a product from its original state to a more valuable state.(Rajalahti *et al.,* 2008)

m) Using tractor for transport purpose.

n) Post-harvest management - processing, grading, standardization of produce, value addition, packaging, storage, certification, etc.

o) Contract farming- Contract farming that helps infusion of new technology and capital in farm business should be popularized and encouraged.

p) They must know the contacts of different institutes working on crop specific machines. There are several institutes which are involved in design and development of commodities specific machinery (Table 4).

Table 4: Details of some institutes involved in development of machineries for different commodities.

Sl. No.	Commodities/Activities	Government/private institute
1	Maize	National database on post-harvest machinery/equipment (ICAR-CIPHET, Ludhiana), ICAR-Indian Institute of Maize Research, New Delhi, ICAR-CIAE, Bhopal, All Agricultural Universities
2	Paddy	National database on post-harvest machinery/equipment (ICAR-CIPHET,

		Ludhiana), ICAR-NRRI Cuttak, All Agricultural Universities
3	Wheat	National database on post-harvest machinery/equipment (ICAR-CIPHET, Ludhiana); ICAR-CIAE, Bhopal, All Agricultural Universities;ICAR-IARI, New Delhi,ICAR- Indian Institute of Wheat and Barley Research, Karnal
4	Pulses	National database on post-harvest machinery/equipment (ICAR-CIPHET, Ludhiana); ICAR-IIPR, Kanpur; ICAR-CIAE, Bhopal; ICAR-IARI, New Delhi
5	Oilseeds	National Database On Post-Harvest Machinery/Equipment (ICAR-CIPHET, Ludhiana); ICAR-IIOR, Hyderabad; ICAR-Directorate Of Groundnut Research, Junagadh; ICAR-Directorate of Rapeseed Mustard Research , Bharatpur; ICAR- Directorate of Soybean Research, Indore
6	Fruits	ICAR-Indian Institute of Horticultural Research, Bengaluru; ICAR-Central Citrus Research Institute, Nagpur; ICAR-Central Institute of Sub tropical Horticulture, Lucknow; The ICAR-National Research Centre for Litchi, Muzaffarpur, Bihar; ICAR-Research Complex for Eastern Region, Patna;
7	Cotton	ICAR-Central Institute for Research on Cotton Technology, Mumbai;ICAR-Central Institute for Cotton Research, Nagpur, Maharashtra
8	Jute and other fibres	ICAR-National Institute of Research on Jute and Allied Fibre Technology, Kolkata
9	Cassava (Tuber crops)	ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala
10	Fish	ICAR-Central Institute of Fisheries Technology, Kochi, Kerala;
11	Post-harvest Processing	ICAR-CIPHET, Ludhiana; Indian Institute of Crop Processing Technology, Thanjavur, Tamil Nadu; ICAR-Indian Institute of Spices Research, Kozhikode (Calicut), Kerala; ICAR-Central Institute for Cotton Research, Nagpur, Maharashtra; Directorate of Cashewnut& Cocoa Development;Central Food Technological Research Institute, Mysore, Karnataka

Challenges faced by Agricultural Extension Personnel in light of Market-Led Extension

Knowledge about suitable farm machines is indispensable for extension personnel. This will help the farmer in wisely choosing tools/implements without much cost burden. They should try to have a linkage between farm machines retailer and farmer. They should regularly enquire about the new machines available in the market. They should not be influenced by the retailer and impose any such machines which are not cost effective to the farmer. Extension personnel should analyze the crop coverage area and accordingly decide the suitability of a machine, either to be procured for a single farmer or group of farmers. Certain machines like combine harvester are very costly (10-15 lakhs rupees). Extension personnel should examine that how much area of wheat is there in the locality which can be harvested, are

farmers willing to pay for its rental service. They should have economical arithmetic in mind before purchasing a costly machine. There are other challenges as well which are listed below:

a) The challenge is to motivate the extension personnel to learn the new knowledge and skills of marketing along with knowledge about relevant machines useful for farmers.

b) A whole network of skilled personnel needs to be engaged in the collection of current information and creation of relevant websites pertaining to/serving specific needs of farmers.

c) They must have know-how of different custom hiring models suitable for farmers.

d) There is a need to upgrade basic facilities and free the extension cadres from the shackles of the red tape and enthuse them to look forward for the motivating factors like achievement, job satisfaction, recognition etc.

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Improving Water Productivity through High-tech Irrigation

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Water is one of the scarcest natural resources in India. Out of all uses of water, around 80% of it is used by agriculture. But the share of water in agriculture will be decreased by 10 to 15 % in next two decades. With the passage of time water availability is decreasing and India is fast approaching a stage of water scarce country and decreasing per capita water availability. This situation requires better and efficient utilization of water. Improving water productivity through modern irrigation techniques is one of the solutions to this emerging problem.

The role of water in the development of the plant is immense. Ninety percent of the plant body is constituted by water. It is essential for creating a favorable climate for seed germination, plant growth and uptake of nutrient. Photosynthesis activity can be possible only in the presence of water. It regulates temperature and humidity for its growth and helps in the chemical, physical and biological reaction in the soil. Judicious use of water as irrigation is todayôs need for growing the better crop.

Water productivity (WP): Water productivity is defined as yield (expressed in terms of mass or value) per unit of water used. It me be expressed in two ways.

Physical Water Productivity -

WP = Production (kg/ha)/ Water applied (m^3/ha) expressed in kg/m^3

Economic Water Productivity -

EWP = Production (Rs/ha) Water applied (m^3/ha) expressed in Rs/m^3

Different aspects of water productivity

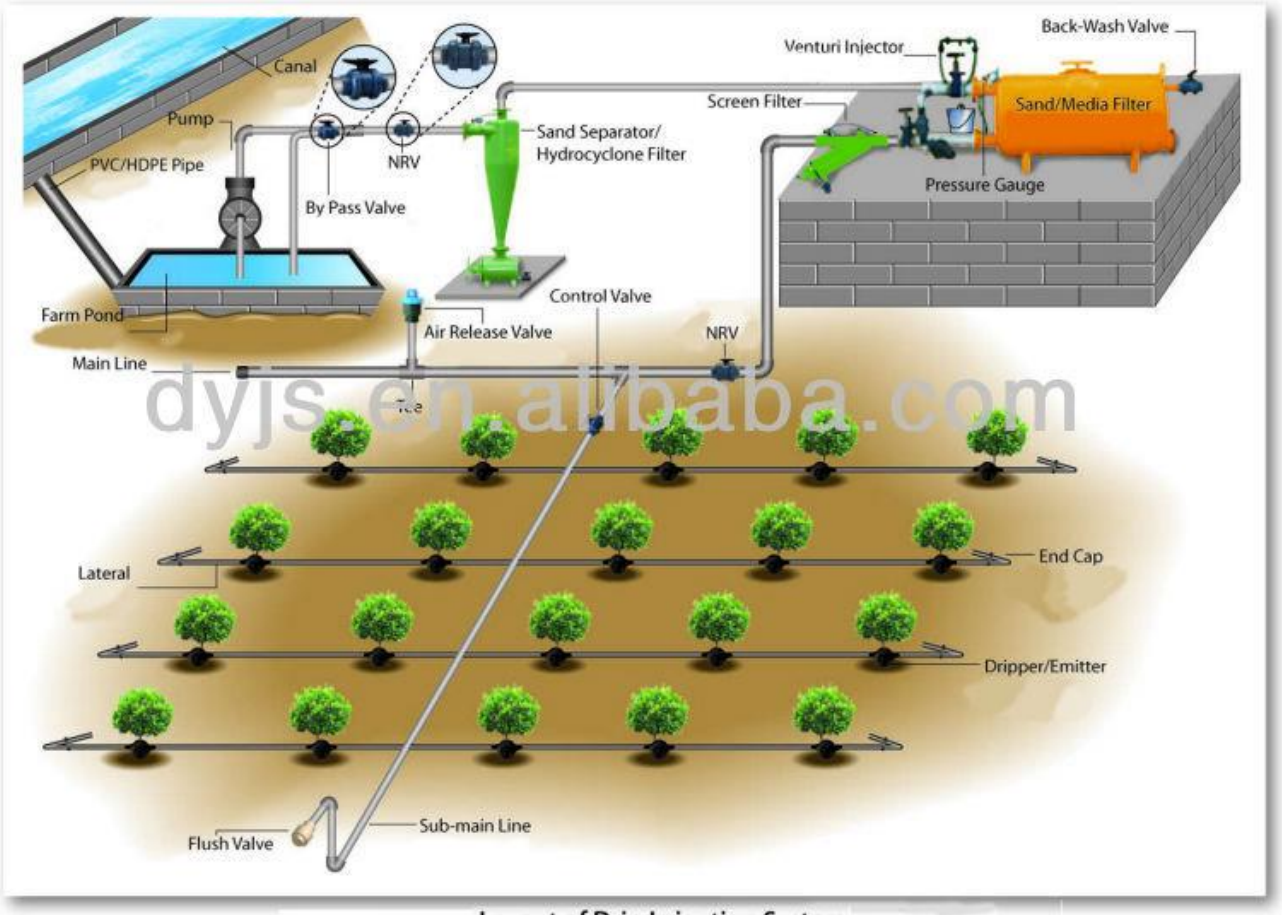
Improving WP is possible, but maximizing WP is not always a potential option. Improving physical WP in water scarce basins could harm the end users. In water scarce areas increasing economic WP is a better option. Maintaining physical WP within the sustainable limits of water use is desirable. Improvement in water productivity can be done by efficient and modern irrigation technique such as application of micro irrigation e.g. drip and sprinkler irrigation systems.

Drip Irrigation

Drip irrigation system, also known as trickle irrigation, is based on the fundamental concept of irrigating only the root zone of the crop rather than the entire land surface. It consists of a large network of pipelines through which water is carried and applied nearer to the plant root zone through an emitting device. Even application of water at a low rate to the plant root zone at frequent intervals to suffice the crop water requirement. It can be used in a variety of tree crops as well as vegetable, cash

crops and flowers e.g. mango, litchi, grape, banana, orange, pomegranate, capsicum, cauliflower, tomato, cucumber, sugarcane, marigold rose etc.

Layout of Drip Irrigation System



Layout of Drip Irrigation System

Source: www.dyjsenallbaba.com

Components of Drip Irrigation system

A. Head Control Unit

Control head of drip irrigation includes the following components

i) Pump unit or Overhead tank ii) Non return valve iii) Non return valve iv) Air release valve iv) pressure gauge v) Filters: a) Media filter, b) Hydro-cyclones or centrifugal filters or sand separators, c) Screen filters vi) Fertigation unit a) Fertilizer tank b) venturi injector c)fertilizer injection pump

B. Distribution network

i) Main pipe
(ii) Sub-main pipe

ii) Fittings of main and sub main pipes
iii) Laterals
iv) Fittings of laterals
v) Emitting devices
    a) Inline drippers
    b) Online drippers

Type and number of emitters chosen must wet adequate root volume. Flow rates of emitters must supply the peak daily needs of water when operated on a schedule allowing sufficient off time so that soil saturation and consequent root impairment are avoided.

Advantages of Drip Irrigation System

- Water and labor saving
- Fewer disease and pest problems
- No soil erosion
- Enhanced plant growth and yield
- Controls weed
- Energy saving
- Most suitable for water scarce area
- Most suitable to poor soils
- Economy in cultural practices
- Possibility of using saline water
- Improves water & fertilizer use efficiency
- Flexibility in operation

Sprinkler Irrigation System

Sprinkler irrigation simulates like rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air and irrigated entire soil surface through spray heads so that it breaks up into small water drops which fall to the ground. It is ideally suitable for hilly terrains with undulating slope. To operate one sprinkler head to cover a diameter of 12 m 1.0 - 3.2 kg/cm^2 pressure is needed. Use of sprinkler early in the morning and late in the evening is preferable to minimize the evaporation losses.

Components of Sprinkler Irrigation System

A. Pumping unit

i) Main line: It carries water from the source (pumping unit) to the various parts in the field. Portable and fixed types are available.

ii) Sub main: It carries water from main to lateral lines.

ii) Lateral Lines: It carries water from main or sub main pipe line to the sprinkler head through the rise pipe. They are portable and equipped with quick coupling devices

B. Sprinkler head: used for spraying water on the fields they may be-

- Rotating Head
- Fixed Head Type
- Fixed Head Type: Used in landscape

Sprinkler head - classified on basis of pressure

1) Low operating pressure sprinkler (1.5 to 2.5kg/cm^2)
2) Intermediate pressure sprinkler (2.5 to 5kg/cm^2)
3) High pressure sprinkler (5 to 10kg/cm^2)

Advantages of Sprinkler Irrigation System

- Suitable for a complete range of topographies and field dimensions.
- Suitable to all types of soil except heavy clay.
- Elimination of the channels for conveyance, thereby reducing conveyance loss
- High irrigation efficiency due to uniform distribution of water.
- Water saving up to 30 -75%
- Increase in yield from 20 to 40%
- Saves land as no bunds etc. are required and more land is available for cropping.
- Land leveling is not essential.
- Soluble fertilizer, herbicides and fungicides can be applied in the irrigation water economically and with little extra equipment
- Suitable for irrigating crops where the plant population per unit area is very high. Sprinklers are also used to irrigation high valued plantation crops like, coffee, cardamom and orchards apart from irrigating close growing crops like pulses and cereals.
- Mobility of system which provides ease of operation
- May also be used for undulating area

- Influences greater conducive micro-climate
- Areas located at a higher elevation than the source can be irrigated easily
- Possibility of using soluble fertilizers and chemicals

Fertigation: Fertigation is the technique in which chemical fertilizers are applied to the field with the help of micro irrigation system for achieving better fertilizer use efficiency. With the help of fertigation the yield of a crop can be increased in the range of 10 to 15%.

Advantages of Fertigation

- High fertilizer use efficiency
- Controlled application of nutrients and water
- Increased flexibility of fertilizer application
- Allows better timing of application correlated with crop growth stage
- Allows small dosage application
- Minimizes leaching and negative environmental impacts
- Increased water use efficiency
- Potential to reduce fertilizer inputs, reducing production costs

Strategies to Reorient Agricultural Extension Functionaries towards Market Led Extension

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The public and private extension system in India has gone through a large number of changes both in institutional as well as functional level. The older extension system was focussed on the production of agricultural produce to provide food security to the Nation. Most of the extension activities were limited to providing input and technical know how to farmers for increasing their productivity. After liberalization, privatization and Globalization phenomena in the Indian economy during the 1990s, several sweeping changes occurred in agriculture sector also. Several multi-national companies entered the Indian market for selling of agricultural inputs like seed, fertilizers, pesticides etc. Some of them entered in processing and value addition sector also. They slowly and steadily captured a large chunk of the Indian market. With this, there was a major change in marketing system of produce. Indian farmers had to compete with their global counterparts for selling of their produce at a higher price. This demands production of good quality produce and proper sorting, grading, labeling, storage etc. In the backdrop of these changes, Extension system in India also changed.

The public extension system in the country is heavily burdened with the performance of several types of activities in the field. Extension system acts as a liaison between the researcher and farmer. They are endowed with the responsibility of conveying research findings from the scientists to the farmers and providing feedback or impressions of the farmers to the scientists. The new dimension of ómarketingô is a major challenge and can become an agenda beyond their comprehension and capability. The public extension system is already under severe criticism for its inability to deliver the services. In the light of this, the challenge remains to motivate the extension personnel to learn the new knowledge and skills of marketing before assigning them marketing extension jobs to establish their credibility and facilitate significant profits for the farming community. Extension cadre development poses a new challenge to the newly designed role. The present extension system suffers from several limitations of stationery, mobility, travel allowances, personal development, etc. There is a dire need to upgrade these basic facilities and enthuse them to look forward to the motivating factors like achievement, job satisfaction, recognition etc.

The most effective means of bringing small and marginal farmers into a new market economy and increase their farm income is the intensification of farming system and diversification of from traditional crops to high-value crop/livestock enterprises. These modifications require following

a. Appropriateness to agro-ecological and natural resource conditions of the area.

b. It should reflect the resource endowment of predominant farm households.

c. It must anticipate new and/or expanding marketing opportunities.

