Working Group Report on Postharvest Technology & Value Addition for Haryana





Haryana Kisan Ayog
Government of Haryana

Working Group Report
on
Postharvest Technology
&
Value Addition for Haryana

Haryana Kisan Ayog
Anaj Mandi, Sector - 20
Panchkula-134116

FOREWORD

Member Secretary
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The management of postharvest losses of crops and livestock products is important from the point of view of increased food security and income to the farmers. In India, post harvest losses continue to be very high on account of extreme weather conditions and poor postharvest management practices including low level of value addition. According to one estimate, post harvest losses in fruits and vegetables in India is about Rupees 2 lakh crore. Some estimates suggest that about 30-40 percent of fruit and vegetables are lost or abandoned after leaving the farm gate. Physical grain looses in case of cereals, pulses, and oil seeds range from 5 to 10 percent. Post production losses estimated in case of milk and vegetable crops are relatively much higher (10-30 percent). International markets reject fruits and vegetables containing unauthorized pesticides, with pesticide residues exceeding permissible limits, and with inadequate labeling and packaging.

Postharvest management determines food quality and safety, competitiveness in the market, and the profits earned by producers. Better postharvest management practices, technological interventions and innovations, value chain development, improvement in infrastructure can play a significant role in reducing postharvest losses. With the increasing investment in agricultural development in Haryana, in particular the investments to improve horticultural production and productivity, postharvest management interventions and value addition initiatives need to improve so that farmers are able to reap full benefits of increased production. It will also help in improving the food and nutritional security.

Although many good postharvest management and value addition technologies exist, yet their adoption by the farmers and value chain operators has somehow remained limited due to a number of supply and demand side constraints.

It was indeed thoughtful of Dr. Paroda, the founder Chairman of the Haryana Kisan Ayog to have constituted a working group on, 'Postharvest Technology and Value Addition for Haryana', with distinguished experts in the area. In fact, it is the visionary leadership and guidance of an academic giant in Dr. Paroda that put this Ayog on a sound footing. We are indebted for his services to the Ayog and the state.

Dr.Nawab Ali, as Chairman, Dr. R.K.Gupta, Dr. D.V.K. Samuel and Dr. S.S.Dhawan as members, beside Dr. K.N.Rai as Nodal Officer, of the Working Group deserve all appreciation for their sincere efforts in finalization of this expert group report "Postharvest Technology and Value Addition for Haryana". I am quite confident that this report will provide a "Way Forward" for the State to achieve excellence in Postharvest Management in Haryana.

I believe that this valuable publication will be highly useful to the organizations/institutions involved in postharvest management of agricultural produces. It will be also useful for the administrators, researchers, policy makers, planners, farmers and entrepreneurs.

R.S.Dalal

PREFACE

Chairman
Working Group on
Postharvest Technology &
Value Addition for Haryana

The Working Group on Postharvest Technology and Value Addition (WG on PHT&VA) Constituted by the Haryana Kisan Ayog (HKA) on 3rd December, 2013 had three meetings during 10-11 Feb, 21-23 April, and 9-10 June, 2014 with the officials of HKA and other stakeholders and made visits to various governmental and non-governmental postharvest management and food processing facilities such as dairy plants, sugar mill, mushroom enterprise, agricultural markets, etc. and also visited R&D Institutions like NDRI, Karnal, CCSHAU, Hisar and LUVAS, Hisar. The last and the final meeting of the WG was held during 11-12 December, 2014 at HKA Office, Panchkula to discuss and finalize the report.

A Brain Storming Workshop on PHT&VA in Haryana was also organized on 09 June, 2014 at CCSHAU, Hisar, in which 12 papers related to PHT&VA to plant and livestock produces pertaining to Haryana were presented & discussed. About 100 scientists from CCSHAU, Hisar and LUVAS, Hisar participated and took part in the deliberations & discussion. The WG on PHT&VA along with the officials of HKA also visited the Centre of Food Science and Technology (CFST), College of Home Science (COHS), Dairy Produce Processing Laboratory (DPPL), Department of Livestock Product Technology (DLPT) and the College of Agricultural Engineering and Technology (COAET), CCSHAU, Hisar and saw various products, technology and machines developed by them.

The report highlights various concepts and terminology used in production to consumption agriculture including livestocks and explains different postharvest management technologies involved in processing and value addition to plant and animal based harvested biomass. Postharvest technology is commodity and location specific, hence, raw and fresh food commodities have been grouped into four categories, namely grains (cereals, pulses & oilseeds); cash crops (sugarcane, cotton & guar); horticultural produces (fruits & vegetables, medicinal & aromatic plants, spices, mushroom, honey & floriculture); and livestock produces (dairy, poultry, meat & fish). Appropriate management of agricultural residues, livestock wastes and processing byproducts along with agri-business management and guidelines for establishing agro-enterprises have also been discussed. It also contains observations on food processing in Haryana, suggestions and recommendations. Overall, the report runs into 11 chapters and an appendix.

The WG has critically analyzed the present status of PHT&VA to the plant and livestock produces of the state of Haryana and its problem and prospects and came out

with suggestions and key recommendations for appropriate storage & processing of various food commodities of plant and animal origin to minimise postproduction losses and to produce value added products for local consumption and sale to urban consumers & export. The WG believe that this document/report will facilitate planners and scientific community of the State for working out short-term & long-term strategies to minimise postharvest losses, produce value added product in the production catchment and make an economic utilization of crop residue and processing byproducts. It would enhance human, animal & soil health and better economic returns to the farmers and better quality food at an affordable price to the consumers and thereby help in strengthening the State and thereby the National food and nutritional security for one and all.

The WG expresses its sincere thanks & gratitude's to Dr. R.S. Paroda, Founder Chairman of the HKA for giving this opportunity and also to DR. R.S. Dalal, member-Secretary of HKA; Dr. K.N. Rai, Consultant, HKA and Dr. Gajender Singh for providing administrative supports, technical backstopping, logistics and other facilities to the WG. The Group also thanks the officials of various establishments whose premises were visited and who had volunteered for a fruitful discussions and to all those who helped the WG, directly or indirectly, in completing its task.

Nawab Ali

RK Gupta

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The report of working group on Postharvest Technology and Value Addition for Haryana is an outcome of series of meetings and fruitful discussions carried out with planners, policy makers, scientists, Haryana Government Officers, entrepreneurs and other stakeholders having interest in farmers' welfare. The working group consisting of Dr. Nawab Ali, Chairman, Dr. R.K.Gupta, Dr. D.V.K. Samuel and Dr. S.S.Dhawan members was constituted by the Chairman of Haryana Kisan Ayog. The Ayog is indebted with deep sense of appreciation for the vision and leadership of its founder Chairman Padma Bhusan Dr. R.S.Paroda who selected eminent experts having expertise in the field of postharvest technology along with the good knowledge of the postharvest management of agricultural produce in Haryana. The Ayog express its sincere thanks to Dr. Nawab Ali, Dr.R.K.Gupta, Dr. D.V.K. Samuel and Dr. S.S.Dhawan for completing this important assignment by identifying the complex issues and problems of postharvest management and value addition and suggesting appropriate solutions for the benefit to the farmers making farming a more remunerative enterprise.

The Ayog feels highly indebted to Sh. Dhanpat Singh, IAS, Principal Secretary, Agriculture, Govt. of Haryana, Sh. Ramesh Krishan, IAS, Director General, Agriculture, Govt. of Haryana, Dr. A.S.Saini, DG, Horticulture, Govt. of Haryana,

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K.N. Rai

List of Abbreviations and Symbols

APC	Agro-Processing Centre
AYUSH	Ayurveda, Yoga & Naturopat hy, Unani, Siddha and Homeopathy
CAS	Controlled Atmosphere Storage
CCSHAU	Choudhary Charan Singh Ha ryana Agricultural University
CFB	Corrugated Fiber Board
CIPHET	Central Institute of Post harvest Engineering and Technology
COAET	College of Agricultural Engineering and Technology
COHS	College of Home Science
DDG	Deputy Director General
DLPT	Department of Livestock Product Technology
DPPL	Dairy Produce Processing Laboratory
DPR	Detailed Project Report
F&V	Fruits and Vegetables
FPT	Food Processing Technology
FST	Food Science and Technology
GDP	Gross Domestic Product
HACCP	Hazard Analysis Critical Control Point
HAIC	Haryana Agro-Industries Corporation
HKA	Haryana Kisan Ayog
HPP	High Pressure Processing
HTST	High Temperature Short Time
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
IQF	Individual Quick Freezing
IT	Information Technology
ITC	Indian Tobacco Company
kg	Kilogramme
KVK	Krishi Vigyan Kendra
LUVAS	Lala Lajpat Rai University of Veterinary and Animal Sciences
M	Millions
M.P.	Madhya Pradesh
MAP	Modified Atmosphere Packaging

MAS	Modified Atmosphere Storage
MSP	Minimum Support Price
NDRI	National Dairy Research Institute
NGO	Non-Governmental Organization
NMPB	National Medicinal Plants Board
NRCM	National Research Centre for Mushroom
NRCSS	National Research Centre for Seed Spices
PHC	Postharvest Conservation
PHM	Postharvest Management
PHT	Postharvest Technology
PPS	Post-Production System
R&D	Research and Development
SHG	Self-Help Group
SSF	Solid State Fermentation
t	Tonnes (1000 kg)
UHT	Ultra High Temperature
UP	Uttar Pradesh
VA	Value Addition
VFD	Vacuum Freeze Drying
WG	Working Group
ZWT	Zero Waste Technology

CONTENTS

Executive Summary

1. General

The Haryana State, created on 01st November, 1966 has made a substantial progress in agriculture. As of now, agriculture contributes about 17% to state GDP and is the main livelihood of more than 50% population. The major crops of the State are wheat, rice, maize, sugarcane, cotton, pearl millet, rape seed & mustard, guar, gram etc. and the cropping intensity is about 185%. The average productivity of foodgrains in the State has reached about 3.5 t/ha as against 2t/ha at the National level. The State enjoys first position in the production of scented rice, ***Basmati*** and also in the productivity of wheat (5.2 t/ha), pearl millet (2.0 t/ha) and rapeseed & mustard (1.9 t/ha).

2. Secondary Agriculture

2.1 Haryana agriculture including livestock farming, needs an equal attention towards post production management, also called secondary agriculture, to achieve higher income through processing and value addition to different food commodities in the production catchment itself, by a group of farmers and/or cooperative food processing units having backward and forward linkage with producers and the market for agricultural & livestock produces & products. Such activities would generate and provide employment to rural youths and others and thus it would also help in checking rural migration to urban areas which is already crowded and have poor living amenities for migrants. However, for this, farmers would require technology, fiscal incentive and policy supports.

2.2 There is a need for capacity building of farmers and rural youths through entrepreneurship development and self-employment oriented agricultural education by introducing vocational courses at diploma/certificate level in areas like dairying, seed production, food processing, bee keeping, organic farming, agri-business, protected cultivation, agricultural tools & machinery manufacture for production & post production agriculture, etc.

2.3 Promotion of renewable energy such as solar, bio-mass & wind in production and post production agriculture need special attention and consideration to reduce the cost of production and processing making plant & animal based biomass production & utilization more economical and affordable.

2.4 The policy for procurement and MSP including risk management like insurance, need to be considered for all major crops, horticulture and livestock produces to ensure higher and sustainable production,

productivity and profitability of agriculture which makes human beings and their accompanying livestock to survive and perform. In fact, farming feeds the world; therefore, farm, farmer and finance which are needed for agriculture, need higher priority and promotional efforts.

2.5 Agricultural markets should have facilities with automation for most of the operations such as weighing, sampling, handling, cleaning, grading, storage, etc. for higher efficiency and better return on investment to farmers and market functionaries.

2.6 Fiscal incentives in terms of soft loans and tax exemptions for a specific period on import of machinery, export of processed products, etc. for establishing and operating food processing industry in the rural sector need to be encouraged.

3. Food Processing Industry

It is highly fragmented comprising of a few large scale and a multiple of small scale and cottage industries engaged in processing of foodgrains, dairy and horticultural produces. There are no APEDA notified agri-export zones (AEZ) in the State. Food parks at Rai, Sonepat and Saha, Ambala are being developed and maintained by Haryana State Industrial Development Corporation (HSIDC). The Haryana State Agricultural Marketing Board (HSAMB) is, however, implementing some of the projects, such as:

3.1 Development of apple market at Panchukla and mandi modernization including establishment of new mandies.

3.2 Construction of agro-malls at Panchkula, Rohtak, Karnal, and Panipat.

3.3 Establishment of cold chain**;** ripening chambers; grading, sorting & packaging facilities for horticultural produces at 11 locations in the State with the assistance of National Horticulture Mission (NHM) and also cold chain infrastructures at four places with NHM.

3.4 Setting up of an Ultra Modern Postharvest Management Support System cum Agro-Processing Trade Centre at Ganaur spread over 200 ha.

3.5 Commodity specific markets for F&V**,** fodder, fish, grains, etc.

3.6 Agribusiness Information Centres**.**

3.7 Cold Chain projects at three locations with the assistance of the Ministry of Food Processing Industries (MOFPI), GOI.

4. Industrial Policy

Recently, the State Government has formulated, Haryana Industrial and Investment Policy-2011, wherein emphasis has been laid down on Agro-based food processing and allied industries as a thrust area. A National Institute of Food

Technology, Entrepreneurship and Management (NIFTEM) have been set-up by the Ministry of Food Processing Industries (MOFPI), Government of India in Sonepat. The NIFTEM facilitates capacity building and caters to the needs of skill development in food processing sector through imparting training and it also offers courses in the field of food technology and other management streams.

4.1 The strategy for food processing in the State may include demand driven & cluster based farming for processing; integration of postharvest processing & value addition infrastructure from farm to market and promotion of a dynamic food processing industry that could lead to a high growth in the processed food sector.

4.2 Most of the fruits & vegetables produced have been consumed fresh except for a small quantity used for the manufacture of pickles, ketchups, chips, fruit preserves, dehydrated vegetables, etc. However, now with the changing dietary patterns, demand for fresh and processed fruits & vegetables in the domestic market is increasing and to meet such rising demands, production of F&V processed products, such as dried onion & garlic powder, ginger & garlic paste; jam, jelly from individual and/or mixed fruits; fruits juices, concentrates & squashes; canned & frozen beans, cauliflower & okra; pickles of mango, lime & chillies-tomato puree & ketchup; mango fruit drink & nectar; chilli sauces; mango-chutney, etc. Processed products offer good returns and create new market and expand the market availability for a longer period. The State of Haryana may like to explore the possibility of processing line to develop newer products in F&V sector.

4.3 Some of the modern processing technologies that could be made use of for processing and value addition to F&V are membrane technology, microwave heating, freeze drying, osmotic dehydration, high pressure processing and so on.

4.4 Fruit wastes are generated at various stages such as harvesting, handling, transport, storage, marketing, processing or even during their use in the kitchen. Wastes are generally classified as field wastes (fruits drops, bird & insect damaged fruits, injured & braised due to faulty picking, underutilized/culled fruits); transit storage and market wastes (damage & spoiled fruits, unsold & wilted, etc.); and processing and kitchen wastes (cores, peels, seeds, stones, pomace, spoiled fruits & their products). At present most of the solid wastes are dumped outside and these are eaten and scattered by stray animals. These wastes need

to be economically utilized for extracting specific ingredients like pectin, essential oils, phytochemicals and the balance for feed and/or compost.

5. Grain Processing

Haryana has made a significant contribution in the production of cereals (18-20 Mt) pulses (0.1 Mt) and oilseeds (1.0 Mt). To make further headway on economic front, it has to concentrate on processing and value addition of grains. As of now, there are about 600 grain-processing (wheat, rice, pulses and oilseeds) and 65 bakery industries in the State and these are set-up with an investment of about Rs 2383 Crores and provide direct employment to over 18260 persons with a turnover of Rs 5100 crores, as in 2011-12. Haryana is one of the largest exporters of rice. The State government is required to strengthen backward & forward linkages between the Farmer (Producer), the Industry (Processor & marketers) and the consumer, so that farmers should get a reasonable share in the prices paid by the consumers.

It is suggested that primary and secondary processing of grains should be done in the production catchment to provide better economic returns to the farmers and to supply better quality food products to the consumers rural & urban and at the same time enhance animal and soil health through an appropriate and economic utilization of crop residues and processing byproducts for feed and compost.

6. Cash Crops

The major cash crops of Haryana are sugarcane, cotton & guar**.** Production of these crops during 2011-12 was about 7.0 Mt of sugarcane with an average productivity of 73 t/ha; 2.6 Mt of cotton with an average yield of 740 kg/ha and 0.36 Mt of guar with a productivity of 1.3 t/ha.

6.1 Sugarcane is a multi-product crop contributing to the production of sugar, ethanol, electricity, paper and other allied products. As of now, the recovery of sugar has shown a declining trend during the last five-year. This might be due to non-systemic and unbalanced varietal promotion and incidence of pests & diseases. During 2011-12, the average recovery of sugar in private sugar mills was about 9.82%, whereas that in cooperative sector was 8.72%. This indicates that the mills in cooperative sector have scope for improvement through better management.

6.2 Cotton is a fibre, fuel, feed and oil crops and in Haryana, it is a major cash crop in Kharif Season. There is a scope to increase cotton productivity in the State by adopting improved variety and production technology. Cotton is a seed fibre and after processing, it is used for apparel, home furnishing and industrial applications. Production of biogas from willow-dust, particle board & paper from cotton stalks and edible oil from seeds is done. As of now, there is a need to develop high yielding

varieties of cotton having resistance to biotic & abiotic stresses and suitable for mechanical harvesting. Processing of crop residue and ginning byproducts need appropriate utilization for better returns.

6.3 Guar is a legume and rainfed crop. It is sensitive to salinity and water logging but responds to irrigation under low moisture conditions. In Haryana, guar is cultivated in the districts of Bhiwani, Gurgaon, Mewat, Mahendragarh, Rewari, Hisar, Fatehabad and Sirsa. Haryana contributes about 30% of total guar production in India. Rajasthan is the major guar growing State of India. The most important industrial use of guar is in the form of guar gum. About 90% of the total guar production is used for the production of guar gum and the rest is used for culinary purposes and cattle feed. A byproduct of guar processing is guar meal (mixture of husk & germ) which is potential sources of protein. It is used for cattle and poultry feed. The pharmaceutical uses of guar gum are about 5% and the rest 5% is used in cosmetics & other miscellaneous items like mosquito coils. As of now, there is a need to develop varieties having quality gum as required by the industry and promotion of guar production with a strong backward linkage with farmers to ensure higher productivity and remunerative prices to the farmer, and a reasonable profit to industry and other stake holders in guar production, processing, marketing, export and byproducts utilization chain.

7. Horticultural Produces

These are the major contributors to nutritional security, rural employment, and export promotion, urbanization, improved living standard, and higher income. However, the horticultural produces are perishable in nature by virtue of having high moisture contents at maturity and losses occur during their harvest, handling, processing, marketing, and consumption. It is estimated that such losses are 15-25% depending upon the commodity and location. In order to minimise such quantitative as well as qualitative losses of horticultural produces, there is a need to have a strong post-harvest infrastructure for creation of awareness among handlers of such produces which as producers, wholesalers, processors, retailers and consumers about the biological and environmental factors involved in deterioration of horticultural produces and use of appropriate postharvest tools and technology in minimizing the losses during handling, transport, storage, processing, marketing and utilization. It is more economical and timely to reduce the postharvest losses than compensate it by an additional production.

The share of different horticultural produces in Haryana state is 60% vegetables, 30% fruits, 6% plantation crops, 3% spices, 0.6% flowers and 0.4% aromatic &

medicinal plants. The production of major fruits and vegetables in Haryana during 2011-12 was 1.22 and 4.78 million tonnes, respectively. If the rural women and younger generation are trained in some of the simple, low-cost & energy efficient technology for management and value addition to fresh fruits and vegetables, at farm and/or village level, it would help in reduction of losses, fetching better returns to the growers making horticultural produce available at reasonable price to the consumers and create rural employment opportunities.

There is paucity of processing units and value addition to horticulture crops in the state. While the state has some good agro industries mostly in and around cities, rural based small scale industries are required for processing of surplus produce. This will not only help in reducing post harvest losses but also benefit farmers considerably.

7.1 Fruits and Vegetables

There is a considerable gap between production and the net availability of F&V to the consumers on account of losses and deterioration by the time it reaches to the consumers. Mechanical damage to F&V during harvest, handling and transport results in bruising, cracking and cuts which predisposes the produce to microbial spoilage. Physiological changes caused by respiration and ethylene liberation or changes in pigments, organic acid and flavour during ripening may lead to undesirable quality. Efficient management of the produce during harvest, grading, packaging, transport, storage and marketing can prevent these quantitative and qualitative losses.

There is a need for F&V primary processing Centres in the production areas for collection, grading, cooling, packing and refrigerated transport of F&V to the markets and/or processing units. Training of horticultural farmers, especially the women is needed in primary processing of F&V to minimize the postharvest losses, and on how to maintain the quality of the harvested produce.

Production of F&V based value added products for domestic & export markets & economic utilization of byproducts through public-private partnership involving all the stakeholders in production to consumption value chain need to be given priority. Such processing units may be located in the rural areas.

7.2 Medicinal and Aromatic Plants

Haryana has varying climatic conditions which harbour several kinds of native medicinal plants ranging from herbs to perennial trees having neutraceutical values. There are many pharmaceutical and herbal

industries which have a vast requirement of medicinal and aromatic plants. In spite of having potential, farmers in the State have not shown much interest in cultivation of medicinal plants. The area coverage under various crops has been on decline. Some of the important medicinal and aromatic plant species which can be grown in south west region of Haryana with low rainfall, dry climate and light soils are isabgol, senna, mulathi, ashwangadha, satawar, aloevera, tulsi, citronella, mint and guggal. On the other hand, crops which require high irrigation facility, fertile land and medium to heavy clay soils are brahmi, kalihari, gillie, kaunch, kamlegh, satawar, tulsi, menthe, etc. This calls for state sponsored promotion of these plants by creating suitable market infrastructure and encouragement of entrepreneurship. There is also a need of organized marketing and trade of medicinal & aromatic plants and their various products.

7.3 Spices

Haryana grows a number of spices, such as chillies, coriander, fennel, fenugreek, garlic, ginger, turmeric, etc. and has potential to increase the production of these spices. Harvesting is one of the major factors that determines the quality of the produce. Major deterioration in quality and losses take place at the farm level. The stage of harvest varies from crop to crop. Coriander is harvested in 90-135 days, cumin in 100-110 days whereas fennel takes 170-175 days.

Value addition at farm level is required because major deterioration and postharvest losses occur at this stage. A mobile seed processing unit can be adopted at village level. Prices of cleaned & graded spices are much more than uncleaned ones.

Machines that are used in spice processing are cleaner, grader, horizontal/vertical burr mill, etc. The NRCSS, Ajmer has developed a mobile seed spices processing machine and it is very much beneficial for small & marginal farmers as the produce can be processed in the village itself. At secondary level, spices are processed for essential oils, oleoresins, natural colours and spice extract. A variety of products can be made from the pepper. Ground and packaged spices, single or multi ingredients can be prepared and marketed. For high quality ground spices, cryogenic grinding is suggested.

Strengthening and modernization of on-farm primary and secondary processing of spices need to be done for quality up gradation and diversification towards newer products for domestic as well as global markets. The postharvest management and processing of spices play a

greater role in quality up gradation and need to be given priority to enhance international trade in spices and its products.

7.4 Mushroom

Mushroom farming is an efficient means to convert agricultural wastes into high value protein source, at the same time it provides additional income & employment to rural people. As of now, mushroom cultivation is centered on white button mushroom, accounting for about 85% of the total mushroom production. The domestic marketing channels lack adequate price support faced with erratic demand and supply. Lack of trained manpower is among other drawbacks for the growth of mushroom industry. Mushroom as a nutritious food needs to be popularized to combat protein malnutrition among majority of the vegetarian people. There is a need for the development of processed products and enhancement of self life.

7.5 Floriculture

The commercial cultivation of flowers in Haryana is a recent introduction at present; a number of flowers are grown in Haryana, both outdoor and under protected cultivation. The major flowers are marigold, rose, gladiolus and chrysanthemum. The expansion has been highest in marigold followed by tuberose. This augurs well for the future of floriculture industry in Haryana.

Cut-flower quality and longevity are influenced by pre and post harvest practices. About 20-40% of the cut flowers produced are lost due to faulty harvesting, postharvest handling, storage, transportation and marketing. These losses can be reduced by careful harvesting, handling, temperature management, sanitation and judicious use of floral preservatives. There is a need to improve packaging system, grading of flowers for quality, quick and refrigerated transport, organized marketing with minimum intermediaries. The value added products from flowers are dry-flower & pot-pourri, essential oils, flavours & fragrance, pharmaceutical & neutraceutical products, pigments & natural dye, gulkand, rose water, vanilla products and insecticidal and nematicidal compounds. The proximity of Haryana to NCR offers excellent marketing channels, establishment of processing industries and export of flowers.

8. Livestock Produces

There is a great scope for production and value addition to livestock produces thereby enhancing rural employment opportunities and farmers income. In Haryana, the major livestock produces are milk (6.6 Mt), meat & chicken (0.32 Mt), eggs (0.21 Mt) and fishes (0.11 Mt). In general, the organized dairy plants in the State are

handling only 35% of the surplus milk (16% of total milk production); and the bulk (84%) of the surplus milk is handled by the unorganized sectors (sweetshops, vendors, etc.). Shifting of handling and processing of surplus milk, from unorganized sector to the organized sector holds the key to sustained profitability of dairy farming. Buffalo meat production holds an unparalleled opportunity for the State and will serve to fast track the animal improvement ensuring high revenue returns to investment, greater profit margin to farmers, higher economic growth and human development. Rural broiler and egg production can serve as a transforming agent, for the poor in terms of nutrition and health. Fish farming and its marketing, as a quality product under hygienic conditions in an appropriately designed fish market would help farmers to generate employment and earn more. For urban market and export, fish processing units on cooperative basis need to be established in the production catchment having cold room & refrigeration facilities to transport the minimally and/or processed fish & fish products.

The fresh as well as processed livestock produces such as milk, meat, chicken, egg and fishes are high quality protein and mineral sources and need to be promoted for better health of the people so that they can perform better and deliver more of high quality work outputs.

