VISION-2025

भाकृ अनुप
ICAR

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

VISION-2025

CENTRAL INSTITUTE OF POST HARVEST ENGINEERING AND TECHNOLOGY

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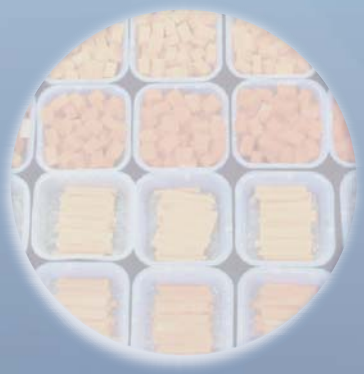

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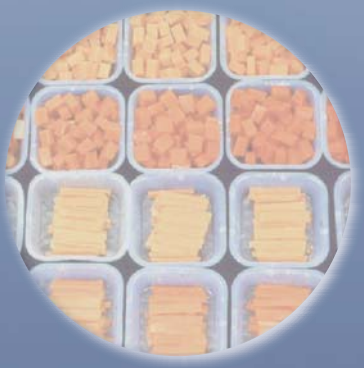

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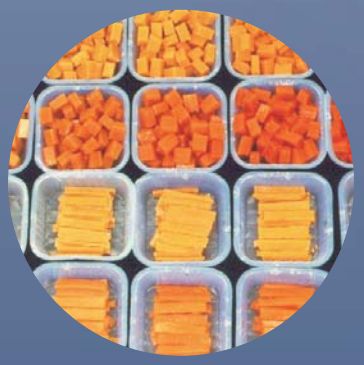

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Indian agriculture must continuously evolve to remain ever responsive to manage the change and to meet the growing and diversified needs of different stakeholders in the entire production to consumption chain. In order to capitalize on the opportunities and to convert weaknesses into opportunities, we at the ICAR attempted to visualize an alternate agricultural scenario from present to twenty years hence. In this endeavour, an in-depth analysis of the Strengths, Weaknesses, Opportunities and Threats (SWOT) was undertaken to place our research and technology development efforts in perspective so that we succeed in our pursuit of doing better than the best. Accordingly, the researchable issues are identified, strategies drawn and programmes indicated to have commensurate projects and relevant activities coinciding with the launch of the 11th Five Year Plan.

Inadequate processing and value addition has been resulting into severe post harvest losses and reduced income and employment in farm and rural sector. At present, only about 40% of the agricultural produce is commercially processed and the net value addition is a paltry 12%. The present share of processed products in Indian diet is about 15% and it is likely to rise to 40% by 2025 on account of changing life styles, changing demography at work place and reduced time available for cooking. The ground realities of Indian farm sector and the huge untapped potential bring the role of Central Institute of Post Harvest Engineering and Technology into focus. The vision of the institute is to integrate agricultural production catchments with processing and marketing so as to reduce post harvest losses, permit value addition, develop diversified products and utilize agro-residues through structured R&D programmes including food safety and quality, intelligent packaging and storage and novel product development using advanced extrusion and non-thermal processing techniques for comprehensive and sustained economic development along with environment security and social equity. Application of biotechnology and nanotechnology for conversion of agricultural produce into value added products is being sought to impart novel traits, cost competitiveness and quality attributes.

It is expected that realization of the Vision embodied in the document would ensure that the CIPHET, Ludhiana continues to fulfill its mandate and make Indian agriculture locally, regionally and globally competitive. The efforts and valuable inputs provided by my colleagues at the ICAR Headquarters and by the Director and his team at the institute level for over an year to develop Vision 2025 deserve appreciation. It is hoped that the implementation of the programmes mentioned in the document will go a long way to strengthen agriculture sector in the country.

(MANGALA RAI)
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and
Director General, Indian Council of Agricultural Research
Dr. Rajendra Prasad Road, Krishi Bhawan, New Delhi - 110 001, India

February 2007

PREFACE

Indian agriculture contributes only 1/4th of GDP while it sustains 2/3rd of the population and continues to determine the growth rate of national economy. Agricultural production is increasing faster than the population and consequently increasing the market surplus and more pressure on post harvest technologies particularly for perishables. Further, inadequate storage, transport, handling and processing has led to unacceptable level of wastage and value loss. The magnitudes of these losses are as high as up to 30% in case of fruits and vegetables. Value addition is the easiest way to reduce these losses, however, the value addition in the fruits and vegetables is only 2%. The small scale and unorganized sector which contributes about 70% of the processing and where the employment lies, suffers from low efficiency due to lack of efficient PH Technologies and value addition processes.

The Central Institute of Post Harvest Engineering and Technology (CIPHET) was established in the year 1989 under aegis of ICAR. Mandate of the Institute is to develop technologies for reduction in post harvest losses to farm produce including livestock and fisheries. It is also one of the objective to adopt, develop and promote technologies for value addition to agricultural produce for domestic use and export. Institute has developed a good number of technologies for reduction of post harvest losses as well as value addition to agri-horti-aqua produce. Institute is credited with 25 patents/patent applications.

During the last decade the global food processing scenario has undergone rapid changes due to free trade policy that offers both global opportunities for market access and also challenges. Our country has food processing industries in organised as well as in unorganised sector which facilitate processing of agricultural produce in production catchments. We have to gear up this activity to enchance employment and income generation in rural areas through processing and value addition to raw produce.

The Vision 2025 document of CIPHET gives status, growth, important landmarks, SWOT analysis; activities and programmes proposed to be taken up in future to meet the challenges visualized. The vision document highlights the future thrust areas and their implementation strategies. The vision document will be periodically revised, updated and therefore, it is hoped to have feed back from the researchers, policy markers, processors and peers of profession. We hope that this document will help in accelerating the research and development activity in the field of post harvest and value addition in National Agricultural Research System to accomplish successfully the cherished goal of bringing ever green revolution in India.

I acknowledge with thanks the valuable suggestions and guidance from Dr. Mangala Rai, Secretary, DARE & Director General, ICAR, Dr. Nawab Ali, DDG (Engg) and Dr. Pitam Chandra ADG (PE) in developing this document. The help rendered by Drs. S.K. Nanda, K. K. Singh, M. Prasad, R. K. Goyal and V. K. Bhargav and other colleagues at CIPHET in preparation of this document is highly appreciated. Technical assistance rendered by Sh. Gurdeep Singh in compilation of this document is acknowledged.

(R.T. Patil)
Director

Ludhiana
August 2007

EXECUTIVE SUMMARY

The growing concern for nutritional and food security and greater emphasis on consumer needs as well as tough competition from other countries has opened a host of challenges and opportunities as well as the necessary incentives to farmers and producers with huge potential for processing and value addition of agro produce for creation of additional income to the farm families and avenues for employment generation. Besides producing high quality raw material for the table consumption and some processing (only 2% of the horticultural produce is being processed as compared to more than 80% in Philippines and Malaysia for domestic consumption as well as for export, the full potential of Indian agriculture cannot be realized unless India emerges as a major player in the world agriculture. The crops produced in India are not only diverse but they possess unique aroma flavour and taste along with many therapeutic benefits. The sensitization of farmers/producers is therefore necessary about the importance of quality, reduction of cost at every level through reduction in losses, appreciation of good farming practice and need for understanding and observation of codes and standards for maintaining high quality of raw produce so essential for storage, further processing and packaging. In order to provide continued research and development support to agricultural sector with respect of engineering and technology inputs. CIPHET was established on 29th December 1989 with vision "Higher profitability of agricultural production systems ensuring better income to farmers and increased employment opportunities in rural sector through efficient post harvest engineering and technological interventions for loss reduction and value addition to agricultural produce and byproducts resulting in high quality and safe food and feed at competitive prices for domestic and export markets" and mission "Creating prosperity through minimization of post harvest losses from 15% to 5% and increase in value addition from present level of 10% to 30% to produce and by-products from crops, horticulture, livestock and fisheries sectors". CIPHET has to ensure national priorities, and provide infrastructure for basic and applied research and coordinating the activities in respective areas and perform advisory roles on policy issues. CIPHET has been developing cost effective technologies for various post harvest operations and promoting entrepreneurship and is expected to support post-harvest led agriculture.

With greater awareness among the consumers for safety as well as nutritional quality of foods, there is tremendous scope of modernizing existing post-harvest operations of various agro-produce. There is a need to improve and develop primary, secondary and tertiary processing techniques for further value addition for better income at all levels. The demand for appropriate post-harvest/agro-processing machinery is increasing at a fast rate. Similarly, the demand for processed and convenience food is likely to increase more both in the domestic and export markets. Also to meet the challenges posed by higher production and productivity, there is an urgent need for development of appropriate technologies for loss prevention, handling, storage, value addition, packaging, transportation and marketing of various agricultural produce and products including by-products and residues for domestic and international markets. Higher production has resulted in the need of mechanizing Krishi

Upaj Mandis with provision of handling, cleaning, grading, temporary storage as well as primary processing of food grains (cleaning, grading & scientific storage) as well as fruits and vegetables (cold chain and minimal processing. The basic and applied research on modern storage facilities for food grains (with computer models and expert system based approach for aeration) and freezing/pre-cooling as well as MA and CA storage of value added and minimally processed perishables using nanotechnology will be needed. The demand for convenient and ready to cook, ready to eat foods with higher nutritional and food safety standards is steadily increasing. Hence modern processing techniques like extrusion, high pressure processing, microwave thermal processing need to be adopted for processing of conventional as well as internationally liked products from our crop wealth. This demands greater thrust in post harvest technology of grains, fruits, vegetables, oilseeds, animal, fish products and products of other commercial crops.

With continued shift in agriculture towards commercialization, diversification and agri-business, substantial land area is expected to get occupied by high value commercial crops such as medicinal aromatic plants and fruits like amla, jamun, bel, etc. Their present day use is mostly in pharmaceuticals. However its value addition through conventional and modern food (nutraceutical and therapeutic fruits based on whole grain concept) needs to be developed to make the crop production sustainable and profitable for long times to come. For increasing productivity of these high value crops, covered crops cultivation should be adopted on large scale and it calls for development of cost effective green houses and control of environment in such structures. For greater attention to this important commodity CIPHET has proposed to establish Division of Commercial Crops Processing .

For higher production of milk, eggs and quality meat products, design of animal and poultry shelters, fishponds, slaughterhouses, etc. need to be improved on scientific lines. In this context, R&D efforts for feed and fodder management are also expected to assume greater importance. Though consumption of poultry, meet and milk products is substantial in the country, use of modern techniques for their processing and value addition are not practiced. It is therefore essential that processing techniques and quality evaluation gadgets as well as machinery to modernize, slaughter and meat extraction suitable for adoption under Indian Socio Economic condition be developed. Hence CIPHET has proposed to establish a Division of Livestock Products Processing Technology.

The food processing industries are highly energy intensive as well as they involve operations like drying, blanching, pasteurization and cooking. Hence greater emphasis is needed on utilization of renewable sources of energy for agro-processing operations. CIPHET would include this aspect in its R&D programmes. Developing/adoption of energy efficient processes and techniques for cogeneration of energy from processing waste through enzymatic fermentation or catalytic conversion will be needed.

Primary processing of various agro-horticultural produce will continue to get priority in our future programmes due to its potential of reducing postproduction losses and generating additional income and employment at rural level. CIPHET will also pay due attention to effective technology transfer through production and supply of prototypes, setting up of pilot plants, custom hiring,

consultancy services and training. Modern seed processing plant, agro-processing centre, agro-processing industrial park, information and communication centre proposed to be established at CIPHET are expected to be effective tools for technology transfer. Proper linkages will have to be developed with other national and international R&D institutions, KVKs, SAUs, Industries, NGOs, etc. for effective R&D and technology transfer.

With reference to above perspectives, CIPHET has identified following thrust areas.

- ❖ Post harvest technologies for loss reduction
- ❖ Value addition technologies
- ❖ Technology transfer, entrepreneurship development, training and capacity building through market intelligence
- ❖ Byproduct utilization and Waste management
- ❖ Improvement of agricultural structures
- ❖ Biotechnology in PHT sector
- ❖ Environment control for higher productivity
- ❖ Livestock produce processing

To achieve the goals set out in above thrust areas, CIPHET in association with two AICRPs would undertake following major R&D programmes:

1. Constant assessment and minimization of post harvest losses in food grains, oilseeds, horticultural crops, livestock and fish during harvesting, handling, storage, transport through upgrading existing practices and adopting modern technique.
2. Modernization of dhal milling and oil expelling industries for higher recovery & better product and byproduct.
3. Modernization of traditional food processing, packaging and improvement in product shelf life.
4. Novel technologies for processing and utilization of vegetable protein and their byproducts.
5. Modernization of jaggery and khandsari industry and development of value added products for increased domestic consumption and export.
6. Development of prototypes/technologies/equipment for processing of medicinal and aromatic plants.
7. Develop suitable technologies for genetically architectured produce for their processing and preservation.

8. Effective and economical method for processing and utilization of crops residues, agro-processing byproducts and wastes for food, feed, fuel, conversion into products of industrial and pharmaceutical importance.
9. Development of appropriate agricultural structures and environment control system for plants, aqua and livestock.
10. Evaporatively cooled, MAP and CA storage and packaging for perishable products for increased shelf life.
11. Development of functional & health food.
12. Application of modern non-destructive technologies such as near infrared spectroscopy (NIRS), computer tomography, magnetic resonance, imaging, computer vision, image processing for precision quality sorting and grading of agricultural and food product for effective post harvest management and processing.
13. Development of technologies and pilot plants for production of biofuel and industrial chemicals from agricultural biomass through enzymatic conversion process.
14. Development of processes and processing equipment and pilot plants for value addition, income and employment generation from food crops, livestock and fishery.
15. Development of protocols and equipment for bio-technological engineering application e.g. enzyme, fermentation technologies for processing and product development.
16. Development of non-thermal process such as irradiation, electric pulse and high pressure for safe processing and storage of food produce.
17. Studies on thermal and microwave processing for product development and storage of food products.
18. Development of novel value added products using extrusion-processing technology from agricultural, horticultural, aquacultural and livestock based raw materials.
19. Application of nano technologies in processing and preservation of value added products.
20. Multiplication of proven prototypes, establishment of pilot plants, Front Line Demonstrations and entrepreneurship development in post harvest technology.
21. Quality testing of processed products, development of protocols for Good Agricultural Practices (GAP), Good Hygiene Practices (GHP), Good Manufacturing Practices (GMP) and Good Processing Practices (GPP), Hazard Analysis and Critical Control Points (HACCP) and Loss analysis and Critical Control Points (LACCP).

To meet the proposed challenge in the post harvest technology sector, a sum of Rs. 48817 lakhs up to 2025 under Plan budget would be required with additional manpower of 38 scientists in different categories.

1. Preamble

The growing concern for nutritional and food security and greater emphasis on consumer needs as well as tough competition from other countries has opened a host of challenges and opportunities as well as the necessary incentives to farmers and producers with huge potential for processing and value addition of agro produce for creation of additional income to the farm families and avenues for employment generation. A large number of unemployed youth in the rural areas could be induced to take up these simple, low cost yet profitable agro-processing activities, which have the potential to keep them tied with their roots as against the constant migration of rural youth to the urban areas in search of employment having frightful consequences. Secondly, the boost in the agro processing activities will also provide momentum to the creation of infrastructure for handling, transport and marketing. The value addition offers 1.8 direct jobs and 6.4 indirect jobs for each Rs. 10 lakhs invested. Generally private sector waits for the opportunities to be created and when that happens, it finds it attractive enough to enter into the area. The talk of industrialization of rural areas will continue to be a mere wish until the basic necessities required for establishment of micro and small enterprises (which could pave the way for attracting corporate sector to show their presence in a sustained manner) for earning profit are met. Otherwise we shall witness only industrialization in rural areas rather than of rural areas. The role of R&D institutions, government agencies, financial institutions, peoples organizations and other as facilitators and change agents has become very crucial, but it could be truly effective only when most of the players act in a coordinated manner.