Intensifying and diversifying farming system will require an interdisciplinary team of trained scientists and extensionists who can work together to assess, validate more profitable production system to the different group of farmers.

New Concepts of Customer oriented marketing

- The consumer is the king and therefore, the satisfaction of the consumer must be the prime object.
- Needs and wants of the customers must be identified properly and deeply before starting production. Production must be in accordance with these needs and wants.
- All the resources of production must be utilized to their best extent, so that the cost of

  production may be minimized.
- Profits must be increased only by reducing the cost of production or by reducing the cost of sales and not by increasing the selling price.
- Every activity of an enterprise must start with the consumer and end with the satisfaction of the consumer.
- Stresses upon marketing research.

Crisis arising for extension system in India in light of new challenges

1. Knowledge-skill Input Crisis: Besides the production technologies, the extensionists now, have to get equipped with market information which requires further training to the extensionists and additional funding.

2. Effectiveness Crisis: Already, the extension system is under criticism. With the increase and enriched role, they have to perform multiple activities to prove their efficacy.

3. Credibility Crisis: Even with all the market knowledge and efficacy in performing their role, the extension system may face the credibility crisis due to rapid and unexpected changes in the market.

4. Reorganization Structure Crisis: With assumption of new roles, the organization structure may be prone to changes and the system has to adjust itself to this shock

Reorientation to Changing role of extension functionaries for Market Led Extension

- ✓ SWOT analysis of the market: Strengths (demand, high marketability, good price etc.), Weaknesses (the reverse of the above), Opportunities (export to other places, appropriate time of selling etc.) and Threats (imports and perishability of the products etc.) need to be analyzed about the markets. Accordingly, the farmers need to be made aware of this analysis for planning production and marketing.

- ✓ Organization of Farmersô Interest Groups (FIGs) on the commodity basis and building their capabilities with regard to management of their farm enterprise.

- ✓ Supporting and enhancing the capacities of locally established groups under various schemes / programmers like watershed committees, users groups, SHGs, water usersô associations, thrift and credit groups. These groups need to be educated on the importance, utility and benefit of self-help action.

- ✓ Enhancing the interactive and communication skills of the farmers to exchange their views with customers and other market forces (middlemen) for getting feedback and gain the bargaining during direct marketing ex. Rythu Bazars, Agri-mandi, and Uzavar Santhaigal etc.

- ✓ Establishing marketing and agro-processing linkages between farmersô groups, markets and private processors

- ✓ Advice on product planning: selection of crops to be grown and varieties suiting the landholding and marketability of produce will be the starting point of agri-enterprise.

- ✓ Extension system plays an important role in providing information in this regard

- ✓ Educating the farming community: to treat agriculture as an entrepreneurial activity and accordingly plan various phases of crop production and marketing

- ✓ Direct marketing: farmers need to be informed about the benefits of direct marketing. In some of the states, Rytu Bazars in AP, Apni Mandis in Punjab and Haryana and Uzavar Santhaigal in Tamilnadu have shown success

- ✓ Capacity building of FIGs in terms of improved production, post-harvest operations, storage and transport and marketing

- ✓ Acquiring complete market intelligence regularly on various aspects of markets.

  Regular usage of internet facility through computers to get updated on market intelligence

- ✓ Publication of agricultural market information in newspapers, radio and Television besides internet

- ✓ Organization of study tours of FIGS: to the successful farmers/ FIGs for various operations with similar socio-economic and farming systems as the farmers learn more from each other

- ✓ Production of video films of success stories of commodity specific farmers

- ✓ Creation of websites of successful FIGs in the field of agribusiness management with all the information to help other FIGs achieve success

Information Domains for Extension Professionals in Market led extension

- Present agricultural scenario and land use pattern
- Suitability of land holding to various crops/enterprises
- Crops in demand in near future
- Market prices of crops
- Availability of inputs
- Usage of inputs
- Credit facilities

- Desired qualities of the products by consumers
- Market network of the local area and the price differences in various markets
- Network of storage and warehouse facilities available
- Transport facilities
- Regular updating of market intelligence
- Production technologies like improved varieties, organic farming, usage of bio-fertilizers and bio-pesticides, IPM, INM, and right methods of harvesting etc.
- Post-harvest management like processing, grading, standardization of produce, value addition, packaging, storage, certification, etc. with reference to food grains, fruits and vegetables, eggs, poultry, fish, etc.
- Contract farming
- Private modern terminal markets
- Food retail chains
- Food safety and quality standard
- Certification
- WTO regulations

Conclusion:

The focus of the extension functionaries need to be extended beyond production. Farmers should be sensitized on various aspects of quality, consumerôs preference, market intelligence, processing and value addition and other marketing information. This will help the farming community to realize high returns for the produce, minimize the production costs, and improve the product value and marketability

Improving Farmers Income through Commercial Litchi Production and its Marketing

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Introduction

Presently, about 54% of the population in India is involved and dependent on agriculture for livelihood. Despite the economic progress the country has made in past decades, with agriculture contributing its due share, the people directly involved in food production have not witnessed a proportionate improvement in income generation and economic status. For the equitable progress of every section of the society, it is therefore very important to improve the income and means of livelihood of this vast proportion of Indians involved in agriculture. The Government of India has initiated the process for doubling the farmerôs income by the year 2022. An important tool in this endeavour is by means of the greater adoption of agricultural technologies and proper marketing of produce.

Litchi is one of the most important commercial crops in Bihar, with the state contributing to about 40% share of the country`s area and production. Tens of thousands in Bihar are dependent on the fruit for livelihood. Litchi is harvested during the hottest months of the year (May-June). The harvested fruit is highly perishable and rapidly loses its bright red colour to dull brown within hours. Therefore, harvested litchi normally needs to be immediately marketed so that growers realise good prices and generate income. However, a very common practice in Bihar is the system of marketing where the orchards are auctioned to pre-harvest contractors (PHC) who take over the responsibility of marketing. This ultimately results in poor income generation among litchi growers as they have negligible influence in deciding the final price that the consumers pay.

Marketing of litchi is, therefore, an important component of litchi enterprise. It is the one single step that ultimately decides the quantum of income among growersand separates the risk-takers from the ones that play safe, from lowly earners to high-income earners. In this chapter, we discuss such marketing channels, and ways and means of modern marketing that can be beneficial for litchi growers in realising high income from their produce. Additionally, marketing of litchi also depends on the production of good quality fruit. Thus, significant emphasis is also laid on new concepts and technologies in litchi production system.

MARKETING

As mentioned earlier harvested litchi needs to be marketed immediately after harvest before the fruit turns brown. Alternatively, depending on availability of infrastructural facilities the produce can be stored for up to a month at 4-6ºC and 55-60% RH before distribution to retailers. Due to short shelf life and high perishability, marketing of litchi involves a great deal of risk. Therefore, it is quite uncommon to find litchi growers who undertake self-marketing of their produce.

Marketing channels

There are three main marketing channels through which litchi are marketed. The most prevalent practice is through the involvement of pre-harvest contractors, who take over the orchards and pay a pre-agreed amount after the produce has been marketed. In the second channel, the producers sell directly to the wholesalers who then distribute it to the retailers and finally reach the consumers. The third channel involves village level agents and commission agents who directly procure and market the produce. It is quite obvious that the main profiteer out of these channels is the pre-harvest contractors, as they are able to buy from the farmers at a relatively low price and make a good profit on its sale, although it can also be argued that they take all risk in the process. It is therefore quite evident that farmers can increase income from litchi fruit if they are able to change the way they market their produce. This can happen either through entrepreneurship in small scale-direct marketing or through farmer cooperatives. In this regard, policy decision towards improving infrastructural facilities for cold storage and logistics is essential.

Figure 1.Predominent marketing channels for litchi in Bihar

E-market place

In this modern age, there exists the tremendous potential for growth of e-marketing of agri-horti produce. Consumers today are highly conscious of what they purchase and consume, in ways like never before. Consumers are also willing and able to pay more for the produce of assured quality. E-marketing coupled with modern logistics already exists for specialty fruits, vegetables, and spices. The same

can be achieved in case of litchi, and only requires a change in the way the farmer has been marketing his produce. E-marketing also ensures modern day marketing requirements such as traceability and assurance of product quality. It helps in changing the pattern of conventional marketing from one where the seller looks out for the buyers to the other way round.

Litchi Treatment Plant – An experience on NRCL-BARC collaboration

Short shelf life has remained a constraint in the successful marketing of litchi to distant markets. The Bhabha Atomic Research Centre (BARC), Mumbai has developed a litchi treatment technology which can increase the shelf life of litchi up to 60 days. ICAR-NRC Litchi in collaboration with BARC established a litchi treatment facility based on this technology, and during the litchi season of 2017, farmers and entrepreneurs were able to treat their produce to the tune of 15 MT. The treated litchi was then marketed to distant metropolitan cities in India. Although just the beginning, this experience goes on to show that with improvement in cold storage infrastructure and logistics, litchi growers can expect to increase income through direct marketing.

NEW CONCEPTS AND TECHNOLOGIES IN LITCHI PRODUCTION

As the nodal agency that provides leadership at the national level in all aspects of research and development in litchi production and utilization for all end-users, ICAR-NRC litchi has been instrumental in the development of several technologies to make litchi cultivation and profitable and attractive enterprise.

Improved varieties

Shahi and China are leading commercial cultivars in Bihar. Recently, three new varieties of litchi have been released by ICAR-NRC on Litchi. These are GandakiSampada, GandakiLalima, and GandakiYogita.

Increasing farm income through nursery management

In addition to the marketing of litchi fruit, nursery management is another aspect which can provide high income to farmers. The availability of good quality planting material is one of the most important impediments to low productivity of fruit crops in general. ICAR-NRCL has developed and refined nursery practices in litchi for obtaining round the year air-layers, increasing the success rate in propagation and improving the survival of air-layers and potted plants in the nursery.

Canopy architecture management and HDP

Litchi is conventionally planted at a wider distance to provide adequate space to the growing plant. However, if left unattended the litchi tree can grow a huge and dense canopy that is difficult to manage in terms of orchard operations. Canopy architecture management is a vital component of litchi production system. It involves the development of strong tree frame in the initial plant growth stages and maintaining optimum space for vegetative and reproductive growth in subsequent bearing stages. Poor canopy management results in overcrowding of branches, less air circulation, and poor light penetration inside the canopy. These increase the number

of unfruitful branches or terminals. Proper canopy management helps in enhancing the use of natural resources, eases orchard operations, and provides opportunity and scope for mechanization and adoption of modern approaches for higher fruit production and quality enhancement. Planning for canopy management in litchi includes understanding the tree`s growth and fruiting behaviour, the tree architecture intended to be established, and striking a balance between vegetative growth and fruiting.

Increasing cropping intensity under litchi ecosystems

Since litchi is a perennial tree with long juvenile phase, the initial few years after planting can be less remunerative. The interspaces can be efficiently utilized by introducing suitable intercrops, so as to increase income during the unproductive years.Raising intercrops during initial years of litchi plant growth not only generates orchard income but also controls weeds. Intercropping or cover cropping with suitable and synergistic crops improves soil fertility and supplements organic matter to the soil. Short duration annual crops such as vegetables are best suited for use as intercrops. Some crop combinations for interspaces of litchi plants include: Cabbage (Oct.-Feb.) ï Cowpea (March-June) ï Fenugreek (July-Sept.); Okra (Sept.-Dec.) ï French bean (Jan.-March) ï Tomato (April-July); Potato (Nov.-Feb.) ï Amaranth (March-May) ï Cowpea (June-Aug.) ï Radish (Sep.-Oct.); Cauliflower (Aug.-Nov.) ï Potato (Dec.-March) ï Dolichos bean (April-July). Fast-growing and early-bearing fruits trees such as guava, papaya, citrus or phalsa can also be grown as intercrops/fillers during the pre-bearing years of litchi to provide additional income to growers.

Regular fruiting through girdling and application of chemicals

Irregular bearing at the young stage of the litchi plant is a constraint in litchi, particularly in cv. China. This phenomenon happens in litchi due to failure to bloom owing to the continuous vegetative growth of the tree. Girdling is the complete removal of a strip of bark, and underlying cambial tissue, from around the entire circumference of a limb/branch of the plant. Girdling operation is performed in litchi after the plant has produced the second vegetative flush, which corresponds to last week of August or first week of September under Muzaffarpur conditions. The operation is done by removing 2-4 mm wide bark 3-4 mm deep around the entire circumference of the limb using a sharp pruning saw. Girdling ensures flowering and fruiting in the ensuing season. Alternatively, flowering and fruiting can be ensured through the application as PGRs (Ethrel, KNO_3, and paclobutrazol).

Integrated pest management

One of the biggest production problems in litchi is the infestation of litchi fruit and shoot borer. This insect can incur losses to the tune of up to 70% if unmanaged. Litchi fruit borer population can be kept at bay by adopting an integrated pest management schedule. Precautionary measures include adopting good orchard management such as the pruning of infested twigs in June, field sanitation, and

removal of young fallen fruits. A prophylactic spray of a neem-based formulation (4mL/L) when new flush emerges during September-October, and a preventive spray of neem oil (4mL/L) before flowering can be done. Integrated management schedule includes two sprays of systemic insecticide viz. thiacloprid or imidacloprid @ 0.5 ï 0.7 mL/L during September at 15 days interval. This should be followed by a spray of Novaluron 10 EC @ 1.5 mL/L when fruit attains clove size, cypermethrin 25 EC @ 0.5 mL/L 25-30 days after fruit set, and another spray of novaluron 10 EC @ 1.5 mL/L about 10 days before expected harvest.The other two pests that can cause widespread damage include bark-eating caterpillar and litchi mite. Both can be easily managed by adopting integrated management schedule developed by the centre.

Bunch Bagging

Bagging of litchi fruit bunch is a low cost, eco-friendly, sustainable, and economically viable technology that improves fruit quality. Non-woven polypropylene bags have been found superior in terms of conferring physical protection against entry of insect pests and reduce sunburn and fruit cracking by creating a shading effect and favourable in-package micro-climate. For best results bagging operation is done one month before harvest. Bagging also lowers production cost as growers can forgo chemical sprays.

HARVEST AND POSTHARVEST TECHNOLOGIES

Successful litchi marketing begins with adopting improved practices to produce high quality fruit and harvesting at the right fruit maturity stage. Fruits harvested too early may not be as visually attractive and sweet, while those harvested late may not keep longer. It is therefore important to harvest the fruit at the right stage for optimum postharvest life and quality.

Harvest maturity in litchi

Litchi fruit should be harvested during the early morning hours, as much as possible. Maturity indices include colour, calendar days, days from full bloom, TSS, acidity etc. However, our experience with fruit quality determination indicates that the ratio of TSS over acidity (TSS: Acidity) is the most important indicator to judge harvest maturity in litchi. The Litchi should be harvested when TSS: acidity is more than or equal to 40.

Sorting and grading

Cracked, sunburnt, diseased, insect-infested, and other culls should be sorted from the lot. Fruits of uniform size and colour should be graded together.

Precooling

Litchi is harvested during hot summer time and is a highly perishable fruit. Harvested fruits rapidly lose moisture and dehydrate, resulting in what is commonly known as pericarp browning. If left exposed and unattended, harvested produce exhibit a complete change of colour from attractive red to dull brown within 48 hours. Such brown fruits lose market value due to severe impact on consumerôs decision to

purchase. Therefore, it is very important to remove field heat (Precool). Precooling can be easily achieved by dipping the fruit in chilled water (5ºC) for 15 min, which brings down the pulp temperature from about 30ºC to 10ºC. Thereafter, the fruit should be surface dried before packaging.

Packaging

Although different packaging materials are conventionally used in litchi, CFB boxes with polythene liners are recommended owing to their uniformity, durability, and stability. They can be staked over each other, offer considerable strength, and are relatively cheap. Litchi fruit should neither be under-packed or over-packed to avoid vibration and compression injury, respectively.