9. Agricultural Wastes and Byproducts

There is a variety of agricultural and livestock wastes and byproducts generated during production, processing and utilization of the harvested biomass of plant and animal origin in the premises of various farms, agro-industries, kitchen and restaurants. These wastes and products need an economic utilization in order to enhance overall agricultural & livestock productivity and profitability and at the same time protecting the environment from pollution and degradation. Production of foodgrains, oilseeds and other industrial field crops like sugarcane, cotton, guar etc. result in a lot of (more than 50% of the total biomass synthesized) biowastes in the form of crop residues and processing byproducts. Similarly, horticultural & livestock farming also generate substantial residues, wastes and byproducts. These agricultural residues and wastes can be used for feed, fuel, manure, paper, particle board, packaging materials, insulation, mushroom growing, building materials and others. Many chemicals and pharmaceuticals can also be prepared from agricultural residue & wastes. Collection, processing and utilization of various residues & byproducts are specific to each group of agricultural and livestock commodities.

There is a substantial wealth in agricultural and livestock wastes and byproducts. If, these are efficiently utilized for soil amendment, livestock feed, biofuel and industrial applications, would result in high employment and economic returns to farmers as well as to small and medium scale entrepreneurs. Such initiatives would

enhance agricultural and livestock productivity benefiting all those involved in value-addition chain as well as to the nation.

10. Agri-Business Management

It is the management of inputs & outputs of the production and post-production agriculture and livestock farming in respect of its procurement, storage, processing and marketing with the purpose of earning profit by satisfying the needs and wants of the consumers, taking into account the well-being of the society and the environment. Its domain covers all agricultural and allied management activities having commercial objectives covering the entire food chain from production to consumption. Agri-business not only includes those who farm the land but also the people and firms that provide the inputs, process the outputs; manufacture tertiary ready-to-eat products, and transport and sell the tertiary processed food products to consumers, restaurants, super markets, etc.

The important agri-business includes production, processing and marketing of plant and livestock based produces and other allied activities. It may be run by a single person, generally known as agri-entrepreneur; in partnership mode with two or more persons; cooperative or as a corporation/company. Various agri-business activities are village & cottage industries, micro-enterprises, small scale industries, medium enterprises, women enterprises, export oriented units and so on.

Finance is needed at all the stages of agri-business and this could be tapped from sources such as own capital, money lenders, commission agents, market operators, commercial & cooperative banks. Public sector banks have been advised to open at least one specialized branch in each district and provide loans to micro, small & medium enterprises (MSME) and 60% or more of their advances must go to MSME sector.

As of now, many governmental agencies and NGOs have come forward with many strategies to promote marketing of agricultural produces and other rural products to urban consumers, giving a better share of the profit to rural producers. These arrangements need to be encouraged and promoted for the marketing of agricultural, livestock and other produces of the farmers.

11. Agro-Processing Centers

Rural people migrate to urban areas for employment and better amenities of life, because such opportunities are presently not available in rural sector but could be created through the development of infrastructures such as roads, electricity, health care and education, mechanization of agriculture and appropriate postharvest management and value addition to the harvested biomass in the production catchment. Such facilities in rural sector would contribute towards enhancement of per capita food availability and employment resulting into rural prosperity and better

living and also check rural migration. For all these to happen, integration of production agriculture with on-farm processing is necessary. It can be done through establishment and operation of agro-processing centres in the production catchment itself to facilitate backward linkage with farmers, have fresh and best quality raw food materials for processing and value addition minimize material movements, check migration of rural people to urban areas for jobs and thereby reducing pressure on public utilities in urban areas.

Such agro-processing centres would be a very strong tool for rural reconstruction and development. It would help in reducing rural-urban disparity and in ensuring household food and nutritional security for one and all at an affordable cost. The technology is available but political will and commitment is required to implement the programme to shape a new State in the 21st Century (New millennium) where every one could be healthy and happy. It is in the interest of the State of Haryana and its people and thereby, the Nation as a whole.

12. Recommendations

In order to meet the food and nutritional requirements of the growing population and to provide remunerative price and additional income to the farmers, an integrated and intensified farming system with on-farm processing, along with fixation of Minimum Support Price (MSP) and procurement policy; not only for cereals but also for pulses, oilseeds and horticultural produces is needed. Crops like groundnut, soybean, sorghum, sunflower, guar, castor and pigeon pea are the potential crops which can be promoted under diversification to maintain and enhance soil fertility and agricultural productivity.

It is, therefore, recommended that agro-processing centers at Panchayat level, having facilities for cleaning, grading, drying, storage and processing of grains; cooling, grading, minimal processing, packaging, cold stores and refrigerated transport for marketing & value addition to horticultural produces; modernization of cooperative sugar mills to realize higher recovery of sugar and efficient utilization of crop residue, wastes and byproducts; fiscal incentives and technological support to food processing industries along with that offered by MOFPI, GOI and better than neighbouring states; dairy sector should continue as per AMUL pattern with more diversification in the product range; and appropriate & economic utilization of agricultural residue, livestock wastes and processing byproducts of agriculture and livestock based food processing industries.

Postharvest management and primary processing of seed spices, medicinal and aromatic produces need attention through financial incentives, technical support and trainings in primary processing of these agricultural commodities of higher value, providing better health at an affordable cost.

There is also a need for creation of speciality agricultural hubs and branding of the products, such as Basmati Rice, Dairy Products, herbal medicines, foods having specific neutraceutical and functional attributes based on nutri-cereals and other plants & animal based ingredients through fortification and fermentation and extrusion cooking technologies, further quality control & testing laboratory back-up to meet national and international food standards for domestic consumption and export should also be created.

To summarize, it may be said that follow an integrated and intensive farming system to have higher and sustainable agricultural & livestock production and productivity; process the produces in the production catchment to minimize post-harvest losses and get better quality fresh & processed products for consumers; have an economic utilization of agricultural residues, wastes & processing byproducts for feed and/or compost to enhance animal health & soil fertility for better productivity; do the marketing of fresh and value added products through designated cooperative hulk and/or retail markets with minimum possible number of middlemen/intermediaries; have more employment for rural men & women and thereby more income to farmers/producers of raw materials. All these when planned & implemented successfully, the rural/urban gap in prosperity & living comforts would be minimized and people may start reverse migration from urban to rural areas in search of better food, environment, health, happiness and longevity

Chapter-1

INTRODUCTION

1. Haryana State and Its Spread

The Haryana State came into existence on November 1, 1966 as a result of re-organization of erstwhile Punjab State. Haryana is divided into 4 Divisions, 21, Districts, 74 Tehsils, 119 Blocks, 10 Towns and 6,955 Villages. The State has a natural geographical boundary with the Shivalik hills in the North, the River Yamuna in the East and the River Ghaggar in the West. The South-west of the state is bounded by the *Aravali hills* which run through Southern Delhi and Gurgaon district up to Alwar in Rajasthan. The State lies in the Trans-Gangetic Plains Region (Agro-Climatic Zone VI) of India (Fig1.1). There are three agricultural zones having their own strengths & weaknesses and accordingly the farming systems and cropping patters have emerged (Fig.1.2)

Shivalik hill region with semi-arid to dry sub-humid conditions has alluvial calcareous soils and high rainfall (890mm) area and covers parts of Ambala, Kalka, Karnal, Panchkula, Panipat and Yamunanagar along the Himachal Border. Alluvial plains with semi-arid conditions and medium rainfall area covers parts of Ballabhgarh, Faridabad, Gurgaon, Jind, Kaithal, Karnal, Kurukshetra, Palwal, Panipat, Rohtak and Sonipat districts. Alluvial plains with semi-arid conditions and medium to low rainfall (561mm) covers parts of Bhiwani, Hisar, Rohtak, Sirsa and whole of Mahendragarh districts. Sand dune region with arid conditions and low rainfall (360mm) is spread in south-western parts of Bhiwani, Fatehabad, Hisar, Rewari, Sirsa and Mahendragarh districts adjoining Rajasthan.

The State has mainly 4 types of soils with pH varying from 6.5 to 9.0. The soils are mostly deficient in nitrogen and zinc, lower to medium in phosphorus and normal in potash. The climatic conditions in the State range from dry sub-humid to arid along North-East and South-West transects, respectively. The State experiences extreme temperatures raging from 0-48^{0}C in winter and summer, respectively. The winter season lasts from November to March, while April to July are the hottest summer months. In southern districts, due to high temperature and wind velocity, dust storms are very common. The annual rainfall varies from less than 300mm in the western and south-western parts along Rajasthan border to over 900 mm in north east zone.

Fig. 1.1 The State of Haryana created out of Punjab in November, 1966

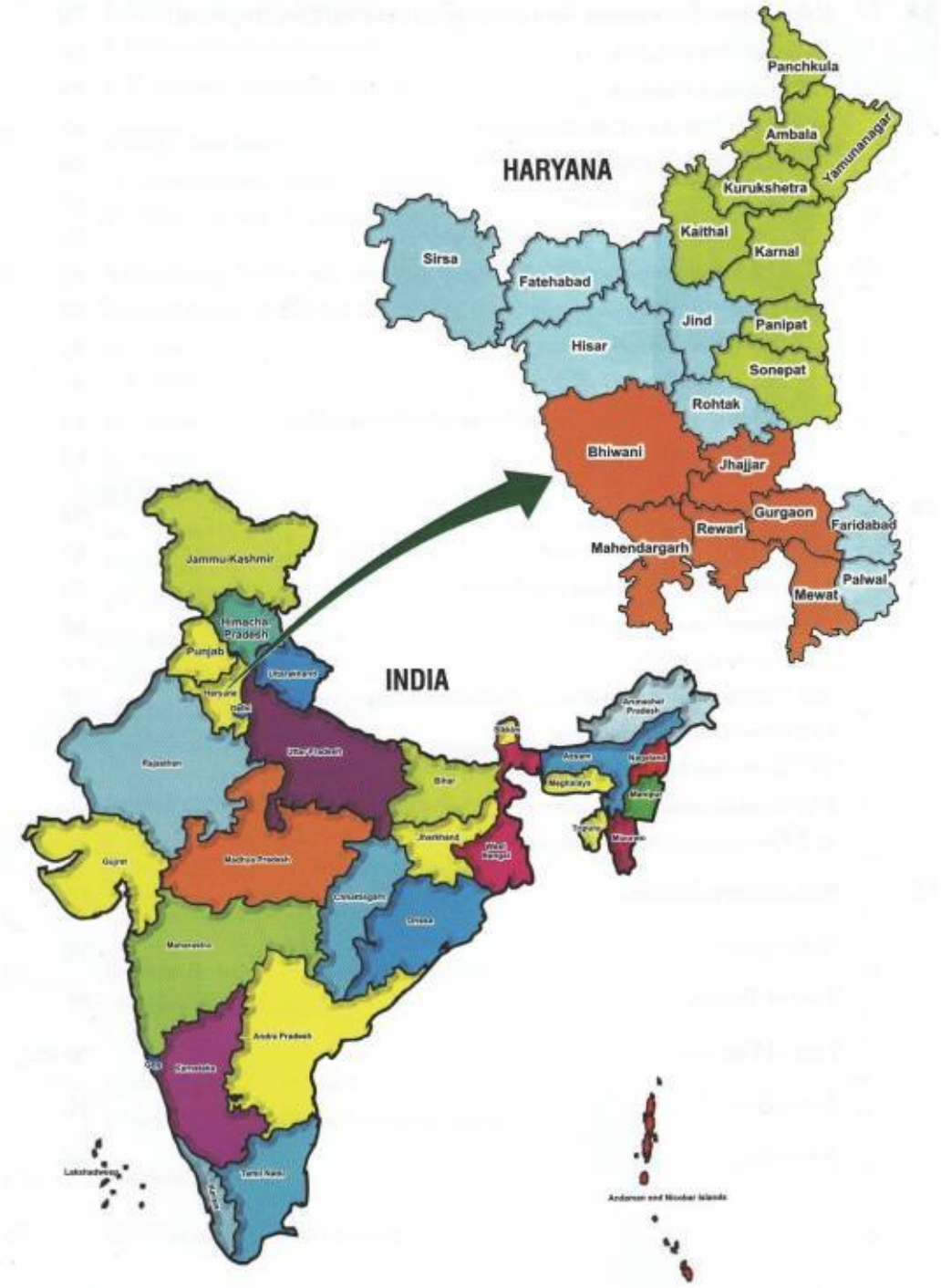

Fig. 1.2 Ecological zones, agricultural options and cropping pattern in Haryana

Zone	Districts	Area %	Agricultural options
I	Panchkula, Ambala, Kurukshetra, Yamunanagar, Karnal, Kaithal, Panipat and Sonepat	32	Wheat, rice, sugarcane, maize, cows, buffaloes, and poultry
II	Sirsa, Fatehabad, Hisar, Jind, Rohtak, Faridabad and Palwal	39	Wheat, cotton, rice, sugarcane, bajra, buffaloes, cows and poultry
III	Bhiwani, Mahenergarh, Rewari, Jhajjar, Gurgaon and Mewat	29	Pearl millet, rapeseed & mustard. Mewat area is also suitable for agro-forestry, sheep and goat rearing

ecology and cropping pattern zones

Note: Zone I and II have better irrigation facilities and overall infrastructure

The monsoon season commences on the end of June and lasts till the end of September. Irrigation canals are the lifeline of Agriculture. The western Yamuna canal irrigates the districts of Kurukshetra, Karnal, Jind, Sonipat and Rohtak, while the Gurgaon Canal irrigates parts of Gurgaon and Faridabad districts. Bhiwani and Mahendragarh districts are fed by Juhi, Bhiwani and Jawaharlal Nehru canals. About 75% of the cultivated area in the State is irrigated. The contribution of tube- wells and pump sets is about 50%.

1.2 Agricultural Scenario

Haryana State has a geographical area of 4.45 M ha, 1.37% of the total geographical area of India and less than 2% of India's population. The cropping intensity in the State is around 185 percent. Agriculture is the mainstay of the economy of the State and continues to be the main source of livelihood for 70% of population. From being a deficit state since its inception in November 1966, food grain production increased over six times to about 18.33 million tonnes in 2011-12 (Table 1.1). Various factors responsible for this includes thrust on improving irrigation system and diversification in agriculture using superior varieties, biotechnology, organic farming, post harvest management, contract farming and marketing coupled with transmission of latest technical knowhow to farmers. Currently, Haryana is not

only self-sufficient in food production but is the second largest contributor to India's central pool of food grains.

Table 1.1 Production of Major food commodities in Haryana during 2011-12

Food Commodity	Production, Million tones (Mt)	Remarks
• Cereals	18.22	• Total production of major food commodities of plant & livestock origin in Haryana was about 32 Mt. • Production of Plant based major food commodities in Haryana was 25 Mt. • Livestock based major food commodities were 07 Mt.
• Pulses	0.11	
• Oilseeds	0.97	
• Fruits	1.22	
• Vegetables	3.56	
• Sugar	0.50	
Total, Plant based	24.56	
• Milk	6.60	
• Meat	0.32	
• Egg	0.20	
• Fish	0.10	
• Total, livestock based	7.22	
Grand Total	31.78	

The state has 3.8 M ha cultivable area of which 3.55 M ha (98.4%) is cultivated. Out of the 15.28 lakh farming families, 2.94 lakh are small farmers occupying 12% of land, while 7.04 lakh are marginal farmers occupying 3.17 lakh ha of area. Over 43 lakh farmers and farm workers are engaged in agriculture in the State. Thus, measures for enhancing income opportunities for rural areas are one of the prime concerns of the state. The State Govt. has accorded highest priority to the agriculture sector and because of the farmer friendly policies of the State Govt; it has made rapid progress in agriculture. The funding of agriculture programmes increased from Rs. 59.67 crores during 2004-05 to Rs. 222 crores during 2009-10. Similarly, non-plan outlay of Rs. 72.74 crores during 2004-05 increased to more than 158 crores during 2009-10.

1.3 Need for Diversification and Secondary Agriculture

After self-sufficiency in food grain production, there has been an increasing awareness in India for need to achieve food, nutrition and environment security for the people along with income security for the farmers. Conservation of biophysical resources during human activities while utilizing these for livelihood,

has assumed greater importance now than ever before. At the same time, the adopted farm techniques must provide sustained economic benefits to the farmer and food and nutritional security to the community. These guiding principles necessitate diversification in agriculture for minimizing the risk by integrating the present agriculture with livestock, poultry, fisheries, horticulture and post-harvest management in the production catchment itself.

Of the total GDP from agriculture, 64% comes from crop-husbandry, 30% from animal husbandry, while 6% is contributed by the horticulture sector in spite of the enormous possibilities of much higher returns and employment opportunities as a result of better land use by growing high value horticultural crops. The economic importance of horticultural produce and products has been increasing over the year due to increasing domestic and international demand. Investment made in horticulture have been rewarding in terms of increased production and productivity to ensure nutritional security, employment opportunities and gender equality, reversing the declining profitability. It has thus been identified for inclusive growth of agriculture sector in the country. The overall development in farming infrastructure, primarily irrigation and communication networks in Haryana, have provided the needed assurance for this and for profitability and viability of high value agriculture.

1.4 Post Harvest Management Infrastructure

There is a need to construct integrated pack houses for perishables like F&V, in the state. Each pack house should have fruit and vegetable grading machine, 3-5 cold storage units with 25-100 tonne capacity, pre coolers of 5-10 tonne with add on facility of refregration chambers 2-5(5-10t each). The pack house at Rohtak is in operation and has been given on lease to a private player. The pack houses and markets need to be linked with collection centre at block level.

Modern fruit and vegetable market and Agro processing units are needed at block level. Marketing is as important as production. It is the market where prices are determined and the fate of farmer's produce and ultimately his income is decided. Lack of proper marketing infrastructure is the factor responsible for poor returns to the farmers, especially in case of perishable commodities. Marketing system should, therefore, be more efficient and should also be pro-farmer as well as pro-consumer.

The maximum post harvest losses and price spread are in perishable horticultural, fisheries, dairy and poultry products. There is an urgent need for specialized modern mandies for fruits, vegetables and flowers, milk and milk products, fishery and poultry products with cold chain and primary processing/packing facilities supported by Information technology (IT) driven

market intelligence. This could be achieved by making suitable modification in the Agricultural Produce Markets Act allowing establishment of private/cooperative markets as well as permission for direct sale by the farmers/producers, especially of vegetables, fruits and flowers. It will not only help in bringing healthy competition, but would also ensure better price to the farmers as well as consumers.

Agricultural prices are often volatile and famers are not so well organized to regulate supply of their produce. Thus, minimum support price (MSP) for major agricultural commodities, including some important vegetables like potato, onion, tomato with effective procurement system has to be ensured. MSP should be at least 1.5 times of the cost of production. There should be a dedicated system of procurement and prompt payments to the farmers.

Distress sale is a common phenomenon for the farmers, in view of their pressing requirement for cash. Thus, there is an urgent need to develop pledged storage or warehousing facilities, at nominal rates, around a cluster of villages *or mandies* with the provision of negotiable receipt as well as loans at low interest rates. (3-4 per cent)

Contract farming is an important means of linking farmers to the market and safeguarding them from wide price fluctuations. Contract farmer would invariably cultivate specified crop/variety under the strict supervision/management of the contractor. The inputs are invariably provided by the contracting firm. In spite of following all directives, the contractor invariably imposes some deductions in the guise of quality of the product. This process requires proper check and balance through an appropriate regulation issued by the Government. A Memorandum of Understanding (MoU) could be devised and used with provision of dedicated disputes settlement mechanisms.

Kisan Bazaars under different names are working effectively in some States like *Raitu Bazaar* in Andhra Pradesh, ITC e-chopal in M.P. and *Apni Mandi* in Punjab. These enable farmers to avoid exploitative practices of traders in the markets. Also Kisan Bazaars bring producers and consumers in direct contact. Hence, there is an urgent need to have *Kisan Bazaar* in the State with proper facilities for marketing and storage. The farmers bringing their own produce to *Kisan Bazaar* may given be free marketing space, travel and transportation for a reasonable distance within the State, as is being followed in Andhra Pradesh. Agriculture Marketing Board could be mandated to establish around 100 *Kisan Bazaars* in the first phase.

The State has some good agro-processing industries, mostly in and around cities. However, rural based small scale agro industries in the State are required

for processable surpluses. These would not only help in reducing the post-harvest losses but would also benefit farmers considerably. Hence, emphasis is required on creation of multi-purpose low cost rural based agro-processing complexes/parks. For this, the Farmers Self Help Groups (SHG) or the Cooperatives should be established with provisions of needed incentives and rewards.

Government support system for risk management and insurance are the two important measures to protect the farmers from natural calamities and weather uncertainties associated with agricultural enterprises/practices. Hence, these measures be further strengthened. Natural calamities are unavoidable adverse factors affecting agricultural production thereby reducing the income of the farmers. These also erode available natural assets. The natural calamities are invariably a localized phenomena and hence be assessed either at village or at block level. The current practice to consider Districts as a unit for assessing the losses due to natural calamities is not helpful to the farmers. It is, therefore, desirable that in future, either a village or a block be considered as minimum unit for such assessments. Also there should be a provision of some interim relief to the farmers, till such time when final assessment is done by the state/central government agencies.

1.5 Quality of Food Commodities

The quality of various food commodities and their nutritional contents mostly depend on soil fertility, water quality, variety of crop & the species of livestock raised and the ecology of the place. Land is the basic resource and sink for all residues of agricultural & livestock production & processing enterprises. As of now, land availability for agriculture is decreasing on account of rapid industrialization, urbanization and development of various infrastructural facilities. The land available for agricultural production is also facing a continuous decline in its health on account of use of heavy dozes of chemical fertilizers and pesticides to enhance agricultural productivity to meet the ever rising demands of food, feed, fibre, fuel, shelter, etc. All these, result into declined organic/humus content in the soil and thereby in its fertility.

It is now well established that if soil is poor in its fertility, the agricultural outputs from it would also be nutritionally poor, especially in food micro-nutrients leading to the development of chronic diseases in human being, forcing them to go for medication. The need is to check the declining soil fertility through an integrated farming system comprising of crops, horticulture & livestock production and postharvest processing in the production catchment.

1.6 R&D, Human Resource and Extension

Agriculture plays a vital role in the socio-economic development of the state where about 50% of workforce is employed in agriculture. The state government is strengthening agricultural research, education and extension as well as ensuring adequate availability of irrigation water, timely supply of essential inputs and dissemination of improved technologies to the farmers and other stakeholders. These supports of the government have resulted in an agricultural revolution in the state. However, the up-coming second generation problems like depletion of natural resources, decreasing total factor productivity (TFP) and globalization of agri-business are forcing the planners and scientists to reassess and fine-tune the current research and extension programmes in order to address the new challenges.

The state government has created facilities for human resource development and established institutions like Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar; Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Hisar; and Haryana Agricultural Management and Extension Training Institute (HAMETI), Jind. Besides, there are a number of ICAR Institutes / Regional Stations and GOI establishments in the state which help in strengthening technology development and extension programmes.

1.7 Working Group on PHT&VA and the TOR

The Working Group on PHT&VA Constituted by the Chairman, HKA, Panchkula, has been mandated to study the present status of post-harvest management and value addition to the harvested biomass of plant and livestock origin including crop residue & byproducts utilization and make recommendations on various issues pertaining to Haryana. The terms of reference (TOR) for the WG are as follows:

1.7.1 Review of current status and appropriateness of existing storage and processing facilities and suggest measures to overcome the existing gap.

1.7.2 Possible options for efficient on-farm storage and rural warehouses for perishables, semi-perishables as well as durables that minimize storage and associated losses, in order to enable primary producers negotiate better and earn higher income.

1.7.3 Identifying low cost technologies for post harvest processing and value addition at rural level.

1.7.4 Options for harvesting technological advancement that enhance shelf life, quality, and nutritive value and provide protection against post-harvest losses due to insects, pests and mycotoxins.

1.7.5 Modernization and cost reduction of cleaning, grading, sorting, milling, processing, packaging and proper storage for food grains, oilseeds, horticultural crops, animal products, fish etc.

1.7.6 Use of modernized processing and packaging options which can help in better utilization of agricultural commodities / crops and their residues while ensuring that they meet international standard to make our produce/products globally competitive.

1.7.7 Suggest research for development needs in the field of post harvest management, including requirements for infrastructure and human resource development.

Consequent to the constitution of the WG, in December, 2013, it had three meetings in February, April and June, 2014 with the officials of HKA and other stakeholders and made visits to various government and non-government postharvest management and food processing facilities such as dairy plants, sugar mills, mushroom enterprises, agricultural markets, R&D Institutions, Universities and their constituent colleges and also organized a Brain Storming Workshop on PostHarvest Technology and Value Addition for Haryana on 09 June, 2014 at CCSHAU, Hisar. These activities helped the WG to know about the status of postharvest technology & value addition to various commodities and administrative, technical & financial issues involved.

The Working Group has critically analyzed the present status, prospects & problems of PHT&VA in Haryana and has come out with appropriate suggestions and key recommendations for better storage, processing, residue and byproducts management, which when implemented will result in the minimization of losses, production of value added quality products for local consumption & sale to urban consumers and export. The report has been divided into 9 chapters, starting with an introduction giving background of Haryana Agriculture, status of PHT&VA, Government Efforts & initiatives, etc. The 2nd chapter explains the concept of PHT&VA to different commodities, preferably in the production catchment. Status of postharvest processing and utilization of various commodities in Haryana, such as processing of grains (cereals, pulses & oilseeds); cash crops (sugarcane, cotton & guar); horticultural produces (F&V, medicinal & aromatic plants, spices, mushroom, honey & floriculture); livestock produces (dairy, poultry, meat & fish); agricultural residue & byproducts; agribusiness management and guidelines for establishing agro-enterprises are given in

chapters 3, 4, 5, 6, 7, 8 & 9, respectively. Observations & suggestions and recommendations are given in Chapter 10 & 11, respectively. Besides, an appendix giving details of constitution of the WG on PHT&VA and a list of postharvest equipment and machinery manufacturers, and some photographs are also given.

It is hoped that the report would be perused by the officials concerned of the HKA and the State Government for the necessary follow-up actions in the interest of farmers and other stakeholders in Haryana agriculture, livestock and allied activities.

Chapter-2

POSTHARVEST TECHNOLOGY AND VALUE ADDITION

2.1 Importance and Role

There are four ways in which per capita availability of food, fibre and other commodities could be increased. These are putting more area under agriculture and allied activities to get more production; increasing land and labour productivity to enhance total production; controlling population growth to have better share by each individual; and minimizing postharvest losses to make greater amount of product available for distribution.