Besides producing high quality raw material for the table consumption and some processing (only 2% of the horticultural produce is being processed as compared to more than 80% in Philippines and Malaysia) for domestic consumption as well as for export, the full potential of Indian agriculture cannot be realized unless India emerges as a major player in the world agriculture. Presently, the Indian share in global agricultural trade is very small. Most of the produce exported from India is raw (except Basmati rice, some spices and cashew) and only lately the processed food has started to be exported. Increasingly, the emphasis will have to be on the export of processed food, which has an excellent advantage of longer shelf life and greater margin of profit. This will entail thorough understanding of the global agricultural scenario under the prevailing liberalized trade under the WTO Agreement with attendant implications of stiff competition, strict implementation of codes and standards and the comparative and competitive advantage of selected commodities in which we have strength. The agricultural crops produced in India are not only diverse but they possess unique aroma, flavour and taste along with many theurapetic benefits. The sensitization of farmers/ producers is therefore essential about the importance of quality, reduction of cost at every level through reduction in losses, appreciation of good farming practice and other such related issues and of course the need for understanding and observation of codes and standards for maintaining high quality of raw produce so essential for storage, further processing and packaging and export.

India produces around 91 million tonnes of rice accounting for around 22% of world rice production. Wheat accounts for around 30% of the total cereal production in the world. The major

producers of wheat are China, the former USSR and USA followed by India. The total world trade in wheat is estimated to be around 90 million tonnes accounting for about 50% of total cereals traded in the world. India's share in the international trade of wheat is negligible. Very recently the local wheat grown in India has attracted international buyers for their unique quality and processability. The total world maize production is around 530 million tonnes of which USA alone accounts for about 45%. India produces around 10 million tonnes of maize in a year. Out of the total maize production of around 10 million tonnes in India, about 4 million tonnes is used as animal feed, about 5 million tonnes is dry milled and 1 million tonnes is wet milled. The important major products of wet milling are starch, gluten and a large number of starch derivatives. World over maize is used for ready to eat value added products due to very good functional properties. These technologies need to be adopted for Indian grown maize as the market for ready to eat foods is increasing very fast.

The losses of foodgrains due to improper handling and storage is as high as 10% in India. More than 6% of rice is lost due to poor storage design and practices. Gradual shift to improved storage methods using scientifically designed containers is evident. The bulk storage facilities existing in India are inadequate to meet the increasing storage requirements due to rising production of food grains. Significant losses are recorded during transportation of food grains due to improper stitching of bags, multiple handling, usage of hooks and pilferage. In the developed countries, the entire transportation, handling and storage system has been highly mechanized. The grains are transported in specially designed box cars in bulk quantities in the developed countries and manual handling is minimized. This results in very low spillage losses. Such mechanized handling, loading and unloading devices suitable for India are need to developed.

In India about 66% of rice is milled in hullers, while the remaining in shellers and modern rice mills. There has been a five-fold increase in modern rice mills over the last two decades. While about 80% of wheat is milled in 'atta chakkis' (indigenous mills), around 20% is done in roller flour mills. There has been a three-fold increase in roller flour mill capacity since 1971. Bulk of maize (50%) is dry milled in small quantities for direct consumption. About 10% is wet milled to obtain starch and its derivatives, oil and cattle feed, the rest is used as fodder. Almost the entire quantity of sorghum is dry milled for direct consumption. Around 10% or rice is processed into traditional products like popped rice, flaked rice etc. in the cottage industry. Wheat flour is processed mainly into bread and biscuits and to a small extent to pasta products. This indicates tremendous scope for processing and value addition into novel products from these grains.

India has been exporting around 500,000 tonnes of Basmati rice and around 300,000 tonnes of white rice accounting for less than 5% of the global trade. Very small quantities of wheat and maize are currently exported. Rice exported from India is mainly for its unique flavour and grain quality. Similar is the case with many of its agro produce. Hence, if properly processed and packed for export they will easily earn premium price in world market.

India with its current production of around 45 million tonnes accounts for about 8% of the world's fruit production. Although India is the second largest producer of fruits in the world, the per capita is only about 100g per day due to its bulging population. However, it is estimated that more

than 25-40% of the total production of fruits is lost due to spoilage at various post harvest stages, thus the per capita availability of fruits is further reduced to around 80g per day which is almost half the requirements for a balanced diet. The fruit production in India has recorded a growth rate of 3.9%, whereas the fruit processing sector has grown at about 20% per annum. The growth rates have been extensively higher for frozen fruits & vegetables (12.1%) and dehydrated fruits & vegetables (24%). There exist over 4000 fruit processing units in India with an aggregate capacity of more than 1.2 million tonnes (less than 4% of total fruits produced). It is estimated that around 20% of the production of processed fruits is meant for exports, the rest caters to the defense, institutional sectors and household consumption.

India is the second largest producer of vegetables in the world (ranks next to China) and accounts for 11% of the world's production of vegetables. The current production level is over 85 million tonnes and the total area under vegetable cultivation is around 6.2 million hectares, which is about 3% of the total area under cultivation in the country. It is estimated that around 20-25% of the total vegetables is lost due to poor post harvest practices. Less that 2% of the total vegetables produced in the country is commercially processed as compared to 70% in Brazil and 65% in USA. India exported 429,798 tonnes of processed vegetables worth Rs. 11.3 billion in 2002-03.

India is host to many unique fruits and vegetables having unique aroma, taste and flavour and nutritional properties and health benefits. Many ethnic fruits like guava, anola are rich in vitamin C. The fruits like bel, jamun, Lehberries (high attitude) have unique ability to control chronic diseases of modern day caused due to junk and imbalanced food. These fruits and vegetables as well as medicinal and aromatic plants which are unique to India will be required by rest of the world. Hence to get the highest return from this precious agro-wealth, modern food processing techniques and developing novel value added products will be essential to keep up the competitive edge over other countries in our region.

In order to provide continued research and development support to agricultural sector with respect of engineering and technology inputs, continuous support and strengthening of CIPHET is essential. CIPHET has been developing cost effective technologies for various post harvest operations and promoting entrepreneurship and is expected to support post-harvest led agriculture in the country. CIPHET would also ensure identifying national priorities, and provide infrastructure for basic and applied research and coordinate the activities in respective areas and also perform advisory roles on policy issues.

1.1. Mission

Creating prosperity through minimization of post harvest losses from 15% to 5% and increase in value addition from present level of 10% to 30% to produce and by-products from crops, horticulture, livestock and fisheries sectors.

1.2. Vision

Higher profitability of agricultural production systems ensuring better income to farmers

and increased employment opportunities in rural sector through efficient post harvest engineering and technological interventions for loss reduction and value addition to agricultural produce and byproducts resulting in high quality and safe food and feed at competitive prices for domestic and export markets.

2. Mandate

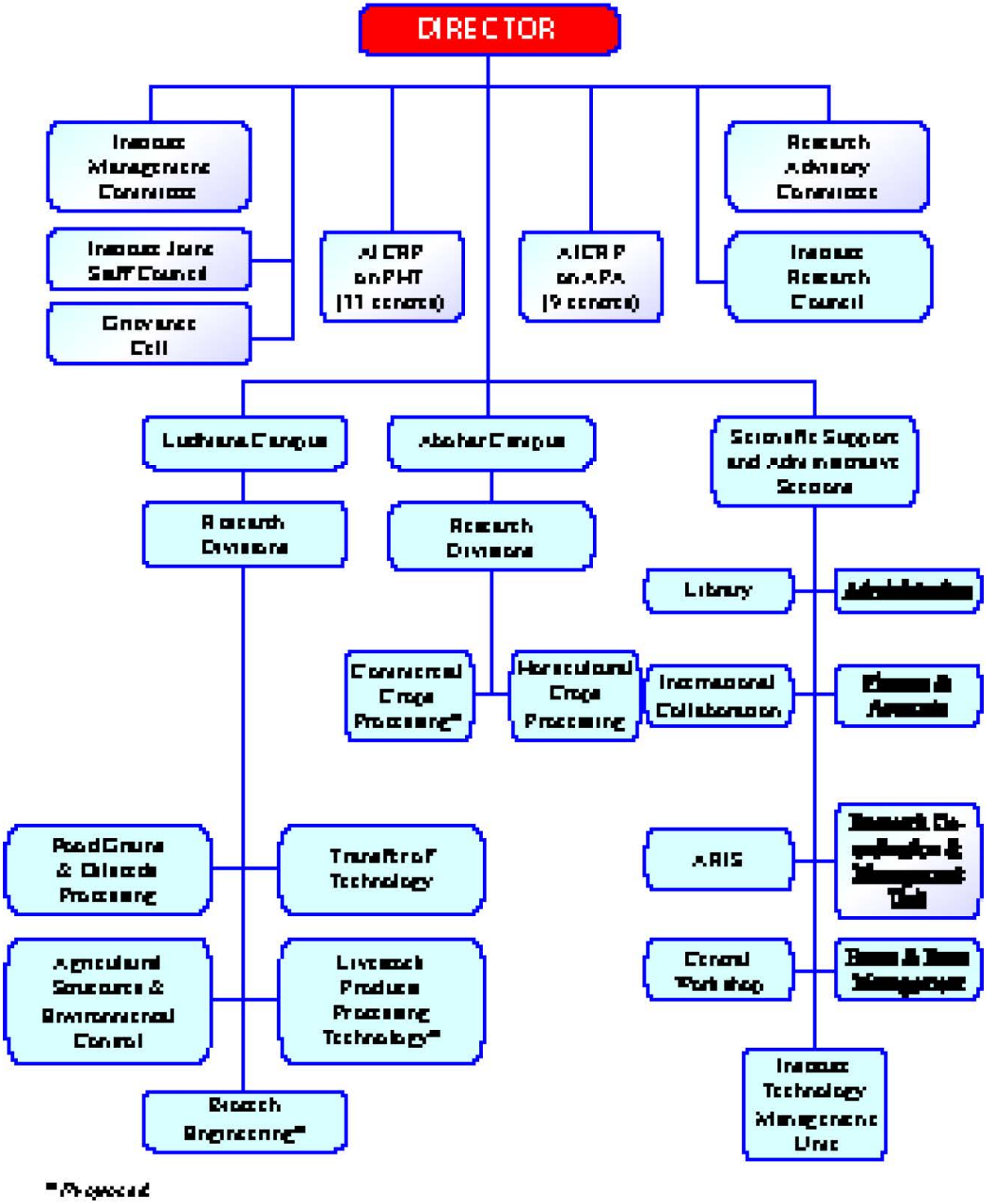
- To undertake basic, applied, strategic and adaptive engineering and technology research in post production sector of produce of plant origin, livestock and aquaculture produce including agriculture structures and environmental control, quality and safety.
- To act as national institute for research, education/teaching and training in post harvest engineering and technology.
- To act as national repository of information on processes, equipment, products and technologies on post harvest engineering and technology.
- To transfer technology and provide advisory and consultancy services and promote entrepreneurship.
- To develop and strengthen linkages with the growers/farmers, private and public sector food processing enterprises in the mandated areas.

3. Growth

3.1. Infrastructure

CIPHET acquired 10 ha land at Ludhiana and 31.6 ha at Abohar during the period March 1992 and March 1993, respectively. Master Plan has been developed and construction of buildings, boundary walls, roads, etc. was started. Workshop building was completed in 1993 at Ludhiana and KVK building at Abohar was completed in 1995. The administrative block at CIPHET Ludhiana was completed in 2001 and at Abohar in 2004. The divisional building to house various laboratories at Ludhiana is under progress. Efforts are going on to develop and equip various laboratories proposed in different Divisions. The buildings to house various pilot plants such as modern dal mill, chilli processing and Agro processing cluster for processing and value addition of various crops and fruits and vegetables are being constructed. It is proposed to have additional land from PAU, state government of Punjab at their farm at Ladowal in Ludhiana for meeting requirement of field experiment to produce organic as well as specific varieties suitable for various processing applications. Organizational structure of the Institute has been as shown in following organogram.

ORGANIZATIONAL STRUCTURE



Laboratories/Facilities

Following research laboratories/facilities have been proposed for different Divisions of the Institute.

Ludhiana Campus

i) Food Grains and Oilseeds Processing Division

- Primary Processing Laboratory
- Drying
- Food grain milling (cereals, pulses)
- Oilseed milling
- Product development
- By-product utilization
- Sensory evaluation and quality analysis lab

ii) Agricultural Structures and Environmental Control Division

- Storage and package engineering
- Material handling and testing lab
- Environmental control lab
- Food quality and safety lab

iii) Livestock Products Processing Technology Division

- Poultry processing lab
- Fish processing lab
- Meat processing lab
- By-products utilization

iv) Transfer of Technology

- Prototype production and testing Centre
- Technology promotion cell
- Consumer acceptability and market research
- Agri-Business Promotion Cell
- Video conferencing, audio visual and photography Cell

Abohar Campus

vi) Horticultural Crops Processing Division

- Fruit processing lab

- Vegetable processing lab
- Floriculture lab
- Packaging and storage lab
- Sensory evaluation and quality control lab
- Byproducts utilization lab

v) Commercial Crops Processing Division

- Primary processing lab
- Product development lab
- By-products utilization lab

Though some of the laboratories have been developed satisfactorily, most have been under initial stages of development. In addition to the research laboratories, the following central facilities are proposed at both Ludhiana and Abohar campuses of CIPHET.

- National Library on Post Harvest Engineering and Technology
- Central Instrumentation Laboratory
- CAD Cell and Simulation Laboratory
- Referral Laboratory for quality and safety analysis
- Agro-Processing Clusters
- Pilot plant complex
- Biotech Engineering Laboratory
- Agricultural Research Information System (ARIS)
- Institutional Technology Management Unit

Pilot Plants

i) Cereal Processing
ii) Pulse processing
iii) Oil extraction, refining and testing
iv) Horticulture produce processing
v) Cold storage and environmental control chambers
vi) Pilot scale extrusion processing plant
vii) Non-thermal processing facility for preservation and value added products

Agro Processing Clusters

There is great need for establishing agro processing clusters in the production catchments

to provide the facility for training, demonstration and hands on experience on latest equipment/ technology in operation for the benefit of entrepreneurs, industries, researchers and farmers. Under this facility, there will be intensive collaboration with the industries and other stakeholders. It will function as a technology incubation facility. This facility will cater to the needs of the producers and processors as well as strengthening the linkages amongst them. While locating the cluster in production catchments the proper connectivity with the consumption centre especially big cities and towns need to be maintained with the purpose of giving higher returns to the producers. Maintaining quality and coming out with the quality products at competitive prices will be the main goal of these clusters.

The Institute, to start with, proposed to establish two Agro Processing clusters in the country as per following details.

i) Ludhiana - rice, wheat, pulses and horticultural crops

ii) Bangalore - sorghum, ragi, oilseeds and plantation crops

These clusters will catalyze local entrepreneurship and promote agri business not only for meeting the domestic needs but also for export. They will also work in collaboration with the proposed Agri Export Zone (AEZs). Based on the feed back from above two clusters, some more clusters will also be developed by CIPHET at different places in the country catering to other crops, commodities and regions.

Agricultural Technology Information Centre (ATIC)

This has been a very innovative concept, which has been tried successfully in many ICAR Institutes and Universities for the dissemination and transfer of technology to the users. The facilities include the sale of products/seeds/gadgets and also provide access to the latest developments in the R&D sector. Such facility will be available to the farmers and users in the local language besides English and Hindi and will also save much time of the farmers and others seeking information from different establishment of the Institute. Hence, it will be truly single window access for the technology and services. The Institute proposes to establish ATIC, Abohar.