Storage and transportation

As already mentioned litchi is a highly perishable fruit and loses its marketability within a short time. There is no alternative to cold temperature storage and all postharvest treatments to improve shelf life and quality are to complement the cold storage. Litchi can be successfully stored at 4-6ºC and 55-60% RH for up to four weeks. The transportation of litchi should be done on refrigerated vans/trucks, and cold chain integrity should be maintained throughout the long and difficult journey from harvest to consumer.

Conclusion

Litchi is an important fruit in the Indo-Gangetic plains, along the foothills of the Himalayas. If successfully marketed the fruit can be highly remunerative and bring prosperity to its many growers, concentrated especially in Bihar. With improvement and refinement of production and postharvest technologies, there is ample scope for obtaining the high yield of quality fruit and successful handling of litchi fruit after harvest. Although the presence of pre-harvest contractors is still predominant, policy changes and private investment in developing infrastructural facilities, logistics, and financial assistance can help farmers in shifting to self-marketing. This can revolutionize the litchi industry in not only making the fruit available to all Indians in every corner, but also increase the income of the litchi farmers manifold.

Agricultural Production Models for Livelihood Improvement

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Introduction

An NAIP (National Agricultural Innovation Project) Component- 3 sub project entitled ñSustainable Livelihood Improvement through Need based Integrated Farming System Models in Disadvantaged Districts of Biharò was implemented by ICAR Research complex for Eastern Region, Patna in participatory mode in four disadvantaged districts, namely, Vaishali, Darbhanga, Samastipur and Munger of Bihar. The project was planned to address farmersô centric livelihood security based on farmersô resources and perspective. The project envisaged to identify the target groups and to improve livelihood security of rural people through technology innovative farming systems encompassing wider process of social and economic change covering different stakeholders.A number of successful models were developed under the project in participatory mode. This paper discusses in detail the Makhana based IFS model for livelihood improvement giving a brief about the other successful models developed under the project.

Half Acre IFS Model for Small holders

Half acre integrated farming system model was developed in Chakramdas village of Vaishali district which included crop, buffalo, duck cum fish culture and backyard vegetable production. Vermi-compost was prepared with crop and livestock wastes. The cost benefit analysis showed six fold increase in net income (Rs 55578/-) over traditional cropping system (Rs 7528/-).

One Acre IFS Model for Small & marginal farmers

Similarly, one acre IFS model was developed in the same village with agri-horticrop-goat-poultry as the village is dominated by rice-wheat cropping system followed by fruits and vegetable production. The net return from the system was achieved at Rs 59428/- and gross return of Rs 235072/-.

Two and Half (2.5) ha IFS Model

Two and half hectare IFS model was developed in Chakramdas, Vaishali where 1 ha of land was kept for field crop production in which rice-wheat crop sequence was followed. A land of 0.6 ha was allocated for vegetable production, 0.05 ha for orchard, 0.02 ha for poultry rearing (500 Nos) and 0.012 ha for mushroom production. All around the field bund about 2.5 feet raised bunds was constructed where creeper vegetables were cultivated. With system 7-8 cow and buffalo were

also integrated (0.03 ha) and dungs were recycled. The net income from the system was recorded as Rs. 292825/-.

Makhana based IFS model for livelihood improvement

North Bihar is very rich in the availability of natural water bodies. Owing to the plenty of natural water bodies, it has ever been a natural hub of makhana production at the global level. Due to high depth of stagnant water, except makhana there is no scope of other crops in these water bodies. Further, due to lack of required inputs and proper agronomic management, the average productivity of makhana crop is very low (10-12q/ha). As a result, the economic condition of makhana growers is very poor. To solve this problem, makhana based integrated farming system seems to be the best answer through sustainable use of natural resources.

In this context, with a view to improve the livelihood of Makhana growers, through adoption of new technology, project entitled **"Sustainable Livelihood Improvement through Need Based Integrated Farming System Models in Disadvantaged Districts of Bihar"** was initiated w. e. f. April, 2008in 50 ha area of makhana ponds**.** Initially, this project was confined toSadar block of Darbhanga district only, where 96 traditional Makhana growers of 19 villages were associated with this project. But, during the year 2013-2014, the coverage area of this project was extended from one district to three districts (Darbhanga, Madhubani and Muzaffarpur) and system of Makhana cultivation widened from traditional ponds to shallow agricultural fields. During 2013-14, out of total 50 ha area, 36.4 ha wasallotted under pond system while rest 13.6 ha was covered under field system of Makhana cultivation. In both systems, apart from major component of Makhana crop, some other components like fish, water chestnut and rice were also incorporated to enhance the net income of Makhana farmers.

The details are summarized under two heads of Makhana based integrated farming systems, i.e. pond system and field system.

Pond System

Traditionally, Makhana is the crop of pond ecosystem. Till date, majority of Makhana growers for their livelihood are engaged in this system. Perhaps, this is due to availability of abundant natural water bodies in north Bihar. In these water bodies, generally, Makhana is grown as an orphan crop. The starting of this crop begins with the germination of Makhana seeds in the month of February. After 75-80 days of germination, the leaves of young saplings come out on the water surface and their exponential growth gets started. In the month of June, unsynchronized flowering and fruiting is appeared and it continues up to the month of August. After 35-40 days off lowering, the fruits become matured and their rupturing takes place. After rupturing of the fruits, for 2-3 days all the seeds float on the surface of water and later on they get settled in the bottom of water bodies. The process of bursting of fruits and deposition of seeds continue in an unsynchronized way by the end of crop period. After completion of the crop period, the harvesting (collection of seeds from bottom of

pond) of seeds is made by the skilled laborers. In this system, crop is ready for its harvesting by the month of August to October. The next cycle of crop is re-started in the month of February with the germination of left out seeds of previous Makhana crop. In this way,due to high depth of water, farmers do not utilize these water bodies for other crops. Hence, round the year, these water bodies are engaged in the monoculture of Makhana. Due to annual single crop, the net income of Makhana growers is very low.

Hence, in order to improve the economic condition of traditional Makhana growers, an effort was made to explore the potential of different component combinations namely, **Makhana+fish**, **Makhana-water chestnut**, **Makhana+fish-water chestnut** and **Makhana** in the ponds of Makhana growers. Out of total 36.4 ha pond area, 22.6 ha was allocated under Makhana+fish integration, 6.4 ha under Makhana-water chestnut, 4.65 ha under Makhana+fish-water chestnut and 2.75 ha under Makhana alone. To implement this integrated approach, a Makhana nursery was raised separately and in the month of March the healthy saplings were transplanted in the well prepared pond. The spacing was kept 1.20m between the plants and 1.25 m between the rows. After 15 days of Makhana transplanting, the integration of different carp fingerlings was made @ 5000 nos./ha. The ratio of these fingerlings was kept 40% for Rohu and 20% each of Catla, Common carp and Mirgal. The harvesting of Makhana is made between August and September. After harvesting of Makhana, water chestnut is transplanted as a tertiary crop and it is harvested in 4-5 pickings from October to November. The harvesting of fish is made in last of November to mid December. The results of different component combinations in pond system are presented in table 1.

Table 1: Economic analysis of different combinations in pond system of Makhana cultivation

Component combinations	Total area (ha)	Total production (q.)			Average productivity (q/ha)			Gross return (Rs)/ha	Net return (Rs) /ha
		Makhana seed	Fish	Water chestnut	Makhana seed	Fish	Water chestnut		
Makhana+Fish	22.60	336.74	140.12	--	14.86	6.75	---	2,05,270	1,02,635
Makhana-Water Chestnut	6.40	103.68	---	883.2	16.20	---	145.60	2,15,320	1,07,660
Makhana+Fish-Water Chestnut	4.65	67.33	17.06	641.7	14.48	3.67	138.00	2,53,010	1,26,505
Makhana	2.75	45.54	----	----	16.56	----	----	1,15,920	57,960

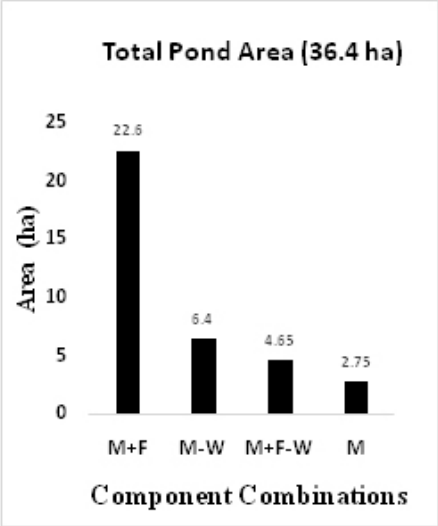

Fig-1:Total pond area for different omponent combinations.
(M-Makhana, F-Fish, W-Water chestnut)

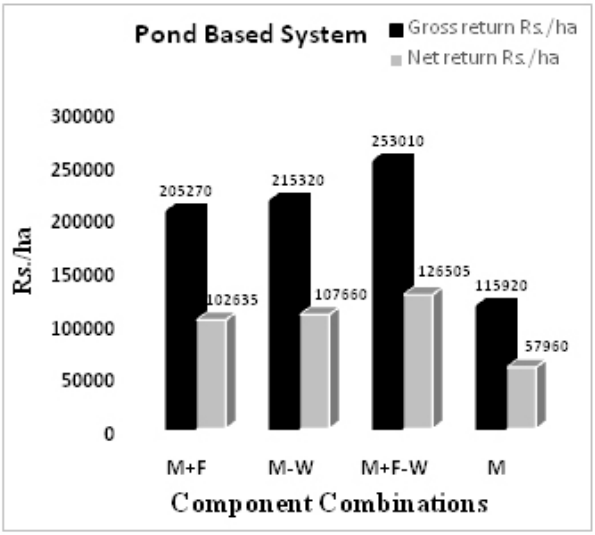

Fig-2: Gross and Net return of differentcomponent combinations in pond system of Makhana cultivation.

Fig. Pond based makhana + fish model

Fig. Pond based makhana - waterchestnut

Field System

This is entirely the new systemof Makhana cultivation. In this system,Makhana is cultivated in shallow water (1 ft.) condition in agricultural fields having clay soil of normal pH. In these fields, apart from the major crop of Makhana, some other crops / components **(Makhan+Fish, Makhana-Rice, Makhana-Water chestnut and Makhana alone)** can also be raised successfullyto enhance the net income of makhana growers. The seedlings of Makhana are raised in a separate

nursery block and then they are transplanted in a well prepared shallow field. Depending upon the availability of main field the transplanting can be made between the months of February and April. For integrated mode of makhana and fish cultivation, 10% area of the main field is left in the centre during the makhana transplantation and after 15 days of this the integration of fish is made. For this purpose, fingerlings of Rohu, Catla, Common carp and Mrigal (in the ratio of 40:20:20:20, respectively) are stocked @ 5000 nos. / ha. The harvesting of Makhana is made between July and August while the harvesting of fish is made in the month of November or December. In other option, after harvesting of makhana crop, either rice or water chestnut is transplanted as the next crop and by the end of November month these crops are over. The results of field system are presented in table-2 and illustrated with the help of suitable graphs (fig-c).

Table 2: Economic analysis of different combinations in field mode of Makhana cultivation

Component combinations	Total area (ha)	Total production (q.)				Average productivity (q/ha)				Gross return (Rs)/ha	Net return (Rs) /ha
		Makhana	Fish	Water chestnut	Rice	Makhana	Fish	Water chestnut	Rice		
Makhana + Fish	8.40	240.24	37.80	-	-	28.40	5.60	-	-	2,82,810	1,21,520
Makhana - Rice	3.00	90.72	-	-	123.60	30.24	-	-	41.20	2,73,480	1,16,322
Makhana - Water Chestnut	1.20	35.54	-	252	-	29.62	-	210.00	-	3,54,340	1,56,436
Makhana	1.00	31.56	-	-	-	31.56	-	-	-	2,20,920	88,368

Note: The average market price (Rs. /q) of fish, makhana seed, scented paddy and water chestnut is 15000,7000, 1500 and 700 respectively. The net profit of Makhana in field system is 40% of gross return while in pond system it is 50%.

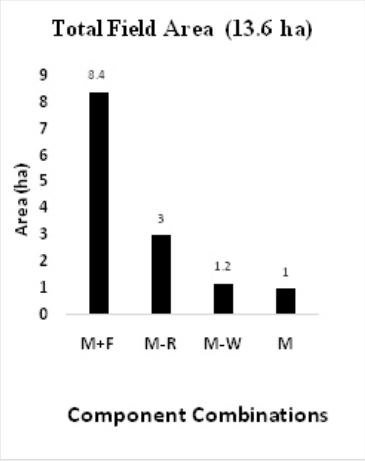

Fig-3:Total field area under different

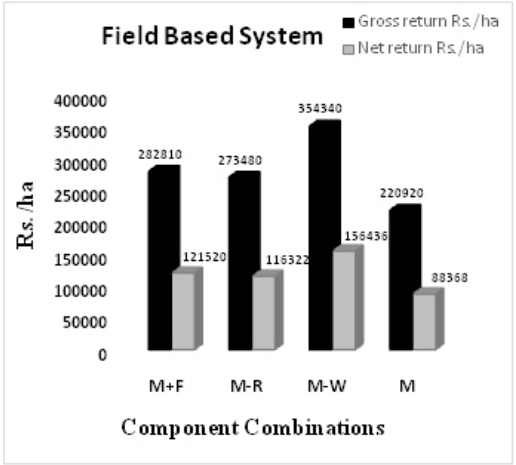

Fig-4: Gross and Net return of different component

component combinations combination in field system of Makhana cultivation. (M-Makhana, R-Rice, F-Fish, W-Water chestnut)

Fig. Field based makhana cultivation

Fig. Fish production in makhana fields

Fig. Harvesting of fish from makhana field

Fig. a view of harvested fish

Fig. a view of rice crop in makhana field

Fig. a view of water chestnut in makhana field

Results:

Pond system: In this system, thediagrammatic presentation of area under different component combinations and their gross and net monetary returns are illustrated in fig-1 and fig-2 respectively. While, data on all other aspects are given in table 1. From this table it is clear that in pond system, the maximum net return (Rs.126505/ha) was reported in **Makhana+fish-water chestnut** combination while the minimum value (Rs.57960/ha) was observed in **Makhana** alone. The net return of Makhana +fish (Rs.102635/ha) and Makhana-water chestnut (Rs.107660/ha) were found significantly higher than Makhana alone but on the other hand they were found significantly lower in comparison of Makhana+fish-water chestnut combination.

Field System: Infield systemthe diagrammatic presentation of area under different component combinations and their gross and net monetary returns are illustrated in fig-3 and fig-4 respectively. While, data on all other aspects are given in table 2. From this table it is clear that in field system, the maximum net return (Rs.156436 /ha) was reported in **Makhana -water chestnut** combination while the minimum value (Rs.88368 /ha) was observed in **Makhana** alone. The net return of Makhanaï rice (Rs.116322/ha) and Makhana+fish (Rs.121520/ha) were found significantly higher than Makhana alone but on the other hand they were found significantly lower in comparison of Makhana-water chestnut combination

Conclusion

The results of this project revealed that from economic point of view the integrated mode of Makhana cultivation is much better than the monoculture of Makhana in pond as well as field condition. Further, the comparative outcomes of different components in two integrated systems of Makhana cultivation revealed that in field mode the net monetary return of each component is significantly higher than the pond system. The value of this superiorityis 52.46%, 45.30% and 18.40% for Makhana, Makhana-water chestnutand Makhana+fish respectively. Among all combinations in both integrated systems, the highest net return (Rs.156436/ha) was observed for Makhana-water chestnut in field condition followed by Makhana+fish-water chestnut (Rs.126505/ha) in pond system, Makhana+fish (Rs.121520/ha) and makhana-rice (Rs.116322/ha) in field system of Makhana cultivation.On the basis of results of this project it is concluded that integrated farming system of makhana cultivation is an ultimate solution for the economic and social upliftmentof poor makhana growers.

Option of Fruit Based Production Systems for Increasing Income

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Fruit crops received special attention due to their multiple health benefit. As a results technologist and entrepreneur are trying to access the unexplored area for the production of fruit crops. In this context, growing of fruit crops in the eastern region of India receives special attention. In the eastern region of India, a vast tract of plateau area was not explored properly. Although there is less provision of irrigation, heavy rain can meet the water demand of fruit crops. Various technologies were developed which ensure the successful production of fruit crops in this region.