As of now, increasing area under agriculture and allied activities is very difficult because of population pressure, industrialization and urbanization. Regarding population control, government of each country is trying to check it through various family-welfare measures. However, it is difficult to achieve zero-growth in near future. For increasing productivity, scientists are trying to develop high yield potential and disease and pest resistant varieties using biotechnology and other scientific tools followed by the development of the package for cultural practices. But large scale commercial cultivation of such new varieties takes time and has a limit for yield realisaiton. In such a situation and for economic reasons, minimization of the postharvest losses is the best option to increase per capita food availability. It also helps to generate more employment and income. Investment in postharvest measures is more economical and time-saving than that in production activity for obtaining the same amount of a particular commodity. Production process would take three five months or more, depending upon the crop/commodity. Hence, it may be said that Postharvest Technology is a very strong tool for rural and social development through employment and income generation, especially for the rural women.

2.2 Postharvest Conservation and Processing

The purpose of postharvest conservation *(PHC)* is to prevent the losses in harvested biomass and maintain their quality as far as possible during postharvest handling and storage. Postharvest measures, as given below, are adopted to achieve these objectives of loss prevention and quality maintenance.

- Harvesting at an optimum stage of maturity
- Threshing and winnowing
- Cleaning and grading
- Handling and transport
- Conditioning and storage

The purpose of food processing technology (FPT) is to make food raw commodities fit for consumption through appropriate processing. It is done in stages and at each stage of processing value is added to the product. The lowest and the highest monetary values of a food item are, respectively, when it is in raw and fresh form and when it is in processed and ready-to-eat form. FPT is commodity and location specific.

In the agro food chain, harvesting is the stage between the phase of actual agricultural production and that of post production processing. Whether harvesting is done by hand or with the help of machines, it takes place when the produce has reached to its optimal maturity.

2.2.1 Optimum Stage of Harvesting

The harvesting is the operation of gathering useful part(s) of the plant. It is a voluntary intervention by human, carried out at the time when all the nutrients have been developed and when the edible parts have reached the degree of maturity appropriate to the treatments to follow. For the harvest to take place at the most propitious time, account must be taken not only of the length of growing period, which differ according to variety, but also of the degree of maturity of the grain (Table 2.1). The higher the moisture content of the grain at harvest time, the greater the risk of loss from moulds, insects and germination. On the other hand, the longer the grain remains in the field for further drying of the product, the greater the risk of losses from spontaneous fall of grains**,** or from attacks by birds, rodents and other pests.

Table 2.1 Level of moisture content considered appropriate for good harvest conditions and the characteristics permitting assurance of physiological maturity

Crops	Grain Moisture, % wb (wet basis)	Some of the Physical Characteristics of the crop at maturity
Rice	22-28	The panicles bend with their own weight, yellowed hulls, and full grains, neither too ripe nor too green.
Maize	23-28	Cobs almost dry, hard and glassy kernels, resistance to scouring with thumbnail, black dot in the caryopsis
Sorghum	20-25	Dried stems and leaves, hard grain resistant to the thumbnail, glassiness depending on variety.
Beans	30-40	Pods ripe and yellow, shells dried, skins of kernels easily detached.
Groundnut	30-35	Leaves yellow, shells dried, skin of kernels easily detached.
Sunflower	9-10	Upper leaves dry and flower faded

Field crops and horticultural products (fruits and vegetables) reach their maturity when all the physiological processes going on in them stop. Thereafter, during the post physiological maturity period, it is only a physical process of drying that takes place, especially in the field crops. By harvesting after physiological maturity, a farmer can get maximum field yield, best quality produce and his/her field gets vacated 7-20 days earlier enabling him/her to make use of the residual soil moisture for sowing the next crop, if he/she so desires. Delay in harvesting causes field losses due to shattering, rodents, birds, insects and weather. Sun-checks are induced in rice kernel causing breakage during milling. Microbial attack on matured fruits and vegetables deteriorates the quality and accelerates the process of spoilage causing economic loss.

Fishes, birds and meat animals reach a stage of their growth when the desired product say the flesh/meat is at its optimum in comparison to bones and other byproducts and the conversion ratio of feed into flesh is at its peak. This is the optimum time to net the fish and slaughter the bird and animal for table purpose to

get maximum economic and nutritional advantages. Milking of animals twice a day, preferably in the morning and evening helps to get more milk yield in comparison to that which could be obtained by milking only once a day. It is, therefore, desirable and recommended that harvesting of food commodities of plant and animal origin be done at their physiological maturity and the stage at which desirable component is maximum.

2.2.2 Harvesting, Handling and Transport

Mechanical harvesters like reapers and combines are now being used for harvesting field crops such as rice, wheat, oilseeds, etc., and their use especially on custom-hire basis, is increasing. Still, in most of the Asian countries, field crops and horticultural produces are harvested manually using local/improved sickles/tools. Handling of harvested materials is mostly done manually in bundles (crops) and baskets (fruit & vegetables) and transported to threshing yard and/or home or local markets as head-load, on shoulder-slings, bicycles; bullock carts; and power-tiller and tractor trollies. An appropriate package of practices, suitable for each crop, is desirable to be followed to minimize losses during harvesting, handling and transportation, as well as to maintain the quality of the harvested biomass.

Field curing or pre-drying is the stage of the postharvest system during which the harvested product is dried in order to undergo the next operation of threshing under the best possible conditions. At harvest time, the cut portion of the plant may contain too much green plant matter, while grain may not have reached a uniform degree of maturity and have too high a moisture content. One of the simplest and most common methods of pre-drying is, especially in favourable weather, to postpone the harvest till the desired grain moisture is achieved.

2.2.3 Threshing and Winnowing

Threshing consists of separating the grains or the desired products from the portion of the plant that holds them. This separation done by hand or machine is obtained by threshing, friction or are shaking the products. The difficulty of the process depends on the varieties grown, the moisture content and the degree of maturity of the grain at the time of threshing.

When the field crop is harvested using combine harvesters, threshing and winnowing operations are not required as these are performed during combine harvesting itself. However, when reapers and manual harvesting are employed, the harvested crop is laid in wind rows, gathered in bundles and transported to a threshing yard. There it is threshed using foot trampling, hand beating, animal and tractor treading or mechanical threshers depending upon farm size, availability of threshers and type of crop gown. A number of companies manufacture and market mechanical threshers, in most of the countries. Majority of the small and marginal

farmers get their crop threshed on custom-hire basis. This trend is now leading to the design and manufacture of high capacity multi-crop threshers.

In case of trampling by feet, hand beating or animal and tractor treading, winnowing of the threshed mass is essential to separate the grains. It is done manually using natural air breeze with the help of baskets made of bamboo, plastics, light weight metals, etc. However, when there is no air current, winnowing is performed using winnowers. Manufacturers of winnowers are less in number and decreasing as the farmers are going for mechanical threshing either on ownership or on rental basis. Among various units operations, threshing is the most mechanized one.

2.2.4 Cleaning and Grading

Threshed and winnowed grain masses, harvested fruits and vegetables, netted/captured fish and marine products, meats, eggs, etc., are cleaned and graded before these produces are sent for marketing, storage or processing. Cleaning and grading offer following advantages:

- Enhancement in the quality of the produce and thereby better market price. More returns to the farmers.
- Produce needs less space for storage as the impurities have been removed.
- Cleaned and graded biomasses are less susceptible to insect infestation and microbial attack. Hence no or minimum quantitative and qualitative loss to the product during postharvest handling and storage.
- Adjustment of plant machinery and quality parameters become easier as the feed to the processing plant is made homogeneous because of cleaning and grading.
- Capacity of the food processing plant is increased as there is no running of impurities through out the whole processing system.
- Less wear and tear of processing machines because it is mainly caused by the impurities present in the feed. Cleaning and grading remove this. Overall maintenance time and break-downs are also reduced.
- Quality of end products and that of byproducts is pure and better. This helps to establish the brand name in the market on quality assurance count. Economic utilization of byproducts becomes more viable.
- Helps in selling of product through sample.

A number and variety of cleaners and graders are manufactured and marketed in each country. These may be selected and used depending upon the commodity, and volume of operation. The use of cleaners and graders is in the interest of individuals as well as in that of public at large. An individual gets a pure and hygienic product full of health and there is a saving of energy, better use of byproducts, more working life of processing plant, resulting in more output – all these are in the overall public interest.

2.2.5 Conditioning and Storage

Demand of food is regular and uniform whereas the production of most of the food raw materials is seasonal and time-bound. Moreover, all the raw commodities for food are to be processed before use and the food processing plants have their limited daily capacity. All these necessitate storage of harvested biomass for varying periods. In addition, to these, food grains, oilseeds, tubers, etc. are also stored as seed for the next crop. Storage of food is also essential to overcome the calamities like flood, famine, war etc. In the rural areas of most of the developing countries, grain is still used for the payment of daily wages to the farm workers and to other labourers, thus requiring storage. Also, in order to establish and regulate the price of food commodities all the year round, a buffer stock of appropriate size need to be maintained, which again requires storage facilities.

Drying is the phase of the postharvest system during which the product is rapidly dried until it reaches the safe moisture level for storage. The aim of this desiccation is to lower the moisture content in order to guarantee conditions favourable for storage or for further processing of the product. Drying permits reduction of losses during storage from causes such as:

- Premature and unseasonal germination of the grain.
- Development of moulds.
- Proliferation of insects.

2.3 Processing and Utilization

Various food commodities are processed either for home consumption or for trade. In case of the latter, processing is done both at small and large industrial scales. For most of the developing countries of the South, food processing at small scale employing women is more appropriate because small-scale food processing technologies and equipment are mostly dependent on manual operations in comparison to large-scale automated technologies used by food processors in industrialized countries of the North. The loss in productivity because of manual operations is insignificant compared to the under-utilized and high investment costs of larger automated equipment. The gain in employment and sparing use of

resources make these small-scale technologies more sustainable and, therefore, more valuable to the national economy.

The level of interest in small scale food processing in developing countries increased dramatically in 1990s. It may be due to the promotion of income generating activities in rural areas especially for women and the success of agricultural development programmes producing surplus food commodities necessitating preservation and processing. Many government and developmental agencies are promoting food processing as a means of poverty alleviation in rural and semi-urban areas, because of the following:

- Food is familiar to the target group.
- Raw materials are readily available.
- Technologies for small-scale operation are available and affordable.
- Equipment could be manufactured locally, in most of the cases.
- Creation of further employment and food product varieties.

The products that are more suited for small-scale production are those for which a high value can be added by processing. For example, cereals, fruits and vegetables and root crops have low-price when in their raw state, but can be processed into a range of baked foods, snack foods, dried foods, juices, pickles, chutneys, etc., which have considerably higher value. Acidic foods like yoghurt, pickles, fruit juices, jam and most type of dried foods have a low-risk of transmitting food-poisoning and micro-poisoning. In contrast, low-acid foods such as meat, milk, fish, and some vegetable products are much more susceptible to transmitting food-born illness through poor hygiene of workers or incorrect processing conditions. The small-scale food processing entrepreneurship has, therefore, to be examined on technical, economical, social and health aspects before it is launched.

2.4 Agro-Processing in Production Catchment

A typical agro-processing centre in a production catchment should have, depending upon the commodity produced there, facility and equipment for cleaning, grading, drying, storage and milling of foodgrains; oil extraction and filtration; washing, grading, packaging and transportation of horticultural produce; cleaning, packaging, storage, transport of meat and fish and storage, transport and value added products from milk. It should be established at an appropriate location in the production catchment. This would result in the minimization of post-production losses and production of value added quality products for consumers at an affordable price. Byproducts of processing could be utilized for livestock feed, manure or any other value added products depending on commodity and its ingredients.

2.5 Emerging Technologies in Food Preservation

Physical and chemical preservations along with technology advances will continue to improve the efficiency and effectiveness of the processes and the products. Thermal processing of foods inactivates spoilage micro-organisms and ensures prolong shelf-life and food safety but use of high temperature causes detrimental changes in sensory and nutritional values of the products. As of now, application of non-thermal processing has shown a great potential as an alternative technology to heat treatments, ensuring safety and quality attributes of food.

2.5.1 low cost Processing Technology

2.5.1.1 Minimal Processing

Increasing urbanization, fragmented life styles, nutritional awareness and dual income have further made the consumer more demanding. Minimal processing has a good scope in hotel industry and fast chain restaurants. There has been a continuous demand of pre-cut salads, shredded onion and cabbage from airlines. Minimal processing falls in the realm of an art by which trimmed and cut fruits and vegetables are preserved without causing significant changes in their fresh like properties. Such products are quite stables for salads, curries, porridge and custard like preparations. The basic steps involved in minimal processing include washing of the vegetables harvested at optimum maturity, then grading, peeling, turning, slicing/dicing/shedding, pre-treatment, surface drying, modified atmosphere packaging, storage at optimum low temperature and marketing. The method confers several advantages namely, fresh like vegetables, free of wastage, in ready-to-cook from, reduction in bulk, extension of storage life, easy transportation and value addition upto 60%. The vegetables which can be minimally processed are ashgourd, beetroot, beans, bitter gourd, carrot, cabbage, cauliflower, cluster beans, drum sticks, cucumber, green peas, green chillies, knoll khol, okra, onion, plantain, snacks gourd, tomato, turnip and leafy vegetables such as coriander, curry mont, fenugreek and spinach.

2.5.1.2 Dehydration

Dehydration is considered as the simplest technology of value addition and extension of storage life of fruits and vegetables by removal of water to a residual moisture content of between 5 to 15 percent. Dehydration can be achieved by various methods such as sun drying, solar drying, drum drying, spray drying, microwave drying and osmotic drying, etc. Dehydration has many advantages like reducing the bulk, reducing the freight charges and enhancing storage life. A number of fruits can be dehydrated successfully such as mango, pineapple, jackfruit, apples, grapes, pear, apricot, peach, guava, ber and vegetables like mushroom,

peas, okra, potato, onion, tomato. Produce can be dehydrated by solar drying or mechanical drying.

2.5.1.3 Osmotic drying

Another dimension of dehydration is osmo-dehydration, which involves the use of sugar/salt solution depending on the desired fruit or vegetables. Osmo-dried product maintain excellent texture and flavour with added sugar. Most of the fruits & vegetables are subjected to drying by the use of conventional tray dryer and vacuum dryers which do not keep the original flavour, colour and texture. Fruits like apple, apricot, banana, ber, pineapple, jackfruit, mango, guava, grapes, aonla, papaya, pear, etc. and vegetables like carrot, melon, onion, potato, tomato, etc. can be dried by these methods. The method is very simple and can be adopted in rural areas.

Hot air drying reduces notably the quality of processed food stuffs. Osmotic dehydration is an alternative technology to reduce water content, as well as to improve the quality of the final product. This process is being used in industry to dehydrate fruits, vegetables etc. Osmotic dehydration happens in the immersion of cut food in concentrated solution of sugars or salts. A flux of water out of the food and another of the solute into food stuff developed due to the difference in the osmotic pressure. The products losses some water to the external solution. Osmotic dehydration reduces the weight of slices upto 50% prior to vacuum drying. Osmotic dewatering rate can be enhanced by increasing the concentration of the osmotic solution.

2.5.1.4 Canning

Thermal processing is a relatively recent technique used for fruits and vegetable preservation and has proved most effective. Canning or thermal processing involves heating of foods packed in hermetically sealed containers for sufficient time at a high enough temperature to eliminate pathogenic micro-organisms that endanger the public health and those micro-organisms and enzymes that deteriorate the food during storage. For food products the rapid heat by convection, high temperature short time (HTST) and ultra high temperature (UHT) technique have been developed to minimize the severity of heat treatment and promote product quality.

Heat process used for these foods are dependent on the type of food, its chemical composition and types of micro-organisms that cause, spoilage or public health concern in addition to properties related to container material, shape and size as well as properties related to the heating medium. Apple, mango, guava, pineapple, plum, tomato, beans, cauliflower, peas, potato, carrot, etc. can be canned.

2.5.1.5 Freezing

Foods are being preserved by various methods such as sun drying, pickling, canning dehydration, pasteurization, fermentation chemical preservatives, refrigeration and freezing etc. Consideration of factors such as (I) product quality (2) process feasibility and (3) economics, shows that freezing preservation of foods is one of the most attractive and practical methods, since freezing is a quick, convenient and an easy methods of preserving foods.

In actual practices the freezing of food slows down, but it does not stop the physical and biochemical reactions that govern the deterioration of foods. When properly handled and processed frozen food are often perceived by other methods these qualities depend upon (a) the use of raw material (b) control of freezing process (c) careful pre-freezing preparation and (d) post freezing storage of the product. Quality of frozen food is considered to be far superior to that of similar foods preserved by other conventional methods of preservation like canning dehydration and chemical preservation etc.

2.5.1.6 Freezer storage

Proper storage of frozen fruits and fruit products is of paramount importance. In the beginning it was felt that a temperature of 9^{o} to $-7^{o}C$ was satisfactory for long-term storage of frozen fruits. However, it was soon learnt from experience that the holding temperature as low as $-29^{o}C$ was good for long storage. All frozen foods should be quickly cooled at least to a temperature of $-18^{o}C$ in the centre of the products.

2.5.2 Modern Processing Technologies

2.5.2.1 Membrane Technology

Membrane technology was originally developed in 1960 for production of potable water from seawater and brackish water. The food industry has especially benefited from this technology because it is a gentle and efficient way of fractionating, concentrating and clarifying components in liquid and gaseous streams. It is based on the use of semipermiable membranes (membranes that are permeable to some component but not to others) to separate molecules primarily on the basis of size and to a certain extent on shape and chemical composition. For example as shown in Fig. 1 reverse osmosis (RO) can be used to concentrate the solids in as liquid food, whereas nanofilteration (NF) membranes are designed to separate salts (primarily monovalent ions) from multivalent slats, sugars and larger compounds. Ultra filtrations (UF) can be used to fractionate components in the feed solution whereas microfiltration (MF) is used to clarity slurries or remove suspended matter. Membrane technology requires less energy than many other dewatering techniques.

2.5.2.2 Microwave Heating

Microwaves are electromagnetic (EM) waves of very short wavelength. In the EM spectrum microwaves lie between the television frequencies and infrared. Radio waves are measured in kilometres, television frequencies in meters, microwaves in cms, and infrared in microns, the microwave fall in between the range of $250x10^6$ to $7.5x10^9$ A^0 , microwaves cause damage to the eyes, and other tissues when exposed to them. All microwave ovens have inter locks. MW like infrared and visible light, are reflected, transmitted and absorbed. They are reflected from metal surfaces. The microwave oven is basically a metal box in which waves reflect from the walls and create a resonant the microwaves are transmitted, that is , they pass through many materials including glass, ceramics plastic and paper. Some materials are only partially transparent to microwaves that absorb some energy. When microwaves are absorbed their energy is converted to heat. It can be applied for cooling and pasteurization for better yield & quality and decreased sanitation load.

2.5.2.3 Freeze-drying

Freeze drying (lyphilization) is the drying of material in the frozen state. It is usually carried out under vacuum, at absolute pressures that readily permit ice to sublime (chage directly from solid to vapour). Absolute pressures used in freez-drying range between 50mm Hg and 1500mm Hg. During food freeze drying, ice sublimes and bound water desorbs as vapour. Most bound water remains when the last ice has sublimes. Almost all have to be removed to provide stable, freeze dried food. To do this, the product temperatures are raised and added Vacuum drying time is provided after the last ice sublimes.

Vegetable for dried soup mixes mushrooms, herbs, spices, cheese starter cultures, shrimps fruits for ready to eat breakfast cereals and vegetables, meals, fish and fruits for military, camping and space travel ration have been tried commercially.

2.5.2.4 Freezing system

During storage foods are subjected to changes that affect food quality and that sooner or later will lead to severe deterioration and eventually spoilage of the foods. These chages are caused by microorganisms and chemical and physical reactions. The reactions will cause changes, lowering the quality, primarily by changing the sensory properties of the food product. The purpose of all food preservation methods are to inhibit or decrease the speed of reaction responsible for the deterioration. All of these reactions are among other factors influenced by temperature. Cooling and chill storage therefore are perhaps the most important methods of enhancing the storage life of most food products. When temperature of food is $<-10^0C$ microbiological growth will cease, chemical, biochemical and physical reactions will still continue at very low temperatures but at a slow pace.

2.5.2.5 Intermediate Moisture Foods

Intermediate moisture (IM) foods technology offers a simple, inexpensive and excellent alternative to traditionally used dehydration and canning processes for preserving fruits and vegetables. Moist infusion (desorption) of fresh fruits and vegetables in a soak solution containing ingredients such as glycerol (humectants), sucrose, salt, potassium sorbate (antimycotic), potassium/sodium metabisulphite, dextrose, pectin coupled with or without partial dehydration is intrinsic to IM technology in obtaining acceptable shelf stable products through osmotic process. A number of IM fruit slices (such as guava, pineapple, mango, banana, jackfruit, apple and sapota) and IM fruit bars (based on fruits with soft gel like texture like mango, banana, guava, papaya, jamun, pineapple jackfruit and apple) have been developed with final moisture content of 30-40% and 12-13.5% and water activities of 0.70-0.80 and 0.58-0.68 respectively. The mango fruit bar meets the stringent nutritional and microbiological standards worthy of a space food. The IM products have a minimum shelf life of 6 months under ambient conditions when packed in paper aluminium foil polyethylene laminated pouches. Some of the IM fruits, namely banana, mango and pineapple are eminently suitable for being included in fruit beverages mixes and fruit custards during mountaineering expeditions.

2.5.10 Irradiation

Radiation is of two types, ionizing and non-ionizing. Irradiation is the application of ionizing radiation for treatment under controlled conditions for a pre-determined time. Food irradiation is exposing prepackaged or bulk food materials to direct ionizing radiation. The ionizing irradiation is part of the electromagnetic spectrum with radio waves at one end and the high energy X-rays and Gamma-rays at the other. In the middle are the visible light rays, with infra-red and ultraviolet rays on either side. Between the radio and infra-red rays are the microwaves which are becoming common in every house-hold. Ionizing radiation is a non-thermal food pasteurization process that reduces or eliminates spoilage & pathogenic micro-organisms by fragmenting DNA.

Post-packaging potential for irradiation include disinfection of grains, spices, fruits, vegetables & tubers. The irradiation is measured in dose, which is the quantity of energy absorbed by the food while it is exposed to the irradiation field. The international unit is the Gray (Gy). One Gray represents on joule of energy absorbed per kilogram of irradiated product. One Gy is equivalent to 100 radiation absorbed.

2.5.11 Osmotic Drying

It is a process that entails the partial removal of water of food items such as vegetables & fruits by immersion in a hyper-tonic solution. Osmotic dehydration enables fruits & vegetables to be stored for a longer period of time. Since the cell

membrane responsible for osmotic transport is not perfectly selective, solutes present in the cells such as organic acids, reducing sugars, minerals, flavours and pigment compounds can also be leached into the osmotic solution, which affect the organoleptic and nutritional characteristics of the product.

2.5.12 Homogenization

It is a process of reducing the particle size of fluid products such as milk, fruit juices, sauces, etc. under conditions of extreme pressure, sheer, turbulence, acceleration and impact, to make them more stable and have a better texture.

2.5.13 Disinfection

It is a process of pest control in which the area to be disinfected is completely filled with a gaseous pesticides or fumigants to suffocate or poison the pests within it. It is utilized for control of pests in building (structural fumigation), soil, grains, and other produces. Fumigants are chemical compounds which are volatile at ordinary temperatures and sufficiently toxic.

2.5.14 Crystallization

It is a chemical process of solid-liquid separation. The manufacture of cane & beet sugars is an important example of crystallization in food technology. It is also used in making glucose, lactose, salt, ice-cream etc.

2.5.15 Extrusion

Food extrusion is a process in which food ingredients are forced to flow, under one or more conditions of mixing, heating, and shear, through a die that form and/or puff-dries the ingredients. It can transform a variety of raw ingredients into intermediate and finished products. The cooking temperature can be as high as 180-190^{o}C during extrusion, but residence time is usually 20-40 seconds. It is also called high temperature and short time (HTST) process.

2.6 Processing and Value Addition

2.6.1 Processing

All the harvested biomass are converted into ready to use form through processing at primary, secondary and tertiary levels. Primary processing includes cleaning, grading, conditioning and storage of agricultural produces to maintain its quality and quantity with a minimum loss through appropriate tools and technologies without intentionally changing the shape, size or form of the produce. When fresh or primary processed produce is transformed into more convenient or ready to cook form, the process is termed secondary processing. When secondary processed products are further processed to make it ready to utilize immediately or later by extending then shelf life through appropriate packaging and storage, it is known as

tertiary processing. Value addition is minimum in primary processing and it increases when processed at secondary and tertiary levels.

While producers must receive remunerative prices, the consumers expect both the quality and quantity for the money spent. The goals of social equality, environmental safety and human health suggest that suitable post harvest activities need to be promoted in the production catchments. 65-70% rural population in India are not only the producer of biomass but consumer too, of the agricultural produce. Post harvest activities are, therefore, should be carried out in the production catchments because it has all the positive attributes towards human, animal and soil health

Lack of proper preservation and storage facilities in the rural sector, force the farmers to sell their perishable produce at low price during the peak harvest seasons. In India, one finds that on an average when tomatoes are sold for Rs. 5/kg., the value added tomato ketchup is sold at Rs 70/kg. Similarly, three kilograms of mixed fruit used in preparing jam are sold for over Rs. 100/kg. This does not translate into higher prices to farmer for tomato and F&V nor does it help the growth of the processed food industry. Today in the dairy sector, farmer get 66% of what the consumer pays for milk whereas in F and V sector farmers get less than 20% of what the consumer pay.

Postharvest technology is commodity and region specific. Agricultural processing in the production catchment would minimize the post-harvest losses and result into high quality value added products for consumers at an affordable price. Processing byproducts could be utilized for livestock feed, manure or any other value added products depending on the commodity and its ingredients. In the long run, processing of harvested biomass in the production catchment would enhance human, animal, soil and economic health of the region.

Chapter-3

GRAIN PROCESSING

(Cereals, Pulses and Oilseeds)

3.1 Introduction

Grains, such as, cereals, pulses and oilseeds have a predominant place in an average diet throughout the world, especially in developing countries and their dietary and economic importance is globally appreciated and recognized. These are rich and less expensive source of protein and are potential supplier of several other important nutrients. They can be grown under a wide range of agro-climate conditions and processed for consumption. By and large, at each stage of processing, value is added to the produce.