National Library

Central library of CIPHET is located at Ludhiana campus. It is in the process of acquiring latest books and journals in the area of Post-Harvest Engineering and Technology. The collection up to 31.03.2007 was 27 Indian Journals, 14 Foreign Journals, Books 1933, standards 583 besides other documents and annual reports. Under NATP sub-project "Strengthening of Library Improvement and Networking" TLSS Library Software Package, Food Science and Technology Abstracts (FSTA) on CD-ROM form 1969 to 1989 & 1990 to present, AGRIS on CD-ROM from 1991 to present AGRICOLA on CD-ROM from 1970 to present. Foreign Journals have been purchased/subscribed. Apart from the purchase of books and periodicals, Institute Library is rendering following services to the readers:

- Current contents service: Current content service of journals and list of new arrivals is being

circulated every month among the CIPHET Staff and ICAR Institutes.

- Library consultation services: Faculty members and students from other Institutes and Universities are also consulting CIPHET Library. The library will also facilitate patent search service.
- Sale of publications: The Library is doing sale of the Technical Bulletins and Books published by the Institute.
- Reference service: The library also provides photocopy of research articles from other libraries on payment basis as per reader's request. Library arranges references and abstracts of research papers/articles as per request of the readers on a specific subject/keyword from SAARC Agricultural Information Centre, Dhaka (Bangladesh).

Farm

As stated earlier, the Institute has a total area of 10 ha at Ludhiana and 31.6 ha at Abohar. At Ludhiana, most of the land is covered under buildings and roads. Similarly about 10 ha land is under buildings and roads at Abohar and the remaining land is utilized for demonstration under seed production of various crops. The produce, after processing at the Agro Processing Centre, Ludhiana and in seed processing plant at Abohar, is marketed to generate additional funds for infrastructural development.

Table 1: Budget of CIPHET for the X Five-Year Plan

(Rs. Lakh)

Head	2002-03	2003-04	2004-05	2005-06	2006-07	Total (Approved)	Actual Expenditure
A. Recurring							
Pay & Allowances	7.31	10.00	10.50	10.50	11.69	50.00	85.21
TA	4.99	6.01	6.00	6.00	7.00	30.00	28.60
HRD	-	0.50	3.00	3.50	3.00	10.00	1.72
Contingencies	58.15	68.00	76.00	85.00	92.85	380.00	396.63
Total (A)	**70.45**	**84.51**	**95.50**	**105.00**	**114.54**	**470.00**	**512.16**
B. Non-recurring							
Equipment	29.69	125.00	125.00	120.31	100.00	500.00	470.29
Works	28.44	84.70	148.86	113.00	125.00	500.00	359.91
Library	6.05	10.95	11.00	11.00	11.00	50.00	33.55
Land	-	-	-	-	-	-	-
Vehicles	-	-	6.00	-	-	6.00	7.24
Livestock	-	-	-	-	-	-	-
Furniture/fixtures	-	8.00	8.00	7.00	7.00	30.00	26.39
Total (B)	**64.18**	**228.65**	**298.86**	**251.31**	**243.00**	**1086.00**	**897.39**
Grand Total (A+B)	**134.63**	**313.16**	**394.36**	**356.31**	**357.54**	**1556.00**	**1409.55**

3.3. Human resource

The details of the sanctioned staff strength at CIPHET and status of filled positions has been given below in Table 2 & 3.

Table 2: Sanctioned strength of staff at CIPHET and positions filled

STAFF POSITION (as on 31.07.2007)

Details of Personnel	*CIPHET, Ludhiana and Abohar*		*AICRP on APA*		*AICRP on PHT*	
	Sanctioned Posts	*Posts in Position*	*Sanctioned Posts*	*Posts in Position*	*Sanctioned Posts*	*Posts in Position*
Scientific	71	32*	4	1	2	1
Technical	28	28	1	1	1	1
Administrative	18**	18	2	2	2	2
Supporting	6	4	1	1	1	0
Total No. of Posts	123	82	8	5	6	4

* Including Director ** Including Administrative Officer

Table 3: Discipline-wise cadre strength of sanctioned scientific posts at CIPHET

Discipline	*Cadre Strength*			
	Scientists Scientists	*Senior Scientists*	*Principal*	*Total*
Agricultural Structures and Process Engineering	15	10	8	33
Farm Machinery and Power	1	-	-	1
Soil and Water Conservation Engineering	2	-	-	2
Food and Nutrition	1	-	-	1
Food Science & Technology	2	2	1	5
Microbiology (Plant Science)	1	3	1	5
Biochemistry (Plant Science)	1	1	-	2
Agricultural Entomology	0	1	-	1
Agronomy	1	-	-	1
Mechanical Engineering	1	1	-	2
Horticulture	3	1	-	4
Agricultural Economics	0	1	-	1
Electronics and Instrumentation	1	-	-	1
Chemical Engineering	3	1	2	6
Plant Pathology	2	-	-	2
Agriculture Extension	1	-	-	1
Bio Technology	2	1		3
Livestock Proc Tech	2	1		3
Fish Proc Tech	2			2
Total	41	23	12	76

4. Salient research achievement

4.1 Research and development

4.1.1 Agro processing equipment developed by CIPHET

Lac scrapper cum grader

The machine is capable to scrap lac sticks simultaneously, crush and grade the scrapped lac in to three grades by their grain sizes. It eliminates any chances of mixing of the sticks and wood particles with scrapped lac. Non-uniform lac encrustations are crushed by means of a pair of crushing rolls at moisture content of 3% (db), after two passes. The machine comes in two variants of 20 kg/h and 50 kg/h capacities. It is operated by 2 hp and 5 hp electric motor, requires two persons to operate and costs of machine is around Rs. 30,000 and Rs. 50,000 respectively.

Groundnut pod grader

The mechanical grader has two main sections to clean and grade the groundnut pods, with a capacity of 650 kg per hour. The groundnut pods fed to the hopper either manually or with a bucket elevator enter the rotary scalper where extraneous matter is removed and then travel down by gravity and forced air stream to the pneumatic grading chamber. In the pneumatic chamber, the pods get separated into three lots depending upon density difference. Each of three fractions is further graded into four distinct grades by means of thickness and size graders. Thus, pods could finally be graded into a maximum of twelve distinct grades and the pods in each grade are nearly uniform in size, shape and weight. These grades derived from heavy and medium fractions are more suited to direct uses such as seed, table purpose and export directly without any further manual grading. The medium and light fractions can be used for oil extraction. The machine runs on 3 kW electric motor, requires two people to operate. The cost of the machine is approx. Rs. 2,00000/- and capacity is 650 kg/h.

Groundnut pod decorticator

A composite unit of groundnut decorticator was developed especially for producers of value added products from whole kernel. The unit consists feed hopper, decorticating drum, aspirator, and sieve grader to grade kernel in two grades. The capacity of the unit is 60 kg/h and price is Rs 65,000. The dehulling efficiency is 87% with no breakage of the kernel.

Low cost filter for micro irrigation

It is a cost effective filter suitable for micro irrigation in green house. The unit is easy to fabricate by local artisan and performs better if used along with sand filter. The unit is suitable for use under low head drip irrigation system (1.2 m) with improved efficiency without head loss. Maximum flow rate is 3-7 m^3/h and it can be operated at a pressure of 1 – 1.2 kg / cm^2

CIPHET castor decorticator

A castor decorticator was developed for operation of depodding and decortication to be performed simultaneously. There was no damage to castor capsules in this machine. The capacity of the unit is 50 kg/h.

Sunflower dehulling mill

The unit consists of feeding mechanism, centrifugal type dehuller, aspirator for separation of hull from dehulled product and grading unit, which separates whole, broken and unhulled kernels. The capacity of the unit is 400 to 500 kg/h

CIPHET tomato grader

A grader for grading fresh tomatoes based on gravity was developed. Tomatoes roll down the pipes due to gravity and fall immediately wherever they find the space bigger than their dimensions. The tomatoes are graded in 3 sizes (Grades : 25-40 mm, 40-55 mm, 55-70 mm and > 70 mm). The collector is inclined at 10° so that the tomatoes slide directly into crates. The important feature of grader is its ability to adjust the gap between the pipes and inclination of grading table and hopper. It can also be used for grading other round fruits and vegetables.

CIPHET rotary maize cob sheller

A manually operated maize cob sheller of unique design to reduce drudgery involved in handheld maize shellers was developed. The capacity of unit is about 60 kg/h of grain. Since there is no damage during shelling the unit is highly recommended for shelling of the cobs for seed purposes.

Method of determining maturity of mango

A maturity index based on TSS was defined to measure the maturity objectively using the colour values. The model developed to predict maturity is simple and can be used on farm with the colorimeter. Alternatively a colour and maturity index chart has also been developed to use it with

any colorimeter. Method is nondestructive and easy to use at any place.

Banana comb cutter

It is useful to de-stem the comb from the banana bunch. It replaces the use of sickle, which is labour intensive and time consuming. It is safe to use compared to conventional sickle. It is also safe for banana combs and can be used for faster work.

Mobile agro processing unit

Mobile Agro Processing unit consist of grain cleaner (100-200 kg/h, 1 kW); horizontal burr mill (75-100 kg/h, 3.75 kW); Vertical Masala Mill (15-25 kg/h, 1.5 kW); Pop Corn Making Machine (4 kg/h, 1.5 kW); and Diesel Generator Set: 7.5 KVA, three phase. Cost of mobile unit is about Rs. 2 lakh.

4.1.2 Value added products and processes

Porous bricks

The porous brick was designed and developed for construction of evapoatively cooled room for storage of perishables. The bricks have lower dry weight, higher water absorption capacity and better rate of evaporation from its surface. The raw material used for making this bricks was brick earth and crop residues.

Mustard sauce

A low cost process for production of pure vegetarian Mustard Sauce has been developed. The process consists of production full fat edible quality mustard flour using unique CIPHET process. The condiments, citric acid, vinegar, and plant based emulsifier, spices, salt are used in preparation of sauce in either sour taste or in sweet taste. The product meets International standard with preferred taste, colour, appearance and viscosity. It costs Rs 80/kg compared to Rs 250/kg for conventional sauce.

Method to prepare dried garlic slices

A method for preparation of dried garlic slices was developed. The cloves are separated, peeled and sliced across the length. Slices of 3mm thickness are dipped in 0.5% sodium metabisulphite solution for 15 min at ambient temperature and dried to 6% moisture content (db) in a fluidized bed dryer at 60C air temperature. Slices thus obtained are immediately packed in

airtight containers.

Sunflower based confectionery products

Various confectionary products using sunflower seeds were developed. Sunflower-sesame kernel confection *Chikki* was prepared taking jaggery, sunflower kernel and sesame kernel. Sunflower based ready to eat sweetmeat was also developed. Both these products are liked as substitute sesame based products.

Process technology for making aonla beverage

The nutritious beverage using aonla was prepared. The major composition in beverage was aonla juice (20 %), sugar syrup (70 % - 25 0B), other fruit juices (guava, pineapple juice, etc) (10 %). Other ingredients used were black salt, white salt, black pepper, *amchur* powder and dhania. The final mixture is bottled and sterilized in hot water before storage.

Process technology for guava bar

Guava can be processed into a number of products like fruits bar and beverage. A number of products like leather, bars and cubes using guava were developed. Other nutrients rich fruits such as mango and papaya were blended in to guava to improve its acceptability and flavor. The developed products could be stored up to 6 months.

Process technology for *Anardana* and its powder

The process for *Anardana* powder from wild pomegranate was developed. The product with desirable acid sugar ratio retained maximum quality parameters (sugars, TSS, vitamin C and minerals) up to six months of storage. Various products like chutney, digestive churan and tablets were also developed using the powder.

Process technology for pomegranate jelly and granadine

The process for making pomegranate jelly and granadine was developed. The products were excellent in appearance, colour, nutritionally rich in vitamin A and minerals, good keeping quality with natural flavour. They could be stored for 4 months under ambient conditions and 6 months in cold storage.

Process technology for *b*er preserves

Ber preserves were prepared with and without stone of ber. The developed products have

excellent natural color and very good texture. The products were rich in vitamin C and minerals. The products were found to have least enzymatic browning.

Sorghum-soy-blended biscuit

Biscuits are convenient and one of the most popular and widely consumed processed food products. The quality of protein can be enhanced by fortifying locally available protein rich foods like soybean, millets like sorghum for good source of dietary fibre and complex carbohydrates. Glucose biscuits, prepared from wheat flour, sorghum flour and fortified with soybean developed at CIPHET, were rich in protein and dietary fibre. Composite flour containing 70% wheat flour, 20% pearled sorghum flour and 10% soybean flour was used for making biscuit. Biscuits provide 47% more proteins, 8.3 times more fibre and 38.98% more minerals than the commercial biscuits

Two stage evaporative cooler

A cooler unit with two stage evaporative cooling was designed and developed. The cooler is portable and 1.5m x 1.0m x 2.0m in length, breadth and height. The developed two stage evaporative cooler could reduce the temperature up to the wet bulb depression and up to 90 % relative humidity. The effectiveness of the two stage evaporative cooler ranged from 1.1 to 1.2 over the single evaporation.The hourly cooling capacity of TSEC ranged from 2125 to 4500 Watts

Mobile cool chamber

It was developed for short duration storage and transportation of fish for retail marketing. The insulated box was designed such that it could hold 8 plastic crates of size 540x360x295 mm in two layer of four each for keeping fish. The total capacity of storage was 150 kg of fish with 80% filling of each plastic crates and 1:1 ratio of ice and fish. It costs around Rs. 18,000-20,000/- and can be used for fruits and vegetables also.

Evaporatively cooled room for storage of fruits and vegetables

An evaporatively cooled (EC) room (3x3x3m. size) was developed for on-farm storage of fruits and vegetables. The summer temperature inside the EC room was 5-8C lower than that inside the ordinary room and winter temperature was 5-8C higher than ordinary room. Compared on the basis of 10% physiological loss in weight (PLW) the shelf life inside the room was 34 days for early kinnow, 23 days for late kinnow, 11 days for cauliflower and 4 days for spinach as compared to 21, 11, 5 and 2 days respectively in an ordinary room at the same time. The cost of the chamber is Rs.

35000 and capacity is 2 tonnes.