1. Fruit based multi-tier cropping system

The fruit based multi-tier cropping system is a self-sustainable system where solar energy can be harvested at different heights, soil resources can be efficiently used and cropping intensity is increased. The system consists of three main components such as, main crop; filler crop and inter crops which occupy three different tiers in the space of the production system.

The main crops: The main crops are the fruit species having a larger canopy size and prolonged juvenile as well as productive phase. They utilize the uppermost layer of the multi-tier system from which the economic productivity is obtained. Generally the crops utilize the entire land after 20-25 years, whereas, only 25-30 % of the land is effectively used up by the main crop up to 10 years. Under the multi-tier system, these plants are planted at wider spacing. Mango, litchi and aonla were found suitable main fruit crops. In addition to this, sapota, jackfruit, bael, and cashewnut can be used as main crops.

The filler crops: The filler crops are the fruit species which are precocious in nature, prolific bearers having short stature. They utilize the middle layer of the multi-tier system from which economic productivity is obtained. These plants are planted with the purpose to generate additional income from the land during the initial 10 years of the orchard (during the juvenile and initial bearing stage of the main crops) by utilizing the unused land and space. The plants are generally hardy in nature and have a shorter economic life than the main crops. The filler crops are planted within the main crop at a closer spacing. The filler plants can be removed after the main crops attain an effective canopy size for yielding economically. Guava, lemon, custard apple and drumstick were found as suitable filler crops.

Inter crops: The intercrops occupy the lowermost layer of the multi-tier system and are grown in the remaining unused land of the multi-tier system. Generally the

intercrops are the location specific annual crops, selected as per the climatic and socioeconomic suitability. The inter crops also include the dependant crops like creepers which are grown with the support of main or filler crops. During the initial years of the multi-tier system any crops can be taken whereas during the later years shade tolerant crops can be grown as inter crops. Turmeric, ginger, elephant foot yam was found suitable as inter crops. In addition to this ground nut and rice can be grown as intercrops depending upon the climatic condition.

Figure 1. Mango based multitier cropping system

2. High Density and Meadow Orchard planting System in Fruit Crops

High density planting technique is a modern method of fruit cultivation involving the planting of fruit trees densely, allowing small or dwarf trees with modified canopy for better light interception and distribution and ease of mechanized field operation. HDP gives higher yield as well as returns/unit area due to increasing the no. of the trees/ unit area. It is possible by regular pruning and use of bio regulators for maintaining the size and shape of the tree.

Table: 1- Spacing at different planting system in fruit crops

Sr. No.	Crop	Normal spacing (m)	HDP spacing (m)	Meadow spacing(m)
1.	Mango	7.5 X 7.5 - 12.5 X 12.5	3 X 2.5 ï 5 X 5	2.5 X 2.5 - 3 X 1
3.	Citrus	6 X 6 ï 8 X 8	3 -6 X 3 -4.5	-
4.	Papaya	2 X 2 ï 3 X 3	1.8 X 1.8	1.2X1.2 - 1X1
5.	Gauva	6 X 6 ï 8 X 8	3 X 3 ï 3 X 1.5	2X2 - 2X1
6.	Sapota	10 X 10	5 X 5	-

7.	Aonla	10 X 10	5 X 5	-

Components of HDP

1. Dwarf scion varieties
2. Dwarf rootstock varieties
3. Training and pruning
4. Suitable crop management practices
5. Use of bio-regulators
6. Planting density
7. Planting geometry
8. Mechanization

Use of dwarf scion: Various dwarf scion can be use for developing high density orchard. In mango amrapalli and in sapota PKM-1 and PKM-2 can be used.

Use of dwarf rootstock: Some of the dwarf rootstock can be used to induce dwarfness in high density planting (Table 2).

Table 2: Dwarf rootstock for HDP

Sr. No.	Crop	Varieties
1.	Mango	Vellaikolumban (Alphanso), Olour (Himsagar and Langra)
2.	Gauva	Pusa srijan, Psidium friedrichsthalianum, Aneuploid-82
3.	Citrus	Trifoliate orange, Sour orange, Citranges

Training and Pruning: Training and pruning are effective tools in HDP and meadow orcharding by virtue of their impact on the shape and size control of the tree. The training begins when the tree is first planted and continues throughout its productive life. Proper tree forms, branch angle and limb spacing in itself aids in growth control. First training is done after one growing season. Each plant is allowed to maintain single stem (main stem) with upward growth up to 60- 80 cm and then four scaffold branches are allowed in four directions to make the tree frame. Thereafter, 2 shoots arising from each primary branch at a distance of 60-75cm from main stem is allowed to form secondary and likewise the tertiary branches. After the start of bearing in plants, shoots arising from secondary and tertiary branches are given 15-20 cm deep pruning soon after fruit harvest. Spray of 1% urea combined with 0.2% Blitox-50 or any other copper fungicide should be done soon after pruning.

Use of bio-regulators: 1. Prolonging dormancy 2. Reducing vegetative growth 3. Flowering 4. Reducing fruit drop

Adoption of suitable crop management practices: Mulching, Fertigation, Organic farming, INM, IPM are the suitable management practices generally adapted to high density planting.

Planting Density: Even though a small canopy with a high number of well-illuminated leaves are efficient in photosynthesis, but it is very poor in light interception, which leads to low potential yield per hectare. Light interception could be improved by increasing tree density. An optimum tree density is the level of density, which is required to facilitate optimum light distribution and interception leading to high photosynthesis. As a result, yield per hectare is maximized. An optimum light interception is a factor of plant form, planting density, tree arrangement and leaf response to light for photosynthesis. Optimum light interception can be defined as a level of light intercepted by an orchard system above or below which, the economic yield will be reduced.

Planting Geometry: Planting system is a combination of tree arrangement and plant form. Tree arrangement in HDP system must have sufficient alleyways for movement of farm machinery. The way trees are arranged also determines the light distribution pattern and light interception level. Single hedge row and double hedge row system and square system having enough alley space is being practiced in developed countries for HDP.

Mechanization: Another component in high density fruit planting is the system automation, which contributes to high production. One of the important farm operations that can be automated is irrigation and fertigation vis-à-vis indiscriminate mechanical. In fact, irrigation and fertigation have been identified as one of the key factors for the success of high density orchards. The plant should not be kept under stress after pruning therefore, assured irrigation coupled with fertigation is essential after pruning and during fruit development in high density orchards.

Figure 2 High density Planting of guava

3. Rejuvenation of old orchard

In general, 40-45 years old mango trees exhibit decline in fruit yield because of dense and overcrowded canopy. The trees do not get proper sunlight, resulting in decreased production of shoots. New emerging shoots are weak and are unsuitable for flowering and fruiting. The population of insects and pests built up and the incidence of diseases increases in such orchards. These unproductive trees can be converted into productive ones by pruning.

Intermingling, diseased and dead branches are removed. Thereafter undesirable branches of unproductive trees are marked. At the end of December, these marked branches are beheaded at 1.5 to 2.0 meters from the distal end and the cut portions are pasted with copper oxychloride solution. During March-April, a number of new shoots emerge around cut portions of the pruned branches. Only 8 to 10 healthy and outward growing shoots are retained at proper distance so that a good framework has developed in the following years. Unwanted emerging new shoots are regularly removed to maintain the tree canopy and avoiding recrowding of the branches. It also helps in getting proper nourishment to retain shoots. After two years of pruning new shoots come into bearing and the yield of fruit increases gradually. Thus, old and unproductive trees are converted into productive ones.

Figure 3. Rejuvenation of old mango orchard

4. Jalkund - low cost rainwater harvesting structures

Unavailability of adequate amount of water during the dry season is a serious problem for successful farming in high rainfall areas. This problem can be minimized by rainwater harvesting and its judicious use of the crop production. Direct rainfall

collection through water catch ponds/pits (Jalkund) can be highly beneficial to farmers for providing irrigation to crops during moisture scarcity conditions during dry seasons. Rainwater can be stored directly in Jalkunds during the rainy season which can be utilized to provide protective irrigation to the crops for successful cultivation. Otherwise, it may cause soil erosion and nutrient loss through runoff. Stored water can also be utilized for animal husbandry activities, Piggery, Poultry and Duckery. Fish rearing can also be taken up in the harvested water. Harvested water can be used for cultivating high value vegetable crops such as Brinjal, Chilly, Tomato, Radish, Amaranthus, Coriander, Cowpea

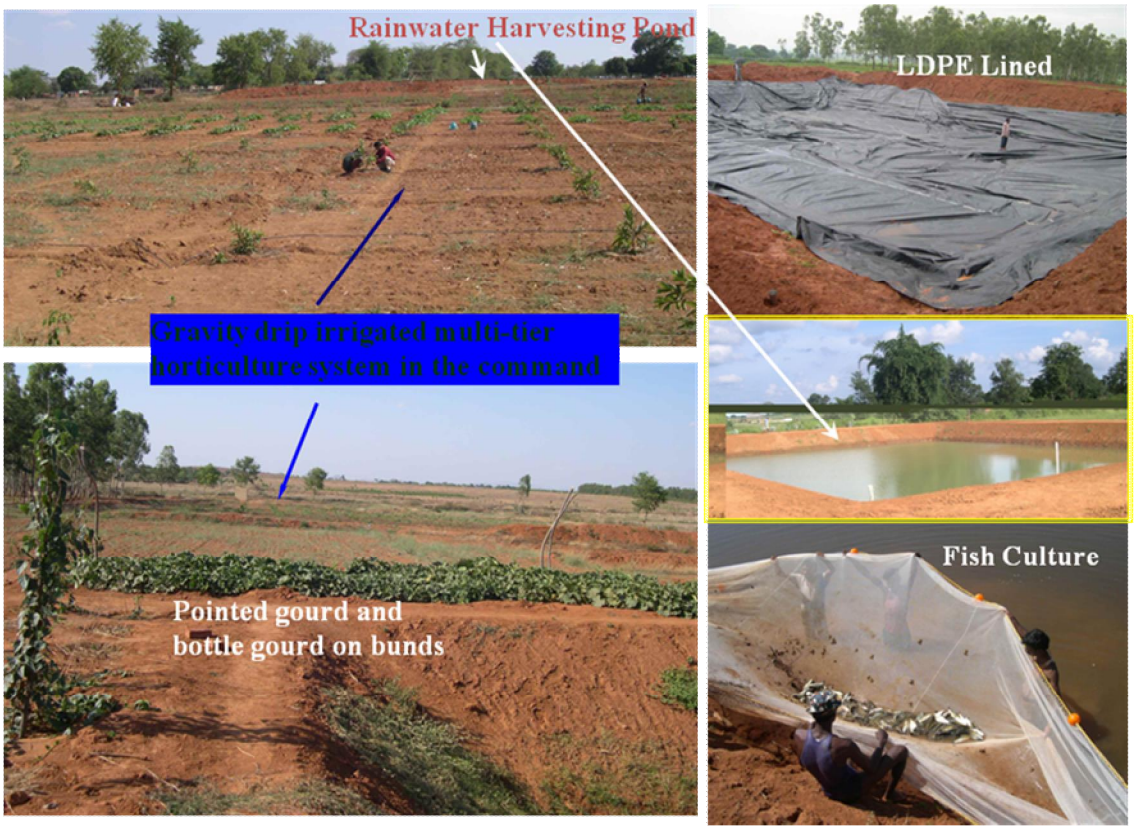

Figure 4 Jalkund and its multipurpose use

Conclusion: Various technologies have been developed for successful production of fruit crops in the eastern rain-fed area. This can be used to increase the farmersô income in this region.

Agricultural Price Policy in India

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Introduction

Agricultural price policy in India was introduced since independence. But the agricultural price policy formulated in India has varied widely for different years and also for different crops. This policy put much emphasis on the prices of food grains like wheat, rice and coarse cereals such as jowar, bajra, maize etc. In India, the price policy was first introduced in 1947 with the formation of Food grains Policy Committee which recommended a policy of progressive decontrol, reduction of imports or food grains and a substantial increase in the production of food grains. Again in 1950, Foodgrains Procurement Committee was appointed which introduced the system of rationing and control in the supply of food grains in the country.

The main objective of the price policy in India was to protect the interests of consumers. In this policy, no attention was paid to provide incentive price to farmers. It was only in 1964, a clear-cut policy was introduced for providing incentive price to farmers. The Third Plan document rightly observed that ñthe producer of food grains must get a reasonable return. The farmer, in other words, should be assured that the prices of foodgrains and the commodities that he produces will not be allowed to fall below reasonable minimum.ò Accordingly, the food grains Price Committee was appointed in 1964.

This committee recommended various measures such as:

(a) Introduction of rationing in major cities,

(b) Establishing lower prices through lower prices or Fair price shops,

(c) Acquisition of control over adequate stocks,

(d) Withdrawing restrictions of inter-state movement of food grains,

(e) Imposing regulation and licensing of wholesale trade of food grains and finally strengthening of the administrative machinery in the States. Again as per the recommendation of this committee, the Agricultural Price Commission was set up in 1965.

In 1966, the government appointed another foodgrains Policy Committee which recommended the following matter in connection with the prices of agricultural commodities:

(i) In order to create a favourable condition for increasing production, the government should announce the minimum support prices well in advance of the sowing season.

(ii) Procurement price should be higher than support price so that it can offer proper incentive to the producer and reasonable price to consumer.

(iii) To create a favourable climate for long-term investment, minimum support prices should be fairly stable.

(iv) Making adequate marketing arrangement for making purchases at minimum support prices.

Moreover, in 1965, the Food Corporation of India (FCI) was set up for making necessary procurement, storage and distribution of food grains. In 1989-90, total capital employed in FCI was to the extent of Rs 5,138 crore with its total storage capacity at 18 million tonnes.

The policy of minimum support prices was accepted by the Fourth Plan but its effectiveness depends on the efficacy of the purchasing machinery like FCI and State Trading Corporation (STC). The Fifth Plan also formulated the agricultural price policy in order to meet two important considerations, i.e., firstly for providing an incentive for sustained and higher agricultural production and secondly for inducing the farmers to plan the production of various crops as per estimated demand through discriminating manipulation of intercrop prices relationship. In order to build up buffer stocks, various public sector organisations would announce purchase prices at different times which would be higher than minimum support prices.

Again, the Sixth Plan realized the importance of price policy for agricultural development on the following grounds. ñFirstly, modern agriculture increasingly involves the use of costly inputs as part of improved technology and hence an assured minimum prices become a necessary underpinning for sustained agricultural production. Secondly, price policy is an important tool for facilitating crop planning, an aspect which so far has not received adequate attention in the country. Finally, price policy can be geared towards community are not eroded by continuing unfavorable terms of trade between the agricultural sector and non-agricultural sector.ò

To fulfill this last consideration necessary arrangement was made for amending the terms of reference of the Agricultural Prices Commission and the commission was advised to take care of movement in terms of trade.

The Seventh Plan realized the importance of rationally determined support prices for wheat and rice in reducing price fluctuations, raising profitability and stimulating the growth of output. The Plan argued to introduce such systems for coarse grains, pulses, and oilseeds and also agreed to determine the appropriate relative prices of different types of crops in order to make provision for efficient use of resources in the country.

At present, the government decides on the MSPs for various agricultural commodities taking into account the recommendations of the Commission for Agricultural Costs and Prices (CACP), the views of state governments and central ministries as well as such other relevant factors which are considered important for fixation of support prices for agricultural commodities.

In 2011-12, the MSPs for various agricultural crops have already been increased. In the mean time, the MSPs of some major crops exhibit a rising trend in line with costs and as incentive for higher output.

Minimum Support Price/Procurement Price for Wheat and Paddy

(Rs. per quintal)

Crop Year	Wheat	Paddy (Common Variety)
1980-81	117	105
1990-91	225	205
1995-96	380	360
1999-00	580	490
2000-01	610	510
2001-02	620	530
2002-03	620	530
2003-04	630	550
2004-05	640	590
2005-06	650	600
2006-07	750	610
2007-08	800	645
2008-09	1000	850
2009-10	1080	1000
2010-11	1100	1000
2011-12	1170	1080
2012-13	1285	1250
2013-14	1350	1310
2014-15	1400	1360
2015-16	1450	1410
2016-17	1525	1470
2017-18	1625	1550

Source: Economic Surveys

Why Need of Agricultural Price Policy?