3.2 Production

Grain crops are not only an important subsistence crops in the developing countries but are also important cash crops for commercial pusrpose. The principle cereals grown in the world are wheat, rice, corn, barely, oats, rye, sorghum and millets. However, the major cereals grown in Haryana are wheat and rice followed by corn and pearl-millet. The production of cereals has increased dramatically over the years (9 times during 1966-67 to 2011-12) due to improved methods of agriculture and use of high yielding varieties (Table-3.1) and that of pulses decreased drastically from 0.56 Mt in 1966-67 to 0.107 Mt in 2011-12, (05 times,Table-3.2). A remarkable increase in food grains production is visible in Haryana State since its inception. The food grains production in the State has reached an impressive level of 18.3 million tonnes during the year 2011-12, registering an increase of more than seven times as compared to a meager 2.6 million tonnes production in 1966-67 (Table 3.3). The wheat and paddy crops have played a major role in pushing up the agricultural production. The production of wheat and rice has increased significantly.

Table – 3.1 Production of Major Cereals in Haryana during 1966-67 to 2011-12

Agricultural year	Production, million tones (Mt)						
	Rice	Wheat	Pearl millet	Sorghum	Barley	Maize	Total
1966-67	0.223	1.059	0.373	0.049	0.239	0.086	2.029
1970-71	0.460	2.342	0.826	0.057	0.124	0.130	3.939
1980-81	1.259	3.490	0.474	0.048	0.181	0.081	5.533
1991-91	1.834	6.436	0.526	0.065	0.107	0.049	9.017
2000-01	2.695	9.669	0.656	0.023	0.118	0.034	13.195
2010-11	3.465	11.578	1.183	0.038	0.130	0.019	16.413
2011-12	3.759	13.069	1.177	0.033	0.153	0.024	18.215

- Total cereal production has increased from 2.03 Mt in 1966-67 to 18.22 Mt during 2011-12. (An increased of more than 09 times).
- Rice production has increased about 17 times.(0.223 Mt to 3.76 Mt)
- Wheat production has increased about 12 times.(1.06Mt to 13.07 Mt)

Table-3.2 Production of Major pulses in Haryana during 1966-67 – 2011-12

Agricultural year	Production, million tones (Mt)					
	Chickpea	Green gram	Lentil	Black gram	Others	Total
1966-67	0.531	0.0047	0.0124	0.0028	0.0120	0.5630
1970-71	0.789	0.0094	0.0108	0.0037	0.0189	0.8320
1980-81	0.455	0.0029	0.0131	0.0076	0.0239	0.5025
1991-91	0.469	0.0058	0.0108	0.0013	0.0548	0.5417
2000-01	0.080	0.0012	0.0052	0.0003	0.0131	0.0998
2010-11	0.110	0.0127	0.0050	0.0007	0.0300	0.01580
2011-12	0.072	0.0070	0.0060	0.0008	0.0210	0.1068

- Production of total pulses has decreased from 0.563 Mt in 1966-67 to 0.1068 Mt in 2011-12 (About 05 times)

Table 3.3 Production of Foodgrains in Haryana during 1966-67 to 2011-12

Agricultural Year	Foodgrain Production, million tones (Mt)		
	Cereals	Pulses	Foodgrains
1966-67	2.03	0.56	2.59
1970-71	3.94	0.83	4.77
1980-81	5.54	0.50	6.04
1991-91	9.02	0.54	9.56
2000-01	13.20	0.10	13.30
2010-11	16.40	0.16	16.56
2011-12	18.20	0.10	18.30
• Production of foodgrain in Haryana has been rising since 1966-67 and it reached to 18.30 Mt in 2011-12, an increase of about 07 times.			

The production of wheat and rice was 13.07 Mt and 3.76 Mt during 2011-12, registering 12 fold increase in wheat and 17 fold increase in rice production as compared to 1.06 and 0.022 million tonnes wheat & rice production during 1966-67 (Table-3.1).

As of now, the rice and wheat have emerged as the second and fourth largest commodities in the agricultural exports of India after marine products and oil meals. Indian basmati rice has great market in the world but share in the world exports of wheat is around 1 per cent. Because of improper storage conditions and inadequate storage facilities, a large percent of losses of cereal grains occur in storage godown. Through primary and secondary processing, the raw food materials are made more convenient for tertiary processing leading to ready to eat products. At each stage of processing, value is added to the products. However, the extent of value addition varies with the level of processing.

3.3 Observations

Haryana has made a significant contribution in agricultural production in the country. To make further headway on economic front, it has to concentrate on food processing and Agro based industries since it enjoys the natural advantage of locally available inputs. With this in view particularly having considered the potential of this industry for diversification and commercialization of agriculture, employment generation in rural and urban areas, value addition and export possibilities, the State has identified the Food Processing and Agro Based Industry as a thrust area. In Haryana, there are more than 972 food processing and Agro-based industries in large and medium sector, which have been set up with an investment of Rs. 3680.54

crores and are providing direct employment to over 30,716 persons with turnover of Rs. 11,152.84 crore (Table 3.4).

Haryana is one of the largest exporters of rice, pickles, guar gum, cotton yarn and several other food products. There are a large number of units in the State which are engaged in manufacturing and export of noodles, dalia, confectionery items, etc. The food processing industries of Haryana mainly comprises of rice milling, wheat milling, pulse milling, oil processing, preprastion of spices, bakery products, pickle, chutney, dairy products, sugar, animal feeds and cold storage. The present status of grain processing industries is shown in Table 3.4.

3.4 Suggestions

In the continuing effort to lead impetus to growth in this sector, the State Government is required to provide assistance for strengthening backward linkage from the processed food industry to primary agriculture and other production systems, setting up/expansion/modernization of food processing industries, establishment of food processing industrial estates/food parks, research and development on food processing, development of traditional food products, processes and packaging, and utilization of byproducts of the primary food production system and of the food processing industry. The tremendous potential of the food processing sector in both, the domestic and the export market is now required to be tapped by the Govt. with the aim of resource optimization. The Food Processing Policy should aim at accelerating growth in Food Processing sector focusing on areas that show potential for rapid growth through intensification as well as diversification and result in reduction of poverty, regional disparities, and economic development and dissemination, development of infrastructure, greater participation by the rural and urban community in decision making policy and institutional constraints that limit growth and greater private sector participation.

In the present day context of opening up of the economy for international competition, agro industries need to be given special status keeping in view their employment potential and prevailing unemployment situation in general and that of rural unemployment in particular.

It can be concluded that grains including cereals, millets, pulses and oilseeds need to be appropriately processed to have a place in second generation functional foods, with or without blending with cereals/pulses/other foods. This offers opportunities for further utilization of these agricultural commodities for export through value addition and improvement in the nutritional status of population in the developing countries, like India.

Table 3.4 Sector-wise Food Processing Industries in Haryana as on March, 2012

Sector	Units	Investment Rs, lakhs	Turnover Rs, lakhs	Number of empl-oyees (labourer)	Number of labo-urers per unit	Investment, Rs, lakhs per unit	Turnover / Investment
Wheat milling	69	2605.48	10554.93	632	09	37.76	4.05
Rice milling	525	220662.82	407482.55	15016	29	420.31	1.85
Pulse milling	18	612.29	5917.38	116	6	34.02	9.66
Oilseed processing	39	4678.78	40478.06	769	20	119.97	8.65
Bakery Industry	65	9698.39	46661.17	1722	26	149.21	4.81
Others*	256	129796.24	604189.49	12461	49	507.01	4.65
Total	972	368054.00	1115283.58	30716	971	8216.42	67.45

*The other industries include Pickle/Chutney, Dairy products, Sugar, Animal feed, cold storage facilities, etc.

Chapter 4

CASH CROP PROCESSING

4.1 Introduction

The major cash crops of Haryana are sugarcane, cotton & guar. Production of these crops in Haryana during 2011-12 was about 7.0 million tonnes of sugarcane with an average productivity of 73t/ha; 2.6 Mt of cotton with an average yield of 740 kg/ha (0.74t/ha) and guar 0.36 Mt with a productivity of about 1.3t/ha.

4.2 Sugarcane

It is a multi-product crop contributing to the production of sugar, ethanol, electricity, paper and other allied products. The approximate composition of sugarcane is given in table 4.1. It contains 70% of water, 15% fiber, 12% sugar & other constituents. There is little scope for increase in area under the crop and hence increased demand for sugarcane has to be met through productivity enhancement. The crop is also associated with inherent inconsistencies in area and production due to various factors like climate, cane and sugar pricing, high input and labour costs etc. The sugar sector demands not only increase in sugarcane production but also stability for its sustained growth. India has witnessed remarkable growth in sugar production during the past few decades mainly due to adoption of improved varieties and technologies.

The area under sugarcane in Haryana was 1.5 lakh hectares in 1966-67 which thereafter started declining, (Table 4.2). The productivity has increased from 34.00 q/ha in 1966-67 to 732 q/ha in 2011-12. However, there still exists a gap in yield and sugar recovery which needs to be narrowed down by sustained and concerted R&D efforts. This crop is mainly grown in Yamunanagar, Ambala, Kurukshetra, Kaithal, Jind, Sonepat, Rohtak, Hisar, Karnal, Panipat, Palwal, Sirsa and Fatehabad districts of the State. Haryana and Punjab have very low temperature in December-January which often causes frost. During May and June, the temperatures are extremely high. Due to extremes of weather, the active sugarcane growth is restricted to 4-5 months only.

The recovery of sugar has shown a declining trend during the last five years. This is mainly due to non systematic and unbalanced varietal promotion and incidence of pests and diseases. During 2011-12, the average recovery of private sugar mills was about 9.82%, whereas the average recovery of mills under the cooperative sector was about 8.72% (Table 4.3). This indicates that the mills in cooperative sector have great scope for improvement through better management.

Table 4.1 Sugarcane Production in India during 1950-51 – 2011-12

Year	Production, Mt	Productivity, t/ha	Remarks
1950-51	57.05	33.42	• Sugarcane production and productivity in India have increased from 57 Mt in 1950-51 to 360 Mt in 2011-12 (6.32 times) and 33.4 t/ha to 71.60 t/ha (2.14 times), respectively. Area has increased from 1.71 Mha in 1950-51 to 05 Mha in 2010-11 (2.84 times).
1960-61	110.00	45.54	
1970-71	126.37	48.32	
1980-81	154.25	57.84	
1990-91	241.05	65.40	
2000-01	295.96	68.58	
2010-11	325.00	66.95	
2011-12	360.00	71.60	

Table 4.2 Area, Production and Productivity of Sugarcane in Haryana during 1966-67 – 2011-12

Year	Area, Mha	Production, Mt	Productivity, t/ha	Remarks
1966-67	0.150	0.510	3.40	Though the area under sugarcane declined but productivity has increased from 3.4 t/ha in 1966-67 to 73.25 t/ha (21.5 times) in 2011-12.
1995-96	0.143	0.809	5.62	
2011-12	0.095	6.959	73.25	
In Haryana, during 2011-12, a total of 5.43 Mt of Sugarcane was crushed with an average sugar recovery of 9.10% producing 0.494 Mt of sugar. There is a scope to enhance the sugar recovery by 01-1.5%.				

Table 4.3 Performance of Cooperative and Private Sector Sugar mills in Haryana during 2011-12.

Sugar Mills	Crushing Capacity, tones/day	Cane crushed, lakh tonnes	Sugar Recovery, %	Sugar produced lakh tonnes	Remarks
Cooperative Sector					The average Sugar recovery in cooperative sector was 8.72% whereas it was 9.82% in private sector. Crushing capacity in cooperative sector was 54.4% and that in private sector was 45.60%. There is a need to improve sugar recovery in both the sectors.
Panipat	1800	2.501	9.25	0.231	
Rohtak	3500	3.991	7.93	0.317	
Karnal	2200	2.887	9.07	0.262	
Sonipat	1250	2.534	8.82	0.224	
Shahabad	5000	5.316	9.02	0.479	
Jind	1250	2.462	8.50	0.209	
Palwal	1250	2.095	8.10	0.170	
Meham	2500	3.427	8.70	0.298	
Kaithal	2500	2.979	8.21	0.245	
Gohana	2500	3.437	9.08	0.312	
Hafed (Assandh)	2500	2.986	8.75	0.261	
Total	26250	34.615	8.75	3.008	
Private Sector					
Yamunanagar	13000	12.724	10.01	1.274	
Bhadson	5000	3.661	9.40	0.344	
Naraingarh	4000	3.296	9.53	0.314	
Total	22000	19.681	9.82	1.932	
Grand total	**48250**	**54.296**	**9.10**	**4.940**	
The cane prices were Rs. 231/q for early, Rs 226/q for mid and Rs 221/q for late varieties.					

4.3 Cotton

Globally, cotton is planted in diverse farming system on an area of 33-35 million hectares, representing less than 2.5% of the world's arable land. It is a fibre, fuel, feed and oil crop. India occupies maximum area under cotton (12.2 million hectare) and accounts for 28% of the world acreage. It is second to China in cotton production. India produces about 6.035 Mt of cotton and thus contributes to 21% of the world harvest. India is the only country in the world where all the four species of cotton viz., *Gossypium hirsutum, G. arboreum, G. herbaceum* and *G. barbadense* are cultivated commercially. The area, production and productivity have undergone a sea change after the launch of Cotton Technology Mission and introduction of GM cotton hybrids.

It is a major cash crop of Haryana State in kharif season. It occupies 6.03 lakh hectare area, constituting 4.95% of total cotton area of the country. However, some progressive farmers are producing even more than 35 to 40 q/ha of cotton. There is an immense scope of increaseing the productivity of cotton in the State by adopting improved technology with timely operation similar to states like Punjab and Gujarat. The area, production and productivity are shown in Table 4.4. The potential cotton growing districts with 78% area and production are Fatehabad, Hisar and Sirsa.

Table 4.4 Area, Production and Productivity of Cotton in Haryana

Production year	Area, Mha	Production, Mt	Productivity, t/ha	Remarks
1966-67	0.183	0.287	0.268	Cotton production in Haryana has increased more than 09 times during 1966-67 and 2011-12
1995-96	0.651	1.284	0.335	
2011-12	0.603	2.621	0.739	

Cotton is a seed fibre and after processing, it is used for apparel, home furnishing and industrial applications. In addition to these value added items, production of bio-gas from willow dust, manufacture of particles board and paper from cotton stalks and edible oil from seed is done.

In India most of the cotton, whether rainfed or irrigated, is hand picked by human labour. A grown up person can pick about 20-70 kg of seed cotton per day, compared to average picks of over 1000 kg by an average single row spindle type picker. Manual cotton picking is not only a tedious and laborious work but also costlier. Two types of mechanical harvesting equipment are used to harvest cotton: the spindle picker and the cotton stripper harvester. Cotton after harvesting goes through various processes like ginning, spinning, weaving or knitting, wet processing and finishing. Ginning is the process by which seed cotton, also called kapas, is

separated into lint and seed. Quality of both, the seed as well as that of the lint is maintained.

There are two types of ginning machines. One is Roller ginning and the other one is Saw ginning. In the first, the fibres on the seed are gripped and the seed itself is hit when some fibres get removed. This process is continued until all the fibers combed by means of saw points. In India, mostly roller gins are used.

The amount of lint varies from cotton to cotton and it is very important to pre-assess this parameter before any commercial transaction. The ginning percentage is the weight of lint realizable from seed cotton.

Grading of cotton is usually done by expert graders by taking into account various factors and by matching the sample against the prepared standards. Grading is usually carried out on the lint obtained after ginning the seed cotton (kapas). The grade of cotton lint is determined by three factors namely, colour, foreign matter and ginning preparation. The colour of cotton gives information concerning the weathering or exposure undergone by the cotton and, in some cases, information concerning attack by fungi, insects, etc. The amount and type of foreign matter are dependent on the conditions of harvesting and storing as well as on the weather conditions before and during picking. The ginning preparation gives information concerning storage or handling conditions prior to ginning and also how carefully and efficiently the cotton has been ginned.

Grading is done according to the official cotton grade standards. The standard grade boxes are prepared for each variety. The standards are absolute but replicas are made every year from the same variety. Each description of variety has six grades, Extra Super Fine (ESF), Super Fine (SF), Fine (F), Fully Good (FG), Good to Fully Good (G-FG) and Good (G). The basic grade of each description is Fine as over 50% of the crop of any variety will be equal to this grade. Good is below grade or a rejection box. In preparing these standards, colour, dust; leafiness, stains, nippiness, etc. are considered. For grade, classification is based on appearance and is accomplished chiefly through the sense of sight by integration of three factors such as colour, leaf and preparation in the given sample. The appearance of the sample is compared with the standard grade box.

As of now, in Haryana, there is a need of developing high yielding varieties of cotton having resistance to biotic and abiotic stresses and suitable for mechanical harvesting and processing of crop residue and ginning byproducts need appropriate utilization for better returns.

4.4 Guar

Guar / Cluster bean (Cyamopsis tetragonoloba L Taub) is a native to the Indian subcontinent. It is a rain fed crop and is sensitive to salinity and water logging but

responds to irrigation under low moisture conditions. India accounts for 80% of the total guar production in the world and is the largest exporter to over 65 countries. The foreign exchange of Rs. 5.0 crores earned in 1971-72 has exponentially increased to Rs. 2805 crores in 2010-11. Guar is grown in Rajasthan, Gujarat, Haryana and Punjab. In Haryana, it is cultivated in south west districts viz., Bhiwani, Gurgaon, Mewat, Mahendergarh, Rewari, Hisar, Fatehabad and Sirsa. Though Rajasthan ranks first in respect of both area and production, Haryana contributes to nearly 30 per cent of the country's guar production from an area of merely 9% (3 lakh hectare) with production of 3.6 lakh tonnes, and productivity of 1300 kg per hectare (2010-11). This increased productivity is due to development and release of high yielding short duration guar varieties. Most of the varieties developed by CCS HAU are high yielding with export quality gum content.

The most important industrial use of guar is in the form of guar gum. Approximately 90% of total guar produce is used for production of guar gum and rest is used for culinary purposes and cattle feed, etc. A byproduct of guar processing is guar meal (mixture of husks and germ) which is a potential source of protein. It is used for cattle as well as poultry feeding. Guar gum is derived from guar seed. The guar seed is typically made up of 40 to 46% germ, 38 to 45 % endosperm and 14-16 % husk. The gum is obtained from grounded seed which has a vast range of industrial applications. Fifty to fifty five percent guar gums is used in oil drilling, textile, paper, explosives, mining, water treatment and fire fighting while 35-40 % is used in frozen foods, bakery, dairy products, canned foods, dressing, instant mixer, beverage and pet foods. The pharmaceutical use of guar gum is around 5% mainly for laxative, slimming aids, diabetic patients, tablet preparations, ointments etc. and the rest 5% is used for cosmetics and miscellaneous items (like mosquito coils).

Guar beans have a large endosperm that contains galactomannan gum, a substance which forms a gel in water, and being natural gelling agent have several utilities for industrial purposes like thickening agent, emulsifying additive, stabilizer, bonding agent, hydrocolloid, flocculant, fracturing agent and natural fibre. The consumption pattern of guar seed is largely influenced by demand from the petroleum sector/ industry of USA and the oil fields in the Middle East. Guar, as a crop, has the potential to give higher returns with bare minimum inputs and to earn foreign exchange from its byproducts which find diversified uses and applications. Guar is also used as cattle feed and green manure and can be eaten as a green bean. Guar gum, which is a very important product of guar seed processing, is used as an emulsifier, thickener and stabiliser in food, cosmetics and pharmaceuticals, explosives, textiles and carpets, oil well drilling, mining, construction and paper industry. The byproducts of guar processing, Churi and Korma are used as cattle

feed. Guar gum recovery normally comes around 31% of total guar seed processed, whereas Churl and Korma accounts for 29% and 37% respectively.

On arrival at the processing plant, seeds are screened for removal of dirt, stones, sand, metal debris, chaff and broken seeds. Standard seed cleaning vibrators, electromagnets, and shifter are used for cleaning. Dehulling and splitting of the seed is done by two processes i.e. dry grinding and wet grinding. In some of the industries, charring of the hull is done by flame treatment also and then separation of husk is done. Recovery in wet processing method is 8 to 10% higher than in dry processing. However, the quality of the gum is not good. Hence, dry processing or charring the seed is used in many industries. Burr mills, pin mills and modified hammer mills are usually used for splitting of guar seeds into two halves so as to separate the germ and endosperm. The splits are then heated in kilns and passed through the dehusking machines usually consisting of a two-tired chamber, each with a rotating saw-toothed blade. Splits stripped of their hull pass to sifters that separate the clean endosperm pieces on a 20-mesh screen. Guar gum powder is produced from endosperm splits by grinding in attrition mills, hammer mills, ultra fine grinders or other size reduction equipment. However, guar gum with the best thickening power and fastest hydration rate is produced when the splits are first soaked in water and then flaked, extruded or ground.

Natural guar gum is usually derivatized to enhance certain properties for specific applications. For industrial applications, many guar gum products are formulated with additives that control rate of commercial derivatives of guar gum, They are hxdroxypropylguar, carboxymethylguar and 2-hydroxy-3 (trimethylammonium chloride) propylguar**.** Various steps involved in processing of guar gum are as under:

- Guar seed pods are first sun dried and threshed to separate seeds from them. These seeds are then processed in industry. The byproducts of guar, korma & Churi, are utilized for cattle feed.
- The seeds are then pulverized and the gum is separated from endosperm, which contains about 80% Galactomannan (gums) and polysaccharides. Two halves of the endosperms are obtained from each seed, known as Un-dehusked Guar Splits.
- When the polished endosperms are removed and separated from the fine layer of fibrous material, husk and refined guar splits are obtained and these refined splits are then pulverized treated and processed using tailor made technology for specially grade products for usage in industries specified. After pulverization, sieving is done to get the required mesh size i.e. fine, coarse, etc.

- The guar gum is mechanically extracted by roasting, differential attrition, sieving and polishing of guar seeds. The sieved gum is then passed through the blenders to make it homogenous and later is packed for marketing.
- The gum is refined to make yellowish white powder as per the quality specifications required by consuming industries and grades specified. It is consumed in this form world wide.
- The modern high technology units employ hammer or jet mills and other equipments using the latest techniques to produce powders with higher fineness, finer colloid formation, higher water absorption and consistency, especially as per Pharmaceuticals, Cosmetics and Food processing industries requirements.

Guar is a rain fed monsoon crop, which require 20-40 cm of rain in 3-4 spells and is harvested in October-November. It is sown immediately after first showers say in July and harvested around November each year. The crop yield is directly related to the monsoon. It requires a relatively long growing season of 18-20 weeks. Being a leguminous crop, it fixes atmospheric nitrogen to the soil and thereby enriches the soil fertility.

For storage and handling, guar gum powders are generally packed only in clean, dry and virgin polythene bags placed inside gunny bags or multi-ply craft paper sacks. Guar gum powders and its derivatives are stable in dry form. It has a long storage life in its dry form provided that it is warehoused properly. The properties of guar gum remain unchanged for 12-18 months. However, when exposed to humid conditions, guar gum absorbs moisture which results in microbiological degradation, fermentation and lumping of the powder and the properties of the gum is adversely affected. Hence, guar gum should be packed in moisture proof packets/containers and stored in a cool dry place away from heat and sunlight. It is advised to consume the guar gum within a reasonable time period once the bag is opened. The shelf life of guar gum may be extended by adding suitable preservatives.

As of now, in Haryana, there is a need to develop varieties having quality gum as required by industry and promote the production of guar with strong backward linkage with farmers to ensure higher productivity and remunerative price to the farmers and profitability to industry and to all those involved in guar production, processing, trade/export & domestic marketing and utilization of guar products and byproducts.

Chapter - 5

HORTICULTURAL PRODUCE PROCESSING

5.1 Introduction

Horticultural produces (Table 5.1) are perishable in nature by virtue of having high moisture contents at maturity and losses occur during their harvest, handling, processing, marketing, and consumption. It is estimated that such losses are 15-25% depending upon the commodity and location. In order to minimise such quantitative and qualitative losses of horticultural produces, there is a need to have a strong postharvest infrastructure for creation of awareness among handlers of such produces such as producers, wholesalers, processors, retailers and consumers about the biological and environmental factors involved in deterioration of horticultural produces and use of appropriate postharvest tools and technology in minimizing the losses during handling, transport, storage, processing, marketing and utilization. It is more economical and timely to reduce the postharvest losses than compensate it by an additional production.

Table 5.1 Production of Major Fruits and Vegetables in Haryana during 2011-12

Horticultural produces	**Production in million tones**		**Remarks**
	2009-10	2011-12	
Citrus	0.104	0.214	
Guava	0.054	0.0872	
Mango	0.065	0.077	
Ber	0.037	0.043	
Aonla	0.009	0.013	
Total (Fruits)	**0.269**	**1.219**	Total production of F&V in 2009-10 was 2.94 Mt and it has increased to 4.78 MT during 2011-12. Fruits & Vegetables production during 2011-2 were 1.22 Mt & 3.56 Mt, respectively.
Vegetables			
Potato	0.515	0.619	
Cauliflower	0.488	0.585	
Tomato	0.385	0.418	
Onion	0.331	0.590	
Radish	0.319	0.425	
Carrot	0.279	0.367	
Cabbage	0.206	0.270	
Brinjal	0.145	0.282	
Total (Veg.)	**2.668**	**3.556**	
Total (F&V)	**2.937**	**4.775**	

5.2. Fruits and Vegetables

Losses of agricultural produce occur after harvest owing to their handling, transportation and storage. There is a considerable gap between production and net availability to the consumer. Quality of a sizable produce also deteriorates by the time it reaches the market, which adversely affects the competitiveness in the market and the profits earned by the farmers. Mechanical damage to F&V during handling and transport results in bruising, cracking and cuts which predisposes the produce to microbial spoilage. Physiological changes caused by respiration and ethylene liberation or changes in pigments, organic acids and flavour during ripening may lead to undesirable quality. Efficient management of the produce during harvest, grading, packaging, transport, storage and marketing can prevent these losses. There are also constraints of poor infrastructure and involvement of too many middlemen in the market. At present, postharvest management of agricultural produce in the country is far from satisfactory. Strategies aimed at reducing postharvest losses right from farmer's field until the produce reaches the end users have to be worked out and put in place to achieve the national goal of food and nutritional security. Several postharvest management technologies that have been developed by different ICAR, CSIR institutes and State / Central Agricultural Universities can be effectively utilized in addressing postharvest problems.