CIPHET evaporative cooled storage structure

Evaporatively Cooled Structure (ECS) maintains a moderate low temperature and sufficiently high relative humidity for short term storage of fresh fruits and vegetables. This system requires no or very minimum level of consumption of electricity, less initial investment and negligible maintenance cost. The unit has special design of roof, orientation and uses wetted pad for cooling. It can achieve 20C lower temperature than outside temperature and relative humidity as high as 70 – 99 % depending upon the outside temperature. An ECS of about 5 -7 tonne storage capacity may

4.2. Technologies and patents

4.2.1 Patents

A number of patents have been filed by CIPHET and a few of them are at the stage of grant. The list of patents filed is presented below

S.No.	*Title of Patent*
1.	CIPHET Fruit Saver
2.	Pre-grinding of oilseed prior to mechanical expelling
3.	Development of process of debittering of kinnow juice using an absorbent
4.	Alternate cheaper bleaching material for edible oil refining
5.	High speed, precision grading of groundnut pods grader
6.	High capacity lac scrapper cum grader for simultaneous scrapping and grading on lac encrustations
7.	CIPHET fruit collector cum grader
8.	Method of determining maturity of intact mango on tree
9.	A new technique of processing the mustard seed for reducing refining cost improving quality of oil
10.	CIPHET Tomato grader
11.	Low cost technique for enhancement of shelf life of tomato
12.	Development of new process for stick lac removal at a faster rate by means of a newly invented, powder operated lac scrapping machine
13.	A low energy process of dehulling the mustard seeds
14.	Groundnut pod grader
15.	Lac scrapper cum grader for graded raw lac production at individual lac grower's level.
16.	Use of by-product of mustard seed having anti-bacterial and anti-fungal moisture repellant properties.
17.	Process for debittering of kinnow / citrus juices by using pretreated indigenous adsorbent resin
18.	Development of sunflower kernel based confectionery products
19.	Process Technology for making Digestive Product from Anardana (Anardana Hazmahazam
20.	Process Technology for making "Anardana Ready to mix Chutney"
21.	A process for production of Kernels from NSFH-36 Variety of Sunflower seeds (Helianthus annus L) for confectionery purpose in Food Industry

22. Energy efficient bengal gram *sattu* making technology
23. CIPHET Castor Depodder /Decorticator
24. A new process of oil extraction from karanj seed *(Pongmia glabra)* through mechanical expression
25. Rotary Maize Cob Sheller

4.2.2. Technologies ready for adoption /commercialization

1. Two Stage Evaporative Cooler for enhanced cooling capacity
2. Evaporatively cooled room for storage of fruits and vegetables
3. CIPHET Evaporative Cooled Storage Structure for storing 5 t fruits and vegetables
4. Small capacity Lac scrapper cum grader Equipment (20kg/h) for individual lac farmer
5. High Capacity Lac scrapper cum grader Equipment (50kg/h) for group of 3 farmers
6. High capacity Groundnut pod grader for use in value added products industry.
7. Sunflower dehulling mill
8. CIPHET Tomato Grader for primary processing at farmers level.
9. Hand operated CIPHET rotary maize cob sheller to remove drudgery involved in minimal operations.
10. Power operated CIPHET rotary maize cob sheller for processing industry
11. Method for making porous bricks for constructing efficient cool living and storage rooms
12. Method of determining maturity and total soluble solids contents of mango in tree by non-destructive instrumental technique
13. Method to prepare dried garlic slices for value addition and preservation of essential oils
14. Process for making ginger powder for preservation and value addition.
15. Sunflower based caramel confectionery products to promote food uses of sunflower
16. Process technology for making aonla beverage effective for value addition to anola
17. De-bettering of kinnow juice by using indigenous adsorbent resin
18. Process technology for *Anardana* and its powder
19. Process technology for pomegranate Jelly and Granadine
20. Process Technology for making Anardana Hazmahazam (Tablets)
21. Process Technology for *ber* preserves
22. Process technology for plain and blended guava leather/bar
23. Pilot plant for drying and processing of chilli into powder and paste.

24. Pilot plant for processing of tomato for packaging, puree and powder making.
25. APC Models for Punjab based on future diversification and existing surplus crops.
26. Application of Plastic in Aquaculture
26. Low cost filter for micro-irrigation
27. Low-cost green house for cultivation of vegetables and high value crops (medicinal and aromatic)
28. Database for Post Harvest and Agro Processing Equipment
29. Technology for mustard sauce/flour and its utilization as functional food
30. Mobile cool chamber for storage and transportation

5. Impact assessment and lessons learnt

5.1. Impact assessment

1. National Agricultural Research System has benefited the farmers and rural entrepreneurs in the adoption of post harvest technologies developed in R&D institutes.
2. The number of modern rice mills, roller flour mills, pulse mills, oil mils, solvent extraction plants, fruit and vegetable processing units have increased in the last five decades. However, growth in the area of processing, value addition and by product utilization need to be accelerated as these operations only will reduce post harvest losses which are even today to the tune of 10% for foodgrains and 25% for perishables. The post harvest sector has great potential of generating income and employment through value addition and agro processing activities in production catchments (8 jobs for each 10 lakhs invested).

Impact Analysis – growth:

- Adoption of primary processing activities in rural areas mainly for preservation and loss reduction.
- Beginning of minimal processing in production catchments.
- Establishment of 250 Agro- processing centers in the country.
- Modernization of rice milling industry.
- Promotion of agri-preneurs in the area of post harvest engineering and technology.

5.2 Lessons learnt

During the last two decades, emphasis has been on increasing productivity without proper support for storage or processing. This resulted in tremendous losses and low price to farm produce. The research effort in post harvest management had slow pace of adoption due to limited infrastructure

for transfer of technology, validation and refinement. The effort of ICAR in developing rural friendly technologies have generated interest among farmers/entrepreneurs to minimally processed or value added the valuable agro product. Hence agro-processing centers established were very effective in transfer of technologies. This pace can be accelerated through establishment of more agro-processing centers, regional centers of the institute in different parks of the country by involving SAUs / ICAR institutes and Government & Non- Government organizations for multi-locational trials. There is a need to sensitize farmers, small and medium entrepreneurs to come forward and take up post harvest activities at production level to minimize post harvest losses and get remunerative price for their value added products.

Lessons Learnt

- Thrust only in loss prevention in agriculture sector is not sufficient.
- Value addition of these commodities need to be done in production catchments.
- Need to establish region specific agro processing centers, which farmers can operate
- Transfer of technologies to the end user has remained limited & there is a need to expedite it through farmer's fair, exhibitions, and distribution of extension literature and identification of committed group.
- Farmers are not well aware of post harvest technologies generated at R&D institutes hence thrust should be given to organize sensitization workshops.
- Agro processing industries have been adhered to traditional technologies and there is a need to organize institute industry interface meetings frequently in the hub of processing industries.
- Entrepreneurs who are willing to take up processing & value addition as business activity do not have opportunities to have hand on practice on different machine. Hence, it is necessary to organize technology based entrepreneurship development programme to generate confidence.
- Agro-processing centers in rural areas have shown positive results and this momentum needs to be maintained through interactive workshops with the Self Help Groups, women organizations and cooperatives.

6. Scenario and SWOT analysis

6.1 Scenario: Current and future

Food processing situation in India

The Indian Agriculture contributes about 25% of GDP and sustains 67% of population. The Indian food-processing sector is one of the largest in the world, ranks 5th in term of its volume processed and consumed. It attracts 6% of total industrial investment in the country and employs around 1.6 million workers – almost 10% of country's industrial labour force. However due to inadequate and inefficient post harvest preservation and processing facilities about 10% in food grains

and 25-40% in fruits and vegetables are lost which in monetary terms is equivalent to Rs. 590,000 million. The value addition levels are only 2% in fruit and vegetables compared to 80% in country like USA and Malaysia and meager 10% in other commodities compared to 100% in other countries. The changing trends in food habits, curiosity about health benefits and functional characteristics of Indian varieties has suddenly increased interest of developed nations in them. Hence it is a ripe opportunity to develop our R&D processing industry to process the raw produce using cutting edge technologies to meet international standards and quality.

For supporting 7-8% growth rate in the national economy, the post harvest and value addition sector is required to grow at about 10% with 4% growth in agricultural sector. At present the PHT sector faces the problem of erratic and inadequate supply of quality raw material, non-availability of adequate infrastructure, inadequate investment in organized sector, lack of trained manpower and lack of quality analysis lab. The problems resulted in high cost of processing and poor quality of processed products. The present level of processing of different crops including dairy, meat and poultry is described in the table below.

Table 4: Level of processing in different agriculture sector

Sr. No	*Sector*	*Production: raw material (mt)*	*Value: raw produce (Rs.crores)*	*Value: processed raw produce (Rs.crores)*	*Processing level (%)*
1	Cereals	163	1,16,334	63,984	50
2	Pulses	11.1	15,920	11,940	75
3	Oilseeds	14.8	30,177	27,159	90
4	Sugarcane	287.4	28,042	24,677	88
5	Fruits & Vegetables	140 .0	1,28,633	2,573	2
6	Spices	3.4	16,574	14,917	90
7	Tea	0.838	3,998	3,998	100
8	Coffee	0.275	1,884	1,884	100
9	Dairy	86.2	1,07,544	25,12 3	33
10	Meat & products	5.9	24,876	5,489	7.5
11	Fisheries	6.1	31,534	1,866	10

Hence, efforts have to be made to develop equipment and technology for various operations of processing at primary and secondary level. With globalization, the tertiary processing is more important to fetch the price from international market. The consumption trend is changing. The rural India spent 10% of their food share on processed food while urban it was 20% during 2004. The value addition of food products is expected to increase from current 10% to 35% by 2025. To meet this requirement, the processing in fruit and vegetable should increase from 2 to 25% by 2025. The sector wise perspective is described below:

Fruits and vegetables

Consumer demand for fresh fruits and vegetables is growing at the rate of 11%. Of this, 1.9% is contributed by population growth while the remaining 9% is contributed by increase in per capita expenditure. The installed capacity of the processing plants is 2.2 million tonnes with quantity processed are about 1.1 million tonnes. To meet this demand level of processing for fruits and vegetables need to be increased to 25% and 35% in 2015 and 2025, respectively.

Rice mills	:	139,298
Modern Rice Mills	:	35,088
Under-Runner-disc Sheller	:	4538
Huller-cum Sheller	:	83585
Metallic hullers	:	91,287
Roller Mills	:	820
Bakery products	:	3 million tones

Foodgrain sector

This sector includes rice, wheat, maize, jowar, bajra, and barley. Although, India is second largest producer of rice and wheat however the quality of end product has to be improved. Most of the processing done for these crops are primary processing. Bakery product contribute the largest segment of grain-based processed food (over 50,000 unorganized and 15 organized). The total grain based snacks and namkeen is worth Rs. 29,000 million (85% unorganized). The food habits are changing and liking market for ready to eat snacks is growing at faster rate. All these grains form important ingredients for making expanded snacks. The grain - based product are expected to grow 3 times by 2025 from present worth of 1,500,000 million. The trend of fortified and packaged grain flour is also growing fast and hence offers scope for grain based technology as well as enterprise development.

Pulse

India is the largest producer, consumer and importer of pulses in the world. The India produces pulses of share 25% of global production and consumes 27% of global. The import is 11% of global. The pulses are mainly processed into dal (75% of available) in 14,000 dal mills. These mills are mostly in unorganized sector and face problems like inadequate efficient machines. The losses during milling are estimated to the level of 7-8%. If these losses are reduced, the import in pulse milling sector can be reduced. Also the pulses industry is not energy efficient due to unorganized sector. The attractive price for good quality dal over the brokens, has revived the interest of entrepreneurs for up grading existing mills and also to establish modern milling equipment and protocols. Hence scope for R&D and TOT in this sector is expected to grow very fast. The trends to consume low fat legume snacks, need newer product development using extrusion and microwave puffing processes and hence demand for industrialization. The packaging of good quality dal as well marketing of blended dal to provide balanced essential amino acids composition offers great promise.

Edible oil sector

India is the world's fourth largest vegetable oil economy with 15,000 oil mills, 600 solvent extraction units, 230 vanaspati plants and over 500 refineries, employing over one million persons.

The utilization capacity of this industry is only 30 – 40% of installed capacity. The demand for edible oils is expected to increase from 12.3 million tonnes due to per capita consumption increase by 4% and a population growth of 1.9%. The Industry has to acquire over all growth @ 6% pa. The increase in availability of edible oils can be through efficient oil extraction method as well as exploring non edible oils like rice bran, cotton seed, castor etc. for food purposes. To get optimum blend quality fatty acids for good health offers good scope for reprocessing for blending and marketing of this tertiary processed product. The by product of oil milling like lecithin, tocopherols have proven their health benefits hence R & D & TOT on by product utilization of oil milling also needs to be attended to. The major by product of oil milling is generally high protein cake. If processed properly this cake can be put to food uses in place of whole oilseeds. This opens up altogether new industry to process oil seeds.

Meat and poultry

Indian consumers prefer to buy freshly cut goat or chicken from the market, rather than processed or frozen meats. A mere 6% of production (about 100,000 tonnes) of poultry meat is sold in processed form. Of this, only about 1% undergoes processing into value added products (ready to eat / ready to cook). India is likely to be the fastest growing meat consumption nations, due to rising affordability, population growth, and conversion from vegetarianism and hence offers scope for hygienically processed and value added meat products. The goat meat is more popular than chicken and costs 2 times higher than it. Even then proper meat extraction, packaging and value addition has not been paid much attention. With popularization of burgers the demand for proper processing of meat will increase the opportunity of R & D in this area.

Fisheries

Of the total fish production, 62% is on account of capture production and 38% is on account of aquaculture. In capture production coastal fishing constitutes the bulk and deep sea fishing accounts for only 12%. About 35% of India's population consumes fish. Domestic demand for fish is likely to grow at an annual rate of 2.4% from present range of 5.9 –6.0 million tonnes in a year. To meet this demand processing level in fisheries need to increase to 25% by 2025. Similar to chicken and meat, the eating of fish is increasing. The newly introduced population to eating fish has greater acceptability for processed and ready to eat product from fish and hence offers great scope of R & D and its commercialization.

Confectionary

The size of the Indian confectionery and chocolate market is estimated at Rs. 26000 millions. Sugar confectionery where fruit pulp can be added accounts for 61% of this market, with the balance being chocolates and mints & gums. The confectionery segment where aonla, ber, guava can be utilised is expected to grow nearly 6-fold by 2025. With growing confectionary market due to easy imports and indigenous production has also regenerated interest of consumers into ethnic confectionaries like, gond laddu, burfy, son papadi etc. Some of the Indian ethnic confectionaries

have health benefits and are in great demand in elite markets. The R & D and TOT on this sector also offer great promise.

Spices

India is the global leader in spices production and export. During 2004-05, 335488 tonnes spices worth Rs. 27900 millions were exported from India. Despite huge demand of spices worldwide, India is exporting only about 10 % of its total production due to low quality and high domestic demand. If Indian spices have to compete in the market it is necessary to upgrade the quality as per international standard. There is also untapped potential of various extracted produce from spices. The major exports are of primary processed spices. The secondary and tertiary processing need to be done in this area. The Indian spices are in demand because India produces variety of spices which are known only to Indian housewives or cooks. Due to globalization renewed interest is being generated world over in Indian specialty spices, e.g. Anardana, which offers great scope for its R & D and TOT.

Dairy

India ranks first in the world in terms of milk production at 91 million tonnes and growing at the rate of 4 %. Only about 35% of milk produced in India is processed. There is huge potential for processing and value addition, particularly in ethnic Indian products, which are largely sold in unbranded form in the market.

Medicinal and aromatic plants

India having diverse ecosystems is immensely rich in medicinal and aromatic plants. It is one of the eight important Vavilovian centers of biodiversity. Uses of the plant medicines both for primary health care as also remedies are its age old culture. During the recent past, there is a resurgence of interest in study and use of medicinal plants. Many traditional plant based remedies are back in use and find increasing applications as (i) source of direct therapeutic agents, (ii) as a raw material base for the elaboration of more complex semi-synthetic chemical compounds, (iii) as models for new synthetic compounds, and (iv) as taxonomic markers for the discovery of new compounds. The production, consumption and international trade in medicinal plants, and phytomedicines, therefore, are growing and expected to grow in future quite significantly.In order to position the medicinal plants sector on its growth path, an all-out, plant based action in cultivation, post harvest technology, processing, manufacturing, research, patenting and marketing is necessary.

6.2. SWOT Analysis

Strengths

- ❖ CIPHET is a multi disciplinary institute with well defined mandate, vision and mission. CIPHET has scientists in all disciplines of Post Harvest Sector.
- ❖ CIPHET is located in an agriculturally advanced state which is going towards introducing new crops for diversification and hence provides great opportunities for development of agro-

processing enterprises in catchment areas.