Movement of price is a common feature. But rapid and violent movement or fluctuations in the prices of agricultural commodities have serious consequences on the economy of the country. As the sudden steep fall in the price of a particular crop, result in huge loss to the farmers producing that crop as their income declines. This will force the farmers not to cultivate the crop next year leading to a serious shortage in the supply of that food item and that may force the government to import that food crop from foreign countries.

Alternatively, a sudden hike in the price of a particular crop may cause huge suffering to the consumers which may force the consumers to discard it or to curtail their other expenditure substantially for meeting the consumption expenditure on that crop. In

both ways, the large scale fluctuation in the price of agricultural produce will create a disastrous effect on the economy of the country.

Price policy of the government for agricultural produce seeks to ensure remunerative prices to growers for their produce in order to encourage higher investment and production and also for safeguarding the interests of consumers by making available food supplies at reasonable prices.

The price policy of the country also seeks to evolve a balanced and integrated price structure in keeping with the overall needs of the economy.

In order to achieve this end, the government announces minimum support prices (MSPs) for major agricultural commodities in each season and also organises purchase operations through the Food Corporations of India (FCI), and cooperative and other agencies designated by state governments for the purpose.

In order to safeguard the interest of both producers and consumers a comprehensive agricultural price policy must be suitably formulated. This should be supported by maintaining buffer stocks of agricultural commodities alongwith the extensive network of public distribution system.

These will provide a minimum support price to the producers and arrange the supply of these agricultural produce to the consumers at fair prices. Thus while fixing the minimum support prices and procurement prices care must be taken to fix those prices at such level which will induce the farmers to produce more. Thus, the agricultural price policy can be designed as an ñinstrument of growthò.

Objectives of Agricultural Price Policy:

The agricultural price policy of the country like India should have the following objectives:

(1) To protect or insure the producer through guaranteed minimum support price, which as a stabilisation measure reduces the variability in product prices and therefore price risk of the farmers. The impact of the risk reduction is expected to induce farmers to undertake large investments and to adopt improved production technology.

(2) To induce the desired outputs of different crops according to growth targets.

(3) To induce an increase in aggregate agricultural output through large input use and adoption of high yielding seed, fertilizer and water responsive technology.

(4) To induce farmers to part with a large proportion of foodgrains production as a marketed surplus.

(5) To protect the consumer against the excessive rise in prices, especially to protect the low income consumers in periods when supplies lag behind demand and market prices rise continuouslyò.

Measures Introduced for Enforcing Agricultural Price Policy:

Thus the agricultural price policy which was introduced just after independence made a compromise with the situation and followed a variable policy of progressive decontrol in 1947 and then a partial control in 1955. Then in 1959, the government introduced the state trading in food grains particularly in rice and wheat.

After that in 1964, the government introduced food zones for imposing restriction on the movement of food grains from one zone to another in order to enforce stability in agricultural prices.

In 1965, the Agricultural Price Commission was set up which announced the minimum support prices and procurement prices in the successive years in order to guarantee minimum prices to the producers and for building up buffer stocks to maintain the public distribution system.

The minimum support price for wheat which was fixed at Rs 37.50 per quintal in 1964-65 gradually raised to Rs 50 per quintal in 1965-66 and then to Rs 350 per quintal in 1993-94. The procurement price for paddy per quintal was also gradually raised from Rs 77 in 1977-78 to Rs 230 in 1991-92.

The procurement price for coarse grains was also raised from Rs 48.29 pre quintal in 1965-66 to Rs 205 in 1991-92. While fixing these procurement prices, the large farmersô lobby has played an important role in its decision making.

Again in order to meet the minimum needs of the weaker sections of the society, the rationing system through public distribution system was introduced in India and accordingly the total number of fair price shops has also increased from 2.39 lakh in 1979 to 3.54 lakh in 1980. This public distribution system has been handling about 19 million tonnes of foodgrains.

NAFED is also an important agency which appoints state agencies for undertaking Price Support Scheme (PSS) operations. The losses, if any, incurred by central agencies on undertaking PSS operations are reimbursed up to 15 per cent by the Central Government. Apart from this, government also provides working capital to the central agencies for undertaking PSS operations.

Moreover, the government also implements Market Intervention Scheme (MIS) for horticultural and agricultural commodities, especially perishable in nature and not covered under the PSS which helps the farmer to get remunerative prices for their produce.

The MIS is contingent on the basis of specific request of a State or Union Territory (UT) government which is just ready to bear 50 per cent (25 per cent in respect of north-eastern states), if any, incurred on its implementation.

However, the loss in such case is restricted up to 25 per cent of total procurement value. However, the profit earned, if any in implementing the MIS is retained by the procuring agencies.

Moreover, in order to ensure a minimum remunerative price to the farmers some other steps were also followed by the government which included state trading, building up of buffer stocks, nationalization of wholesale trade in wheat and rice, procurement from wholesalers, import of food grains etc.

Evaluation of Agricultural Price Policy:

The agricultural price policy in India has succeeded in establishing certainty and confidence in respect of the prices of agricultural commodities through the fixation of minimum support prices by Agricultural Prices Commission (later on renamed as Commission for Agricultural Costs and Prices). But due to the variations in the degree of enforcement of procurement in different years, some degree of uncertainty and instability in prices were experienced by the Indian farmers.

Again raising the minimum support prices and procurement prices offered incentive to the producers to increase their production but these benefits were mostly restricted to large farmers. Moreover, the public distribution system in India is also subjected to various limitations such as its restricted operation in wheat and rice only, insufficient coverage of rural areas, inadequate coverage of the people lying below the poverty line and its too much expensiveness due to lack of targeting.

As argued by several economists, continuous increase in the procurement prices has resulted a spurt to inflationary pressures in the economy. This increase in the price of food grains has also resulted in huge hardships to the rural poor consisting of marginal farmers and landless laborers who constitute the bulk of rural population.

Moreover, the fixing of uniform purchase price for the country on the basis of cost of production of huge cost states by the Commission for Agricultural Costs and Prices has benefitted the developed states having low average cost of production such as Punjab, Haryana etc. Thus, the policy had a bias in favour of the rich states at the cost of consumers in general.

Features of Agricultural Price Policy in India:

Following are some of the important features of agricultural price policy followed by the Government of India since independence:

(i) Setting up Institutions:

The Government of India has set up some institutions for the implementation of agricultural price policy in the country. Accordingly, the Agricultural Price Commission was set up in 1965 which announced the minimum support prices and procurement prices for the agricultural products.

In 1985, the name of this institution was changed into Agricultural Cost and Prices Commission. Moreover, the foodgrains Policy Committee was appointed by the Government in 1966 which also recommended various measures of price support.

FCI:

The Food Corporation of India was C. In 1989-90, total capital employed in FCI was to the extent of Rs 5138 crore with its total storage capacity at 18 million tones. The corporation organizes the price of food grains at government determined prices and sale these food stocks through the network distribution system.

(ii) Minimum Support Price:

The government fixes the minimum support prices of agricultural products like wheat, rice, maize, cotton, sugarcane, pulses etc., regularly for safeguarding the interest of farmers. The FCI also make their purchases of food grains at the procurement prices so as to maintain a rational price of food grains in the interest of farmers.

Accordingly, minimum support price of food grains fixed by the government increased from Rs 388.26 per quintal in 2003-04 to Rs 429.22 in 2007-08 and then to Rs 1500 (at average) in 2017-18.

(iii) Protecting the Consumers:

In order to safeguard the interest of the consumers, the agricultural price policy has made provision for buffer stock of foodgrains for its distribution among the consumers through public distribution system.

(iv) Fixation of Maximum Prices:

In order to have a control over the prices of essential commodities the government usually determines the maximum price of agricultural products so as to protect the general people from exorbitant rise in prices.

Effects of Agricultural Price Policy:

Important effects of Agricultural Price Policy are as follows:

(i) Incentive to Increase Production:

Agricultural price policy has been providing necessary incentive to the farmers for raising their agricultural output through modernisation of the sector. The minimum support price should be determined effectively by the government which will safeguard the interest of the farmers.

Accordingly, minimum support price of food grains fixed by the government increased from Rs 388.26 per quintal in 2003-04 to Rs 429.27 in 2007-08 and then to Rs 829.94 (at average) in 2012-13

(ii) Increase in the Level of Income of Farmers:

The agricultural price policy has provided necessary benefit to the farmers by providing necessary encouragement and incentives to raise their output and also by supporting its prices. All these have resulted in an increase in the level of income of farmers as well as their living standards.

(iii) Change in Cropping Pattern:

The agricultural price policy has resulted in a considerable change in cropping pattern of Indian agriculture. The production of wheat and rice has increased considerably through the adoption of modern techniques by getting necessary support from the Governments. But the production of pulses and oilseeds could not achieve any considerable change in the absence of such price support.

(iv) Benefit to Consumers:

The policy has also resulted in considerable benefit to the consumers by supplying the essential agricultural commodities at reasonable price regularly.

(v) Benefit to Industries:

The agricultural price policy has also benefitted the agro industries of the country, like sugar, cotton textile, vegetable oil etc. By stabilising the prices of agricultural commodities, the policy has made provision for adequate quantity of raw materials for the agro industries of the country at reasonable prices.

(vi) Price Stability:

The agricultural price policy has stabilised the prices of agricultural products to a large extent. It has become successful to contain the undue fluctuation of prices of agricultural products. This has created a favourable impact on both the consumers and producers of the country.

Suggestions for Rationalisation of Agricultural Price Policy:

Following are some of important suggestions which can be advanced for the rationalisation of agricultural price policy of the country:

(i) Establishment of Some More Agencies:

Apart from Food Corporation of India, some more agencies should be set up for ensuring rational prices of other agricultural products and also for procuring other agricultural products. In the meantime the government has already set up Cotton Corporation and Jute Corporation, which needs to be further, strengthened.

Moreover, the government should set up a separate agency for providing necessary minimum price support to perishable commodities like potato and other vegetables, fruit, etc., considering its growing potential market both for internal consumption and exports. The operational efficiency of existing agencies like FCI should be improved.

(ii) Extension of the Price Policy:

The agricultural price policy should be extended to cover more commodities over and above the 15 commodities covered at present. The commodities like pulses, potato, onion and other important vegetables and fruits may also be covered.

(iii) Rationalisation of Price Fixation:

The prices of agricultural commodities should be fixed in the most rational manner so that it could cover the entire costs of production. While fixing the prices, the increasing cost of agricultural input should be taken into consideration.

(iv) Protection of Consumers:

The agricultural prices should be so determined that it can also protect the interest of the general consumers.

(v) Modernisation:

The agricultural price policy should be framed in such a manner so that it can induce the farmers to go for modernisation of their agricultural practices.

(vi) Improvement in Agricultural Marketing:

In order to ensure the success of the agricultural price policy, the improvement of the agricultural marketing system is very important. The farmers should be set free from the clutches of middlemen and all intermediaries.

(vii) Improvement of PDS:

The public distribution system should be improved so as to ensure a success in the operation of agricultural price policy. The operation of fair price shops should be streamlined and be made more efficient and transparent.

Appraisal of Price Policy

The policy has been instrumental in creating a fairly stable price environment for the farmers to induce them to adopt new production technology and thereby increase the output of food grains. The subsidized distribution of food grains has helped in improving economic access to food. Owing to the decline in the real prices (prices vis-à-vis the income) of basic staple food, the organized sector and the industry could keep their wage bills low. The benefits of price policy and input/food subsidies, have, thus been shared by all the sections of society. However, the present price policy has certain shortcomings discussed as follows:

(i) The price policy has to evolve a qualitatively superior crops mix i.e. to provide incentive for growth of crops which are nutritionally superior or the crops where the country has comparative advantage. In India this aspect of agricultural price policy has remained largely neglected.

(ii) During the last few years, lack of prudence in fixing the level of support prices of rice and wheat led to not only accumulation of excessive stocks but also raising the public cost of food grain policy. During these years, the government fixed MSPs of rice and wheat at much higher levels than that recommended by CACP. Currently however the stocks are below or almost close to the minimum prescribed levels.

(iii) The farmers in the new emerging states could not get the minimum support prices for their produce. This happened mainly because the nodal agency (FCI) and

state agencies in the new emerging surplus states are not geared to undertake price support operations. The FCI remains occupied with large volumes of purchases traditional surplus producing states (like Punjab, Haryana, and western U.P)

Conclusion

The agricultural price policy has relied too heavily on price incentives in the form of assured crop prices for achieving increase in production. The non-price factors such as efficient technology, financial inputs, land reforms and improved human resources are all very significant in expanding the volume of aggregate output and productivity. The scarce stateôs economic resources should be used in improving social and economic infrastructure in the rural area rather than providing subsidized agriculture output to the public at large. The price policy cannot produce desirable effects of improving agricultural productivity if the agricultural infrastructure is weak. It is desirable that the agricultural prices are announced for few commodities as it is commercially unsustainable for government to procure food grains at higher price and allow off take at subsidized price. Further, an adequate attention is given to the infrastructure development.

Public Private Partnership for Effective Marketing of Agricultural Produce

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The Canadian Council for Public Private Partnerships defines Public Private Partnerships as a cooperative venture between the public and private sectors, built on the expertise of each partner that best meets clearly defined public needs through the appropriate allocation of resources, risks and rewards. The two elements that characterize the definition given by the Council are provision of public services and sharing of risks between the partners. The definition given by the National Council for Public Private Partnership of United States also emphasizes the provision for public service and sharing of risks and rewards between the two partners. The definition states that Public-Private Partnership is a contractual agreement between a public agency and a private sector entity. Through this agreement, the skills and assets of each sector (public and private) are shared in delivering a service or facility for the use of the general public. In addition to the sharing of resources, each party shares the risks and potential rewards.

As a science-based activity, agricultural research is best performed by multidisciplinary and inter-institutional teams of scientists from both public and private sectors. Agricultural growth is a prerequisite for economic development, especially in the countries with agri-based economy. Even when all irrigation potential is developed, one half of the arable land of the country remains rain-dependent. Therefore, the high growth in agricultural sector would progressively depend more on the development of rain-fed agriculture. Unless production in rainfed regions is increased, inequalities between irrigated and rainfed areas in the country will remain. To accelerate pace of rainfed agriculture and to harness its potential benefits, there is a need to introduce appropriate technologies and create suitable institutions and infrastructure to promote a shift to high-value added crops. There are emerging opportunities for traditional and high value crops that offer potential to raise rural incomes. Such a shift will enable rainfed agriculture to increase production, augment farm-income, generate employment, alleviate poverty and conserve precious soil and water resources and the promotion of high-value commodities may act as the catalyst to bring a ñsecond-generationò Green Revolution in rainfed areas.

Though interaction of private sector and public sector is not new, yet the level is very low. Certain areas of interactions in Agriculture are Field trials, Pesticide testing, Germplasm evaluation, Collaborative technology development ï hybrid rice and in Biotech: Biosafety studies, Germplasm/Agronomic evaluation, Animal feeding

studies, Ecological studies. With partnership between public and private sectors, the strengths of both the sectors are leveraged. On the one hand, public sector has highly skilled and efficient manpower in agriculture and on the other hand private sector has excellent managerial resources. The decentralized decision-making in private sector helps in reducing time for commercialization. Proper budget management and global regulatory expertise are certain other benefits of the system, while availability of diverse germplasm of different crops and diverse breeding crops can be boasted by the public sector

The Inter-Ministerial Task Force on Market Reform has strongly recommended that, the effective reforms in the agricultural marketing system of the country are inescapable to enable our farmers to face challenges and avail the benefits created out of the changed trade environment on account of liberalization, privatization and globalization. Accordingly, Ministry of Agriculture, Government of India prepared a Model Act called Agricultural Produce Marketing (Regulation & Development) Act, 2003 in consultation with all the state Governments/UTs to which they have agreed to amend in their respective State APMR Act in the line of Model Act to bring about the requisite reforms in the sector. The Salient features of the Model Act are setting up markets in the private/co-op sector, rationalization of market fees, promotion of Contract farming, direct marketing and grading and standardization including setting up of a grading and standardization Bureau in each State/UT etc.