5.2.1 Maturity Index

Agricultural crops should be harvested at their appropriate stage of maturity, failing which the produce is likely to have poor colour, flavour, poor quality and low keeping quality or storage life. Harvesting at the right stage leads to enhanced shelf life, ensure sensory quality, regulates harvesting and packaging operations, minimizes losses and maximizes profits. It is difficult to decide the appropriate stage of harvesting for a particular crop. Nevertheless, the maturity indices for some of the horticultural crops grown in Haryana are given in table 5.2.

5.2.2 Harvesting at Optimum Maturity

Fruit harvested at proper stage of maturity has direct effects on its quality and market value. Stage of harvesting influences the postharvest enzymatic activities of horticultural produce, which determine the levels of different pigments, sugar, acids, flavours and vitamins. Different crops require different methods of harvesting and proper handling. To ensure better after harvest quality of produce, harvesting at proper stage of maturity and using suitable method should be done during the coolest part of the day; early morning or late afternoon. Do not harvest produce when it is wet from dew or rain. Protect harvested produce in the field by keeping it under shed when transport is not immediately available. Pre-cool the produce immediately after harvest if facility is available for refrigerated transport or refrigerated storage.

Table 5.2 Maturity Indices for some Horticultural Crops Grown in Haryana

Crop	Maturity Index
Fruit Crops	
Aonla	Change in fruit colour from green to yellow green or reddish green
Ber	Change in colour from green to light yellow
Guava	Specific gravity between 0.8 to 0.9 and TSS between 10^{o} to 15^{o} brix
Mango	Specific gravity between 1.01-1.02; Change of peel colour from green to light yellow or red; fullness of cheek.
Pomegranate	TSS: acid ratio: 55-60:1
Sapota	Arrest of latex flow: potato colour of fruit surface; change in pulp colour towards orange red.
Strawberry	For distant markets: $3/4^{th}$ red coloured fruits. Local markets: fully red fruits
Vegetable Crops	
Pepper	30-40 days after fruit set
Onion	One week after leaf fall
Brinjal	15-20 days after fruit set
Cucumber	15-20 days after anthesis
Tomato	Local markets:Pink/light red state fruits, distant markets: colour break stage
Okra	6^{th} day after anthesis
Peas	When pods are filled, green and turgid
Gourds	8-10 days after fruit set
Potato	When holms start drying
Radish	Indian: 40-45 days after sowing Japanese: 55-60 days after sowing.
Flowers	
Gladiolus	When 1-2 florets start opening
Rose	When 1-2 buds start opening

5.2.3 Pre-Harvest Chemicals Spray

Auxins, gibberellins, cytokinins, ethylene, growth retardants and inhibitors, abscisic acid are commonly used for regulation of various physiological processes so as to increase production and enhance postharvest life of horticultural produce (Table 5.3). Some of the common practices that can be used are:

- Pre-harvest application of GA3 at mature stage delays ripening and improves storage life in mango and guava and also improves colour in citrus.
- Pre-harvest sprays of 0.6% calcium chloride 10-12 days prior to harvest improves shelf-life and reduces physiological losses in weight in grape and ber.
- Application of 2, 4-D @ 20 ppm may be gainfully utilized for reducing fruit drop in Kinnow, Malta, Sweet Orange and Lime.
- Foliar application of urea (10%) may be practised to control unwanted rainy season crop of guava.

Table 5.3 Plant growth Regulators / Chemicals and Their Effective Use

Growth regulator	Crop	Concentration (ppm)	Application time	Remarks
NAA	Guava	400	2 weeks after fruit set	Effective in avoiding rainy season crop
Ethephon	Pear	150-200	1½-2 months after fruit set	Improves fruit set and yield
2, 4-D	Citrus	20	During the month of June	Reduces fruit drop
Urea	Guava and Pomegranate	10%	Full bloom stage	Effective in avoiding rainy season crop
$CaCl_2$	Ber, guava, Grapes, Kinnow	0.6%	10-12 days prior to harvest	Improves shelf life
GA3	Pear	15-20	20-25 days after full bloom	Improves fruit set and yield

5.2.4 Harvesting Tools and Gadgets

Care in harvesting and handling is necessary to preserve subsequent quality of horticulture produce. Rough handling at the farm directly affects market quality. Lack of knowledge of harvesting and handling techniques results in substantial wastage of produce. At present aonla, ber, jamun are harvested by shaking the trees and fruits falling on the ground are collected. Mango, citrus, pomegranate, bael, sapota and acid lime are individually hand plucked after giving twist. These methods damage the fruits which thus become prone to postharvest losses. The fruits of citrus, pomegranate and sapota should be harvested through cutting by scissors are secateurs retaining a small fruit stalk (0.5cm). Use of simple gadgets/techniques while harvesting can reduce the damage considerably. Some of the simple gadget for harvesting are listed below:

- Decapper for mango (CISH, Lucknow).
- Fruit pickers attached with net bag for mango and ber (IIHR, Bangalore, IARI, New Delhi, and CISH, Lucknow)
- Onion / potato diggers (CPRI, Shimla and CIAE, Bhopal)
- Tripod ladder, clippers, flexible fruit harvesting PVC pipes (CIPHET, Ludhiana and CIAE, Bhopal)
- Plastic crates for collection and transportation (Available in the market)

5.2.5 Handling and Transport

Handling and transport are important components which come right after harvesting. Multi-hand handling of fresh produce is the main cause of qualitative and quantitative deterioration. Further more, there is non-availability of adequate and efficient equipment and machinery to be used in the production catchment areas. Mostly the handling and transportation is done by tractor trollies/trucks which make produce vulnerable to speedy loss either by physical, biological or pathological means. There is lack of technical knowledge at farmer's level regarding handling and transportation techniques. This component requires adequate attention in order to strengthen postharvest value chain right from field itself. Some of the basic tips which can be practiced by the growers are:

- Adoption of plastic crates/bins in entire handling chain, by farmers, wholesalers, and retailers at field and market levels.
- Use of vegetable washing machines at farmer's level and promotion of mechanized sorting, grading and washing at production catchment area and marketing site.

- Use of appropriate packaging material, viz. punnets for strawberry and mushrooms; individual skin wrapping in citrus, tray-packaging for okra, tomato, mushroom, cut vegetables and fruits.
- CF boxes for guava, Kinnow, pomegranate and mango.
- Use of refrigerated vans and containers for long-distance transportation of fruits & vegetables.

5.2.6 Curing

Curing is required to be performed immediately after harvest in root, tuber and bulb crops, in which the produce is exposed to relatively high temperature and relative humidity. In root and tuber crops, curing causes wound healing with the development of new epidermal tissue, which acts as an effective barrier against infection and water loss. In bulb crops, curing is the process of drying of neck tissues and of the outer leaves to form dry scales. Onion and garlic can be cured in the field. After harvesting and neck cutting, onions and garlic should be cured heaped and covered with jute bags and thatches until the temperature reaches up to 30-35^{o}C. To reduce storage losses in onion and garlic handling protocol, i.e., curing, neck cutting, sorting, grading, and packaging need to be followed. Generally 5-10 days of field curing with 10 days shade curing of onion and garlic bulbs along with neck cutting by leaving 2.5 cm is recommended.

5.2.7 Postharvest Ripening

In India, fruits like mangoes and bananas are ripened artificially by using calcium carbide, which is a dangerous practice as it is highly carcinogenic. Technologies are now available to artificially ripen some fruits with the use of chemicals, e.g., etheral (500 ppm). Banana ripening chambers and ethylene generation systems should be established nearby production/marketing sites for artificial ripening of such fruits. Postharvest losses are at present considerably large and can be reduced by simple treatment like sprays of Ca salts and growth regulators that slow down the ripening process. Scanning of harvested fruits, to detect presence of fruits-fly particularly in mango and guava followed by sorting out the affected ones can reduce postharvest losses and improve their price and thus returns to the growers.

Sugar development takes place when potatoes are stored at 0-4^{o}C temperature. This becomes negative quality parameters for both processing industries as well as for the table purpose. However, this problem could be avoided by storing potatoes at 10^{o}C. But at this temperature potato tubers undergo severe sprouting leading to their poor marketability. Sprout inhibitor is widely used both in India and abroad under different commercial names and formulations. Pre-storage application of Chlorpropham 18.0 g.a.i/tonne has proved effective in maintaining tuber firmness

and in checking sprouting, sugar formation, rotting and weight loss of potato tubers. The State Government should facilitate availability of this chemical to curb potato, onion and garlic sprouting problem.

5.2.7.1 Degreening

Some special treatment like degreening designed to improve the eating quality of fruit need popularization. This process is applicable to citrus fruits especially light green colour on half of the surface which can be degreened completely in 48 hrs at 26-30^{o}C with ethylene gas. Degreening unit with one tonne fruit holding capacity has been developed at NRCC, Nagpur. This technique could be popularized in Haryana.

5.2.7.2 Waxing

Surface coating of fruits or vegetables with food grade edible wax emulsions is a common postharvest practice followed after removal from the cold storage. Food grade waxes are used to replace some of the natural waxes removed during harvesting and sorting operations and can help for reducing water loss during handling, storage and retail marketing. It also helps in sealing tiny injuries and scratches on surface of fruits and vegetables. It improves their cosmetic appearance and prolongs the storage life. The commercially available waxes are Citrashine, Stafresh, Sta-fresh 451, Semper fresh, Carnauba wax and Bee wax. These waxes can be gainfully utilized in commercial waxing of fruits like Kinnow and Guava. Among the vegetables, tomato, brinjal, capsicum and cucurbits can also be waxed for improving storage life.

5.2.7.3 Vapour Heat Treatment (VHT)

VHT is very effective in controlling infestation of fruits with fruit flies after harvest. The temperature and exposure time are adjusted to kill all stages of insects (egg, larva, pupa and adult) ensuring that the fruit is not damaged. A recommended treatment for guava, mangoes and papaya is 43^{o}C in saturated air for 8 hours and then holding the temperature for further 6 hours. VHT is mandatory for export of mangoes to Japan and America. This technology may be adopted in the production catchment area of mango and guava. Highly specialized machinery for VHT are presently not available in India but could be imported.

5.2.8 Primary Processing

5.2.8.1 Grading

Although sorting and grading are very important unit operations for appropriate post harvest management of horticultural produce, yet it is seldom being used in commercial operation in India barring a few recently established supply chains. Small size of holding through influence of a large number of middlemen between harvesting and retailing and lack of awareness on the concept of pack-house operations are the

major impediments in popularization of these technologies. However, through Government and Cooperative's societies' initiative, some organized grading facilities could be set up where farmers can get their produce graded on custom hire basis. Mechanical grading for citrus in Punjab (Kinnow) is being undertaken at packaging centers installed with mechanical graders. Grading and sorting of Kinnow over the mechanized line is undertaken at several waxing and grading units installed by Punjab Agro in various Kinnow growing belts, where Kinnow fruits are graded and sorted on custom hire basis. The Haryana government has also created similar facilities for Kinnow which need to be extended to other fruit clusters.

5.2.8.2 Packaging

Packaging fresh fruits and vegetables is one of the important steps in the long and complicated journey from grower to consumer. Proper packaging of a product can reduce not only bruising due to impact/compression, but can also facilitate marketing, reduce moisture loss, prevent microbial contamination, reduce pilferage and maintain suitable environment during marketing. Most farmers in the state either are ignorant or not convinced to adopt existing standardized packaging technologies developed for various fruits and vegetables. In view of this, the farmers need to be trained in some selected fruit and vegetable growing clusters about different packaging material and packing methods. A lot of standard packaging of commercially important fruits and vegetables are available with NHB, APEDA, and IIP and in the market which could be adopted commercially. Some packaging practices in use include:

- Shrink wrapping of individual fruits*:* Tomato, potato, onion, mango, kinnow, sweet corn and cauliflower. Technology of individual shrink wrapping of packaging in non-woven netlon bags, plastic punnet trap etc. could be highly beneficial.
- Packaging in mesh bags*:* Onion, Potato, Sweet corn, Ber.
- Rigid plastic punnets and trays*:* Strawberry, Mushroom, Baby corn and cut vegetables.

5.2.8.3 Storage

High field temperature at harvest is detrimental to the keeping quality of horticultural produce, thus reducing physiological and biochemical changes. Fruits like mango, grape, and vegetables like pea and okra which deteriorate fast need pre-cooling treatment. There are several methods of cooling, namely, forced air cooling, vacuum cooling, hydro cooling, package icing and top icing. There is need to establish pre-cooling units and a cold chain for storage and transportation of fruits & vegetables. This need to be tried and adopted.

5.2.8.3.1 Low Cost Storage

Erratic power supply, rising energy costs resulting in high maintenance expenditure has been impeding the growth of cold storage industry. Efforts have been made to partially substitute the sophisticated high cost energy efficient evaporative cooling system for short term storage of fruits and vegetables.

5.2.8.3.2 Seed Potato Stores

Cool dry rooms are essential for seed potatoes kept on floor or on bamboo racks with proper ventilation. CPRI, Shimla has developed (9.1 x 4.6 X 3.7) m of a cool store of brick masonry structure which is helpful in increasing storage life of potato.

5.2.8.3.3 Onion Stores

NHRDF has developed a low cost storage structure for onion**.** A structure of 4.8 x 1.5 x 1.2 m size with side walls of bamboo splits raised from the ground level by about 20 cm, with a capacity of 40 quintals with proper bottom ventilation is recommended. This structure may be popularized in onion and garlic-growing clusters of Haryana.

5.2.8.3.4 Zero Energy Cool Chambers

For short term storage of fresh fruits and vegetables, zero energy cool chambers have been developed by IARI, based on evaporative cooling. During summer when outside temperature goes beyond 48^{o}C, the temperature inside the cool chamber can be maintained around 25-28^{o}C with 90-95% RH. This chamber is very useful during summer months and could be utilized for short-term storage of freshly harvested fruits and vegetables except onion and garlic.

5.2.8.3.5 Cold Storage

Cold storage in India has been largely adopted for long-term storage of potatoes and high value crops like apple, grape and flowers. The existing cold storages were designed and developed for the storage of some selected commodities which need storage temperature between 3-8^{o}C coupled with 80-90% RH. Practically these cold storage are utilized to store diverse crop groups requiring a temperature range between 0-15^{o}C (Table 5.4). Therefore, there is an urgent need to develop multipurpose cold storage facilities focusing on all fruits and vegetables.

5.2.8.3.6 Storage Compatibility Grouping of Fruits and Vegetables

The Haryana State has 107 cold stores that cater primarily to vegetables. The total capacity of these stores is more than 64,000 tonnes. Various fruits and vegetables have different respiration, ethylene liberation and aroma production traits. Similarly, they are also not alike in their sensitivity to chilling injury, ethylene injury and storage humidity requirements. Most of the producers generally ignore this basic requirement of individual commodity and store them together inside the cold

chamber. This undesirable practice leads to faster deterioration of physical appearance, internal quality and overall acceptability of the produce. According to sensitivity towards ethylene, chilling injury, moisture and temperature requirements, fruits and vegetables could be grouped into five major groups (Table 5.5). Farmers need to be trained on storage aspects to ensure proper storage of their produce according to their requirements of temperature and humidity.

Table 5.4 Recommended Temperature & RH for high cost longterm Storage of Horticulture Produce

Commodity	Temperature °C	RH%	Storage Life
Fruits			
Ber	6-8	90-95	5 weeks
Grapes	0-0.5	90-95	6-8 weeks
Guava	5-13	90	2-3 weeks
Kinnow	5	90-95	3-4 weeks
Litchi	1-2	90-95	3-5 weeks
Mango	10-13	85-90	2-3 weeks
Pomegranate	5-8	90-95	12-13 weeks
Strawberries	0-4	90-95	Up to 1 week
Vegetables			
Beans	4-7	95	25-40 weeks
Carrots	0-2	95-98	30-35 weeks
Cucumber	10-12	95	Up to 2 weeks
Okra	7-10	90-95	1 week
Onion	0-2	65-70	8-25 weeks
Potato	4-5	95-98	3-4 weeks
Radish	0-2	95-98	3-4 weeks
Mushrooms	0-2	95-98	3-4 days

Table 5.5 Storage Compatibility Groups of Fruits and Vegetables

Group	Temperature	Relative Humidity	Crops
Group – I (Sensitive to ethylene)	0-2^{o}C	95-100%	Asparagus, Broccoli, Cabbage, Carrots, Cauliflower, Sweet Corn, Leafy Vegetables, Peas
Group – II (Sensitive to Moisture	0-2^{o}C	65-75%	Garlic, Onions
Group – III (Sensitive to Chilling injury)	4-5^{o}C	90-95%	Lemons, Madarin, Oranges, Potatoes
Group – IV (Sensitive to Chilling injury)	10^{o}C	85-95%	Beans, Cucumber, Brinjal, Okra, Capsicums
Group – V (Sensitive to Chilling injury)	13-15^{o}C	85-90%	Banana, Sapota, Grapefruit, Guava, Lemons, Limes, Mangoes, Watermelon, Papaya, Pumpkin, Tomato

5.2.9 Value Addition to Horticulture Crops

Despite huge production of horticulture crops, only about 3-5% of the total production is processed. A considerable amount of fruits and vegetables produced are lost due to improper post harvest management and lack of appropriate processing technologies. Out of the total production of about 150 million tones of fruits and vegetables in India, only 1-2 million tonne are processed. About 15-25% of the produce worth several crores of rupees is wasted every year.

Value addition for a product can be aimed at economic gain, time and money saving in preparation, quantity and quality improvement or any processes that lead to enhanced return of investment of harvested produce. With increased incomes, urbanization and changing eating habits, the demand for processed food has increased manifold.

About 60 per cent of the consumers live in the rural sector; as a result, the processed food is transported back to where it was produced at much higher prices and that too after incurring substantial losses. Had the produce been processed in the production catchment, the consumers would have accessed the processed food

there at lower prices, post harvest losses would have been avoided and more employment would have been created in the rural areas. Rural folk can play an important role in post harvest management right from harvesting and can salvage a large part of the loss. It will also help in higher availability of this dietary material, which comes under protective foods at lesser cost and improve the nutritional status of vast population of the country. If the rural women and younger generation are trained in some of the simple and low cost, energy efficient techniques for proper management and value addition of fresh fruits and vegetables at farm level, it will help in reduction of losses, fetching better returns to the growers making produce available at reasonable price to the consumers and create rural employment base.

5.2.9.1 Status of Processing Industry

Less than 05 per cent of fruits and vegetables produced are processed in India as against 65 per cent in the US, 70 per cent in Brazil, 78 per cent in the Philippines, 80 per cent in South Africa and 83 per cent in Malaysia. The Ministry of Food Processing Industry has drawn up a 'Vision 2015' for the processing industry entailing an expenditure of Rs 1,00,000 crore.

In Haryana, ber, aonla, guava, citrus and mango are leading fruit crops accounting for over 66% of the area under fruit and over 62% of the total fruit production. The main vegetables grown in Haryana include potatoe, cauliflower, cucurbits, carrot, tomato, radish and onion. These constitute over 61% of the total area and over 67% of production of vegetables in the state. The main spices grown are garlic, fenugreek, coriander and turmeric while the major flowers grown are marigold, rose, tuberose and gladiolus. The integrated strategy for processing should include:

- Cluster based and demand-driven farming for processing.
- Integration of food processing infrastructure from farm to market.
- Promoting a dynamic food processing industry.

This can be achieved by augmenting the level of processing of perishables Advance in processing technologies of perishable crops will help to curb the post harvest losses and result in giving a boost to the food processing industry to accomplish the goals.

In Haryana, there are 29 fruit and vegetable processing centres at present. Major processing centres for horticulture produce are enlisted in the Table 5.6.

Table 5.6 Horticulture Produce Based Processing Industries in Haryana

District	No.	Product
Ambala	2	Fruit and vegetable products
Bhiwani	1	Guar gum
Gurgaon	4	Barley malt extraction, mushrooms
Panchkula	1	Aloevera gel, health products
Panipat	5	Pickles, jams, sauces, murabba
Kaithal	1	Pickles
Rewari	4	Pickles, barley malt
Rohtak	3	Pickles, jam, sauces
Sonipat	8	RTE vegetables, curries, pickle, mushrooms
Total	29	Processed F&V Products

5.2.9.2 Technologies Developed

Most of the fruits and vegetables produced in India are still consumed fresh except for small quantity used for the manufacture of various products such as pickles, tomato ketchup, jelly-jams, dried and fried potato, raw banana and fruit drinks. With changing dietary pattern, demand of fresh and processed fruits and vegetables in domestic market has increased. To meet the challenge, fruit and vegetable production has increased manifold in the last few decades. The production of frozen peas, garlic and ginger paste, tomato puree, mango pulp etc. has been taken up in a big way only recently in India. Some of the popular processed or value added products in the country are dried onions and garlic powder, ginger and garlic paste, jams of mixed fruits, juice and concentrates of orange and litchi, squashes of litchi, canned beans, frozen beans, cauliflower and okra, pickles of mango, lime, chillies and mixed fruits and vegetables, tomato ketchup and puree, mango fruit drink and nectar, chilli sauce, mango chutney etc. In addition to offering higher returns, value added products can open new markets, create recognition for a farm and expand the market season. The processing centres in the state of Haryana can explore the possibility of the processing line to develop newer products in fruits and vegetables as listed in Tables 5.7 & 5.8.

The value added products from flowers include dry flowers and pot pourri, essential oils, flavours and fragrances, pharmaceutical and neutraceutical products, pigments and natural dyes, gulkand, rose water.

It is recommended to use suitable processing varieties wherever available for particular type of processed fruit and vegetable product to maintain uniformity in quality. Hisar Lalit, Hisar Surkha and Apple Color guava varieties are best for nectar

and RTS preparation. Tomato varieties like Pusa Gaurav, Pusa Uphar and Pusa Hybrid 2 are suitable for sauce, ketchup and chutney preparation. Arkel and Pusa Pragati pea cultivars are ideal for frozen and canned products.

Table 5.7 Existing and Newer Products from Fruits

Fruits	Existing Products	New Products
Aonla	Preserve, pickle	Juice and concentrate, osmo-dried segments, powder, salted segment preserve
Bael	Pulp	Preserve, canned, frozen slab, powder, RTS beverage
Citrus	Canned slices, pickle, squash, extraction of citric acid, essential oil from peels	Limonene extraction, flavours, pectin
Grape	Raisins, juice, wine	Canned grapes, concentrate
Guava	Jelly, juice, nectar	Pulp, concentrate, bars, powder
Kinnow	Blended juice	Debittered juice, concentrates
Litchi	Juice, squash, canned	Wine, juice concentrate, instant quick freezing, litchi nuts
Mango (Green)	Pickle, chutney, dried slices, powder	Drink, juice concentrate
Mango (Ripe)	Canned slices, pulp, juices, nectar jam, bar	Frozen slice, mango powder, concentrate, wine, vinegar, Instant Quick Freezing (slices)
Papaya (Raw)	Tutti-frutti	Papain/pectin, Instant Quick Freezing, candy

Table 5.8 Processed Products from Vegetables

Vegetables	Existing Products	New Products
Bitterground	Dehydrated	Juice, powder
Carrot	Juices, dehydrated	Colour extraction, osmotically dried shreds
Cauliflower	Dehydrated	Minimally processed, frozen
Chilli	Chutneys, pickle, dehydrated	Puree, essential oil
Cucumber,	Slices, whole in brine solution	Pickled
Mushroom	Canned, dehydrated, ketchup, pickle	Phytochemicals, freshcut
Okra	Minimally processed, dehydrated	Coated
Onion, garlic	Dehydrated, paste	Ready-to-use gravy base
Shelled beans and peas	In brine, frozen, canned	Protein isolates
Tomato	Juice, puree/concentrate	Ready-to-use gravy base, lycopene extraction

5.2.10 Farmer centric public private partnership

During last decade's public sector institutions have enormously contributed to research and development of Indian agriculture, while private sector has played a significant role in translating the research into products for farmer's use. Despite all these development, farmers have been working in isolation and did not get fair share of these development. In the context of Haryana, this theme becomes more relevant as a good number of Agro-industries already exist in processing sector. Firms like Pachranga pickles and Food Pvt. Ltd. and MDH Masale Pvt. Ltd. are doing commodity specific domestic and overseas business. These firms may be persuaded for having commodity specific buy-back linkage with the farmers. Proper placement of products in the departmental stores, super markets, shopping malls etc. backed-up by publicity is the key to success. It is also possible to have tie-up with exclusive restaurants, star hotels, renowned caterers etc. for regular supplies. Govt. can act as facilitator for entering into future agreements and for negotiating terms of benefit sharing. Necessary changes in the contract modules in the APMC Act with respect to policy of Haryana Govt. may be framed.

5.2.11 Future strategies

The horticulture industry has major contribution for improving food security, enhancing rural employment, alleviating poverty and export-promotion. Increased urbanization, improved standards of living, and the convenience needs of dual income families poised to major market potentialities in the food processing and marketing sectors.

The main issues to be addressed are minimizing of post harvest handling losses, value addition, byproduct utilization and promotion export through public-private partnership. Our ultimate aim should be convergence of technologies and emergence of products or processes, by interfacing and networking of various stakeholders.

5.2.12 Marketing & Export

Horticulture crop marketing, though as important as production, is the weakest link in producer-consumer chain in the entire country. It is characterized by a long supply chain consisting of too many intermediaries. Good Agricultural Practices (GAP) are not followed by farmers. There is also inadequate knowledge about quality standards and packing requirements for domestic and export market. This results in produce of poor quality, deterioration and value loss. As a result, the primary producers receive only 20-25% of the consumer price. Producers also get less share in profits and low income due to inadequate infrastructure, unorganized marketing, inefficient operation and transaction costs resulting in exploitation by commission

agents. Very few mandies exist for horticulture crops with grading, packing and storage facilities supported by market intelligence.

Lack of proper infrastructure, practices, procuring of information related to rules and regulations are responsible for inconvenience, harassment and poor returns especially in case of perishable horticulture commodities. The marketing system thus needs to be more strong and efficient in the interest of development of horticulture.

5.2.12.1 Implementation of APMC Act – As a consequence of recommendation by many committees / task forces on marketing, the Dept. of Agriculture and cooperation, Ministry of Agriculture, GOI, recommended a Model APMC Act during 2003 for adoption.

While several states have amended and notified this act, the Haryana state has only partially amended the act and allowed Contract Farming.

5.2.12.2 Establishment of Modern Terminal Markets – This concept has been introduced under the National Horticulture Mission to be implemented in PPP mode for establishment of a main market and collection centres by private entrepreneurs. There is a provision of equity participation by a producer or Association up to 26% of the total equity. The scheme is reform linked and can be implemented by the states who have amended APMC Act. Such markets are required to ensure direct procurement from producers and lower prices for the final consumers. While the private sector is expected to catalyse bringing in the required investment and management skills for development of such markets, the scheme does not seem to have received a response from private sector. Haryana state has starter developing national market at Ganaur near Sonipat.