- Many leading agro processing equipment and machinery manufacturers are also located nearby and hence development of pilot plants based on new innovations in cooperation with them will make transfer of technology faster.
- The Problems of Indian industries are unique due to their rural location, small size and unorganized status, the equipment and technology from developed nations is not suitable to be imposed on present set up. CIPHET has strong base of engineering scientists to solve the equipment design and process development problems of processing and value addition industry in India

Weaknesses

- Lack of scientific (only 33 position filled against 76), technical and administrative manpower.
- Limited space is available for the institute at Ludhiana and hence establishing different laboratories and growing specialty crops suitable for processing to evaluate the varieties for specific processing requirement will be difficult.
- Lack of scientifically trained manpower to handle the processing machinery. Mostly mechanics or mistries operate and control the operation, hence new innovations are difficult to percolate.
- Lack of supporting infrastructural facilities such as laboratories/cars/buses/trailors etc.

Opportunities

- Growing agricultural production in the country, and greater acceptability to the processed products provides huge potential for technology development.
- Enhanced income, nucleus family structure, time pressure on working couples, wider reach of the television and print media in homes and so on have reflected in the increased demand for processed foods, Ready To Cook (RTC) and Ready to Eat (RTE) food products.
- Existing agro processing equipment is not capable of producing the desired quality product for upper class segment and export and hence technologies need to upgrade the existing processing infrastructure.
- With increasing interest in exports there exists enough opportunities for collaborative work by CIPHET at national and international level.
- With increased income of Indian middle class and exposure to international processed products through print and electronic media, market for domestic processed product has increased and hence many upcoming entrepreneurs are willing to take up agro processing of value addition entrepreneurship.

- Due to increased interest of private sector in food trade and processing due to congenial environment and market friendly policies of the government, there is a greater opportunity for faster commercialization of technologies.
- The crops of Indian origin due to their unique aroma and flavour are being sourced by developed countries at premium price. Hence their value addition and processing for export is getting attention of private players as well as policy makers, which increased opportunity in this sector next to only IT sector.

Threats

- Lack of awareness among the conventional processors about quality and safety codes and standards.
- Relatively high cost and low quality of farm produce for processing, lack of varieties amenable for processing
- Long and fragmented supply chain, tiny and fragmented holdings and low technology,
- Inferior agri-inputs, inappropriate variety, inefficient farm management and cost of logistics.
- High cost of power and inadequate or inappropriate availability.
- Costly and inefficient transportation of raw and finished products
- Comparatively high cost of packaging of finished produce
- In AS&PE, there has been shortage of scientific manpower at national level and hence research in newer areas is difficult to initiate.

7. Perspective

With growing concern for nutritional and food security and greater emphasis on consumer needs as well as results of WTO agreement, there are tremendous challenges posed on post harvest technology. The population is increasing. The Indian Agricultures contributes only 25% of GDP but it sustains 67% of population. Higher production and productivity built pressure on PHT for loss reduction, better handling and storage, value addition, packaging, transport and marketing of various agricultural produce and products including by-products and residues for domestic and international markets. Losses to the extent of 10% and 25-40% are estimated in foodgrain, fruits and vegetables respectively, which is equivalent to Rs. 5,900,000 million. The value addition is only 2% in fruit and vegetables compared to 80% in country like USA and Malaysia and 7% in other commodities compared to 100% in other countries. Present export market (share only 1.2%) is for primary goods only, which fetch very low price. The changing trends in food habits, curiosity about health benefits and functional characteristics of Indian varieties, has suddenly developed interest of developed countries in them. Hence it is a right opportunity to develop our R & D processing industry to process the raw produce to international standard and quality.

8. Issues and strategies

Sl No.	*Issues*	*Strategies*
1.	Post harvest technologies for loss reduction.	- Development of need based post harvest technologies for safe storage, handling and marketing. - Development of agro-processing technologies for different commodities for adoption at rural level to minimize post harvest losses.
2.	Value addition technologies.	- Development of technologies for value added products using novel and innovative approaches.
3.	Technology transfer, entrepreneurship development and marketing.	- Design and development of agro-processing machines for mass scale production for multi locational testings. - Develop technology based one week Entrepreneurs development programme (EDP)
4.	Byproduct utilization and Waste managements.	- Develop technologies for converting by products into value added products. - Development of complete protocol for waste management.
5.	Improvement of agricultural structures.	- Design and development of efficient storage structures for cereals, oilseeds & horticultural produce.
6.	Biotechnology in PHT sector.	- Use of enzyme technology in milling of cereal, pulse & oilseeds as well as for refining. - Development of processed products based on biotechnological approach
7.	Environment control for higher productivity.	- Design and fabricate agricultural structures for animals, poultry and fisheries sector.
8.	Livestock produce processing	- Development of technologies for product development from livestock produce using innovative approaches.

9. Programme and Projects

Based on the thrust area identified, the futuristic programmes up to 2025 in the PHT sector are presented in the following tables

9a. PROPOSED RESEARCH PROGRAMMES ON PHET FOR PERSPECTIVE PLAN (2007-2012)

Short term

Sr. No.	*Thrust area*	*Research gaps*	*Research programmes*	*Expected output*
1	Post harvest technologies for loss reduction in agricultural commodities.	The post harvest losses to the extent of 10% were observed in food grain and 20-40% of total production losses due to spoilage at various stages of post harvest storage of perishables.	➢ Assessment of post-harvest losses and suggesting remedial measures for various commodities. ➢ Development of equipment and package of practices for on farm cooling/chilling of fruits and vegetables ➢ Development of drying technologies for agricultural produce for better quality and safety ➢ Development of technology and pilot plant for organic coating of selected fruits and vegetables for better market appeal and increased shelf life. ➢ Development of post harvest package for longer shelf life and long distance transport of selected fruits, cut vegetables and cut flowers. ➢ Development of PCR and ELISA based kits for rapid detection of *E.Coli* O157 : H7 and Salmonella in raw and processed fruits and vegetable products, dairy and meat products stored under different conditions. ➢ Development of methods for rapid detection of mycotoxins in cereals and cereal based products and techniques for detoxification. ➢ Development of technique/instruments for nondestructive evaluation of internal quality of fruits. ➢ Package for longer shelf life of meat, poultry and fish. ➢ Development of cool chain system for horticultural produce. ➢ Development of MAP/evaporatively cooled storage	Reduction of losses by 80% at various stage of post harvest in different

2. Value addition different technologies	The level of processing is very low, only 2% in fruits and vegetables. The present export is of primary processed goods. There are untapped potential of crops of Indian origin for value addition.	technology for fruits & vegetables ➢ Technologies for coarse cereals & millets ➢ Refinement of technology for processing of oilseeds. ➢ Development of high quality novel products from cereals, pulses and wheat. ➢ farm primary processing of horticultural produce, spices and condiments, medicinal and aromatic plants sort quality raw material for value addition. ➢ Design and development of efficient equipment process of oil expelling from regular as well as based oilseeds. ➢ Development of quick cooking Indian ethnic food and sprouted grains and process for their shelf life. ➢ of current status of khandsari industry and measures to improve its efficiency. ➢ of bio-technology and nano-technology food processing for value addition and preservation ➢ Technology for extraction of oleoresins, bio flavours, and bioactive compounds from agricultural and their byproducts ➢ technology for medicinal and aromatic plants essential oil and bio-active components of importance. ➢ Development of technology for pilot scale production of fermented beverages from milk, whey and other substrates. ➢ Harvest Management and value addition of arid like guar gum for higher recovery and	Value addition to commodity enhance to level of 20%.

minor Oil coarse to and forest items enhancing Evaluation Application in bio-colours crops Extraction for commercial Post legumes

			added products ➢ Development of novel ready to eat extruded products from blend of value cereals and other food ingredients. ➢ Low temperature grinding of spices and coarse to preserve the valuable essential condiments and shelf life studies. ➢ Methods for conservation of nutrients, flavour and ingredients through high pressure processing techniques for value added products from fruits & vegetables. ➢ Development of equipment and pilot plants on ultra texture filtration and membrane filtration technology for liquid foods/juices and value added products. ➢ Application of modern technologies such as NIRS, computer tomography, mangnectic resonance imaging, computer vision, image processing for precision quality sorting and grading of agricultural and food products for their post harvest management. ➢ Studies on pollution control and work environment in agro-processing sector. ➢ Evaluation of existing processing enterprises for their energy use efficiency and suggesting remedial measures for sustainable growth of post harvest sector ➢ Development of technology for functional and health foods. ➢ Modernization of pulse milling technology for improved recovery and reduction in pollution. ➢ Development of technology for production of potato starch and flour at pilot plant scale. ➢ Development of package of technology (mechanical chemical) for processing of oilseeds of forest and developing value added products	
3.	Technology	Traditional and origin	technology still	➢ Development of mobile processing unit for cereals, More entrepreneurs

	transfer, entrepreneurship development and marketing	being followed in PH sector. About 80% of wheat is milled in indigenous mills. The growth in post harvest sector has been recorded very low (1 to 20%).	jaggery, livestock, pulses, oilseeds and major fruits and vegetables, and fish processing. ➢ Dissemination & promotions of technologies developed at CIPHET through Entrepreneurship Development Programme (EDPs). ➢ Application of technology incubation services for the prospective entrepreneurs for confidence building and test marketing. ➢ HRD and training programmes on PHET for national and international organizations. ➢ Providing consultancy services to agencies and entrepreneurs for establishing food processing industries. ➢ Development of technologies & facilities for prototype multiplication.	in value added products. The growth of PH sector should be enhanced from present. More employment.
4.	Byproduct sustainable utilization and waste management	potential of huge biomass resources. Untapped bioethanol damaged production	➢ Development of technology and pilot plants for production using corncob, stalks, grains, vegetable wastes and whey. ➢ Utilization of Agricultural biomass for the production of bio fuel through catalytic conversion. ➢ Application of bio waste in development of packaging materials.	Effective and use of biomass.
5.	Improvement of quality agricultural goods	Export share of fruits and vegetables is only 1.2%.	➢ CA and MA and ultra low O_2 storage for perishable and super atmospheric O_2 levels for preservation of fruits and vegetables and their products.	More profit to the entrepreneurs and product for export. The

6.	Biotechnology in PHT sector	Greater emphasis on genetically architectured products, use of biotechnology, larger role of microorganism lead food will call for change on emphasis on PHET.	➢ Application of evaporative cooling concept to animal shelters for their comfort. ➢ Development and standardisation of pollution measures in animal shelters and processing industries. ➢ Development of micro-processor based temperature control strategies in conventional and modern grain storage structures. ➢ Development/evaluation of nano cooling technology based refrigerated storage structures for bulk and retail storage and transport. ➢ Development and standardisation of polyhouses for off season cultivation and processing of horticultural produce including medicinal and aromatic plants. ➢ Application of enzyme technology for reduction of off flavours and anti nutrients in processed foods. ➢ Development of novel fermented products from coarse cereals and pulses. ➢ Improvement of microbial strains for reduction in processing time and enhanced quality of final products such as fruit beverages, cheese, soy sauce, tempeh etc.	Process enhancement and technology for value added products.

9(b). PROPOSED RESEARCH PROGRAMMES ON PHET FOR PERSPECTIVE PLAN (2012-2017)
(5-10 YEARS)

1. Value addition of different enhanced technologies of	The level of processing is very low, only 2% in fruits and vegetables. The present export is of primary processed goods. There is untapped potential of crops of Indian origin for value addition.	➢ Process and equipment for pre-treatment of oilseeds for higher oil recovery, improved filtration and refining, higher energy efficiency for major and minor oilseeds processing. ➢ Development and standardization of semi-automatic jaggery manufacturing plant. ➢ Characterization of commercial varieties of sugarcane for production of high quality jaggery and recovery, exploring other plant based sweeteners for jaggery manufacture. ➢ Development or adoption, testing and evaluation of improved mechanical extraction system/crushers for sugarcane juice. ➢ Development of extruded products from different cereals and other food grains. ➢ Low temperature grinding of spices and condiments and their shelf life studies. ➢ Advanced extrusion processing for producing specialty food crops. ➢ Methods for conservation of nutrients, flavour and texture of value added products through high pressure processing techniques. ➢ Evaluation of existing processing enterprises for their energy use efficiency and suggesting remedial measures for sustainable growth of post harvest sector. ➢ Studies on pollution control and work environment in agro processing sector. ➢ Development of technology for isolation and	Value addition to commodity to be to level of 40%. The enhancement of export value added products.

			of bioactive agents for their characterization in neutraceticals/health/foods. ➢ Application of Minimal processing of high value fruits & vegetables. ➢ Development of sorter based on machine vision system.	
2.	Improvement of agricultural structures	Traditional package of practices is being followed. Export share is only 1.2% of fruits and vegetables. Controlled and modified atmosphere packaging for increased shelf life of perishable food materials would achieve greater importance in domestic as well as export market.	➢ CA and MA and ultra low O_2 storage for perishable goods and super atmospheric O_2 levels for preservation of fruits and vegetables and their products. ➢ Application of evaporative cooling concept to the animal shelters for their comfort. ➢ Development of micro-processor based temperature control strategies in conventional and modern grain storage structures. ➢ Development/evaluation of nano cooling based refrigerated storage structures for bulk and retail storage and transport.	Enhancement of shelf life.
3.	Environment control for higher productivity	Area under green production is very less. Improved animal and poultry shelters would be required for exploiting the highest genetic potentials.	➢ Development of environment control system for surface covered cultivation and standardization of green house design for different agro-ecological environment. ➢ Development of prediction models for green house environment under various agro-climatic conditions ➢ Environmental control measures to livestock, poultry and aquaculture production ➢ Development of cost effective equipment and tools to promote aquaculture.	Availability of produce during off season.
4.	Technology transfer, value entrepreneurship	Traditional technology still being followed in PH sector. About 80% of wheat is milled	➢ Development of agro-processing cluster for catering requirements of mega cities on branded farm products.	Increased entrepreneurship in added products. The

	development and marketing	in indigenous mills. The growth in post harvest sector has been recorded very less (1 to 20%).	➢ management and consultancy. ➢ IPR, Development of extension literature, detailed manufacturing drawings, feasibility reports, video film and multimedia etc on developed technologies.	growth of PH sector should be enhanced to 40% from present. More rural employment.
5.	Byproduct	Untapped potential of huge	➢ Technology for fuel-alcohols from agricultural	Effective and sustainable

9(c). PROPOSED RESEARCH PROGRAMMES ON PHET FOR PERSPECTIVE PLAN (2017-2025)

1. Value addition different technologies of	The level of processing is very low, only 2% in fruits and vegetables. The present export is of primary processed goods. There are untapped potential of crops of Indian origin for value addition.	➢ Development of milling technology for pulses for food and industrial products including use of by products for higher recovery, energy efficiency, and lower dust and noise pollution. ➢ Development of pilot plants for production value added products including oleoresins from surplus and waste produces such as chillies, betel leaf, ginger, tomato (crush), apple, potato, kagzi lime, banana and jack fruit etc. ➢ Optimization of machine, operational and material parameters for preparation of traditional/ethnic foods like sattu and development of pilot plants. ➢ Development of new value added products, equipment and pilot plants for liquid foods/juices including use of ultra filtration and membrane filtration technology. ➢ Application of modern technologies such as near infrared spectroscopy (NIRS), computer Tomography, mangnectic resonance imaging computer vision, image processing for precision post harvest management quality sorting and grading of agricultural and food product. ➢ Technology for extraction of oleoresins, bio flavours, bio-colour and bioactive compounds from agro-produce and byproducts. ➢ Fresh – cut, ready to eat cook, minimal processed products. ➢ Evaluation of existing processing enterprises for their energy use efficiency and downstream	Value addition to commodity enhanced to level of 80%. The enhancement of export value added products.