Agricultural companies are providing services through payment by contract farming, marketing of high value crops by commercially export companies, Value addition and charged based service centres for farmers. Several corporation at present are involved in agro-commodity trading, processing, exports and have tried to establish systems to ensure timely and consistent supply of raw material of desired quality and at low cost. Some of the agri-business companies like e-choupal, Mahindra Samriddhi, Mahindra Shubhlabh, Tata Kisan Kendra, Chambal Uttam Bandhan in their unique model are also involved in transfer of technology with market support. Farmers have increasingly begun to perceive marketing than production, as the major constraint in enhancing their farm incomes. In recent times reform oriented initiatives have been directed towards a demand driven, broad-based and holistic agricultural extension system involving introduction of a multitude of integrated measures that will on the demand side-enable service users to voice their needs and hold service providers The government of envisions that ñPrivate sector participation will be promoted through contract farming and leasing arrangements to allow accelerated technology transfer, capital inflow and assured market for crop production, especially of oilseeds, cotton and horticultural crops.

Public-Private partnership in India are mostly involved in contract farming models undertaken by agri-business companies which usually takes care of pre-agreed price, quality assurance quantity and time of delivery, and as per the contract farmers are required to plant the contractor's crop on his land and to harvest and deliver it to the contractor, based upon anticipated yield and contracted acreage mostly at a pre-

agreed price. The contractor supplies the farmer with selected inputs along with technical advice. Some cases of private sectors involvement in are:

- Input suppliers/dealers selling pesticides, seeds, nutrients and farm implements,
- Corporate sector (i.e. commercial crops like tobacco, tea, coffee, oilseeds (sunflower) and vegetables;
- farm implementsð tractors, threshers, sprinklers, drip irrigation; etc..
- Community based organizations, including farmers' organizations, farmers' cooperatives as well as farmer interest groups (FIGs) and self-help groups (SHGs)

Four axioms has been identified for a successful ñpartnerships with private partners in a market-driven extension systemò (Singh, 2013).

The ***first axiom*** is that if there isnôt a market, donôt encourage farmers to produce a specific crop or product. Therefore, the first task to be carried out is to assess the potential markets for different high-value crops or products that can be successfully produced in different blocks within the district.

The ***second axiom*** is that if farmers cannot easily transport the product to market, look for more promising products that can be easily marketed.

The ***third axiom*** is that if the crop (or product) cannot be successfully grown or produced within the district due to unfavorable agro-ecological conditions, then look for more promising crops or products that are well suited to the district.

The ***fourth axiom*** is to diversify into a variety of different high-value crops/products that are suitable for different FIGs or WIGs within the district. These approaches will mitigate risk by not saturating the market with one or two products and, thereby, driving down prices.

Market and infrastructure development

The Model APMC Act of Government of India encourages direct marketing to enable the farmers get the best price for their produce and create partnerships with banks, finance and logistics companies for lowest cost financing and marketing. This would attract private investment in creation of much needed marketing infrastructure, create competition and ensure better service to the farmers (Anonymous 2005). In India, ICRISATôs Hybrid Parents Research Consortia brings together 34 small and medium sized domestic firms for the purpose of commercializing sorghum, millet, and pigeon pea hybrids, thus contributing to the commercial viability of both domestic seed firms and the wider seed market in India. Direct marketing like ITC e choupal and the National Dairy Development Board model of public-private partnership, provides a viable alternative for small farmers, should be replicated to provide safety net to farmers by financial risk management and introduce effective Agricultural Insurance.

In the wake of increasing involvement of private sector in agricultural extension Public-Private Partnership in various modes / forms can provide synergistic approach in the extension efforts. Public-Private Partnership has emerged as one of the crucial areas in agricultural extension by ATMAôs in Bihar and it was found quite successful (Singh and Jha,2012).

IMPACT OF PPP IN AGRICULTURE Marketing

The good impact of PPP in any field depends on involvement of institutions and industries in seeking collaboration and combining all available public and private skills (Peter 2002). PPP has made positive changes in market linkage of farm produce, capacity building of farm families, reduction of risk and uncertainties, social mobilization and economic empowerment of farmers (Hisrich and Peters 2002).

Knowledge management

Knowledge management strategies in the context of Public-Private Partnerships results in increased production and better service delivery. This approach has helped in replacement of traditional rice varieties with basmati rice, cultivation of medicinal and aromatic plants and mushroom in Patna district of Bihar (Ponnusamy 2013). Farmers obtained an average net income of ` 22 000/ha by diversifying from groundnut and paddy to maize in Chittoor district of Andhra Pradesh and also expanded maize area from 60 ha to 1150 ha (Srinath and Ponnusamy 2011).

Development of high end technologies:

High end technologies could be developed along with improving efficiency in management of PPPs and improving the institutional intellectual property management skills and information database on available technologies in the public sector. Commercialisation of Bt maize varieties based on partnership between Agricultural Genetic Engineering Institute (AGERI) of Egypt and Pioneer Hi-Bred Company, developing delayed ripening of Papaya between Syngenta and University of Nottingham, development of GM sweet potatoes in Kenya, development of super sorghum through nine globally respected institutions and completion of rice genome sequencing project in 2004 have resulted in high end technologies through PPP approach (Khush 2005).

Reduction of risks and uncertainties

PPP has the potential to reduce risks and uncertainties related to crop failure, pest and diseases, natural calamities and natural resource management. Food safety-related barriers in the export context were addressed through PPP approach for green beans in Kenya and grapes in India. John Deere, a leading farm implements manufacturing company has helped to promote mechanized farming in tribal region of Gujarat by establishing 8 Agricultural Implements Resource Centers each covering 600 acres of cultivated land through PPP (Reddy and Rao,2011).

Productivity enhancement

ICAR and Department of Biotechnology, Government of India initiated dialogue with Monsanto for transfer of Bt cotton technology to India resulting in, Mahyco going into partnership with Monsanto, which finally resulted in the introduction of Bt cotton in India (APCoAB 2007). The country experienced an unprecedented increase in Bt cotton acreage from 29,000 hectare in 2002 to 9.4 million hectare in 2010 (James 2010). The productivity of cotton increased from 301 kg/ha in 2002-03 to 526 kg/ha in 2009-10 and reduction in real cost of production ranged from 16 to 46 per cent (Ramasundaram *et al.* 2011) bringing in more equality in farm-income distribution (Morse *et al.* 2007) .

Economic empowerment of farm women

Public private partnerships in agricultural marketing has also revealed significant opportunities for women entrepreneurs and groups in delivering local services and creating conditions for empowerment at the grass root level. The PPP between Cadbury India, Kerala Agricultural University and DBT during past 23 years trained 250 women and established 28 cocoa chocolate units in different parts of Kerala. Thirumadhuram Pineapple project through PPP involving Kudumbhasree Project Mission, Department of Agriculture, women SHGs and Nadukkora Agro-processing centre could produce 25000 tonnes of pineapple in 500 ha and directly employed 12500 women. (Rajendran *et al.* 2010). PPP in vegetable marketing in Coimbatore district of Tamil Nadu, enhanced the income level of farmwomen by 20 per cent (Thangamani *et al* 2012).

Gender mainstreaming in agriculture

Gender sensitized maize production among tribal farm women of Odisha through PPP approach resulted in enhanced knowledge level, productivity and income, similarly organic farming promoted through PPP mode by Assam Agricultural University enhanced the knowledge and market skills of farm women (Ponnusamy *et al.* 2012). Better market linkage of women vegetable growers with Annapoorna hotel in Coimbatore district of Tamil Nadu resulted in higher income (Thangamani *et.al.* 2012). When the gender as a factor is taken for planning and implementing the agricultural programmes, it is possible to enhance the access of technologies, inputs, credits and markets and result in elimination of gender differences and discriminations in rural area.

Some examples of Public Private Partnership Initiatives by ATMA-Patna, Bihar (Singh,2013)

1. *Using Private Sector for Extension:* Various private sectors were utilized and given platform like Bihar Industries Association, Baidyanath Ayurved Bhawan , Fragrance Herbs, Ayurved Shri Herbals Ltd., Pamer Agro Ventures (P) Ltd., Amrapali Foods, Ltd. Samrat Mushrooms, Micro Tech Nutracueticals, Raj Agrico, Bihar Chamber of Commerce, Decent Enterprises (I) Pvt. Ltd., Golden Fries Ltd

2. *Using NGOs for Extension:* NGOôs can play a very important subsidiary role as was shown by the involvement of NGOôs like Sristi Foundation, Adarsh Gramin Vikas Sansthan, Prem Youth Foundation, RP Channel-5 Vitarani Krishak Samiti, Paliganj Vitarani Krishak Samiti, Manjhauli Vitarani Krishak Samiti, Nari Gunjan, Mahila Bal Jyoti Kendra
3. *Promoting Extension Through Farmer Change-Agents:* Inovative farmers acts likechange agents and were successfully utilized for Diversification in agril, Medicinal And Aromatic Plants cultivation, Mushroom cultivation, Zero tillage, NRM and INM etc.
4. *Kisan Samman Yojana- An Initiative for Farmer-to-Farmer Extension:* Awarded farmers to be involved as Trainers for Farmer-to-Farmer extension
5. *Organizing Women into Commodity-Based Farmer Associations*
6. *Release of the Directory of Extn. Service Providers.*

Encouraging Private Sector Involvement in Technology Transfer

Public service agencies provide subsidized agro-goods and services that are a significant deterrent to the expansion of private sector involvement in technology transfer, because this often leads to the creation of an uneven playing field and discourages market entry by private sector providers. Wherever possible, such subsidies will be phased out in order to stimulate the emergence of a private input supply networks to provide hybrid seeds, artificial insemination services, fertilizers, agro-chemicals, animal feed, machinery, equipment and other agricultural supplies and services to farmers on a full cost-recovery basis. Generally, the costs associated with the research, development and transfer of these material technologies are embodied in the prices of these products. Therefore, farmers cover these costs when paying for the products, making this component of the Agricultural Technology System (ATS) financially sustainable. In the field of material technology disseminationð which includes distribution of inputs such as fertilizer, seed, planting material, chemicals for plant protection and agricultural implementsð a competitive, private sector has developed in almost all states This new policy envisages withdrawal of the public sector from areas where agro-services can be effectively and competitively provided by the private sector. In such cases, the role of the public sector becomes one of facilitator and enabler. Such a system dictates moving towards a realistic system of cost-recovery for agro-services by the state. If the public sector continues to subsidize these services, this will prevent a ñlevel playing fieldò in which the private sector can operate. There will need to be a re-examination of existing rules, regulations and acts to abolish provisions, which constrain private investment in the delivery of agro-services (Singh et al, 2017).

Keys to Successful PPP

1. *Producers need assistance:* Self assessment tools provides learning to the company, Assistance motivates producer, Assessment is an educational process

2. *Producers must respect and trust the third party they are working with*: Implementation dependent on trust must correspond to modern production practices, speak their language
3. *Partnerships work best:* Each agency brings own strengths, Commodity groups critical to acceptance, Education is essential
4. *Producers need Incentives too:* Companies should go beyond compliance, Recognition and awards are desired, Greater access to financial assistance, Less regulatory oversight, liability, and insurance could work on larger operations, Difficult to capitalize on market benefits
5. *Producers must take active role in process:* Plans, assessments, done without producer input rarely get adopted, Education is necessary to get producers to point where input is helpful, Decisions should be documented benefit.

Conclusion:

The importance of Public Private Partnership in Agricultural marketing can be understood in terms of a shared mechanism among partners for input, resource, market, risk, technology and benefits. Establishing PPP cell at research and development organizations would spearhead the growth of PPP and thereby sustainable agriculture and livelihood of millions of poor farm families in India.

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Crop Intensification for Higher Income

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Cultivation of two or more crops simultaneously on the same field for higher yield and increased economic returns is important in the present context of agricultural scenario. The per capita availability of cultivable land has been shrinking due to increased demographic pressures. To meet the growing demand of food, fruits and vegetables for food and nutritional security, it is necessary to increase the productivity of these crops from the limited land resources through sustainable crop intensification. The one way of increasing the productivity is to increase the cropping intensity by growing more number of crops per unit area and time. There is also an urgent need to diversify our traditional cropping systems by the inclusion of short duration leguminous crops and vegetables. This will help in sustaining the system productivity and improving soil health. The inclusion of these short duration crops in traditional cropping systems helps in reducing the build up of insect-pests, diseases, nematodes and weeds. In addition, leguminous crops (pulses, soybean, groundnut, cowpea, etc.) fix atmospheric nitrogen during the growing season and improves soil health. Intercropping system improves cropping intensity as two or more crops occupy the land simultaneously. Intercropping can be defined as ćthe growing of two or more crops on the same piece of land at the same timeĉ. While intercropping has been traditionally practiced in India (Ayyangar and Ayyer, 1942) and found advantageous in comparison to sole cropping, agronomic research was initiated to determine the advantages in terms of the production stability, resource-use efficiency, risk reduction, protein production and the higher monetary values.

When two or more crops are growing together, each must have adequate space to maximize cooperation and minimize competition between them. To accomplish this, four things are need to be considered:

1) Spatial arrangement,

2) Plant density,

3) Maturity dates of the crops being grown, and

4) Plant architecture.

Spatial arrangements

There are at least four basic spatial arrangements used in intercropping.

Row intercropping: growing two or more crops at the same time with at least one crop planted in rows.

Strip intercropping**:** growing two or more crops together in strips wide enough to permit separate crop production using machines but close enough for the crops to interact.

Mixed intercropping**:** growing two or more crops together in no distinct row arrangement.

Relay intercropping**:** planting a second crop into a standing crop at a time when the standing crop is at its reproductive stage but before harvesting.

Benefits from intercropping

Efficient resource utilization and improved yields: The main advantage of intercropping is the more efficient utilization of the available resources and the increased productivity compared with each sole crop of the mixture. When two or more crops with different rooting systems, a different pattern of nutrient and water demand, and a different above ground habit are planted together, growth resources such as nutrients, moisture and solar radiation are used more efficiently. Therefore, the combined yields of two or more crops grown as intercrops can be higher than the yields of the individual crops grown as pure stand.

Improved soil health: Intercropping of leguminous vegetables like beans, field peas, etc. with other crops helps in improving soil health by increasing N_2-fixation and improving organic carbon status of soil compared to non-leguminous vegetables. Maize+cowpea intercropping increases the amount of nitrogen, phosphorous and potassium contents compared to mono crop of maize (Dahmardeh *et al.* 2010).

Reduced incidence of pests: Inclusion of certain crop plants as an intercrop helps in reducing the incidence of insect-pests and diseases. Intercropping of garlic and onion with chilli has reduced the infestation of whitefly, thips, aphids, jassids and pod borer and increased the green chili yield as compared to sole cropping of chilli (Aswathanarayanareddy et al. 2006).Intercropping of marigold with different vegetables reduced the nematode population in soil, number of galls, egg masses per root system, number of eggs per egg mass and root-knot index as compared to growing of vegetables alone continuously (Kumar *et al*. 2005). Incidence of white fly and leaf hopper was lower in brinjal+groundnut intercropping compared to monocropping (Umarajini and Seran, 2008).

Reduced incidence of weeds: Intercropping gives better control of weeds than sole cropping. Weed control can be improved where the intercrop situation provides a community of plants that are in total more competitive than the individual crops. Increased leaf cover in intercropping systems helps to reduce weed populations once the crops are established (Beets, 1990). Shading offered by intercrops has considerable potential in reducing the spread of *Cyperus rotundus* (Patterson, 1982).Srikrishnah *et al.* (2008) reported reduced weed population in

brinjal+groundnut intercropping as compared to sole crop. Maize+pumpkin and maize+bean intercropping reduced weed biomass by 50-66% (Mashingaidze, 2004).