5.2.12.3 Contract Farming*:* Contract Farming which is a partnership between company and a farmer is designed to overcome raw material supply constraints. As a result, it confers benefits to both producers and purchasers. i.e. assured remuneration and marketing opportunities to the farmer of produce of desired quality at a predetermined price. The focus is on enhanced productivity, reduced cost of cultivation, reduced marketing transactions risks, assured price and elimination of wastage resulting in enhanced farm income. Some of the important crops which have been in vogue in different parts are onion, gherkin, papaya, sweet corn, chillies which has been successful.

However, several constraints have also been reported by the farmers in the system by way of delay in payment, lifting produce, high cost of inputs, buyers manipulating grabs and delay in access to seeds.

Further contract farming is considered a partnership among unequal as it empowers the farmer to exploit the small farmers through manipulation in terms and

condition of the contract. However, experience has shown that there has been increase in income to farmers from participation in contract farming.

5.2.12.4 New Marketing Initiatives – Several new initiatives have been undertaken both in public and private sector which in marketing of perishable commodities serve as successful models for adoption with certain modifications to suit the local conditions. These are detailed below:

HOPCOM (Karnataka) – It is a government organization which was established by the Government of Karnataka in 1959. It secures its supplies of fruits and vegetables from about 1500 farmer members through its collection centres which acts as outlet for delivering of inputs and services to them. HOPCOM fixes prices at 10-15% higher than the prevailing market prices in the whole sale market. Farmers realize 70-75% of the consumer's price. The organization markets more than 500 tonnes of vegetable every day through 504 retail outlets mostly in Bangalore. It owns 5 cold stores and one processing unit.

Mahagrape (Maharashtra) – This is a successful cooperative model linking horticulture producers to market. Established in 1991, it is an apex organization of 16 grape grower's which ensures then access to international markets not possible by individual producers. The organization has been a great success in improving yield, quality and export of grapes for India.

Mother Dairy – Mother Dairy Fruits and Vegetables Ltd. (MDFVL) have promoted informal production associations for sourcing its fruits and vegetable to meet growing demand of consumers in Delhi. Marketing of produce can be encouraged at remuneration prices on the pattern of Mother Dairy.

ITC Chaupal (Madhya Pradesh) – This is a model promoted by ITC and consists of setting a number of small internet kiosks at village level to provide farmers real time information related to prices, availability of inputs and other matters related to farmers. Extension services are provided on line. The ITC intervention in supply chain has permitted farmers to increase their sales realization by 10-15%. There is potential of testing this concept for selling produce in Haryana.

***APPTA* (Tamil Nadu) –** It is a modern (unregulated) fruits and vegetable market established in Tamilnadu at Nagercoil which serves as an infrastructure facilities provided are wholesale shops (131), retail shops (504), covered auction hall, open auction platform storage godowns, precooling and ripening chambers and drying yard. Input shops for seed, fertilizers, and pesticides besides public utilities are also provided. The handling capacity of the market is about 3000 tonnes of fruits and vegetables / day. Market revenue comes from entrance fee, rent and maintenance charges.

***Kisan Bazar* (Andhra Pradesh) –** The Andhra Model of Kissan Bazar i.e. farmers bringing their own produce extends free marketing spaces travel and transportation for a reasonable charge. Kissan Bazars are working effectively in some states namely Raitu Bazar in Andhra Pradesh, Apni Mandi in Punjab, ITC e chaupal in Madhya Pradesh enable farmers to avoid exploitative practices by traders. These bring consumers and producers in direct contact.

5.2.12.5 Alternate Marketing Structures – Although reforms in APMC laws is a step in the right direction, it is felt that it may not succeed in bringing in the desired results. Haryana is a state of small producers with an average land holding of 1.6 ha. Most of the small and marginal farmers may not be in a position to deal with buyers on an equitable footing. Thus, there is need to empower farmers by aggregation. Different organizational structures have been tried in the past e.g. Joint Help Group, Joint Liability Group, Farmers Association and Producer companies. However, to make it a success, there is a need for the Government and financial institutions to support such farmer organizations through technical, managerial and financial help till they become strong enough to stand by themselves.

5.2.12.5.1 Organized Retail Chains – Supply chain management is mainly about the integration of producers with wholesalers, retailers and end consumers. A number of retail chains have tried their hand on sale of fruits and vegetables, but without any impact since these continue to depend on existing channels of marketing. Those retail chains which have established backward linkages with farmers for procuring fresh fruit and vegetables have been successful. Farmers do not have to deal with consumers, agents, brokerage which enables them to get better prices. Selling of fresh fruits and vegetables has been witnessing a slow but steady change by its inflow into areas of organized retail.

A number of new domestic and international companies e.g. Bharati Retail Ltd., Birlas, More, Heritage, Food India Ltd., HOPCOM, Mahindra & Mahindra, Shub Labh, Reliance Fresh, Tatas, Rallies India, Thapar, Global Green, Mother Diary Fruits and Vegetables have recently set up Food chains many of which sell fruits and vegetables. India stands at 4% in organized horticulture trade when compared globally to 56%. Further the Indian Government's decision to open FDI in retail has opened up a debate about the potential available in this sector for horticulture produce and products. With organized retailing there is a probability that marketing infrastructure will be built which will lead to better access to the market. Organized retail does provide some hope provided it is a joint effort of public and private sector to develop efficient and effective horticulture retail ventures. Introduce quality standards through retail chain outlets. Retail chain purchase only good quality fruits and vegetables which results in farmers not finding the market for rejects.

5.2.12.5.2 Producer Companies – In recent years a new model in the form of Producer Companies a hybrid between a private sector company and cooperative society has been proposed to link farmers to markets. Its membership is open only to those who participate in such companies as registered under companies act.

5.2.13 Recommendations

5.2.13.1 There is paucity of value addition and processing units for horticulture crops in the state. While the State has some good agro industries mostly in and around cities, rural bases small scale industries are required for processing of surplus produce. This will not only help in reducing post harvest losses but also benefit farmers considerably.

5.2.13.2 In view of the cluster approach in area expansion, need based primary processing facilities or processing factories should be located around such clusters. Hence emphasis is required on creation of multipurpose low cost rural based agro-processing complexes / parks in identified clusters.

5.2.13.3 Suitable processing varieties, wherever available need to be introduced in the State.

5.2.13.4 The existing industry like Pancharanga Pickles Food Pvt. Ltd. and MDH Masalae Pvt. Ltd. may be approached to have commodity specific buyback linkage with farmers.

5.2.13.5 Training in primary processing may be imparted around different horticulture crop cluster in Haryana state. There is good scope of ready to serve food, dehydrated fruits and vegetables industry in Haryana due to its location.

5.3 Medicinal and Aromatic Plants

Haryana has varying climatic conditions which harbour several kinds of native medicinal plants ranging from herbs to perennial trees having neutraceutical values. There are many pharmaceutical and herbal industries which have a vast requirement of medicinal and aromatic plants. In spite of having potential, farmers in the state have not shown much interest in cultivation of medicinal plants. The area coverage under various crops has been on decline. Some of the important medicinal and aromatic plant species which can be grown in south west region of Haryana with low rainfall, dry climate and light soils are isabgol, senna, mulathi, ashwagandha, satawar, aloevera, tulsi, citronella, mint and guggal. On the other hand, crops which require high irrigation facility fertile and medium to heavy clay soils are brahmi, kalihari, gilie, kaunch, kalmegh, satawar, akarkara, sarpagandha, tulsi, mentha etc.

There is a need for state sponsored promotion of these plants by creating suitable market infrastructure and encouragement of entrepreneurships.

Small processing units are being established by private agencies and the crude form of product is being sold to the pharmaceutical companies. It can be a good enterprise if it is done systematically by the growers of medicinal plants. Normally, it is observed that the people start growing medicinal plants without surveying the requirement and then end up in loss. Such situation can be avoided after studying the status and present requirement at indigenous and global level. Frustrations in this kind of business can be prevented with systematic approach.

At present, CCS HAU is the main centre for production and generation of plant material in the State. Five small medicinal plant nurseries with an area of one ha each were also established during 2010-11 by Horticulture Department under NMPB at Cheeka in Kaithal, Satroad in Hisar, village China in Sonipat and village Barola in Karnal. Some of these have already started production of planting material. Aromatic plants clusters are at Panchkula, Ambala, Yamunanagar, Karnal, Gurgaon, Jhajjar, Faridabad and Mewat.

5.3.1 Harvesting, Conditioning & Storage

Many items as raw material of aromatic and medicinal plants is very bulky, the storage of such material becomes a problem more so in the case of aromatic plants. Therefore, small processing units to serve the need of the cluster of village will be a good idea. Small and cost effective extraction unit should be developed and Government will have to support self interest group of farmers for its establishment. Primary processing from the bulk material at village level will reduce the problem of storage and risk involved in the same. This will help the farmers to get more price for their produce.

Some of the problems in processing of medicinal plants are poor harvesting and postharvest practices; ineffective processing techniques leading to low yields; poor quality control procedures; high energy losses during processing; lack of current good manufacturing practices; lack of high quality equipments and trained personnel, facilities to fabricate equipment locally and access to latest technology and market information. Seasonal variation in the concentration of secondary metabolism present in the plant and which are of medicinal importance is found to be a common phenomenon and consequently the efficacy or the potency of the raw drugs may not be the same all round the year or different stages of plant growth. This needs to be very much considered and the collection of the material should be made in the appropriate season.

Proper harvesting and processing of the different parts of the plant material would increase the shelf life and help in the value addition of medicinal plants instead

of indiscriminate and non-judicious harvesting. Instead of assorted material, which may include infested, immature and other kinds of unacceptable material, sorting and grading will be a means of value addition and market potential. Any soil, stones, sand, dust and other foreign inorganic matter must be removed before medicinal plant materials are cut or ground for testing. The container and its closure must not interact physically or chemically in any way that would alter its quality. A well closed container must protect the contents from extraneous matter or from loss of the material under normal conditions of handling, shipment or storage. Different categories of the plant material need different packaging practices recommended to prevent spoilage and also to maintain the quality.

Medicinal plant materials must be stored under specified conditions in order to avoid contamination and deterioration. Formation of moulds, which may produce aflatoxins has to be avoided. Materials that need to be stored at temperature other than room temperature should be stored at low temperatures to avoid decomposition of phyto constituents or deterioration of quality. Low humidity may be maintained using a desiccant in the container if necessary. Medicinal plant materials requiring protection from light should be kept in light resistant container or the container may be placed inside a suitable light resistant (opaque) covering. Information on proper storage practices of medicinal plants is rather sketchy and has not received due attention from experts till date. As is in the case of other plant materials exposure to air, moisture, light, dust, etc. cause deterioration in the keeping quality of medicinal plant raw drugs. However this can be minimized by proper cleaning, packaging and storage.

Dry extracts are usually very hygroscopic and should therefore be ground, mixed under conditions, which exclude moisture as much as possible. Intermediate and end products must also be stored under dry conditions. Annealing or sealing of the products in suitable moisture tight synthetic foils has proved a good method for this.

5.3.2 Processing and Value addition

Thoroughly cleaned and dried plant material is powdered in a pulverizer and sieved to obtain a homogenous powder of the desired particle size. The homogenous powder is mixed with a suitable binding agent and compressed to a tablet or filled into a capsule of desired dosage. The dried and clean plant material free from foreign organic matters is powdered and extracted with a suitable solvent like pure ethyl alcohol or methyl alcohol or solvents diluted with water in a percolator for cold extraction or in sox let extractor. The extracts are distilled under reduced pressure at low temperatures to remove the solvent and the concentrated extracts are spray dried. These extracts can also be standardized to a required strength of the

active/marker compounds. This simple or semi-processing of the medicinal plant material adds to its value manifold.

Food products developed by adding herbal ingredients (only edible medicinal and aromatic plants) important from nutritional and therapeutic point of view. Now a days, the demand of herbal based food products namely beverages, drinks, ice-cream, etc. are increasing day by day. The production of such type of herbal food product is more economical and profitable in the interest of health care. Aloe vera leaf powder is also being used by food processing industries for preparation of herbal yoghurt and other food products such as Tulsi (Ocimum sanctum) leaves, Pudina (Mentha arvensis) leaves, Brahmi (Centella asiatica), Curry leaf (Murraya koengit), Ginger rhizome (Zingiber officinale), Turmeric (Curuma longa), Lemon grass extract, etc. have potential for such health products.

5.3.3 Observations and Suggestions

- Haryana has conducive soil and climatic conditions for the cultivation of wide range of medicinal plant species which need to be exploited by way of providing quality planting material, latest technical know-how, extension support, post harvest handling techniques, processing & value addition and organized-marketing avenues to the growers.
- Transfer of technology takes place through trainings and seminars at District, State and National levels. The strategy for marketing of these crops suggest dividing whole of Haryana into three agro-ecological regions based on agro-climate & geographical conditions and types of medicinal plants grown. Also establishing a multipurpose primary processing and marketing agency in each region located at the central place is the need of the hour. MSP of Medicinal Plants may be fixed by the Govt. Herbal Mandis should be established at the regional level.
- Crop-wise post harvest processing technology for obtaining high quality produce must be developed. The post harvest technology for medicinal and aromatic plants is necessary since the plants after harvesting in green stage, if stored unprocessed for want of purchaser may get contaminated with fungi which may impair the quality of the final product. Therefore, post harvest technology for plants, their grading and packaging and method of storage should be developed.
- The Indian medicinal plants and their products also account for exports. There is global resurgence in traditional and alternative health care systems resulting in world herbal trade.

- The National Medicinal Plants Board (NMPB) set-up in November 2000 by the Government of India has the primary mandate of coordinating all matters relating to medicinal plants and support policies and programmes for growth of trade, export, conservation and cultivation. The Board is located in the Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha & Homeopathy (AYUSH) of the Ministry of Health & Family Welfare. Presently, schemes of NMPB are implanted through NHM and the crops of medicinal & aromatic plants are covered by ongoing schemes of horticulture development relating to area expansion and processing.
- Medicinal and aromatic plants and their various products can be viewed as an important commodity for sustainable economic development of the state & that of the country. There is also a need of organized marketing and trade of medicinal and aromatic plants and their various products. To meet the internal and international demands, it has now become imperative to produce the quality raw materials in significant quantities. This can only be achieved through domestication and cultivation of medicinal and aromatic plants which have internal demand in large quantity and also have export potential.

5.4 Spice Crops

Haryana State grows a number of spices namely fennel, coriander and fenugreek and has potential to increase the production of spices. There has been an increase in area under spices from 10,194 ha to 15,960 ha recording an increase of 56.6% between 2005-06 and 2010-11. Area under dry chillies has increased considerably from 460 to 1,896 ha, (312.2%), followed by ginger (261.8%). Turmeric is fast picking up in area expansion. There was modest area increase in other crops during this period. Major spice growing districts of Haryana are listed in Table 5.9.

Table 5.9 Major Spice Growing Districts of Haryana

Spice Crop	Districts
Chillies	Yamunanagar, Fatehabad, Karnal, Rohtak, Panipat and Mewat
Coriander	Sonipat, Yamunanagar, Kurukshetra, Gurgaon, Rohtak and Ambala
Fennel	Jind, Faridabad, Mewat, Panchkula, Kaithal, Mohindragarh and Karnal
Fenugreek	Sonipat, Yamunanagar, Hisar, Ambala, Kurukshetra and Karnal
Garlic	Karnal, Yamunanagar, Sirsa, Fatehabad, Panchkula, Bhiwani, Gurgaon and Kurukshetra
Ginger	Panchkula, Yamunanagar, Ambala
Turmeric	Yamunanagar, Panchkula, Ambala, Panipat, Karnal and Kurukshetra

5.4.1 Harvesting

Harvesting is one of the major factors that determine the quality of the produce. The major deterioration and post harvest losses take place at this stage. The objective of proper harvesting is to enhance the processable character of produce

and to achieve the quality and safe raw material for processing. This will also provide better income to the farmer, less losses in transport to urban areas for processing as well as creation of gainful employment at rural level. The stage of harvest varies from crop to crop. The crop of coriander matures in 90 to 135 days. The stage of maturity of the fruit at harvest is when central umbels are about to attain yellow colour. Cumin is harvested in about 100-110 days. Fennel takes 170-175 days to mature and harvesting is done before the fruits are fully ripe, umbel attains a slight greenish yellow colour. A good quality fennel for chewing purposes, commonly known as *'Lucknowi saunf* is produced by harvesting the umbel 30 to 40 days after pollination. In fenugreek, the harvest time is judged when the colour of leaves and pods turn yellow. The right time of harvesting is usually done in the morning hours to avoid shattering losses.

Value addition at farm level is urgent need of the time because major deterioration and postharvest losses occurs at this stage. The Mobile Seed Processing Unit can be adopted at village's levels. Average higher prices of Rs.725 and 490 per quintal, respectively for fennel and cumin were obtained as compared to unprocessed product. The farmers are realizing 10-15% higher prices of their processed produce as compared to traditionally unprocessed produce. Such type of processing units is also established in the nearby villages. A mobile agro processing unit developed at CIPHET, Ludhiana, on a four wheeled trailer could be used for processing of seed spices at farm level. The different machines suitable for processing of seed spices including cleaner, grader, horizontal burr mill, vertical burr mill etc. could be installed and operated by a Diesel Electric Generating set. These types of mobile processing machines were also tested at Research Farm of NRCSS, Ajmer and at Farmers' fields and the results are encouraging. This machine is very much beneficial for small and marginal farmers as the produce can be processed at their door step.

5.4.2 Value Added Products

Spices are processed for essential oils, oleoresins, natural colours and spice extracts. A variety of products have been made from pepper like green pepper based products, black pepper and white pepper based products and Pepper by products. The major green pepper based products are canned green pepper, green pepper in brine, bulk-packaged green pepper in brine, cured green pepper, and frozen green pepper, freeze dried green pepper, dehydrated green pepper, green pepper pickle, mixed green pepper pickle, green pepper sauce and green pepper-flavoured products. Black pepper and white pepper based products include Whole black pepper, sterilized black pepper, ground black pepper, cryoground black pepper powder, pepper oil and oleoresin, white pepper and white pepper powder. Other

miscellaneous products from pepper are pepper-flavoured products, pepper extract, curry powder spice blends, peppersal, pepper mayonnaise, pepper cookies and pepper tofu.

Major products of cardamom are bleached cardamom, decorticated seeds and seed powder, cardamom volatile oil and cardamom oleoresin. In addition to these products, encapsulated cardamom, cardamom tea, cardamom coffee and cardamom soft drink mix have also been developed.

Ginger powder, ginger oil, ginger oleoresins, encapsulated ginger, ginger preserves and salted ginger are the value added products from ginger. Major value added products from turmeric are ground turmeric, turmeric oil, turmeric oleoresin and curcuminoids,

The ground seed spices can be incorporated in food dishes more uniformly as compared to whole spices. In spite of these attributes they have limited shelf life and are subject to oxidation, flavour loss and degradation on long storage due to microbial contamination. For small scale production up to 100 kg/day manual grinders are adequate. For large scale production a small powered grinding mill is needed and models are available that can grind 25 kg/hr. The high heat evolved at the time of grinding (42-95^{0}C) resulting in flavour loss. To overcome this, spices are milled at low temperature using liquid nitrogen cryogenic grinding. Coriander powder was prepared by cryogenic grinding at four temperatures - 30^{0}C, -80^{0}C, -120^0 C and -180^0 C at CRSS, Jagudan. By cryogenic grinding at -180^{0}C had smallest particle size, more uniformity and high volatile oil content (0.9%). Coriander powder obtained from cryogenically grinding method is found greener than that obtained from traditional grinding method. The major disadvantage of cryogenic grinding is high cost.

Post harvest operations like harvesting, processing, packing, extraction and development of value added products etc play a major role in maintaining the quality of spices to the specifications of international trade. In addition to reducing the labour, mechanization helps in maintaining the quality and food safety standards. Improvements in hygiene, packing and storage facilities will not only help in keeping quality of spice flavours but also play a major role in reducing aflatoxin and salmonella contamination of our spices and spice products. The present deficiency in on farm primary and secondary processing of spices needs to be bridged for quality upgradation and greater emphasis on product diversification to the newer requirements of domestic as well as global marketing. Thus post harvest processing and management of spices have great scope considering the present international trade scenario.

5.5 Mushroom

The mushroom production is a highly profitable proposition. Mushroom produced in the State is sold in Delhi/other markets through commission agents and also sold directly either to the processing firms or the traders. But these are not transparent and the farmers remain at the receiving end due to highly perishable nature. The marketing costs such as washing, weighing, packing etc, have to be met by the farmers. Haryana has been in the forefront in edible mushroom cultivation on a commercial scale in the country since 1972 when first seasonal mushroom growing was taken up by a school teacher, Master Jagdev Singh, in village Barota, Dist-Sonipat. Since then there has been no looking back. In 1980, a State financed Mushroom Research and Training Scheme was started at the Department of Plant Pathology, CCS HAU Hisar. Regular training on Mushroom cultivation was started at main campus as well as KVKs from 1992. In 1996, a cultivation unit HAIC was established at Murthal (Sonipat). Large commercial mushroom farms with air conditioning facility in tropical conditions also came up in Haryana in early nineties for the first time in the country. The first such farm Mandeep Mushroom Limited, at Khudsa, Gurgaon was started in 1996. In Haryana, Mushroom has gained the status of a cottage industry and is being grown in the state in clusters. Farmers have taken the crop as a challenge. There is a need of organized marketing, refrigerated vans, packing materials and processing units. However, some limiting factors such as inadequate financial facilities, high cost of transportation, inadequate post harvest infrastructure, rising cost of inputs are coming in way of expected progress.

5.5.1. Postharvest Management and Marketing

Increased profitability demands proper post harvest infrastructure to increase shelf life and marketability. Since mushrooms are perishable and delicate in nature, these cannot be kept afresh for more than 24 hrs. After the maturing of the fruiting body, the deterioration starts with the formation of brown colouration and hence the quality deterioration and loss of marketability. To overcome this problem, especially during peak season, suitable post harvest management practices are to be followed to increase the shelf life and marketability of mushrooms. Initial steps are, proper harvesting time and stage. Mushrooms are generally harvested after 3 weeks of casing. Button mushrooms are to be harvested when the CAP size is 30-45 mm in diameter, whereas Oyster mushroom is harvested when the fruiting body becomes curled under edges and there are well formed gills.

The washing treatment of 100 ppm EDTA + 0.02% KMS, followed by packaging in 100-gauge thick polypropylene bags gave superior shelflife to stored button mushrooms. Blanching of oyster mushroom and milky mushroom for 2 min in 0.2%

salt + 0.1% citric acid solution, followed by sun-drying improved the postharvest shelflife of both the mushrooms.

Grading of mushrooms is important for marketing. Generally, the grading is done by segregation of mushrooms into various grade standards as per market demand. For example button mushrooms are graded into Grade A, B and C. The Directorate of Marketing & Inspection (D.M.I.) had formulated the grade standards for dried edible mushrooms as Mushrooms Grading & Marking Rules, 1972 under the Agricultural Produce (Grading & Marking) Act, 1937. Other step is pre-cooling wherein the produce is kept in a plastic bag and stored in cooling unit. Vacuum cooling is another system where water existing in cell walls and inter hyphal spaces of produce is evaporated under low pressure which lowers the temperature. But it is cost oriented system and involves inevitable loss of fresh weight.

Packing is essential to protect the mushroom during marketing. It is generally packed in polythene bags of 250 g-400 g for local markets. For long distance transport, pulp board punnets wrapped with PVC films are used instead of polythene bags. Sometimes, pre-cooled mushrooms are packed in insulated containers having ice in it, so that mushrooms remain fresh, healthy during long transport. The effect of pre cooling is lost partially in post pre-cooling period. Hence, for long distant transport, speedy refrigerated transport system is essential in which CFB cartons containing polythene pouches of mushrooms may be transported by refrigerated trucks. For short distance markets, precooled fresh mushrooms are despatched in wooden boxes with sufficient crushed ice in polypacks. For local retailer's markets mushrooms are packed in polypouches and dispatched by cycle, cycle-rickshaws, auto-rickshaws etc.

Mushrooms are marketed as fresh, dried and preserved. In Haryana, it is mainly marketed in fresh form. The major quantity of Haryana mushroom is consumed in plains of Punjab, Haryana and Delhi during Oct-Nov and Feb-May. During Dec-January, the produce of plain areas also arrives in markets. The middlemen and commission agents collect produce from growers and dispatch to regulated markets/satellite markets or markets outside the State. From consumption trend, it is seen that people of high income group and restaurants are main buyers of mushrooms.

5.5.2. Processing and Value addition

It is necessary to minimize the post harvest losses, For this, the processing techniques such as Canning, Individual Quick Freezing (I.Q.F.), Vacuum Freeze Drying (VFD), Drying, Vacuum Drying, Pickling, Steeping Preservation, Radiation Preservation etc. have been developed. These are used on the basis of their merits per se market demand and end use.

Canning is an established process of preserving mushroom pieces in brine, butter, oil, vinegar etc. It involves six basic operations like cleaning, blanching, can filling, sterilization, cooling and labeling. Through all these operations, mushrooms are graded, cleaned, blanched (pre-cooked), filled in brine solution of cans and ultimately sterilized with heat and cooled through water spray and labeled for storage. Canned mushrooms form major share of world trade.

Individual quick freezing is another popular processing method followed in large industrial units. In this process, raw materials are washed in processing units after receipt from farms, and then the mushrooms are inspected, sliced and graded according to quality. After that, blanched and water cooled mushrooms are subjected to tunnel freezing stage. At this stage, these are cooled in a system having temp –40^{o}C and the core areas of mushroom pieces acquire a temp around –18^{o}C. Subsequently, packed in multi-layer polybags and stored in a cold storage having temp–20^{o} to –25^{o}C. Vacuum freeze drying (V.F.D.) is a further development in mushroom processing technology. In this process the original shape, quality, colour size, texture, freshness properties of thermal sensitive produce are retained. This processing technique involves the cooling of mushroom much below the freezing point i.e. –40^{o}C where moisture present in mushroom is converted to tiny ice molecules which further directly sublime into vapour when subjected to vacuum with a slight rise in temp resulting a dried end product. Other Mushroom Products which can be prepared at home are: pickle, soup, curry, mushroom fry, mushroom biryani, steeping preservation, canned.