			remedial measures for sustainable of post harvest sector. ➢ Studies suggesting on pollution control and work in agro processing sector. growth.	
2.	Improvement of agricultural value life structures	Traditional package of practices is being followed. Export share is only 1.2% of fruits and vegetables. Controlled and modified atmosphere packaging for increased shelf life of perishable food materials would achieve greater importance in domestic as well as export market.	➢ Development of low cost cold chain transport storage for selected fruits and vegetables. ➢ CA / MA and ultra low O_2 storage for perishable goods and super atmospheric O_2 levels for preservation of fruits and vegetables. ➢ Application of nanotechnological storage, intelligent packaging, vacuum packaging for fresh, minimally process and value added products. ➢ Transport simulation for bulk handling improvements in packaging material.	Enhancement of shelf and availability of added products.
3.	Environment control for higher productivity	Area under green production is very less. Improved animal and poultry shelters would be required for exploiting the highest genetic potentials.	➢ Development of low cost equipment for and nutrients management through system in the greenhouse. ➢ Development of dryers for drying of high water micro-irrigation crops.	Cost effective green house production.
4.	Livestock produce processing	The processing level is 6% only in poultry and only 1 % value added products from livestocks.	➢ Development and adoption of tools and for dressing of small animals poultry. ➢ Development of techniques and devices transportation and handling of eggs and egg products, poultry and fishery. ➢ Development of canned and frozen meat, poultry and fish products.	The enhancement of value added products from livestocks produce by 20%.
5.	Biotechnology	Greater emphasis on	➢ Development of technologies for production	Process and technology

	PHT sector in	genetically architectured products, use of biotechnology, larger role of microorganism lead food will call for change on emphasis on PHET.	food additive such as biocolours and bioflavours through microbial fermetation of their extraction using chromatographic and elution techniques and including studies and on flavor encapsulation. ➢ Optimization of parameters for commercial production of Agriculturally Important Enzymes such as glucoamylase, cellulases, xylanases, pectinaes and proteases both through solid state and submerged fermentation and use of biotechnological tools to improve their activity.	for value added products.
6.	Technology transfer, entrepreneurship development and marketing	Traditional technology still being followed in PH sector. About 80% of wheat is milled in indigenous mills. The growth in post harvest sector has been recorded very less (1 to 20%).	➢ Database generation on equipment, processes codes and standards and project files and impact assessment studies. ➢ Value addition in human capital through enhancement of farm producers, manufactures, knowledge and entrepreneurs and extension scientists field officials. ➢ Liaisoning with industries, financial institutions, Govt. line departments, National and International Agencies for sharing of knowledge and infrastructure and TOT. ➢ Establishment of prototype design and manufacturing using CAD, CAM for commercialization, resource generation and user friendly and safe technology.	Increased entrepreneurship for value added products. The growth of PH sector should be enhanced 80% from present. More rural employment.
7.	Byproduct utilization and	Untapped potential of huge biomass resources.	➢ Modern techniques for conversion of biomass into oils fuel	Effective and sustainable use of biomass.

10. AICRP on PHT

10.1 Mandate

- To develop location and crop/commodity specific post harvest technologies for minimization of quantitative and qualitative losses to produce in agriculture and allied sectors.
- To adapt and develop improved post harvest processes and equipment for value addition to other farm produce at rural threshold for higher income and generation of rural employment.
- To develop processes and equipment for economic utilization on bio-wastes and by-products.
- To conduct operational research and multi-location trials on developed technologies to identify technical, financial, managerial and social constraints for better market acceptability to technologies.
- To establish need based agro-processing centres.
- To assess, refine and transfer proven technologies.

10.2 Objectives

- To study the prevailing post harvest practices and identify unit operations, equipment and their components that need improvement or substitution, adequacy and inadequacy of the prevailing practices.
- To develop and adopt farm level cleaners, graders and dryers for cereals, pulses, oilseeds, plantation crops, tubers, other field crops, livestock produce and fish.
- To develop simple processes, low cost equipment and pilot plants for farm/village level processing of food grains, oilseeds and other crops for rural consumption, as well as selling value added products to semi-urban and urban areas for better economic returns.
- To develop simple processes and equipment at farm/village level for better economic utilization of bio-wastes and by-products as food/feed/fuel etc. for increasing profitability of the commodity and income of the farmer.
- To undertake studies on technical feasibility and economic viability of on farm/village level processing industries and other enterprises.
- To field evaluate laboratory proven technologies and carry out operational research trials on the developed technologies for villages to identify technical, managerial and social constraints and take remedial measures before releasing for popularization.
- Facilitating creating of post harvest technology consciousness and transfer of proven technologies in selected villages and monitoring its effects on economics and social development.

- To generate income and employment in rural areas through adoption of proven technologies and equipment through establishing agro-processing centres.

10.3 Thrust Areas for R&D

1. Adoption/development of need based, demand driven technologies for reduction in post harvest losses to produce in agriculture and allied sectors.
2. Development of need based agro-processing centres in production catchments.
3. Prototype production, commercialization of technologies and TOT.
4. Training of growers, researchers, extension workers and industry workers.
5. Environmental up-gradation in processing industries and workers safety.
6. Technology refinement, multi-location trials and commercialization.
7. Improvement in the work environment in agro processing industries
8. Food quality and safety analysis
9. Prototype production facilities for mass multiplication.
10. Entrepreneurship development training programmes for entrepreneurs, women rural youth, farmers etc including the tribal areas.
11. Study of prevalent processes and equipment used for jaggery & khandsari from sugarcane, palm and sweet sorghum.
12. Characterization of commercial sugarcane varieties for quality jaggery.
13. Development and adoption of improved mechanical crusher (s) for higher (above 70%) juice recovery.
14. Development/adoption and evaluation of energy efficient improved furnace(s) and concentration pans and their multi location trial.
15. Development of mechanical filters and popularization of herbal clarificants in jaggery manufacturing.

10.4 Centres of PHT

1. Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra)
2. University of Agricultural Sciences, Bangalore (Karnataka)
3. Acharya N. G. Ranga Agriculture University, Bapatla (Andhra Pradesh)

4. Orissa University of Agriculture & Technology, Bhubaneshwar (Orissa)
5. Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu)
6. Acharya Narendra Dev University of Agriculture & Technology, Faizabad (Uttar Pradesh)
7. Jawaharlal Nehru Krishi Viswa Vidyalaya, Jabalpur (Madhya Pradesh)
8. Assam Agricultural University (Jorhat (Assam)
9. Junagadh Agricultural University (Junagadh (Gujarat)
10. Indian Institute of Technology, Kharagpur (West Bengal)
11. Punjab Agricultural University, Ludhiana (Punjab)
12. G. B. Pant University of Agriculture & Technology, Pantnagar (Uttaranchal)
13. Rajendra Agricultural University, Pusa (Bihar)
14. Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (Chattisgarh)
15. Sher-e-Kashmir University of Agriculture Sciences & Technology, Srinagar (J&K)
16. Maharana Pratap Agricultural University, Udaipur (Rajasthan)
17. Aligarh Muslim University, Aligarh (Uttar Pradesh)
18. CCS Haryana Agricultural University, Hisar (Haryana)
19. Kerala Agricultural University, Tavanur (Kerala)
20. Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP)
21. Tamil Nadu Veterinary and Animal Sciences University, Chennai (Tamil Nadu)
22. Rajasthan Agricultural University, Durgapura, Jaipur (Rajasthan)
23. West Bengal University of Animal & Fishery Sciences, Kolkata (West Bengal)
24. University of Agricultural Sciences, Raichur (Karnataka)
25. Regional Sugarcane & Jaggery Research Station, Kolhapur (Maharashtra)
26. Assam Agricultural University, Buralikson (Assam)
27. Regional Agricultural Research Station, Anakapalle (Andhra Pradesh)
28. Vivekanand Parvartiya krishi Anusandhanshala, Almora (Uttaranchal)
29. Central Institute of Agricultural Engineering, Bhopal (Madhya Pradesh)
30. Central Arid Zone Research Institute, Jodhpur (Rajasthan)
31. Central Plantation Crops Research Institute, Kasargod (Kerala)
32. Central Tuber Crops Research Institute, Thiruvananthapuram, (Kerala)

33. Indian Institute of Sugarcane Research, Lucknow (UP)

Strengthening New Centres with equipment and other facilities

1. Aligarh Muslim University, Aligarh
2. Kerala Agricultural University, Thrissur
3. CCS Haryana Agricultural University, Hisar
4. Y. S. Parmer University of Horticulture & Forestry, Nauni, Solan
5. Tamil Nadu Vetennary & Animal Sciences University, Chennai
6. Rajasthan Agricultural University, Bikaner
7. West Bengal University of Animal & Fishery Sciences, Kolkata
8. University of Agricultural Sciences, Dharwad

Up-gradation of FTE centres and sub-centres to R&D centres

- ANGRAU, Bapatla
- NDUAT, Faizabad
- RAU, Pusa
- AAU, Khanapara

Proposed New Centres

Name of Centre	*Crops/Animals/Fisheries*
Central Agricultural University, Guava,	Fruits and Vegetables (Apple, Plum, Peach, Citrus,
College of Agril Engg & PHT, Gangtok (Sikkim)	Ginger, Peas, Large cardamom), Medicinal herbs and exportable flowers
GAU, Anand (Gujarat)	Milk processing, product development, medicinal and aromatic plants
BSKKV, Dapoli (Maharashtra)	Horticulture and allied products
Indian Agricultural Research Institute,Division of PHT, New Delhi	Fruits, Vegetables and Cereals
SKUAS&T, Jammu (J&K)	Oilseeds, floriculture & fruits
ICAR Complex, Barapani (Meghalaya)	Oilseeds, ginger and horticulture
NERIST, Itanagar (Arunachal Pradesh)	Pineapple, paddy, bamboo
UBKV, Coach Bihar (WB)	Paddy, pineapple, potato, vegetables
Birsa Agril. Univ., Ranchi (Jharkhand)	Lac, rice and pulses
DRR, Hyderabad (Andhra Pradesh)	Paddy processing, by-product utilization
DWR, Karnal (Haryana)	Wheat and value added products
CSAUA&T, Kanpur (Uttar Pradesh)	Mango, guava, papaya, medicinal plant, cereals
CSKKV, Palampur (Himachal Pradesh)	Rice, vegetables, floriculture
Annamalai University Annamalai (Tamil Nadu)	
Panjab University Chandigarh (Punjab)	

Development of AICRP on PHT centres as core/lead centre

- UAS, Bangalore
- TNAU, Coimbatore
- PDKV, Akola
- OUA&T, Bhuabaneswar
- JAU, Junagadh
- GBPUA&T, Pantnagar
- TNVASU, Chennai
- AAU, Jorhat, Khanapara
- WBUA&FS, Kolkata

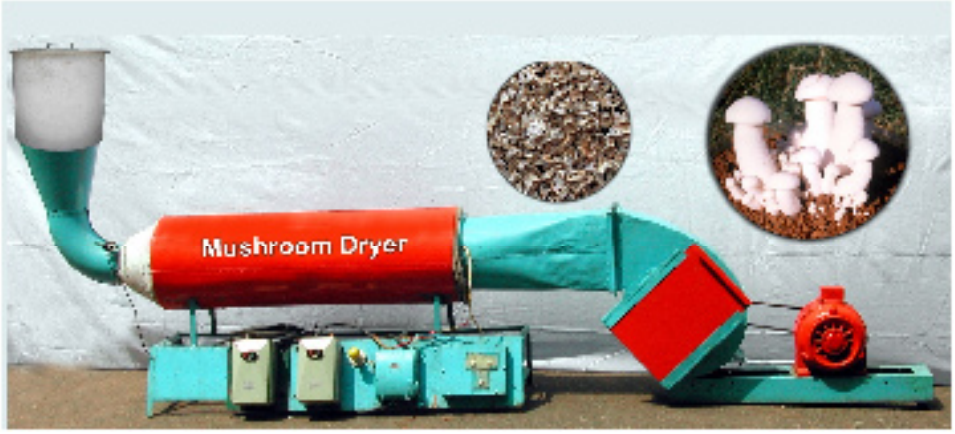
These centres would be upgraded for training & human resources development, computer aided design (CAD), design of equipment and prototype.

10.5 Brief Research Achievements

No.	*Centre*	*Technology Commercialized / Transferred*	*Status*
1.	PDKV Akola	1. PKV mini dal mill	Commercialized
		2. PKV chilli seed extractor	Commercialized
2.	VPKAS Almora	1. Vivek thresher-cum-pearler	Commercialized
3.	RARS Anakapalle	1. Preparation of cane jaggery cubes / blocks	Commercialized
		2. Process for jaggery of improved quality from immature, overaged, scale infested and drought affected cane juice	Technology transferred to jaggery farmers/processors
		3. Double grating Anakapalle jaggery furnace for increased heat use efficiency	Technology transferred to jaggery farmers/processors
4.	UAS Bangalore	1. 2-in-1 Maize sheller-cum-Sunflower thresher	Commercialized
		2. Arecanut dehusker	Commercialized
		3. 3-in-1 mini Groundnut decorticator, Sunflower thresher and Maize sheller	Commercialized
		4. Pedal operated coconut dehusker	Commercialized
5.	CIAE Bhopal	1. Multi purpose grain mill	Commercialized
		2. Pedal cum Power operated grain cleaner	Commercialized
		3. CIAE Dhall mill	Commercialized
		4. Groundnut decorticator, hand operated	Commercialized
		5. Solar cabinet dryer for vegetables	Commercialized
6.	OUAT Bhubaneswar	1. Osmo dehydrated Pineapple slices/rings and tidbit	Commercialized
7.	TNAU Coimbatore	1. House hold insect trap	Commercialized
		2. Four Roller Sugarcane Crusher	Commercialized
		3. Bottling of Sugarcane juice	Commercialized
		4. Household paddy parboiling unit	Commercialized
		5. Mini Dahl Mill	Commercialized
8.	AAU Jorhat	1. Value added products from ginger	Technology transferred to some SHGs
9.	JAU Junagadh	1. Feed Block Making Machine	Technology transferred to some NGOs and Farmers
		2. Cleaner- cum-Grader for Cumin	Technology transferred to some NGOs and Farmers
		3. On-Farm Fruit Grader	Technology transferred to some NGOs and Farmers
		4. Agriculture wastes-fired dryer for Red Chillies	Technology transferred to some NGOs and Farmers
10.	CPCRI Kasargod	1. Development of Shell fired Copra Dryer	Technology transferred to farmer-cum-processors

		2. Process for production of coconut chips	Commercialized
		3. Production of snow ball tender nut	Commercialized
		4. Design of solar cum electrical dryer with biofuel as third source of energy	Technology transferred to Kerala Agro Industries Corps
11.	IIT Kharagpur	1. Grain puffing machine	Commercialized
		2. Bamboo Cement Bin (for paddy storage)	Commercialized
		3. Recirculatory tray dryer	Commercialized
		4. Dehydrated vegetables	Commercialized
		5. Ripe Bael drink and Unripe mango drink	Commercialized
12.	RS&JRS Kolhapur	1. Liquid Jaggery Production Process	Technology transferred to farmer-cum-processors
		2. Modified Electronic / Digital Thermometer to indicate the striking point temperature	Technology transferred to farmer-cum-processors
		3. Churner for defrothing during jaggery making	Technology transferred to farmer-cum-processors
		4. Modified Hardness tester for solid jaggery	Technology transferred to farmer-cum-processors
		5. Cane Juice Boiling Pan	Technology transferred to farmer-cum-processors
13.	IISR Lucknow	1. Drying-cum-storage bin for jaggery	Commercialized
14.	PAU Ludhiana	1. Single Drum Rotary Screen Grain Pre-cleaner	Commercialized
		2. Farm level fruit and vegetable washing machine	Commercialized
15.	GBPUAT Pantnagar	1. Pantnagar Mini Dhal Mill	Commercialized
16.	YSPUH&F Solan	1. Technology for extraction of kernel oil from apricot stones/seeds	Commercialized
17.	CTCRI Trivandrum	1. Hand operated cassava chipping machine	Commercialized
		2. Cassava rasper	Commercialized
		3. Motorised chipping machine	Technology transferred to entrepreneurs
		4. Peeling knife	Technology transferred to entrepreneurs
18.	MPUAT Udaipur	1. Maize dehusker sheller	Commercialized
		2. Garlic bulb breaker	Commercialized
		3. Process technology for Garlic flakes & powder	Commercialized
		4. Technology for ginger and	Technology transferred to

Our centres have so far commercialized 31 technologies, transferred 16 technologies to farmer – processors - entrepreneurs and have another 65 technologies ready for commercialization.