Erosion control: Soil cover provided by the intercropps helps in reducing soil erosion and allows more water to infiltrate into the soil. In maize-cowpea intercroping, cowpea acts as the best cover crop and reduced soil erosion (Kariaga, 2004).

Increased biodiversity and stability: Intercropping is the way to increase the diversity of the farming system. This means more stability, resulting in risk spreading and reduced pests and disease incidence.

Mitigates adverse effect of climate change: Intercropping of legumes helps in increasing carbon sequestration, soil organic matter, conserves soil moisture and maintains soil temperature and thus, reduces the adverse effect of increasing CO_2 and temperature in the atmosphere on sorghum yield.

Indices for evaluation productivity and efficiency in intercropping systems

1. ***Relative yield total (RYT)***

   Relative yield total introduced by de Wit and Van den Bergh (1965) is the most important indix of biological advantages in intercropping systems. The index is based on relating the yield of each crop in an intercrop treatment mixture to the yield of that crop grown as a sole crop. It is calculated as the sum of the intercropped yields divided by yields of sole crops.

2. ***Land equivqlent ratio (LER)***

   The efficiency of intercropping systems are most often assessed in terms of their land equivalent ratio (Willey, 1979), which is defined as the relative land area that would be required as sole crops to produce the yields achieved in intercropping. LER also indicates the relative yield advantage of intercropping. LER of more than 1 indicates yield advantage, equal to 1 indicates no grain or no gain or no loss and less than 1 indicates yield loss. It can be used both for replacement and additives series of intercropping. A LER value of 1.2 indicates that intercropping outyields sole cropping by 20%. LER can be calculated as:

$$LER = La + Lb = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

   Where

   La and Lb are the LERs for the individual crops of the system

   Yab = Intercrop yield of crop ‘a’

   Yba = Intercrop yield of crop ‘b’

Yaa = Pure stand crop yield of óaô

Ybb = Pure stand crop yield of ób

3. ***Income Equivalent Ratio (IER):*** The ratio of the area needed under sole cropping to produce the same gross income as is obtained from 1 ha of intercropping at the same management level. The IER is the conversion of the LER into economic terms.

4. ***Area x time equivqlency ratio (ATER)***

Area x time equivalency ratio was proposed by Hiebsch and Mc Collum (1987) as modification of LER. This takes into account the duration of the crop, and permits an evaluation of crop on a yield per day basis.

$$ATER = \frac{(Ryc \times tc) \times (Ryp \times tp)}{T}$$

Where,

Ryc = Relative yield of crop c (main crop)

Ryp = Relative yield of crop p (intercrop)

tc = Growth duration (days) for crop ócô

tp = Growth duration (days) for crop ópô

T = Growth duration (days) for the whole system

Competition functions

1. ***Relative crowding coefficient (RCC)***

The relative crowding coefficient was proposed by de Wit (1960) relative crowding coefficient (K) and can be calculated by the following formula

as under:

$$Kab = \frac{Yab}{Yaa - Yab} - \frac{Zba}{Zab}$$

Where,

Yab = Intercrop yield of crop óaô

Yaa = Pure stand yield of crop óaô

Zba and Zab are sown proportions of crop óaô and óbô in an intercropping system

2. *Aggressivity (A)*

Aggressively gives a simple measure how much the relative yield increase in crop *a* is greater than that of crop *b* in an intercropping system. It is an index of dominanance. An aggressivity value Zero indicates that the component species are equally impective. A positive sign indicates the dominant species and a negative sign the dominated. The aggressivity (A) was proposed by McGilchrist (1965) and can be calculated by the following formula.

$$Aab = \frac{Yab}{Yaa \times Zab} - \frac{Yba}{Ybb \times Zba}$$

3. *Competitive Ratio (CR)*

Competitive ratio indicates the number of times by which one component crop is more competitive than the other. Relative species competition is often evaluated using competitive ratios (Putnam et al., 1984). The competitive ratio as proposed by Willey *et al*., (1980) can be calculated by the following formula.

$$CRa = \frac{Yab}{Yaa \times Zab} \div \frac{Yba}{Ybb \times Zba}$$

If CR*a* < 1, there is a positive benefit and the crop can be grown in association; if CR*a* > 1, there a negative benefit. The reverse is true for CR*b.*

Some promising intercropping systems

1. Sorghum-based intercropping systems

Sorghum+ pigeonpea

Sorghum + pigeonpea is the most common intercropping system followed by the farmers in semi-arid tropics of India. This system provides greater stability of yield than sole cropping. In assured rainfall areas and medium to heavy soils, intercropping of sorghum with pigeonpea (2:1 or 2:2 or 3:2) not only produces higher yields per unit area and time but also improves soil health and provides nutritional security to rural poorôs of the semi-arid tropics. Sorghum+ pigeonpea intercropping at 2:1 or 2:2 row ratios has been found very promising. The slow initial growth of pigeonpea does not provide any competition to sorghum crop for natural resources and being a leguminous crop, it helps in improving the soil fertility by fixing atmospheric nitrogen and heavy leaf fall. When the sorghum is harvested after 110-120 days, the pigeonpea grows vigorously utilizing the space left by the sorghum crop. Intercropping of sorghum also reduces the incidence of wilt disease in pigeonpea.

The sorghum genotypes vary in their growth behavior, canopy development and duration. This may affect the growth and development of the pigeonpea crop

grown in intercropping system. Intercropping of sorghum ócSH 16ô with pigeonpea (2:1) has been tested at different locations (Coimbatore, Palem, Dharwad and Indore) of the country and found beneficial over sole cropping. This system gave the highest sorghum equivalent yield (6536 kg/ha) and benefit: cost ratio (3.83), besides improving soil health and nutrition of people living in rural areas.

Table 1. Sorghum equivalent yield and Benefit: cost (B: C) ratio in sorghum + pigeonpea intercropping system as influenced by sorghum genotypes (Mean of 4 locations: Coimbatore, Palem, Dharwad, Indore).

Cropping system	**Sorghum equivalent yield (kg/ha)**	**B:C ratio**
CSH16+Pigeonpea(PP) (2:1)	6536	3.83
CSH23+PP (2:1)	5895	3.35
CSV15+ PP (2:1)	6441	3.62
SPV1616+PP (2:1)	6172	3.50
Local+PP (2:1)	6413	3.47
CSH16 sole	2749	2.54
CSH23 sole	2385	2.26
CSV15 sole	2486	2.43
SPV1616 sole	2553	2.44
Local sole	2550	2.53
CD (P=0.05)	556	0.37

Sorghum + soybean

In assured rainfall areas, soybean has tremendous scope for its inclusion in intercropping with *kharif* sorghum. Sorghum area in Maharashtra and Madhya Pradesh has largely been replaced by soybean, because of its market price, supported by a growth in its utilization and allied industry. Intercropping of sorghum with soybean could sustain sorghum production in these states. In alfisols of Coimbatore with low to medium rainfall areas, sorghum + soybean intercropping at 3:6 ratio gave higher grain yields and economic returns (Subbian and Selvaraju, 2000) indicating that soybean can very well withstand the shade effect of sorghum. In Vertisols with medium to high rainfall sorghum + soybean in alternate rows resulted in higher yields and net returns (Bobde, 1993). Results of the experiments conducted at Akola and

Indore under AICSIP revealed that intercropping system is highly beneficial as compared to either of the sole cropping systems (Table 2). In Malwa region of Madhya Pradesh sorghum genotypes JJ 1022, SPV 1616 and CSH 16 were most compatible with soybean intercropping (Table 3).

Table 2: Grain yield of sorghum and soybean as influenced by row proportions (Mean of Akola and Indore locations over 3 years)

Treatment	Yield (t/ha)			Monetary return (Rs/ha)
	Sorghum	Soybean	Sorghum equivalent	
Sorghum+soybean (1:2)	2.27	1.02	5.34	22,120
Sorghum+soybean (2:1)	3.41	0.50	4.92	21,913
Sorghum+soybean (2:4)	2.08	0.90	4.79	20,154
Sorghum+soybean (3:3)	2.69	0.71	5.16	21,298
Sorghum+soybean (3:6)	1.96	0.91	4.69	19,805
Sole soybean	-	1.34	4.02	14,697
Sole sorghum	3.90	-	3.90	18,990
CD (P=0.05)			0.58	2,107

Table 3. Sorghum equivalent yield, net returns and benefit: cost (B: C) ratio in sorghum + soybean intercropping system as influenced by sorghum genotypes at AICSIP Indore.

Cropping system	Sorghum equivalent yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
CSH16+soybean (2:4)	6337	56,274	5.33
CSH23+ soybean (2:4)	5369	46,959	4.62
CSV15+ soybean (2:4)	5993	55,244	5.25
SPV1616+ soybean (2:4)	6374	59,681	5.60
JJ 1022 (Local)+ soybean (2:4)	6658	62,339	5.80
CSH16 sole	3305	29,472	3.02
CSH23 sole	2243	18,128	2.24
CSV15 sole	3498	33,651	3.31
SPV1616 sole	3382	34,172	3.34

Local (JJ 1022) sole	3421	33,465	3.29
Sole soybean	6835	49,152	5.12
CD (P=0.05)	682	5,156	0.85

Sorghum + pigeonpea

Sorghum + soybean

Sorghum+ groundnut

Groundnut being a leguminous and low profile canopy crop fits well with sorghum in intercropping system in semi-arid conditions. Results of the experiments conducted under AICSIP at Dharwad and Palem revealed that groundnut may be planted at 4:2 or 6:3 row ratios to get benefit of higher total productivity and gross returns (Table 4).

Table 4. Yield and gross monitory returns in sorghum+ groundnut inter cropping system at AICSIP Dharwad

Treatment	Grain yield (kg/ha)		Sorghum equivalent yield (kg/ha)	Gross monitory returns (Rs/ha)
	Sorghum	Groundnut		
Sorghum+Groundnut 1:2	3573	1667	8870	31057
Sorghum+Groundnut 2:1	3807	519	5180	23199
Sorghum+Groundnut 2:4	4724	1667	9946	35579
Sorghum+Groundnut 3:3	4701	827	7330	29212
Sorghum+Groundnut 3:6	3188	1358	7442	27263

Sorghum+Groundnut 6:3	4235	556	5999	25111
Sole sorghum	5541	-	5541	26348
Sole groundnut	-	1605	4012	13340
CD (P=0.05)	541	159	675	2660

Sorghum + short duration legumes

Intercropping of sorghum with short duration legumes like greengram, blackgram, cowpea etc. has been found more productive and profitable. In Alfisols of Southern Telangana region with low to medium rainfall, intercropping of sorghum with greengram/blackgram (1:1) with recommended row spacing for the crops has been found profitable inspite of adverse *kharif* season. Sorghum+clusterbean intercropping system have been found superior than with other legumes in sandyloam soils of Hyderabad and New Delhi. Sorghum+cowpea (3:3 or 4:2) produced maximum net returns at Parbhani.

Rao *et al*. (2003) critically reviewed the research work done on different sorghum-based intercropping systems in rainfed regions of India and compiled the values of LER, equivalent yields and net returns (Table 5).

Table 5. Range of LER, equivalent yields, net returns and B: C ratio values in sorghum- based intercropping systems

Intercrops	Row ratio	Range of observations			
		LER	BCEY (t/ha)	Net returns (Rs/ha)	B:C ratio
Pigeonpea	2:1, 3:1, 4:2	1.19-1.51	1.56-6.90	2756-11312	-
Soybean	1:1, 2:2, 3:3, 3:6	1.16-1.57	3.30-5.28	11098-13220	3.28-3.93
Cowpea	1:1, 2:1, 2:2	1.60	-	-	1.87
Groundnut	1:1, 1:2, 2:2	-	-	6146-6181	-
Greengram	2:1, 1:4, 3:3	1.58	3.5-5.3	8672-11346	-

***Rabi* sorghum-based intercropping systems**

As the moisture is a limiting factor during post-rainy sorghum production, intercropping is feasible only in deep soils. Sorghum + chickpea and sorghum+ safflower are the important intercropping systems in *rabi* sorghum growing regions of Maharashtra and Karnataka.

Pearl millet-based intercropping system

Being a rainfed crop, pearl millet is also grown in mixed, cropping or intercropping systems, as an insurance against bad weather. Paired-row system of planting of pearl millet along with a row of legume as an intercrop not only increases the total production but also reduces the fertilzer N requirement of the crop. Pearl millet +

pigeonpea (2:1 paired row 30/60 cm) or 4:2 intercropping system has been found most productive and remunerative. The highest net returns has been obtained when pearl millet was intercropped with greengram 2:1. Paired row planting of pearl millet with greengram or cowpea (30/70 cm) increased the yield of pearl millet with additional yield of pulses. The other intercrops suited with pearl millet are blackgram, cowpea, dew gram, castor and cluster bean. Details of intercropping systems practiced in the country are listed in table 6.

Table 6. Intercropping systems in pearl millet growing regions (Khairwal *et al.* 2007)

States	**Intercropping systems**	**States**	**Intercropping systems**
Eastern Rajasthan	Pearl millet + Cluster bean Pearl millet + Cowpea Pearl millet +Greengram	**Uttar Pradesh**	Pearl millet +Greengram Pearl millet +Cowpea Pearl millet +Sesame
Western Rajasthan	Pearl millet +Mothbean Pearl millet +Clusterbean	**Madhya Pradesh**	Pearl millet +Pigeonpea Pearl millet +Cowpea Pearl millet +Soybean
Maharashtra	Pearl millet +Pigeonpea/soybean Pearl millet + Greengram Pearl millet +Blackgram Pearl millet +Cowpea Pearl millet +Mothbean Pearl millet +Sunflower	**Karnataka**	Pearl millet +Pigeonpea Pearl millet +Soybean Pearl millet +Greengram Pearl millet +Sunflower
Gujarat	Pearl millet +Greengram Pearl millet +Cowpea Pearl millet +Sesame	**Andhra Pradesh**	Pearl millet + Pigeonpea Pearl millet + Soybean Pearl millet +Greengram Pearl millet +Sunflower Pearl millet +Groundnut
Haryana	Pearl millet +Clusterbean Pearl millet +Greengram Pearl millet +Cowpea	**Tamil Nadu**	Pearl millet +Pigeonpea Pearl millet +Soybean Pearl millet +Greengram Pearl millet +Cowpea

			Pearl millet +Sunflower

Sugarcane-based Intercropping Systems

Sugarcane being a long-duration and widely spaced crop and very slow rate of initial growth provides ample scope for growing short-duration vegetable crops. Autumn planted sugarcane is more suitable for intercropping that spring sugarcane because of its slow growth rate during November to February months due to low temperature.Various vegetable crops like potato, onion, peas, palak, radish etc. can be grown with autumn planted sugarcane. Singh and Vashist (2004) reported that onion can be safely intercropped with autumn planted sugarcane in 1:1 row proportion. It has been observed that intercropping of radish and onion performed better without affecting the growth and cane yield of sugarcane. Intercropping of peas with autumn planted sugarcane does not affect the cane yield of sugarcane, but radish, turnip, and palak decrease the cane yield 5.1, 7.4 and 11.5 %, respectively over pure cane. The highest net profit (Rs. 26785/ha) has been obtained with sugarcane+pea intercropping system (Table 7). Sugarcane intercropped with vegetable cowpea recorded significantly higher cane equivalent yield (84.5 t/ha) net returns (Rs45, 446/ha) and B:C ratio (1.30) as compared to sugarcne+greengram and sugarcane+ sesbania (green manuring) intercropping systems (Singh *et al*. 2007).

Table 7: Yield and economics in sugarcane intercropping system

Treatment	Cane yield (t/ha)	Intercrop yield (t/ha)	Equivalent cane yield (t/ha)	Ret profit (Rs/ha)
Sugarcane alone	75.2	-	-	17,847
Sugarcane + pea (2 rows)	75.3	6.29	103.4	26,785
Sugarcane + palak (2 rows)	66.5	19.34	98.7	24,494
Sugarcane + radish (2 rows)	71.4	23.14	97.1	26,404
Sugarcane + turnip (2 rows)	69.6	16.01	87.3	17017

Maize-based Intercropping Systems

Maize has been recognized as a common component in most intercropping systems. Maize-potato cropping system is largely followed in Central plains of India. It is sown in wider rows (60-75 cm). The inter row spaces can be efficiently used by growing short duration vegetables. In Bangladesh, intercropping of bush bean, spinach, coriander and red amaranth with maize were found promising (OFRD, 2006).