5.5.3. Residue and Byproduct Management

Mushroom growing is an eco-friendly activity as it utilizes the byproducts from agriculture, poultry, brewery, etc. and in turn produces a quality food with excellent and unique nutritional as well as medicinal attributes. The spent mushroom substrate (SMS) left after final crop harvest is a matter of concern as it creates various environmental problems including ground water contamination and nuisance. As mushroom production is increasing, so is the SMS generation, which calls for alternative management of this waste. Fortunately, SMS has many positive attributes still left for its potential uses. The material has been found to be a good nutrient source for field and horticultural crops because of its nutrient status. Besides, it has a high cation exchange capacity and has a slow mineralization rate that help in retaining its quality as an organic matter.

5.5.4. Problems and Issues

- Supply of spawn run substrates in urban and peri-urban areas for home cultivation of mushrooms, Involvement of cooperatives and other

marketing organizations for providing the required inputs as well as help in viable marketing of mushroom,

- Ensuring liberal financial support by the government agencies and financial institutions, Declaration of a minimum support price for mushrooms and provisions for insurance coverage,
- Technical guidance and financial support to the small scale and export oriented processing industries,
- Creation of Mushroom Development Board (MDB) like Coffee Board and Coir Board for promotion of mushroom processing and marketing in India,
- Establishment of cold chains for mushroom transport,
- Cultivation of Oyster and milky mushroom in Haryana has tremendous potential, which is yet to be fully harnessed.
- Mushrooms are being processed into fresh, dried and pickled forms. To attract the investment in the food processing and value addition sector, Government should increase the number of industries to increase value addition, establish cold chain system, should promote primary/minimal processing at rural level to generate self employment and should establish more research and development institutes in the wake of the quality consciousness of the consumers.

5.5.5. Research & Development Needs

In India, the retail packaging for fresh marketing is highly crude and primitive and is done in hand sealed polypropylene bags. Similarly, canning in tin cans for button mushrooms and sun drying for other mushrooms are the most common methods of preservation employed in India. The following aspects will have to be given greater attention.

- Low cost drying technology for the domestic and state-of-the-art technology for international market
- Refinement in modified atmosphere packaging (MAP) and controlled atmosphere packaging (CAP) suiting mushrooms for their increased shelf life.
- Use of recyclable and biodegradable packing materials.
- Substitution of tin cans with alternative materials and reduction in blanching losses during canning.
- Development of low cost freeze-drying and IQF technologies.
- Ready-to-cook recipes, value-addition and product diversification to cover pharmaceutical, cosmetic and fast food industries.

5.5.6. Export Potential

Till early 1990's, Indian contribution to world trade was minimal. It gathered momentum as the industry became organised with establishment of large scale export oriented units. Total mushroom exports from India in 2009-10 was around 11000 tonnes valued at Rs 66 crore.

Major export destinations for Indian mushroom are US, Israel and Mexico. India exports mushroom in two forms fresh and prepared/processed. Button mushroom accounts for approximately 95 per cent of total mushroom exports. Indian exports have been subjected to non-tariff barriers and thus the export trend is fluctuating. Although the current share of India in world exports is less than 1 per cent, India has a great export potential. India's per capita consumption (20-25 g) is comparatively low as compared to Europe and USA (2 to 3 kg).

The domestic demand is growing at a rate of 25 per cent. Half of the mushroom cultivated in the world is consumed as fresh. The processed products for mushroom are in dried, canned and frozen form. Half of the processed mushroom is in canned form. Mushroom has short shelf-life due to high moisture content (85-90 %) and is needed to be processed within 24 hours. The post harvest damages are browning, veil-opening, weight-loss and microbial spoilage.

5.5.7 Mushroom Future

Mushroom is an efficient means for the conversion of agricultural wastes into valuable protein and presents huge potential for generating additional income and employment. In India, the full potential of mushroom cultivation is yet to be unleashed. The cultivation practice has centered on white button mushroom, accounting for 85 per cent of the total production. The domestic marketing channels lack adequate price support faced with erratic demand and supplies. Lack of trained manpower is among other drawback for the growth of the mushroom industry.

Mushroom as a nutritious food, needs to be popularised. Mushroom cultivation will help in eliminating protein malnutrition among people, primarily dependent on cereals, and offer remunerative employment opportunities. As India's share in global mushroom trade is minimal, coordinated efforts among R&D establishments are needed to disseminate technology to grassroots.

Mushroom for pharmaceutical purposes also present immense opportunities in the global trade. India needs to adopt high yielding and genetically enhanced varieties, which needs to be complemented by sound post harvest operations. Innovative solutions are required to address the challenges in processing and packaging of mushroom.

National Research Centre for Mushroom (NRCM) is the nodal institute for providing technical assistance for mushroom cultivation in India. The establishment of NRCM has led to both horizontal and vertical growth of mushroom industry. To make Indian mushroom industry globally competitive, NRCM has been mandated with Research & Development and dissemination of the technical expertise to various stakeholders.

5.6 Floriculture

There has been a commercial scale introduction of protected cultivation of cut flowers all across the country. A number of floriculture units have become exporters of cut flowers to Europe, Middle East, Japan, USA, Australia and SE Asian Countries. Improvement in varieties and PHM practices and development of market, even the segment of cut flowers has recorded impressive growth. It is noteworthy that consumer demand for flowers like Marigold, Jasmine and Rose is rising.

The commercial cultivation of flowers in Haryana is a recent phenomenon. It started during 9th plan with a modest area of 3,214 ha which increased by 5.66 times by the end of the 11th plan. A number of flowers are grown in Haryana both outdoor and under protected cultivation. These include marigold, rose, gladiolus and chrysanthemum. The expansion has been highest in marigold followed by tuberose. This auger well for the future of floriculture industry in Haryana State. The major flower growing districts in Haryana as listed in Table.5.10

Table 5.10 Major Flowers Growing Districts of Haryana

Flower	Districts
Chrysanthemum	Rohtak, Gurgaon, Faridabad, Sonipat, Hisar and Karnal
Gladiolus	Faridabad, Panipat, Gurgaon, Sonipat, Mewat, Palwal and Karnal
Marigold	Gurgaon, Sonipat, Jhajjar, Mewat, Karnal and Faridabad
Rose	Sonipat, Mewat, Panipat, Gurgaon and Palwal
Tuberose	Faridabad, Gurgaon, Sonipat and Palwal

5.6.1. Postharvest Handling and Marketing for Cutflowers

Cut flower quality and longevity are influenced by pre and post harvest practices. Nearly 20-40% of the cut flowers produced are lost due to faulty harvesting, post harvest handling, storage, transportation and marketing. These losses can be reduced by careful harvesting, post harvest handling, temperature management, sanitation and judicious use of floral preservatives.

5.6.1.1 Harvesting: Ideally, harvesting should be done dry with use of clean buckets containing clean water, a biocide and sufficient citric acid to reduce the pH

below 5.0. Harvesting should be normally done by hand using shears or a sharp knife. Simple mechanical aids are used to harvest some crops, for example rose shears which grip the flower stem after it has been cut, allowing it to be withdrawn single handedly from the branch. At no time should harvested flowers be placed on the ground because of the danger of contaminating the flowers with disease organisms.

5.6.1.2 Precooling: Precooling is a treatment given to flowers to remove the field heat immediately after harvest. It can be done with ice cold water, cold water or forced air.

5.6.1.3 Pulsing: Treating the flowers with high concentration of sucrose and germicide for a short period of time improve the shelf life and promote flower opening. Pulsing is beneficial especially for flowers destined for long storage period or long distance transportation.

5.6.1.4 Bud opening: Use of germicides, sucrose and hormonal solution to promote the opening of immature buds in crops like chrysanthemums, rose, carnation, gladiolus, and snapdragon.

5.1.6.5 Grading, bunching and packaging: After harvesting the flowers should be graded according to various grades as per specification for local and distant market. Cut flower should be packed in corrugated cardboard boxed or sleeves. Packaging must ensure protection of flowers against physical damage and for this cotton or newspaper can be used as cushion.

5.6.1.6 Cold storage: After pre-cooling and pulsing, the flowers can be stored at low temperature i.e. in cold store to regulate the flower market or to avoid the glut in the market. Controlled atmospheric (CA), modified atmospheric (MA) or hypobaric storage method can be used to enhance the post harvest life of flower.

5.6.1.7 Transport*:* Flower should be transported in corrugated cardboard boxes. The flowers which are sensitive to ethylene, ethylene scrubbers containing $KMnO_4$ should be added to those boxes. Some of the flowers are like gladiolus and snapdragon are sensitive to geotropic bending, so these should be transported in upright position. Some of the flower crops show yellowing during transportation due to lack of light, therefore there should be a provision of light inside the transporting vehicle.

5.6.1.8 Holding*:* After pulsing and storage, flowers are held in a solution containing sucrose, germicide ethylene inhibitor and growth regulator. The flowers can be kept in holding solution either at wholesaler, retailer or consumer level.

5.6.1.9 Marketing: Flowers are tender and hence highly perishable. They are generally used in fresh form but they have very short shelf life. This poses great

problems in their marketing, particularly long distance marketing. Therefore, flower cultivation is concentrated in the hinterland of big cities like Mumbai, Pune, Bangalore, Mysore, Chennai, Calcutta, Delhi etc. But with the development of quick transport vehicles and refrigerated or insulated vans, flowers are transported to distant markets including foreign markets. For successful marketing of flowers, well-developed markets and well organised marketing system is necessary. In the marketing of flowers the different channels of marketing involved are :

- Producer – Commission agent - Retailer – Consumer (in large metro market)
- Producer – Wholesaler – Retailer – Consumer
- Producer – Contractor – Retailer – Consumer
- Producer - Retailer – Consumer
- Producer - Consumer (Local market)

In general, marketing of flowers is not well developed and well organized. There is no improved packing. Flowers like marigold are packed in gunny bags. Transport and commission charges (10-15%) are the main items of costs. Cold chain system of transport is not yet followed for flowers, which are sold in domestic markets. Therefore, long distant marketing (beyond 500 km) is not possible. However, floriculture is emerging as a commercial proposition in recent years due to export of some selected flower types and varieties. Production of export oriented flowers in green houses/poly houses is a recent technological adoption in India, which has given impetus to exports. But there is urgent need to improve packing system, quality of flowers (grading), quick and refrigerated transport and organization with minimum intermediaries. Floriculture crops require intensive cultivation and have high income potential. Therefore, they generate good employment in rural area.

5.6.2. Value added products from flowers

The value added products from flowers include dry flowers and pot pourri, essential oils, flavours and fragrances, pharmaceutical and neutraceutical products, pigments and natural dyes, gulkand, rose water, vanilla products and insecticidal and nematicidal compounds.

5.6.3. Export Potential of Flowers

India is bestowed with several agro-climatic zones conducive for production of sensitive and delicate floriculture products. During the decade after liberalization, floriculture industries took giant steps in the export arena. This era has seen a dynamic shift from sustenance production to commercial production. As per National Horticulture Database published by National Horticulture Board, during 2012-13, the area under floriculture production in India was 232.74 thousands hectares with a

production of 1.729 million tonnes loose flowers and 76.73 million tonnes cut flowers. Floriculture is now commercially practised in several states with West Bengal (32%), Karnataka (12%) Maharashtra (10%), having gone ahead of other producing states like Madhya Pradesh, Gujarat, Punjab, Haryana, Andhra Pradesh, Orissa, Jharkhand, Uttar Pradesh and Chhattisgarh.India's total export of floriculture was Rs. 455.90 crores in 2013-14. The major importing countries were United States, Netherlands, Germany, United Kingdom, United Arab Emirates, Japan and Canada. There are more than 300 export-oriented units in India. More than 50% of the floriculture units are based in Karnataka, Andhra Pradesh and Tamil Nadu. With the technical collaborations from foreign companies, the Indian floriculture industry is poised to increase its share in world trade.

5.6.4 Technological Intervention

Awareness about new technology, strengthening infrastructures, technology support, quality planting material, development of satellite nurseries by unemployed youth, enhancing the role of Women, linkage with other departments, encouraging self help groups, human resource development, database formation, Increased budgetary support should be the future focus.

The Centre has approved two model floriculture projects under horticulture mission for Haryana. The projects worth Rs 1.4 crore will be established in Panchkula and Karnal districts. There was no flower cultivation in the State during 1966-67 but it covered about 4,810 ha during 2004-05. Favorable climate for production of quality flowers, proximity to major markets like Delhi, Chandigarh, Ecotourism are the advantage for Punjab and Haryana for the cultivation of flowers and ornamental plants.

A number of weaknesses, like water scarcity, lesser-availability of quality seeds and quality planting material, poor post harvest management and marketing facilities like cold storage, pre-cooling and waxing centers, processing units and lack of farmer training programmes for horticulture, are needed to be addressed to boost the floriculture sector. The proximity to NCR offers excellent marketing opportunities, establishment of processing Industries and export of flowers to EU and Middle East are feasible.

Chapter – 6
LIVESTOCK PRODUCE PROCESSING

6.1 Introduction

Exploitation of livestock production in terms of industry for Milk, Meat, Poultry (egg, broiler), fish, etc. offer great scope but has not been exploited to its inherent capacity of revenue generation, value addition and marketing. This results into great disadvantage to the LS producers as they do not get the right price and also do not share the profits pocketed by the middle men. Under optimal running conditions, only 35% of the surplus (16.2% of total) milk in the state can be handled by the dairy plants. The bulk of the surplus milk continues to be handled by the unorganized sector (sweet shops, vendors etc.). Shifting of handling and processing of surplus milk, from the unorganized to the organized sector, holds key to sustained profitability of dairy farming. Buffalo meat production holds an unparalleled opportunity for the state and will serve to fast track the animal improvement. This will also ensure high returns to investment, greater profit margins to farmers, higher economic growth and human development. Rural broiler and egg production can serve as a transforming agent for the poor in terms of health and nutrition. Fish farming and marketing it as a quality product under hygienic conditions in an appropriately designed fish market would help fish farmer to generate employment and earn more income. For urban market & export, fish processing unit on cooperative basis need to be established in the production catchment having cold room & refrigeration facilities to transport the minimally and/or processed fish & fish products.

6.2 Dairy Produce Processing

Milk is one product that generates cash income to farmers almost on a daily basis, unlike sugarcane or wheat. Besides being a source of liquidity and insurance against crop failure, milk is the only product where the farmer realizes 60-70 per cent of consumer price; against 20 per cent or so in fruits and vegetables. Dairy industry is generating new jobs to the extent of around 1.0 lakh every year. Even then for policy makers, dairying is viewed as a ‘subsidiary’ activity.

The National Dairy Development Board (NDDB), in partnership with the Government of India and the World Bank, has developed a National Dairy Plan (NDP) in order to increase productivity of dairy animals and to provide rural milk producers with greater access to the organized milk-processing sector. The first phase of the plan, NDP-1, has a financial outlay of 416 million dollars (more than 20 billion rupees) for the period of 2012 and 2017.

Haryana is an agricultural state and the contribution of Agri sector to total GDP of state is 16.7 per cent (2011-12) whereas the livestock sector is contributing to the tune of around 31 per cent of Agriculture GDP (at current prices). However, the contribution of dairy sector to the economy of the state is progressively increasing at a faster rate as compared to agricultural sector. The state has very good potential for further growth over next 10-15 years, probably in the range of 6-7%. Since 1980, livestock GDP has been growing at an annual rate of about 6 per cent, which is higher than the growth in AgGDP and total GDP. Milk accounts for about 70 per cent of the GDP from livestock sector. In spite of its significant contribution to the GDP, the livestock sector in Haryana received only 8.2% of public outlay of agricultural sector (11 Plan) and only 0.38% of the approved total outlay of the 11 Plan.

6.2.1 Milk Production

The state has about 1.8% of Indian Live Stock and possesses a rich wealth of domestic bovines. Haryana occupies an important place on the dairying map of India as it contributes 5.5% of the Nation's milk production with just 2.79% of the country's adult bovines. Buffaloes produce more than 80% of the total milk (6.6 million tones) in the state. Average milk production of indigenous cow is 4.9 kg, exotic/cross 7.9 kg, Buffaloes 7.1 kg and Goats 0.8 kg per day/animal. Buffalo has been an integral part of livestock sector in Asia for over 5000 years producing milk, meat, hides and draft power. Haryana state is richly endowed with high yielding Murrah buffaloes which are well known not only in the country but also over the world.

In general, the people of Haryana are fond of milk and milk products. But there is no authenticated data for the same. Assuming a moderate per capita consumption of 0.35 liters, the daily requirement of milk for home consumption comes to about 89 lakh liters i.e. almost 50% of the total milk produced (182 lakh liters) in the state. There are 27 private milk plants having a total installed capacity of 23.40 lakh liters per day. In addition, there are five plants in co-operative sector with an installed capacity of 8.80 lakh liters and the Model Dairy plant of the National Dairy Research Institute, Karnal having a handling capacity of 0.60 lakh liters. Under optimal running conditions, only 35% of the surplus (16.2% of total) milk in the state can be handled by the dairy plants. The bulk of the surplus milk continues to be handled by the unorganized sector (sweet shops, vendors etc.). Shifting of handling and processing

of surplus milk, from the unorganized to the organized sector or conversion to dairy products, holds key to sustained profitability of dairy farming. During the last decade, 12 new dairy plants, all in private sector, have been established in the state having an installed capacity of 7.00 lakh liters with a range between 0.15 and 2.20 lakh liters. However, the daily milk production in the state during this period went up by 42 lakh liters. The bulk of the surplus milk continues to be handled by the unorganized sector (sweet shops, vendors, etc.). Sweet shops (Halwais) are selling unbranded ethnic Indian products with hardly any benefit to the producers. There is huge gap in processing capacity of state and availability of surplus milk, which pay for the unorganized sector to handle this surplus milk. A significant proportion of the surplus milk is also being sold as fresh raw milk in the adjoining National Capital Territory.

6.2.2 Milk Collection and Issues

As milk is being produced by millions of tiny units, the milk plants find it difficult, unattractive and uneconomical to procure milk in very small quantities from millions of house-holds. Undoubtedly, remunerative pricing of milk is a vital component for sustainability of dairy farming. Presently, the pricing of milk is based on the market value of the fat and other solids in the milk and not based on its production cost. Presently procurement price of milk is Rs 450 /kg fat that means 100kg buffalo milk with 6% fat will be price @ Rs 27/- per liter where as for consumers its price is Rs 48/- per liter. However, Govt. is providing a subsidy @ Rs 4/liter to milk producers who are supplying milk to the dairy cooperatives. But it is not sufficient for sustainability of dairy farmers. The base price of the milk should be based on its production cost plus a profit margin of at least 30% to the producer. The price may be revised from time to time to neutralize the rising cost of various inputs. So, it is need of hour to have a milk price fixation mechanism of the state.

Most of the cow milk produced in the state is from Holstein Friesian/Jersey and their crosses which produced milk with around 3.5% fat i.e. below the present legal standards for Haryana state (i.e. 4.0%). The state needs to take up the issue with Food Safety and Standards Authority of India (FSSAI) to bring it at par (i.e. 3.5% fat) with many other states. The matter being urgent should be addressed on priority to promote rearing of cross bred animals.

In addition, the dairy processing should be given the status of an agricultural activity with all accompanying benefits such as cheap electricity, water, credit facilities and subsidies etc to give the long-awaited impetus. Value addition may also be promoted at the local level to make it more remunerative and to meet the demand of quality produce.

In view of the above facts, it is necessary to highlight the present post harvest processing scenario and future prospects of milk in general and buffalo milk in

particular for value added products under the era of Food Safety and Standards Act, 2006 which was passed by Indian Parliament and notified on 24th August, 2006 and operationalised on 5th August, 2011. All Food Business Operations in India to get Licensed/Registered with Food Safety Authority and old operators also have to register themselves up to 2014. One of the issues related to FSSA, 2006 is that a dairy farmer may be spared from registration/licensing policy under FSSA, 2006.

6.2.3 Milk Quality and Uses

Milk is a part of daily food consumption in most south Asian countries, especially for a population predominantly vegetarians in India. Various studies have established that there is practically no difference in the nutritive value and digestibility of milk and milk products obtained from cow and buffalo milk. When comparison is made among cow and buffalo milk, buffalo milk is found to be healthier as it is richer in saturated fatty acids. It's much higher total solids (18-23% Vs 13-16%) is useful for making cheese, butter fat, several kinds of traditional sweets and ice cream. Buffalo milk is especially important and priced higher. Buffalo milk has a better milk constituents in comparison to cow milk and same is true for their physico-chemical and functional properties so the buffalo milk is more suited for the manufacturing of majority of milk products like mozzarella cheese, dahi, yoghurt, shrikhand, paneer, khoa, cream, cooking butter, ghee, ice-cream, dried cream, dried butter, UHT cream, dried ice-cream mix, edible casein, caseinates, dairy whiteners and infant and health foods.

The Indian population has a great liking for buffalo milk, which forms a thick cream layer (*malai*). This layer thickens further after boiling and storage. The high viscosity of buffalo milk exerts an additive influence on the consumer's preference. It is known to impart a distinct whitening effect to tea and coffee because of higher quantity of whey proteins and casein. Boiling of buffalo milk causes the release of high amounts of sulphydryl compounds, which contribute to nutty, cooked flavour leading to its high acceptance as a drink. Full cream buffalo milk is sold at premium price because of its flavour and its ability to produce good quality products.

6.2.4 Milk Processing

Good hygiene is essential whether the animals are milked by hand or machine. This requires that the milkers' hand and clothes are clean and he or she is in good health, the milking machine and milk storage equipment such as milk cans /churns are kept clean and are in good condition, and immediately after milking, the milk must be cooled preferably to 4^{o}C. This requires mechanical refrigeration or milk cooling tanks.

The shelf-life under Indian tropical conditions is only 5-6 hrs at ambient temperature. The shelf life of milk can be extended to 24 hours by cooling to 5^{o} C. Its shelf life is further extended to 4 to 7 days by pasteurization. By UHT treatments, the

shelf life is extended to few months. Pasteurization needs equipments and electricity. In India, most of the milk is produced under very unhygienic conditions in rural areas sometimes far remote from the places of consumption. If not properly cooled and transported in that state, there can be significant losses as a result of spoilage. In many villages, the electric power is not available and if available, there are frequent failures. It is reported that about 10-12% of raw milk becomes unfit for processing due to sourness, whereas by use of lactoperoxidase system milk can be preserved for 6-12 hours without the need of equipments and electricity, which is consider to be rather safe method, has not yet been approved by the statutory agencies.

Without proper sanitation and chilling facilities at dairy farm, high initial bacterial counts in raw milk tend to develop off-flavours faster during procurement and subsequent storage after pasteurization and therefore pasteurized milk being marketed in India is reported to have a shelf-life of 3-7 days while in western countries it is 14 days. To obviate chilling requirements during procurement lactoperoxodase system of milk preservation was found to be bacteriostatic for the spores and bactericidal foot. The psychrotrophs in raw milk or use of micro-filteration/bactofugation of raw milk reduces the bacterial load in milk by 99%, could be a good option for processors. As per FSSA, processors have to keep standard plate count of pasteurized milk at 30000 per ml. Integration of bactofugation with UHT processing of milk seems to be economical for good quality, UHT milk is produced at temperature as high as 125^{o} C.

Notable efforts are being made to adopt UHT method for processing of milk, liquid milk products, table cream and other dairy products to improve their shelf-live under different climatic conditions. However, the shelf-life of UHT milk is expected to be 3 months. But, according to a report in India shelf-life of UHT milk is 15 days. That is why it is being marketed on a limited scale and the potential benefits of this technology cannot be fully exploited.

6.2.5 Traditional Dairy Products

The traditional milk products provide the means of preserving precious milk solids for comparatively longer time than the fluid milk. Indian milk sweets have played a significant role in the economic, social, religious and nutritional well being of our people since time immemorial. It is estimated that about 50-55 per cent of milk produced is converted by the traditional sector (halwais) into variety of Indian milk products, using processes such as heat and acid coagulation, heat desiccation, and fermentation. The market for Indian milk products is estimated to be more than Rs. 65000 crores. This fact underlines the significance of Indian milk sweets in the national economy. In view of the growing awareness towards the safety aspects of milk based sweets in India, the consumer shall prefer to buy these products from the

organized sector. Data from the national sample survey revealed the rising trend in the monthly per capita expenditure on milk and milk products. Interestingly, such expenditure in rural areas of the Northern India is usually higher (20-40%) than in urban areas. Recently a few organized dairy sectors have started the production of traditional milk products on a commercial scale but their impact has been limited. While many new innovations have been made recently to modernize this sector, it is necessary to look into short, medium and long term strategies to develop core technological strengths within our industy for envisioning a developed indigenous dairy products sector. A vision for this sector is only possible through identifying such core strengths and building on them.

6.2.5.1 Heat Desiccated Products

Approximately 6% of the total milk production is used for producing khoa, according to an estimate about 6 lakh tonnes of khoa is produced annually. It is used as a base material for a variety of popular sweet- meats, such as Barfi, Peda, Gulabjamun and Kalakand etc. Khoa is a type of heat desiccated milk product obtained from cow, buffalo or mixed milk by thermal evaporation of milk in an open pan with continuous stirring until desired concentration of solid (65 to72% TS) is reached. It is used for making different types of sweets. Buffalo milk is preferred for preparation of khoa since it gives better yield.

Buffalo milk khoa is white in colour, smooth textured and granulated which makes it highly suitable for preparation of top-quality sweets. There are three kind of khoa; pindi, dhap and danedar. According to Food Safety and Standards Rules, FSSR (2011), Khoa is the product obtained by rapid desiccation and having not less than 30 percent milk fat on the dry matter basis of the finished product.

6.2.5.2 Heat and Acid Coagulated Products

Paneer is a famous traditional Indian dairy product analogous to fresh cheese like Queso blanco or Queso fresco and used in many recipes. It is a heat and acid coagulated product prepared by coagulation of particularly buffalo milk with acid like lactic or citric or sour milk and pressing the curd in a muslin cloth to drain the excess whey. In India, paneer production has been largely confined to the non-organized sector of the dairy industry. An estimated 1% of the country's total milk production is converted into paneer. Its annual production is estimated at 1.5 lakh tones. Paneer is highly nutritious since it retains approximately 90% fat and protein, 50% mineral and 10% of lactose of the original milk. Though the composition of market samples of paneer vary to a large extent, the product prepared by standard method, on an average, consists of approximately 54% moisture, 25% fat, 17.5% protein, 2% lactose and 1.5% minerals. The yield ranges from 17-18%. More and more dairy plants are going in for commercial paneer production. In order to meet FSSA

standard, the product has to be made from buffalo milk containing 5.5 to 6.0% fat. It shall not contain more than 70% moisture, and milk fat content shall not be less than 50% of the dry matter. The milk fat content of skimmed milk paneer shall not exceed 13% of the dry matter. The paneer is superior when made from buffalo milk. The cow milk paneer is too soft, weak and fragile and after cooking its pieces loose their identity. Technology has been developed at LPT department (LUVAS) for manufacture of ready to serve spiced paneer using certain ingredients having dietary fibre.