In addition to these, Agro Processing Centres (APC) are being established and monitored by several AICRP on PHT centres, viz. CIAE Bhopal, TNAU Coimbatore, PAU Ludhiana, PKV Akola, UAS Bangalore, MPUAT Udaipur, JAU Junagadh, GBPUA&T Pantnagar, OUAT Bhubaneswar and ANGRAU, Bapatla

On the recommendations of Parliamentary Standing Committee, a nation-wide concurrent survey has been undertaken by all the centres of AICRP on PHT for the Assessment of the Post Harvest Losses of Crops and Commodities. This work covers 42 major crops/commodities in about 120 districts (1200 villages) spread over 14 agro-climatic zones. Most of the centres have made satisfactory progress in complete enumeration of selected villages, selection of farmers, selection of different channels of post-harvest operation and collection of data by enquiry as well as by actual observation through statistically valid methodology. Data entry, scrutiny and analysis are being

10.6 Human Resource Development of AICRP on PHT

S.No	*Area*	*Discipline/Project*	*No. of scientists*
1.	Storage of cereals / oilseeds / pulses	AS&PE/Agri. Entomology	3
2.	Milling of food grains and oilseeds	AS&PE/Chem.Engg.	5
3.	Packaging technology	AS&PE /FS&T/Horticulture	2
4.	Food Technology	AS&PE/F&N/FS&T	2
5.	Drying of food grains vegetables / fruits	AS&PE/Chem. Engg.	
6.	By-products utilization	AS&PE/Biotechnology/ Microbiology/Biochemistry	4
7.	Post Harvest Technology of Plantation/Tuber Crops.	AS&PE/Horticulture	2
8.	Livestock produce processing	AS&PE/ FS&T / Microbiology/Biochemistry	5
9.	Information Technology	Computer Applications in Agriculture /other disciplines	5
10.	W/S technology (Advances in turning / fitting / welding/ milling / heat treatment)	Workshop staff	4
11.	Laboratory practice / techniques	Lab. Staff	5
12.	Computer Applications i) Word processing, Database ii) Accounting iii) Operating systems	Admn staff	15

11. AICRP on APA

11.1 Mandate

The mandate of the project is to develop plasticulture technologies with major emphasis to surface covered cultivation techniques, packaging, storage, transportation, water conservation techniques in agriculture, and appropriate technology for aquaculture / inland fisheries sector. It also envisages the field evaluation and operational research of well proven technologies to transfer the perfected technical know how to farmers and entrepreneurs.

11.2 Objectives

The specific objectives are as follows:

- To study adaptability of different plastic materials for various applications in agricultural production and post harvest activities.
- To identify newer areas of plastic applications which will add to the quality of production and enhance the productivity using the available resources and to develop further, appropriate technologies suited to different sections of the society.
- To prepare materials for information dissemination and transfer of proven technologies.
- To organize short-term training programs for extension workers, technicians, farmers and research workers engaged in the field of plasticulture.
- To carry out operational research on laboratory proven technologies and to modify them to acclimatized particular agro-climatic conditions.
- To liaise with plastic industry promoting applications of plastics in agriculture.
- To provide consultancy services to users as well as agencies promoting plasticulture.

11.3 Thrust Areas for R&D

The research programmes of all the cooperating centers were thoroughly discussed and were assigned to individual centers. The following emerged as major thrust areas :

i) Technology for environment control structures & surface covered cultivation

ii) Plastics technology for preservation, packaging, handling and storage of Agricultural produce.

iii) Adoption of plastics for aquaculture engineering &fish packaging.

iv) Water Harvesting, storage and conveyance system

v) Technology for pressurised irrigation systems.

vi) Alternate material for agricultural machines/equipment

vii) Human Resource Development for Plasticulture.

viii) Liaison with industry &Advisory Services.

11.4 Centres of APA

PC unit at Central Institute of Post Harvest Engineering and Technology (CIPHET), Ludhiana.

Cooperating centers

i) Central Institute of Post Harvest Engineering and Technology (CIPHET), Abohar (Punjab)
ii) Punjab Agricultural University Ludhiana (Punjab)
iii) Vivekananda Parvatiya Krishi Anusandhan Shala (VPKAS), Almora (Uttranchal)
iv) Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar (Orissa)
v) Choudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya(CSKHPKV), Palampur (Himachal Pradesh)
vi) ICAR Research Complex for NEH Region, Umiam - 793 103 (Barapani) (Meghalaya)
vii) Sher-e-Kashmir University of Agriculture Sciences & Technology Srinagar (J&K)
viii) Birsa Agricultural University Ranchi (Jharkhand)
ix) Junagadh Agricultural University Junagadh (Gujarat)

STRENGTHENING OF CORE CENTRES

- CIPHET
- CIFA
- ICAR Campus for NEH Region

Proposed New Centres

- PDKV, Akola(MH)
- CIAE, Bhopal (MP)
- TNAU, Coimbatore (TN)
- UAS, Bangalore(KARNATAKA)

11.5 Brief Research Achievements

1) Design and fabrication of Portable carp hatchery for commercial seed production
2) Development of plastic made low cost devices for freshwater fish culture
   a) Floating cages for commercial fish culture made up of

i) HDPE
ii) FRP

b) Translucent FRP pools for fish rearing
c) Seed rearing tubs for catfish culture
d) Closed Loop Water Filtration Unit for Aquarium
e) FRP Transportation tank for live fishes
f) Open enclosure breeding system for carps

3) Technique for fish culture during low temperatures using polyhouse
4) Design of low cost bamboo green house for off-season vegetable production in hills
5) Assessment of cultivars and agronomic practices for economic use of greenhouse space for nursery vegetable production.
6) Design and assessment of plastic hoppers for multi-crop planters
7) Development of Orifice meter for fertigation
8) Low cost designs for lining of small water tanks in uplands of mid-hills
9) Development of low cost filter
10) Design of microtube based gravity fed drip irrigation for hilly terraces.
11) Technologies for efficient use of precious water resources in uplands using drips / pipe irrigations.
12) Assessment of plastic mulching (including biodegradable plastic) for vegetable / fruit production

13) Development of plastic thermocole beehives

The adoption of plastic material provides an opportunity to develop equipments/ systems/ structures of great importance as far as quality production and high value crop aquaculture programmes are concerned. To develop all these gadgets engineering skills are required in designing various structures of greenhouse, low tunnels, systems for water management i.e. drip irrigation system and other appliances. Also, efforts are required to standardize these equipments under various agro-climatic conditions and in developing environmental control measures. The agriculture produce can only fetch higher prices either for domestic use in the country or at exports level, when an integrated approach and relevant technology are used at pre-harvest and post-harvest technology levels. At present, great emphasis has been laid to develop post-harvest technology of storage,

11.6 Human Resource Development and Transfer of Technology

Plan of AICRP on APA

S. No.	*No. of Persons*	*Area of training*	*Institute where training will be given*
A. National			
1	5	Greenhouse technology (environmental control/ design of structure)	IARI, Jain Irrigation,Indo American
2	3	Plastic packaging for agricultural produce	Indian Plastics Institute, CFTRI
3	3	Environmental Study for Agro-Processing Industry	CIPHET
Sub Total	**11**		
B. International			
1	3	Covered crop cultivation greenhouse, low tunnels	Institute of Beltsville Agricultural Research Centre, Maryland, U.S.A.
2	2	Controlled atmosphere storage and Packaging of fruits and vegetables	Ohio Agricultural Research and Development Centre, Wooster of the Ohio State University, U.S.A.
3	1	Aquaculture Engineering	Institute of Agriculture Engineering, Silso, U.K.
4	2	Bio- environmental Engineering	University of Illinois (U.S.A)
Sub Total	**8**		

12. Linkages, coordination and execution arrangements

Interdisciplinary linkages within the institute, sister ICAR Institutes, SAUs, CSIR laboratories, other research organizations in the country and abroad, farmers, manufacturers, processors, trade sector, BIS and developmental agencies would be required to be developed and strengthened.

A.	**WITHIN THE COUNTRY**	
(a) With other Ministries / department at Central / State levels		
1.	Post harvest loss reduction technologies	FCI, CWC, MFPI, NHB, NDDB, NHRDF,
2.	Value addition technology	DFRL, TMO&P, NOVOD Board, MNES, HBTI, NRCM
3.	Improvement of agricultural structures	IGMRI, Hapur & Ludhiana, FCI, CWC, SLIET, Punjab Warehousing Corporation, NHB, NAFD, NHRDF, BARC, IGMRI, MFPI., CDRI, ICT Hyderabad.
4.	Environmental control for higher productivity	Department of Science & Technology, Ministry of Food Processing Industries, DRDO, MPEDA, APEDA
5.	Livestock produce processing	Ministry of Food Processing, MOA,
6.	Technology transfer, entrepreneurship development and marketing	MOA, NHB, MFPI, MHRD, NABARD, State Governments, MARKFED, TRIFED, IIM Ahemdabad
(b)	***With sister organizations***	
1.	Post harvest loss reduction technologies	CIAE, IARI, CFTRI, IITs, IASRI, IIPR,
2.	Value addition technology	IIT, Kharagpur, IITs, RRLs, IIVR, ILRI, IIP, CFTRI, PHTS Centres, NRC Seed Spices, Ajmer, CPRI, Shimla DRR, Hyderabad
3.	Improvement of agricultural structures	CIAE, Bhopal, CPRI, CIRB, CIRG, IARI, CARI
4.	Environmental control for higher productivity	IVRI, CARI, IARI, CPCP, AICRP on PHT, IIT, Kharagpur, IIHR, CSSRI, CSWR&TI
5.	Livestock produce processing	IVRI, CIRG, CARI, NRCM, CIFT, NDRI
6.	Technology transfer, entrepreneurship development and marketing	SISI, AICRPs on PHTS and APA, CIAE, KVIC, NRDC.
(c)	***With state agricultural universities***	
1.	Post harvest loss reduction technologies	Concerned SAUs
2.	Value addition technology	Concerned SAUs
3.	Improvement of agricultural structures	Concerned SAUs
4.	Environmental control for higher productivity	Concerned SAUs
5.	Livestock produce processing	Concerned SAUs
6.	Technology transfer, entrepreneurship development and marketing	All SAUs
(d)	***With Non-governmental Organizations (NGOs)***	
1.	Post harvest loss reduction technologies	M/s Shirke Structural Industries, Pune, NIJJER

		Agro, Pepsi Foods, ITC
2.	Value addition technology	PIL, Akola, Hind Agro, Jain Food, HLL, Cargil, Allana Foods, Venketsawara Hatcheries
3.	Improvement of agricultural structures	M/s Jain Irrigation, Jalgaon,
4.	Environmental control for higher productivity	Hind Agro, BAIF
5.	Livestock produce processing	Hind Agro,
6.	Technology transfer, entrepreneurship development and marketing	KVKs (under NGO), State Consultancy Organizations, SFAC, NAIM, Jaipur
7.	Post harvest management	Grain mandies, F&V markets
B.	***INTERNATIONAL***	
1.	Storage & bulk handling systems	Name of Institutes/Organization will be decided after
2.	Covered crop cultivation	corresponding interacting with concerned institutes
3.	Floriculture	in the particular country under the auspices of
4.	Processing of fruits and vegetables	DARE/ICAR.
5.	Feeds and fodders	
6.	Modified Atmosphere Packaging and Storage of Perishable Food Products	
7.	Rice milling	
8.	Wheat milling	
9.	Advanced Extrusion Processing Technology	
10.	Handling, storage and marketing of fresh agro commodities	
11.	Soya & other oilseed products	
12	Advance technologies for extraction of oils, oleoresins, biocolours and bioactive compounds from agro-produce and by-products	
13	Processing of horticultural products.	
14.	Handling & processing of livestock products and fisheries	
15.	Biotechnology in food processing	
16.	Technology for rapid detection and control of bio-toxins, chemical contaminants and heavy metals in	

To achieve its goal, the proposed programme will be executed by the team of learned scientists in CIPHET along with its AICRPs in collaboration with various national and international organizations. CIPHET has been developing co-operation with other institute and Universities in post harvest sector. All stakeholders would be involved as a partner in the programme. Agro processing cluster for post harvest technology incubation will be developed for effective transfer of technology and entrepreneurship development. All programmes will be coordinated by CIPHET through its established linkages with organizations and users of technology.

13. Critical inputs

13.1 Funds

The requirement of funds for CIPHET for consecutive five year plan up to 2025 is described below in table 5.

Table 5: Proposed budget of CIPHET for the XI-XIV Five-Year Plans

(Rs. Lakh)

Head CIPHET	*XI*	*XII*	*XIII*	*XIV (2022-2025)*	*Total*
A. Recurring					
Pay & Allowances	100	150	200	150	600
TA	60	90	120	90	360
HRD	30	50	100	90	270
Contingencies	500	700	800	600	2600
Total (A)	**690**	**990**	**1120**	**930**	**3730**
B. Non-Recurring					
Equipment	700	1000	1000	500	3200
Works	500	300	500	400	1700
Library	70	80	100	70	320
Total (B)	***1270***	***1380***	***1600***	***970***	***5220***
Total (CIPHET)	***1960***	***2370***	***2720***	***1900***	***8950***
AICRP on PHT	***8290***	***9950***	***11940***	***7880***	***38060***
AICRP on APA	***415***	***472***	***545***	***375***	***1807***
Grand Total	***10665***	***12792***	***15205***	***10155***	***48817***

13.2 Personnel

To achieved envisaged vision following addition scientific man power will be required.