Inclusion of two rows of french bean in between two rows of maize spaced at 90 cm apart has been more profitable. In chilli-maize intercropping, the incidence of*Anthonomus eugenii* was lower and yield was greater compared to chilli alone. The pest and disease problem has been reduced in maize + tomato intercropping.

Table 5: Yield (t/ha) and profitability of maize+vegetables intercropping systems

Treatment	Intercrop yield (t/ha)	Maize equivalent yield (t/ha)	B:C Ratio
Maize + potato	6.22	13.93	2.32
Maize + *lashak*	4.67	14.48	2.68
Maize + spinach	4.53	15.62	2.67
Maize + french bean	5.29	10.42	2.22
Sole maize	-	9.65	1.97
LSD (P=0.05)	-	1.05	-

Diversification of Rice-based Cropping systems with vegetables

Continued adoption of rice-rice or rice-wheat cropping systems has led to decrease the system productivity, sustainability and soil health in different agro-ecological regions of the country. Diversification of these systems with the inclusion of vegetable crops has been found more sustainable and profitable. System productivity of rice - fenugreek -okra was the highest (25.73 t/ha) followed by rice-onion-cowpea (24.15 t/ha) and the lowest (7.85 t/ha) with rice-wheat-fallow system (Jat *et al*. 2012). Rice - fenugreek -okra system had the highest sustainable index, production efficiency, field water-use efficiency and the maximum net returns and B:C ratio (Table 8). Singh and Lal (2011) obtained maximum production (60.24 t/ha), net returns (₹ 98,990/ha), B:C ratio (1.13), production efficiency (190.99 kg/ha/day) and monetary return efficiency (₹ 313.6/ha/day) in potato-onion-rice cropping system. Potato-greengram-rice cropping system recorded the highest value of the sustainable yield index, organic C, available N and P in the soil, while application of FYM @ 10 t/ha to potato crop in the system resulted in highest net returns, B:C ratio, production efficiency, monetary return efficiency and sustainable yield index. Prasad *et al*. (2011) reported that in Chhattisgarh, rice-potato-cowpea system was identified to be the most productive with rice-equivalent yield of (27.04 t/ha/year), production efficiency

(83.97 kg/ha/day), profitability (Rs. 320.36/ha/day), relative economic efficiency (199.29%) and net return (Rs 1,16,929/ha/year) (Table 8).

Table 8: System productivity, sustainability, water-use efficiency and profitability of rice-vegetable cropping systems.

Cropping systems	System productivity (RYE-Rice equivalent yield (t/ha)	Sustainability index	Water-use efficiency (kg RYE/ha-cm	Net returns (Rs/ha)	B:C ratio
Rice-wheat -fallow	7.85	0.27	10.92	20,448	1.58
Rice-wheat-greengram	12.45	0.45	12.97	47,639	2.09
Rice-chickpea-cowpea	11.18	0.40	14.72	44,207	2.09
Rice - fenugreek - okra	25.73	0.97	32.99	96,286	2.83
Rice-onion-cowpea	24.15	0.91	23.00	85,511	2.06

Table 6: Crop yield, rice-equivalent yield (REY), production efficiency, profitability and relative economic efficiency of different rice-based cropping sequences (Prasad *et al*. 2011).

Cropping systems	Rice equivalent yield (t/ha)	Production efficiency (kg/ha/day)	Net returns (Rs/ha)	B:C ratio
Rice-wheat -fallow	9.67	42.6	39,069	1.36
Rice-mustard-green manure	8.69	32.57	33,798	1.25
Rice-coriander (leaf)-moong	16.75	58.97	76,805	1.90
Rice ï table pea-maize fodder	8.0	33.92	12,249	0.37
Rice-brinjal-green manure	21.39	64.82	1,08,741	2.65
Rice-onion-green	16.91	64.53	77,661	1.91

manure				
Rice-potato-cowpea	27.04	83.97	1,16,929	1.62

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Quality Seeds in Market-driven Agriculture

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Introduction

Indian agriculture has gradually transformed itself from subsistence agriculture into market-driven agriculture. Presently, it is envisaged as an enterprise and business, and not the way of life. All out efforts are made to enhance productivity and profitability. However, in this age of market oriented economy, high quality produce is likely to fetch better price and generate additional income to the farmers. Good quality genetically pure seed of high-yielding varieties is a critical input in crop production for obtaining high productivity. Now-a-days, a number of varieties of field and horticultural crops are available which have better nutritional and keeping qualities. The availability of quality seeds of such varieties is highly desirable in this cutting-age of market-driven agriculture.

Seed and major seed quality characters

Botanically, seed is a mature ovule or an embryo. It is a living organism embedded in the supporting or the food storage tissue (endosperm in cereals). In seed, the importance is attached to the biological existence; whereas in grain the importance is provided to the supporting tissue, the economic produce. Seed is a basic input in agricultural enterprise. Agriculturally, any plant propagule is referred to as seed. As per Seed Act (1966), seed includes seed of food crops including edible oilseeds and seeds of fruits & vegetables, cotton seeds, seeds of fodder and forage crops, jute seeds, and seedlings, tubers, bulbs, rhizomes, roots, cuttings, all types of grafts and other vegetatively propagated material for food or forage crops.

Seed quality refers to the sum total of all attributes of seed including the genetic and physical purity, physiological soundness and health status. The major seed quality characters are summarized as below.

1. **Physical Quality**: It is the cleanliness of seed from other seeds, debris, inert matter, diseased and insectsô damaged seed. The seed should have uniform size, weight, and colour, and should be free from stones, debris, dust, leaves, twigs, stems, flowers and fruit without any other crop seeds and inert material. A high quality seed should also be devoid of shrivelled, diseased, mottled, moulded, discoloured, damaged and empty seeds. The seed belonging to a specific variety of a crop species should be easily identifiable based on morphological diagnostics. To maintain a high level of physical quality, harvesting and threshing at appropriate time, proper cleaning and grading of seed (processing) is required.

2. **Genetic purity:** Any released and notified crop variety (cultivar) has specific genetic constitution (gene combination). Genetic purity means maintenance of such specific gene combination in a given cultivar. It is the *true to type* nature of the seed, that is, the seedling/ plant/ tree from the seed should show resemblance to its mother in all aspects. Genetic purity ensures good crop growth, protection from diseases and insect pests and nutritional quality of seed. For perpetuation of genetic purity of a variety across generations, it is necessary to practice rouging in seed production field, keep proper isolation distance from other varieties of the same crop and avoid mechanical mixture during threshing and storage.

3. **Physiological Quality:** It is the actual expression of seed during next generation/ multiplication. Physiological quality comprises seed germinability and seed vigour. Germinablity is directly related to seed viability. The extent of liveliness for production of good seedling or the ability of seed to produce seedling with normal root and shoot under favourable condition is known as germinability. Seed vigour is the sum total of all seed attributes that enables its regeneration under any given condition. It determines the level of performance of seed or seed lot during germination and seedling emergence. Seed which perform well at sowing are termed as quality seed, and based on the degree of performance in production of elite seedling it is classified as high, medium and low vigour seed. The difference in seed vigour may be reflected in the rate and uniformity of emergence and grminability. Therefore, all viable seeds need not be germinable; however, all germinable seed will be viable. Similarly, all vigorous seeds are germinable although all germinable seeds need not be vigorous. Physiological quality of seed can be ascertained through proper selection of seed (matured seed) used for sowing and by caring for quality characters during extraction, drying and storage. Vigorous seed is preferable for raising a good orchard as it will take several years to bring forth fruits (the ultimate economic output). Hence, selection of seed based on seed vigour is important for raising perfect plantation crop.

4. **Seed Health:** It refers to the absence of insect infestation and fungal infection in or on the seed. A good seed health (absence of insectsô infestation and fungal infection) also ensures both physical and physiological quality of the seed in long term storage. The health status of seed also includes the deterioration status of seed which is expressed through loss of seed vigour. It influences the seed quality characters directly, and warrants their soundness in seed for the production of elite seedlings in field or nursery.

Hence, the quality seed should have high genetic and physical purity, high germinability, high vigour, higher field establishment, free from pest and diseases, good shape, size, colour and appearance according to the specification of variety, high longevity/ shelf life, optimum moisture content for storage and high market value.

Classes of seeds

The following four classes of seed are recognized in India:

1. Nucleus seed: It is produced from the basic seed stock available with the breeder. True to type plants are selected individually from the space-planted basic seed stock. The selected plants are grown as progenies, and the progenies that differ from the cultivar in one or more characters are eliminated, and the remaining progenies are composited to constitute the nucleus seed.

2. Breeder seed: It is produced from nucleus seed under the direct control of a qualified plant breeder. The breeder seed is labelled with a golden coloured tag, and serves as the source for the initial and recurring increase of foundation seed. The Indian Council of Agricultural Research (ICAR) institutes and the state agricultural universities (SAUs) have the primary responsibility for the production of breeder seed as per indents received from different seed-producing agencies.

3. Foundation seed: This is the progeny of breeder seed or occasionally of Foundation seed stage-I, and is produced under the control of a seed certification (quality control) agency. Foundation seed (FS) produced directly from the breeder seed is designated as foundation seed stage-I, whereas FS produced from foundation stage-I is designated as foundation stage-II. FS-II is not used for further increase of foundation seed. However, minimum seed certification standards shall be the same for these two classes of foundation seed. Both classes of foundation seed are labelled with white coloured tags.

4. Certified seed: This class of seed is produced from foundation seed or occasionally from certified seed, and is certified by a seed certification agency. Certified seed can be used to produce certified seed or can be used by farmers for commercial cultivation. Only notified varieties are eligible for entering into formal seed chain and production of certified seed. Certified seed may be undertaken by National Seed Corporation (NSC), state seed corporation, SAUs, public and private seed enterprises and registered seed growers. Certified seeds are labelled with blue coloured tags.

In addition to this, progressive seed growers also produce the seed of released cultivars while maintaining satisfactory level of genetic purity and adopting the recommended package of practices. Such seeds are sold as *truthfully labelled* (TL) seed. Similarly, private companies can also breed high yielding varieties and sell their seed under their own trade name under this category.

Designated diseases

Designated disease refers to the disease specified for the certification of seeds, and for which certification standards are to be met with. Such diseases cause contamination, if present in the seed field or within the specified isolation distance (e.g., loose smut of wheat). For this, the minimum isolation distance for certification has been prescribed at 180 m. A few examples of designated diseases have been provided in the Table 1.

Table 1. Designated disease of a few field and vegetable crops.

S.No.	Crop	Designated disease
1.	Wheat	Loose smut
2.	Sorghum	Grain smut, Kernel smut
3.	Mustard	Alternaria blight
4.	Pearl millet	Grain smut, Green ear ergot
5.	Sesame	Leaf spot
6.	Brinjal	Little leaf
7.	Chilies	Anthracnose leaf blight
8.	Cucurbits	Mosaic
9.	Cowpea	Anthracnose
10.	Bhindi	Yellow vein mosaic
11.	Potato	Brown rot, Root knot nematode
12.	Tomato	Early blight, Leaf spot

Seed certification standard

Seed certification is necessary for foundation and certified classes of seed. It is done by the seed certification agency. Each crop has different field and seed standards for production of foundation and certified seed. These variations are mainly because of the variation in the extent and mode of cross pollination. The field and seed standards for a self-pollinated crop (chickpea) are given in Table 3.

Table 2. Minimum field and seed standards for chickpea seed production in India.

S. No.	Parameter	Foundation seed	Certified seed
1.	Isolation distance (m)	10	5
2.	No. of field inspections	2	2
3.	Germination (%)	85	85
4.	Pure seed (%)	98	98
5.	Inert matter (%)	2	2
6.	Plants affected by seed borne diseases (%)	0.1	0.2
7.	Off types (%)	0.1	0.2
8.	Other crop seeds (no./kg)	0	5
9.	Other distinguishable variety seeds (no./kg)	5	10

Chemical composition of seed

Seeds are unique in that they are the storehouse of chemicals that are used as food reserves for the next generation plant. These chemical foods contribute substantially

to meet the demand of human food supply. In addition to this, these chemicals also fulfil our other requirements (cooking oils, lubricants, etc). Seeds store three major classes of chemical compounds: carbohydrates (sugars), lipids (fats and oils) and proteins. The approximate quantities of these compounds stored in seeds vary with crop species (Table 3) and varieties within the crop.

In the case of proteins, seeds may not have the ideal composition in terms of human nutritional needs. Some seeds do not have the optimum quantities of amino acids for human nutrition. For example, corn proteins are generally low in the amino acid *lysine* and *tryptophan* but relatively high in S-containing amino acids *cysteine* and *methionine.* However, the reverse trend has been observed in soybean or pulse proteins. When corn and soybean/pulse seeds are used together, a nutritionally satisfactory balance can be obtained.

Table 3. Approximate chemical composition of various kinds of seed.

S.No.	Crop	Sugars	Protein	Lipids/Fat
1.	Rice	75	7-8	5
2.	Wheat	67	13	2
3.	Maize	62-70	10	5
4.	Pulses	55-60	20-28	2-5
5.	Soya bean	25-30	40	20
6.	Peanuts	23-28	25	45
7.	Rape seed	25-35	20-25	35-42
8.	Barley	76	9	2
9.	Oat	66	12	5

Crops of significance in market-driven agriculture

Older varieties and land races of principal crops are low yielding. In addition, seeds of such varieties and land races do not have better nutritional and keeping qualities. Low *lysine* and *tryptophan* in cereals, low *S-containing amino acids* in legumes and pulses, anti-nutritional factors (ODAP content in grass pea, trypsin and amylase inhibitors in red gram, tannins in urdbean and faba bean, protease inhibitor in mungbean, etc) in pulses and high erusic and glucosinolate in rapeseed and mustard are but a few examples which have been causing health concern. These concern need to be taken care of through breeding of improved varieties. Some crops which have assumed greater significance in market-driven agriculture include basmati rice, durum wheat, maize, canola, linseed, lentil, potato and sugarcane. A few varieties of these crops (Fig 1A & 1B) have been developed that have better nutritional and keeping quality. Such varieties can boost income level of farmers.

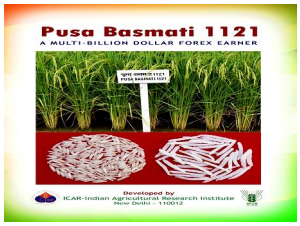

Fig 1A. Pusa Basmati 1121

Fig 1B. Cooked rice of Pusa Basmati1121

Biofortification

Nutritional quality of food crops is improved through agronomic practices, conventional plant breeding, or modern biotechnology. Biofortification differs from conventional fortification in that it aims to increase nutrient levels in crops during plant growth rather than through manual means during processing of the crops. It is a way to reach populations where supplementation and conventional fortification activities may be difficult to implement and/or limited. Some examples of biofortification are: iron-biofortification of rice, beans, sweet potato, cassava and legumes, zinc-biofortification of wheat, rice, beans, sweet potato and maize, provitamin-A/carotenoid biofortification of sweet potato, maize and cassava, amino acid and protein-biofortification of sourghum and cassava. Similarly, golden rice, improved canola varieties (0, 00 and 000) has also been developed. The cultivation of these varieties is important in market-driven agriculture.

Designer seed: a way forward to address mal-nutrition

Most seeds are not high in protein but are high in carbohydrates or lipids. Soybean (high in protein and relatively high in lipids) is the exception rather than the rule. The seeds of most plants store their food reserves mainly in the form of carbohydrates or lipids. In this age of biotechnology, it may be possible to breed a **"designer"** seed plant with the correct levels of carbohydrate, lipids, and protein to meet human nutritional and industrial needs. The development of golden rice and high protein potato has already heralded the ñdesigner eraò. To reap maximum benefit, farmers should pay due attention while choosing the quality seed (variety) for commercial cultivation. Similarly, traders should also address the concerns of consumers who want to pay for better quality.

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