Table 6: Additional Manpower Requirement to meet the ratio of 1:2:3 among PS: SS: S

Discipline	*Scientist Scientist*	*Senior Scientist*	*Principal*	*Total*
AS&PE	6	4	1	11
FMP	-	1	1	2
Food Nutrition	1	-	-	1
Microbiology (Agri)	1	-	-	1
Mechanical Engineering	1	-	-	1
Agricultural Economics	-	1	-	1
Plant Pathology	1	-	-	1
Civil Engineering	1	-	-	1
Agricultural Statistics	1	1	-	2
Food Science and Technology	2	1	1	4
Livestock Production Technology	1	1	-	2
Biochemistry	2	1	-	3
Agril Extension	1	1	-	2
Biotechnology(Plant science)	-	1	-	1
Aquaculture Engg	2	1	-	3
Fisheries technology	1	1	-	2
Total	**21**	**14**	**3**	**38**

11.3 Human resource development

Human Resource Development Training of Scientists in priority areas of technology of CIPHET

No S.	*Area*	*Discipline/Project*	*No. of scientists*
1.	Storage of cereals / oilseeds / pulses	AS&PE/Agri. Entomology	9
2.	Handling of cereals / oilseeds / pulses	AS&PE/Chem.Engg.	9
3.	Milling of food grains and oilseeds	AS&PE/Chem.Engg.	10
4.	Packaging technology	AS&PE /Horticulture	6
5.	Drying of food grains vegetables / fruits	AS&PE/FST	
6.	By-products utilization	AS&PE/FMP/Microbiology/Biochemistry	12
7.	Processing of spices and condiments	AS&PE/FMP	6
8.	Post Harvest Technology of Plantation Crops.	AS&PE/Horticulture	3
9.	Computer aided design	AS&PE/Elect. & Instt./FMP / Mech.Engg.	20
10.	Testing of post harvest equipment	AS&PE/FMP	15
11.	Industry Simulation and Policy analysis	All disciplines	20
12	Fruits and Vegetable Pathology	Plant Pathology	3
13.	Electronic instruments	Elec. & Instn./AS&PE/FMP	6
14.	Instrumentation & control for data collection	Elec. & Instn./FMP	6
15.	Information Technology	Computer Applications in Agriculture / other disciplines	15
16.	Livestock Produce Processing	AS&PE/LPT	15
17.	Statistical Design for Agric. Research	All discipline	6
18.	Soil & water Management	SWE	3
19.	Biological control of insect pests & weeds	Agronomy	3
20.	Quality Control & World Food Standards Food analysis	AS&PE/ Bio-chemistry / FST	3
21.	W/S technology (Advances in turning / fitting / welding/ milling / heat treatment)	Workshop staff	12

22.	Operation & Maintenance of equipment (eg. Transformer / electrical switchgear/ pumps / motors/generators etc.)	Workshop Staff / Lab. Staff.	12
23.	CAD & CAM	Mech., Engg/FMP., Technical staff	6
24.	W/S Metallurgy	Workshop staff	6
25.	Laboratory practice / techniques	Lab. Staff	15
26.	Instrumentation techniques	Workshop staff & lab staff	15
27.	Computer Applications i) Word processing ii) Accounting iii) Operating systems	Tech., Administrative staff	30
28.	Administrative Procedures	Admn. Staff	15
29.	Procurement/Financial Management/ Personnel Management	Admn. Staff	12

Note: The name of institutes and course duration will be finalized after due discussion/correspondence/approval.

14. Risk analysis

The research strategy of CIPHET will be directed towards Post harvest and value addition in agricultural produces including livestock and fisheries, which is well known to have uncertainties due to its diversity requirement. The following risks are associated in achieving envisaged vision.

- Shrinking in government funding and constraint in recruitments. The implementation of vision programme would depend on availability of multidisciplinary manpower and adequate fund support. While latter had been well supported by council, the former even remained a constraint. Scientific manpower non-availability can affect realization the vision
- Commercialization of post harvest and value addition technology would depends on the quality raw material, price behavior which would be guided by marketing and climate/weather factors.
- Acceptability of processed and value added products among the Indian consumers over fresh products
- Stiff competition from foreign technologies for processed and value added products among potential entrepreneurs and existing processing industry.
- Inconsistent supply of quality raw material for value added products.
- Variable production and productivity due to change in environment
- Disparity in consumption pattern in Indian population.

15. Project review, reporting and evaluation arrangement

All the research projects to be undertaken at CIPHET would be need based. Profile of the purchasers and users of the technology will be required to be developed through extensive fields studies. About 80 percent of the research projects will be problem solving in nature. However, in 20 percent cases, projects will need to be taken in frontier areas of technology supported by in-depth review of literature and structured discussion with experts. Activity milestones in all the projects will be required to be developed on time scale and represented through PERT chart.

Matrix mode would be used for management of research projects. During the Perspective Plan: Vision 2025, following would be the major programmes:

- Post harvest technologies for loss reduction
- Value addition technologies
- Technology transfer, entrepreneurship development and marketing
- Byproduct utilization and Waste management

- Improvement of agricultural structures
- Biotechnology in PHT sector
- Environment control for higher productivity
- Livestock produce processing

Hence, projects and sub-projects would be undertaken under these programmes. Project based budgeting is envisaged for effective support to programmes, their monitoring and control as envisaged by the ICAR.

The progress of the projects will be reviewed and evaluated periodically by respective heads of Divisions and Director through review meetings. It will also be reviewed by the Institute Research Council, Institute Management Committee, Research Advisory Committee and higher officials of the ICAR. Long-term reviews would be undertaken by the Quinquennial Review Team and Social Audit teams constituted by the Council from time to time.

16. Resource generation

In addition to the financial support from ICAR, the Institute would endeavour to generate part of its funds requirement through its own efforts. It is envisaged that by the year 2025, CIPHET would be able to generate 15-20 percent of its annual budget through sale of technical services, consultancies and contract services for process protocol, product and machinery development. Important ones have been described below.

Technical Services

Testing Facilities

CIPHET would have a wide ranging scientific instruments, equipment and offer referral lab facilities for testing of a variety of food materials, agricultural products and for processing machinery. These facilities besides their use in R&D, would also be available to private parties, processors, manufacturers, researchers from different Institute/Universities for testing of their products and machinery against payment of test charges. CIPHET will have a Testing Cell for such work.

Project Feasibility Reports

With multi-disciplinary team of scientific and technical experts at its disposal, CIPHET would be well equipped to develop project feasibility reports in different areas of post harvest engineering and processing technologies. The expertise would be available to government organizations, private entrepreneurs and overseas clients on payment of charges.

Training

CIPHET would organize trainings at national as well as international level. These will be organized to improve the skills of scientists, teachers, researchers, managers, technicians, extension workers and individuals. It would include training on advanced analytical techniques, computer aided

design, operation and maintenance of processing machinery, advanced courses on processing of cereals, pulses, oilseeds, horticultural produce and other crops. The Institute also proposes to initiate technology based entrepreneurship development programmes based on R & D results obtained at CIPHET.

Consultancy Services and Contract Research

Consultancy services will be available to government organizations, private parties/industry and to foreign agencies on payment basis. These would include performance auditing of existing organizations and processing plants, re-engineering, demand assessment, product development, packaging, preparation of promotional material, design of new machinery, processes, process plants, food plant sanitation, installation of quality control procedures, waste treatment/recycling and so on. In case the need is for taking up short term R&D projects in the above areas, these would be accepted at as contract research.

Technology Incubation Centre in Agro Processing Clusters

The facility of pilot plants will be opened to CIPHET trained entrepreneurs or clients licenced with CIPHET technologies, so that they can produce the value added products and for test marketing and also till the confidence is built to make the enterprise sustainable.

Hardware Technologies and Materials

Materials, Processed Products and Machinery

Efforts would be made to utilize all the land available to the Institute for growing high value crops and generate adequate resources through sale of nursery, cut-flowers, fruits, HYV seeds value added products and so on. Pilot plants and agro-processing centre in the Institute would also be utilized for processing of agricultural materials into value added products for sale. The Institute would also generate about 5 percent of its budget through sale of improved processing machinery to private entrepreneurs, government agencies, universities and foreign agencies.

Literature and Drawings

Technical bulletins and other literature published by CIPHET would be available on sale. This would add to the resource generation for sustaining its development activities. Also, manufacturing drawings of various improved post harvest processing machines would be available on cost basis to the interested parties for mass manufacturing.

Others

The Institute would utilize opportunities for resource generation through various other sources as well. These may include revolving fund scheme of ICAR, sale of patents, hiring out some of the space for canteen and to bank in the campus, guest house facilities, royalties on books, entry fee for Post Harvest Engineering and Technology Industrial Park, registration fee for special seminars and conferences, fee for use of specialized packages on computer and so on.

17. Output

- Package of practices for minimal processing of fruits and vegetables at farmers' level.
- Processes and pilot plants for development of nutritious value added end products from agricultural produce and by products.
- Food processing incubation center for hands on training for development of confidence in entrepreneurs.
- Technology for safe storage of foodgrains and cool chain for fruits and vegetables and marine products.
- Increased production of processable variety of grain, fruits and vegetables.
- The protocols/method for non destructive determination of internal quality of fruits.
- Value added novel products from meat, poultry and fisheries.
- High quality Indian ethnic ready to cook and ready to eat food products .
- Application protocol for plant based enzymes for reduction in off flavour, anti nutritional factors and for use of pretreatment for higher recovery in the processing of pulses and oil seeds.
- Pilot plants of production of enzymes for food processing applications.
- Testing protocols for evaluation of quality of processed GM foods.
- Quality standard for value added products and hygiene in rural agro-processing units
- Scientifically designed animal shelters for comfort of milch and animal for meat.
- Bioethanol from agricultural residue for fuel use.
- Intelligent packages for storage of value added products using nano and biotechnologies

18. Outcome

- Enhancement of farmer's income leading to rural prosperity and reduction in poverty.
- New ventures of employment generation in post harvest and value addition sector.
- More food security due to reduction in post harvest losses.
- Increased net per capita availability of food.
- Availability of nutritious processed food will eradicate the problem of malnutrition.
- Enhancement of foreign exchange by higher export of value added quality products.
- Increased availability of specialty foods and industrial raw material hence enhanced agro processing activity.
- Sustainable rural livelihood due to increased post harvest activity in rural catchments.
- Bioethanol for reducing the dependence on non renewable source of energy and thus saving in valuable foreign exchange.

19. Concluding remarks

India produces 750 million tonnes of raw food material annually. There are post harvest losses to the tune of 10-40% depending upon the commodity. The level of processing is approximately 40% with average value addition of 10%. The cutting edge technologies like biotechnology, nano-technology, non-thermal processing have potential to use in post harvest sector. The value addition in the Indian post harvest sector is one of the largest in the world and attracts nearly 6.3% of GDP and 13% of the country exports. Therefore, the present status of post harvest sector was analyzed in the perspective plan and keeping in view its strength, weakness and opportunities, CIPHET has set its goal. Evidently CIPHET has to work on war footing to support PH sector as India may become a major value added food producer and supplier by 2025 so as to generate rural income, employment and foreign exchange in a big way. It is the time for CIPHET to shift its demand driven R&D works for reducing costs, enhancing quality and safety, developing and introducing world class technology, promoting synergy between rural level processing to organized processors/export. Accordingly, it is necessary to increase the level of processing and value addition share in the global trade and drastically reduction in wastage/value loss and build excellent quality image for Indian ethnic foods products. It would also require single window approach to serve all stack holders engaged in the handling of agri-produce, processing, marketing, infrastructure development, food safety regulation etc. In order to fulfill aforesaid Vision 2025, the various programs/projects were identified addressing the key issues in post harvest sector to realize the potential of biodiversity in India. After successful implementation, the value addition of food products is expected to increase from current 10% to 35% and processing in fruits and vegetable increased from 2 to 35% by 2025.

Acronym

AAU	Assam Agricultural University
ADG	Assistant Director General
AEZ	Agri Export Zone
AGRI	Agriculture
AICRP	All India Co-ordinate Research Project
APA	Application of Plastics in Agriculture
APC	Agro Processing Centre
APEDA	Agricultural and Processed Foods Export Development Authority
ARFIS	Agriculture Research and Financial Information System
ARIS	Agriculture Research Information System
AS&PE	Agricultural Structure & Process Engineering
ATIC	Agricultural Technology Information Centre
BAIF	Bharatiya Agro Industries Foundation
BARC	Bhabha Atomic Research Centre
BIS	Bureau of Indian Standards
BSKKV	Balasaheb Sawant Konkan Krishi Vidyapeeth
CA	Control led Atmosphere
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CARI	Central Avian Research Institute
CIRB	Central Institute for Research on Buffaloes
CFTRI	Central Food Technological Research Institute
Chem	Chemical
CIAE	Central Institute of Agricultural Engineering
CIFA	Central Institute of Freshwater Aquaculture
CIFT	Central Institute of Fisheries Technology
CIPHET	Central Institute of Post Harvest Engineering & Technology
CIRG	Central Institute for Research on Goat
CPCRI	Central Plantation Crops Research Institute
CPRI	Central Potato Research Institute
CRRI	Central Rice Research Institute
CSAUA&T	Chandra Shekhar Azad University of Agriculture and Technology
CSIR	Council of Scientific and Industrial Research
CSSRI	Central Soil Salinity Research Institute
CSWR&TI	Central Soil and Water Conservation Research and Training Institute
CWC	Central Warehousing corporation
DARE	Department of Agricultural Research and Education
db	Dry basis
DDG	Deputy Director General
DFRL	Defence Food Research Laboratory
DRDO	Defence Research and Development Organization
DRR	Directorate of Rice Research
DWR	Directorate of Wheat Research
EC	Evaporative Cooled
ED	Entrepreneurship Development
EDP	Entrepreneurship Development programme
Elect	Electrical
ELISA	Enzyme Linked Immunosorbent Assay
Engg	Engineering

F&V	Fruits & Vegetables
FCI	Food Corporation of India
FMP	Farm Machinery and Power
FST	Food Science and Technology
FSTA	Food Science Technology Abstract
GDP	Gross Domestic Product
GMP	Good Manufacturing Practice
Govt.	Government
HBTI	Harcourt Butler Technological Institute
HLL	Hindustan Lever Limited
HP	Himachal Pradesh
HRD	Human Resources Development
HYV	High Yielding Varieties
IARI	Indian Agricultural Research Institute
IASRI	Indian Agricultural Statistics Research Institute
ICAR	Indian Council of Agricultural Research
IGMRI	Indian Grain Storage Management and Research Institute
IIHR	Indian Institute of Horticultural Research
IIM	Indian Institute of Management
IIP	Indian Institute of Packaging
IIPR	Indian Institute of Pulse Research
IIT	Indian Institute of Technology
IIVR	Indian Institute of Vegetable Research
ILRI	Indian Lac Research Institute
Instn	Instrumentation
IPR	Intellectual Property Rights
IT	Information Technology
ITC	Indian Tobacco Company
IVRI	Indian Veterinary Research Institute
J&K	Jammu and Kasmir
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidyalaya
KVIC	Khadi and Village Industries Commission
KVK	Krishi Vigyan Kendra
LPT	Livestock Production Technology
MA	Modified Atmosphere
MAP	Modified Atmosphere Packaging
Mech	Mechanical
MFPI	Ministry of Food Processing Industry
MH	Maharashtra
MNES	Ministry of Non-conventional Energy Sources
MP	Madhya Pradesh
MPEDA	Marine Products Export Development Authority
NABARD	National Bank for Agriculture and Rural Development
NATP	National Agriculture Technology Project
NDDB	National Dairy Development Board
NDRI	National Dairy Research Institute
NERIST	North Eastern Regional Institute of Science & Technology
NGO	Non-Governmental Organization
NHB	National Horticulture Board
NHRDF	National Horticultural Research and Development Foundation
NIAM	National Institute of Agricultural Marketing
NIRS	Near Infra Red Spectroscopy

NOVODB	National Oilseeds and Vegetable Oils Development Board
NRC	National Research Centre
NRCM	National Research Centre on Meat
NRCOG	National Research Centre on Onion and Garlic
NRDC	National Research Development Corporation
pa	per annum
PAU	Punjab Agricultural University
PC	Project Coordinator
PERT	Programme Evaluation and Review Technique
PH	Post Harvest
PHET	Post Harvest Engineering & Technology
PHT	Post Harvest Technology
PLW	Physiological loss in Weight
PS	Principle Scientist
R&D	Research & Development
RTC	Ready to Cook
RTE	Ready to Eat
S	Scientist
SAARC	South Asian Association for Regional Cooperation
SAU	State Agricultural University
SFAC	Small Farmers Agri-Business Consortium
SISI	Small Industries Service Institute
SS	Senior Scientist
SWE	Soil Water Engineering
SWOT	Strength Weakness Opportunity Threats
TA	Traveling Allowance
TMO&P	Technology Mission on Oilseeds and Pulses
TN	Tamilnadu
TOT	Transfer of Technology
UP	Uttar Pradesh
WTO	World Trade Organisation

Units

g	gram
ha	Hectare
t	Tonne
kW	Kilowatt.
m	Meter
Rs.	Rupees
cm	centimeter
mm	Millimeter
kg	Kilogram
SS	Stainless Steel
mg	Milligram
W	Watt
C	Centigrade
h	Hour