The *paneer curry* developed at NDRI by hurdle technology had a shelf life of about a month at 30^{o}C and more than 3 months at 15^{o}C. The water activity of gravy and paneer was reduced to 0.95 by using suitable humectants. The pH was lowered to 5.0 by a proper admixing of dahi and skimmed milk powder. The gravy was prepared by using onions, tomatoes, usual spices and condiments, humectants and potassium sorbet. The overall composition of the product was: total solids 40.27%, fat 24.99%, protein 58.8% and ash 3.16%, carbohydrates and glycerol constitute 6.24%.

India's total production of *chhana,* a heat and acid coagulated product, is estimated at 1.2 lakh tones and valued at Rs. 6000 million. The quality of buffalo milk chhana is not comparable to cow milk chhana when prepared using the same procedure employed to cow milk. The product is used extensively as the base and filling for the preparation of a large variety of Indian delicacies namely, rosogolla, sandesh, cham-cham, rasmalai, pantooa, rajbhog, chhana-murki and many more products. To overcome the problems of small scale, some successful attempts have been made to mechanize chhana production. Scope of innovation and value addition is great. Organized dairy sector which has hitherto shown no interest in production of these products needs to take up its production mainly for export.

Very few attempts have been made in this area of product diversification. Chhana obtained is broken into small pieces and transferred to a domestic mixer where it is made into a paste with the addition of water. For every 100g of cow/buffalo chhana, approximately 10 ml/20 ml of water is added. Salt @ 1.0-1.5% is added during grinding. An acidifying agent is also added to lower the pH to 5.1-5.0. For this purpose 1 part of citric or lactic acid dissolved in 1 part of water is added @ 0.8-1.0 ml per 100g of spread. NDRI standardized another protein-enriched table spread using *chhana* as base along with butter. Skimmed milk chhana and butter are blended in 70:30, 60:40 and 50:50 (w/w) proportions and mixed and worked thoroughly in a blender at 15-20^{o}C for about 30 min to yield a homogenous mass. Salt is added @ 2% (w/w). Based on the various physico-chemical and sensory

attributes, use of 40% *chhana* is reported to be best suited for the preparation of spread.

6.2.5.3 Fermented Products

Practice of preserving milk by fermentation is common household technology in India. The Indian medical treatise Sushruta Sanhita describes dahi as a food for longevity, promoting appetite and bestowing strength. The main fermented milk products of Asia are *Dahi, Makkhan, Lassi, Butter Milk, Misti Dahi, Shrikhand* and related products.

Dahi (resembles yoghurt) is a fermented dairy product from fermentation of cow or buffalo or mixture of milk by using suitable lactic acid bacteria (LAB). It is consumed in different form such as sweetened, blended with spices, salted, beverage *"lassi".* Its therapeutic value has been described in the Ayurveda (Indian System of Medicine) literature from around 600 AD. On the commercial scale mixed starter cultures of lactic acid bacteria such as *Streptococcus lactis, S. diacetylactis, S. cremoris* in single or in combination with or without Leuconostoe species along with *Lactobacillus acidophilus*, *L bulgaricus, and S. thermophilu*s are used for dahi preparation, whereas at small scale production old dahi is used as starter to initiate the lactic fermentation in cool boiled fresh milk.

Dahi is a good vehicle for maintaining the beneficial bacterial population in the human gut. Addition of probiotic bacteria such as Bifidobacterium longum, Bifidobacterium hifidum, Bifidobacterium infantis, Lactobacillus rhamnosus, Lactobacillus acidophilus, and Lactobacillus delbrueckii ssp. bulgaricus along with starter induce additional therapeutic effect on consumer health such as anticancer effect, immune modulation effect, antibacterial, anti-diarrhea effect.

Recently, at NDRI probiotic/Fruit Dahi has been developed with enhanced health attributes. The pmbiotic lactobacilli viz. L acidophilus and L easel are used to prepare dahi either alone or in combination with mesophilic dahi culture Lactoeoccus lactis ssp. laces blown diacetylactis-60 and mixed dahi culture 167 (B04). Standardized buffalo milk (fat 4%) as well as milk with different fat % (1 to 3%) is used for preparation of two types of Dahi. Dahi incubation carried out at 37°C for 9-10 hours. After incubation dahi is stored at 40^{o}C (approx.). Dahi exhibited good taste and flavour, also good texture is firm exhibiting pH 4.27 to 4.47 and titratable acidity ranging from 1.08-1.21. A number of probiotic organisms are $7.1X10^{10}$, approximate. Number of probiotic organisms is ranged from $3.8 x10^{10}$- $4.24x10^{10}$.

The processing parameters for manufacture of fruit dahi have been standardized for the development of good quality fruit dahi using various fruits, such as mango, pineapple and banana. Appropriate starter cultures have been employed to get desired flavour and consistency in the product. The Theological properties of the fruit

dahi have been enhanced by incorporation of exopolysaccharide producing cultures and hydrocolloids. The shelf life of the product is about 3 weeks at refrigeration temperature.

Misti dahi is fermented milk product of West Bengal and other parts of India. It is prepared by heating buffalo milk with 12-13% cane sugar. The concentrated milk with a slightly caramelized flavour and brown colour is inoculated with a mixed starter culture consisting of *Lactococcus lactic* and *lactococcus diacetylactis* strains. A firm curd with smooth body, sweet taste and pleasant aroma develops in about 7 hours incubated at 30°C. Lassi is yet fermented milk used a refreshing beverage, often with added sugar, salt and spices and topped with clotted cream. Recently, at NDRI, technology has been developed for manufacture of probiotic lassi using Lactobacillus acidophilus probiotic culture. It is a healthy dairy beverage, the thickness of which depends on the ratio of dahi to water. Thick lassi is made with four parts dahi to one part water and/or crushed ice. It can be flavored in various ways with salt, mint, cumin, sugar, fruit or fruit juice and even spicy additions such as ground chilies, fresh ginger or garlic. The beverage is enjoyed chilled as refreshing beverage during extreme summers. Saffron lassi, which is particularly rich, a specialty of Jodhpur (Rajasthan). Several culinary dishes are also prepared from this by-product. While kadhi is popular in the northern and western parts of the country, kaalan varieties are popular in the south. The lassi has 10 days storage life at 5^0C in polyethylene pouches.

Sweet lassi is a more recent invention, flavored with sugar, rosewater and/or lemon, mango, strawberry or other fruit juice. During 2002, commercial products resembling sweet lassi began appearing on the U.S. market, with names like Drinking Yoghurt and Yoghurt Smoothie.

Buttermilk is a byproduct of Indian dairy industry which is obtained by churning of dahi. During the preparation Dahi is churned continuously until butter is not formed on the surface. The aqueous phase remaining after removing butter is called buttermilk. It consists of components of milk such as protein, lactose, and minerals. Buttermilk also consists of milk fat globule membrane rich in phospholipids especially phosphotidylcholine (lecithin). Phosphatidylethanolamine, and sphingomyelin, provides additional health benefits.

Shrikhand is a semi soft, sweetish sour, whole milk product prepared from lactic fermented curd. The dahi is partially strained through a cloth to remove the whey and thus produce a solid mass called chakka (the basic ingredient for shrikhand). Furthermore, this chakka is blended with the required amount of sugar and flavor for obtaining shrikhand.

6.2.5.4 Fat Rich Products

Buffalo milk is better suited for the manufacturing of cream, cooking butter and ghee as the yield of these products is more from buffalo milk due to higher content of fat. Loss of fat in skimmed milk and butter milk is less due to longer size of globule and higher proportions of solid fat in buffalo milk. The separation of cream and churning of butter is also easier from buffalo milk due to bigger size of the globules and larger proportion of solid fat. Texture of ghee is superior when made from buffalo milk due to bigger size of the grains which, in turn are the result of larger proportions (9-12%) of high melting triglycerides compared to only 5 to 6% in cow milk fat. The keeping quality of buffalo ghee is better with respect to the development of hydrolytic rancidity. Due to higher fat content buffalo milk is better suited for the manufacturing of UHT cream, dried cream and dried butter.

For manufacture of ghee there are many methods, such as Desi or indigenous or traditional method. Creamery—butter method, Direct cream method, Pre-stratification method- and Continuous method. In desi method, making of ghee in the presence of milk proteins yields high levels of conjugated linoleic acids (CLA) which are known to be anti-carcinogenic agents. Ghee made traditionally contains as high at 5 times CLAs as compared to original milk fat in milk. CLAs are also known to be antioxidants and are responsible for higher shelf life of ghee at ambient temperatures. Post WTO scenario presents a big challenge before the Indian dairy industry where competition from overseas manufacturers in global market has become unavoidable. Although Ghee is our indigenous product, besides meeting the international standards it should be manufactured in a manner that is cost effective with considerable savings in energy and without affecting the sensory and shelf life attributes. Dairy plants have tried to modify, scale-up the traditional batch process and adopt Pre-stratification method for commercial production.

6.2.5.5 Low Calorie Traditional Milk Products

Diabetes has become a major health issue in South-East Asia. It has been estimated by the International Diabetics Federation that 23 million people currently have diabetes, which accounts for a sixth of the world's diabetic population. India has the largest diabetic population and one of the highest diabetes prevalence rates in the world. It is predicted that the Indian diabetic population would rise to more than 80.9 million by the year 2030. The dairy industry has responded to the growing needs of health conscious consumers for low calorie and sugar free foods. A low calorie lassi by using aspartame, khoa based sweets using ascesulfame-K, aspartame and sucralose has been developed at NDRI. The Indian counterpart for ice-cream, kulfi and low calories flavoured milk have been developed by LPT department of LUVAS.

6.2.5.6 Western Product

Most of the well known cheese varieties of the world are conventionally produced from cow milk. However buffalo milk too has been utilized with considerable success for manufacture of certain varieties of cheeses. Cheese made from buffalo milk displays typical body and textural characteristics. More specifically where chewing and stringing properties are especially desired as in case of Mozzarella cheese, buffalo milk is technologically prefered over cow milk in Italy. Fresh and pasta Filata cheese, especially Mozzarella has been traditionally prepared from buffalo milk In Balkan countries. Several types of white brined and pickled cheeses are prepared from buffalo milk. Feta (Greece), Domiati (Egypt) and Queso Blanco (South and Central America) and Paneer (India) are among the prominent cheeses mainly prepared from buffalo milk.

Buffalo milk is not considered suitable raw material for making certain ripened cheese varieties, viz. Cheddar, Gouda, Emmental/swiss, etc. As a result, the most common variety, the Cheddar cheese made in India does not develop proper flavour and body and texture when it is made from buffalo milk. The major problem is considerably faster rate of renting and syneresis which result in lower retention of moisture in the finished product. This, in turn, affects adversely the three most important biochemical reactions. i.e. 'glycolysis, proteolysis and lipolysis which constitute the cornerstone of cheese flavour development. In order to overcome this problem, attempt should be made to develop a manufacturing technology which would ensure greater retention of moisture and accelerated rate of ripening. Buffalo milk due to its intrinsic basic differences in its physico-chemical make-up has posed certain problems in manufacture of hard varieties of cheese. The major problems encountered in the manufacturing of hard type of cheese from buffalo milk have been, the slow development of acidity, faster renneting time, lower retention of moisture, hard rubbery and dry body, slower proteolysis and lipolysis and lack of characteristic flavor.

The emerging cheese market in India can be broadly segmented into two distinct classes, one is Varieties for bulk users and customers such as Cheddar including processed cheese and cheese spreads and Mozzarella and the 2nd group is Varieties for the connoisseurs like Gouda, Edam, Swiss, Parmesan, Cottage etc.

6.2.5.7 Mozzarella Cheese

Mozzarella is a white, soft, "spun curd", unripened Italian cheese variety. This cheese was originally made from buffalo milk. In comparison to cow milk, buffalo milk is not only more suited for Mozzarella cheese but it also gives more piquant and aromatic cheese and better stretch ability. The technology has been perfected at NDRI to manufacture good quality Mozzarella cheese employing traditional starter

culture and direct acidification techniques and processed Mozzarella cheese with extended shelf life from buffalo milk using hydrocolloids and emulsifier employing heat processing.

6.2.6 Future Prospects and Strategies

Due to several breeding programmes to improve the productivity of buffaloes, the milk production will enhance enormously and therefore, more and more milk will be available for its judicious processing into value added products to cater the needs of our population and also for export purposes. Buffalo milk has several special features which need to be focused in R&D effort to create values in dairy products. Technological modifications for manufacturing several dairy products from buffalo milk have been already standardized at NDRI.

The Indian milk sweets enjoy mass appeal, give high profit margins and have high export potential. There is an urgent need to modernize this sector to produce high quality products with long shelf life. We need to generate basic data on these products which will help for designing of new equipments or for intelligent selection of existing food processing and packaging lines. Great scope also exists for improving the shelf life of milk sweets by employing newer preservation techniques. While lots of innovations have taken place recently, these innovations have not percolated to the actual users. Industry-R & D organization links need to be strengthened. Collaborative efforts of industry, unorganized sector, equipment manufacture and R & D institutions are required for all round development of this sector.

The share of organized sector is very small (approximately 16 %). While the Government/co-operative sector markets nearly 80 per cent of the milk as liquid milk, the private sector markets only 30 per cent as liquid milk and remaining 70 per cent as milk products mostly comprising powder, butter and ghee. The future for commodities like powder and ghee does not appear sustainable and hence a major shift in product mix for organized dairy industry is foreseeable. Empirical evidences also suggest that the composition of an average Indian's food basket is gradually shifting towards value added products. It is therefore essential for the Indian Dairy Industries to initiate manufacture of mass-market products for domestic as well as export markets. The following strategies are, therefore, very important and need urgent attention to boost dairy industry and to meet obligations under the Food Safety and Standards Act-2006:

- Clean milk production at the producer level; no contamination with residues of pesticides, antibiotics, drugs, hormones, heavy metals and other adulterants etc by following the appropriate practices.
- Hygienic and safe practices during collection and transportation of milk using cold chain.

- Good manufacturing practices at plant.
- Strict quality control and hazard analysis by accredited laboratories using accurate, fast and cost-effective state-of-the-art technologies.
- Designing new health- oriented dairy products to suit taste and needs of the target consumers.
- Encouraging commercial dairy enterprises through transfer of technology and other promotional means.
- Shifting of handling and processing of surplus milk from the unorganized to the organized sector holds key to sustained profitability of dairy farming.

6.3 Meat, Poultry and Fishery

The livestock sector is an important component of Indian agriculture. It not only provides essential proteins and other nutrients to human diet through milk, meat, eggs, fish, etc., but also plays an important role in utilization of non edible agricultural residue & processing by-products. Livestock also provides raw materials such as hides and skins, blood, bone, fat etc. India has a vast livestock population and an efficient utilization of their produce is important to earn increased profits and sustain livestock farming.

Meat and meat products are an important part of the diet around the world. In developed countries, the consumption of animal protein per head of population is the highest and in developing nations, the production and consumption of animal protein is increasing, keeping pace with the levels of affluence. Meat, poultry, eggs and fish are the sources of high quantity and quality of animal proteins, vitamins and minerals. Besides they are also known for their satiety characteristics.

6.3.1 Meat production in India and Haryana

Total meat production in India was about 6.27 million Mt in 2010, occupying 5th rank in world's meat production and accounted for 2.21% of the world meat production (2831 million Mt). The contribution of meat from buffalo is about 23.33%, while cattle contributes about 17.34%, sheep 4.61%, goat 9.36%, pig 5.31%, poultry 36.68% and other species 3.37%. The meat production has increased from 764,000 tonnes in 1970-71 to 6.27 million tonnes in 2010. The compounded average growth rate (CAGR) during the last two decades works out to be 4.5%. The value of meat and by-products was Rs. 79,889 crore including skin and hides, while the export value of meat and meat products was about Rs 6,000 crore in the year 2009-10. Export earnings from buffalo meat touched 17.400 crore in 2012-2013 (APEDA). The contribution of buffalo meat accounts for more than 75% of total exports/foreign earnings. Beef from India is lean, cheaper and is Halal meat which is preferred in

Gulf countries. India became the world's top exporter of beef in 2012 edging out Australia and New Zealand in May 2012. The poultry is also gaining the wide acceptance and growing at 10-15% annually.

Though meat which is exported meets international standards yet, most of the meat sold in India is substandard. The best quality meat is sent abroad while B-grade meat reaches the domestic market. On the Food front, over the last 4 decades, India has witnessed several agricultural revolutions, such as green, white, yellow, golden, blue, etc. However, red/pink revolution in form of livestock protein production is yet to happen in India. There are many reasons for the slow growth rate of the Indian meat industry. Some of these are Quality of animals available for slaughter is poor; Negative attitude of public, in general, toward consumption of processed meat; and Socio-religious consideration.

The livestock sector in Haryana has, of late, become the most vibrant contributor to agriculture as well as to the state economy. Monetary contribution of livestock surpassed that of food grains in 2005-06. The livestock sector contribution to the total output of Agricultural and Allied sector (GDP) increased from 15% in 1981-82 to nearly more than 31% in 2009-10. In fact, the contributions from livestock and Fisheries sub sectors to the economic growth of the state has enabled the agriculture and allied sectors achieve an overall growth of 3.4%.

The meat production in the state of Haryana during 2011-12 was 3.24 lakh tons, 96% of which was contributed by poultry and remaining 4% from sheep, goat, and pig. The per capita annual availability of meat in Haryana stood at 12.60 kg against the national average of 4 kg and the recommended allowance of 11 kg. Cattle and buffalo are not slaughtered in the state in spite of the fact that there is no legal ban on slaughter of the buffalo. Only small animals like sheep, goat and pigs are used for meat production. Excluding the major contribution of poultry, goat contributed 42%, the shares of sheep and swine being 28 and 30 per cent, respectively. The average per animal yield of meat was estimated to be 19 kg for sheep and goat and 42 kg for pigs. Livestock in Haryana is dominated by the buffalo as it constitutes 80% of the bovine population and 67% of total livestock in the state. The buffalo meat is lean, low in cholesterol and possesses outstanding blending quality for production of various products. The buffalo meat is also tender and juicy if the calf is raised on high protein and energy diet. Buffalo meat is excellent for producing a variety of meat products including emulsion products, smoked and cured products, restructured products and traditional meat products. Increased earnings and general prosperity have led to a considerable rise in demand for quality meat and its products. In addition, Haryana can also take advantage of the flourishing market of the National Capital Territory.

Some of the issues of the meat industry in Haryana are that animals are mostly slaughtered by butchers in small, corner shops to produce fresh meat for local consumption. There are no proper slaughter houses or meat processing plants. In the name of abattoirs, local bodies in 29 towns, have earmarked- premises for slaughter of animals. These premises are unhygienic and poorly maintained with no facilities for disposal of waste products and processing of uneatable parts (offals) for value addition. Quality control and food safety are almost missing. These premises and the butcher shops do not have even the basic facilities of cold storage and power back up. Technical know-how and liberal credit facilities need to be arranged by the state. Local bodies should be made responsible to ensure hygienic slaughtering facilities. Regular trainings and health checkups of butchers should be mandatory. Sale of meat should not be allowed unless the quality is certified by the authorized veterinarian. The meat- shops must have cold storage facilities with adequate power back-up.

6.3.2 Poultry Industry

Poultry farming is one of the fastest growing sub sectors of animal husbandry. It has grown from backyard activity to a well organized industry with a prominent position in the national map of poultry farming. The introduction of hybrids like Hyaline, Shaver, Babcock, Ross and Cobb etc., a few decades ago has led to a tremendous improvement in this sub sector recording unprecedented growth. The poultry population has more than doubled during the last decade. Rise in general prosperity had led to changes in food habits of the expanding middle class. The demand for chicken meat and eggs is on rise. Poultry industry in the state is entirely in the hands of private entrepreneurs. All three forms of poultry production namely commercial layers for egg production, broiler farms and hatcheries have recorded a tremendous growth during the last few decades. The numbers of hatcheries have increased and are also meeting the demands of neighbouring states. The broiler farms are more widely spread and are present all over the state.

Some of the issues of the poultry industry are that of diversified poultry farming which is yet to pick up in the state. Farming of quails, turkeys, guinea- fowls and emus is in initial stages of development. There are no organized facilities for marketing of poultry. It is predominated by sale of table eggs and live birds locally as well as in the National Capital Region. Value addition is missing since there are no organized slaughter houses or processing plants for poultry in the state. Fresh chicken meat is the preferred choice and is also the cheapest.

The population of poultry has more than doubled from 13.60 million in 2003 to 28.70 million in 2007. During 2011-12, a total of 4114.21 million eggs were produced as compared to 3543 million eggs in the neighboring state of Punjab. Against the

recommended per capita annual requirement of 180 eggs, the availability in the state had been around 160 eggs for the last five years. Some of issues of egg sector are lack of facilities for value addition through processing of eggs into egg powder or other products. Price of table eggs varies seasonally being 10-20% lower during summer months due to decline in the demand. A majority of the population in the state is vegetarian and do not prefer to include an egg in their daily diet. The surplus stock of eggs is mainly sold in Delhi.

6.3.3 Fishery Sector

The role of fishery sector in the national economy is, in general relatively limited. The fisheries sector has been recognized as a powerful income and employment generator and is a source of low cost animal protein to the people particularly to the economically weaker sections of the society. Hence it can ensure national food security. The fish farming activity in the state of Haryana is of recent origin. In the short span of less than three decades, the fish farming in the state has developed significantly. Haryana stands 2nd in the average annual fish production per unit area in the Country. The average annual fish production in the state is 6000 kg per hectare against a national average of 2260 kg. The total fish production was 600 tonnes during the year 1966-67 which has now increased to 105529.50 metric tonnes in 2013-14 in spite of depletion of fish population in natural water bodies.

Despite limitation of water resources in the state, Department of Fishery of the state has made notable progress. More than 80% of the village ponds in the state have been brought under fish farming. In order to provide marketing support to producers, fishery department has established 3 fish markets at Faridabad, Panipat and Yamuna Nagar.

6.3.4 Meat and Poultry Processed Products

Almost all of meat and poultry are sold as fresh (wet meat) and only about 2% of meat is processed into products. With faster pace of life, increase of economic status and more of women taking employment, consumption of processed ready to eat meat products is increasing, especially in big cities. There are about 170 meat processing units producing a number of meat products including poultry products mostly as small scale units and licensed under Meat Food Products Order, 1973. The major advantages of processed meats are:

- Value added, variety and convenience meat products to consumer.
- Better utilization of different cuts and edible byproducts.
- Facilitates incorporation of non-meat ingredients for quality and economy.
- Promotes employment, entrepreneur ventures and exports.

- Value addition to tough meat resulting into an increased demand and higher returns.

6.3.4.1 Comminuted Meat Products

Meat from spent hen and broiler parent stock is well suitable for comminuted meat products. The processing technologies for high quality sausages, patties, loaves, kababs, meat blocks, balls etc. have been developed for poultry meat. Incorporation of whole egg liquid improves the emulsion stability and increases cooking yield of loaf and chicken rolls. Chicken fat is found to be superior to mutton fat or vegetable fat or a combination of chicken and vegetable fat. Added chicken fat at 15% level results in greater firmness and overall acceptability scores of the products. Chicken fat can be replaced with refined vegetable oils in the formulations of emulsion type of poultry products in case of non availability of chicken fat, particularly from broilers. Patties made from chicken meat have higher yield and overall acceptability than those made from either mutton or combination of chicken and mutton.

6.3.4.2 Restructured Meat Products

Restructuring is a processing technique used for developing convenience products with texture in between intact steak and comminuted product. The purpose of producing restructured products is to effectively market less valuable carcasses from spent or aged birds and animals. Restructuring facilitates the development of more palatable products from meat. Modern technologies like blade tenderization, tumbling and flaking could be used to make tender products and to facilitate production of high quality restructured products. The products include steaks, nuggets, cutlets, chops, masts, rolls and hams. Addition of phosphates to restructured meat products improves the textural properties, sensory attributes and keeping quality. Flaking of meat has been reported to result in lower cooking loss, better binding, improved texture and sensory characteristics in restructured products. Designer health meat products like low fat, low sodium, calcium enriched and fibre enriched products has been standardized by the department of LPT, LUVAS, Hisar.

6.3.4.3 Enrobed Meat Products

Enrobing/coating of meat products with edible materials in the form of batter using flours, whole egg liquid and other additives is a method of value addition which enhances the acceptability of meat products. Enrobing significantly reduces the shrinkage and imparts the product a crispy texture, increases the pleasure of eating with more desirable colours and enhances the shelf life. Product will be juicer as natural juices are retained. Department of LPT has developed enrobed patties using rice flour and grain flour with lower cooking loss, improved texture and sensory characteristics.

6.3.4.4 Snack Products

Extruded meat snacks are made from meat and non-meat ingredients. Extrusion helps to create different forms and shapes of products. They are very popular for convenience, crispness and shelf stability. Meat incorporation in cereal and gram based snacks improves flavour, taste and nutritive value of the products.

6.3.4.5 Traditional Poultry Meat Products

Traditional food plays an important role in human diet. The art of processing is passed on through generations with consequent improvement in acceptability traits like texture, tenderness and flavour profiles. Traditional chicken based fast foods like meat balls (koftas), kababs, tikka, chicken tandoori (roast), biryani, curries, embed and battered products are attracting greater consumer response.

6.3.4.6 Meat Pickles

Mutton and chicken pickles and spread provide smaller quantities for regular consumption which is useful in balancing diets. Pickling is a method of preservation of food products with salt, vinegar, spices, condiments and vegetable oils. Meat pickles are highly acceptable, ready-to-eat and shelf stable convenience meat products of Indian origin. Careful selection of ingredients and their incorporation in appropriate proportion in the formulation is essential for effective preservation and development of desirable sensory attributes of the product. Pickle processed from cooked chicken meat has good acceptability and is stable up to 10 months at ambient temperature.

6.3.4.7 Chicken Soup

Spent hens are also known as soupers because of their use in soup production. Chicken soup is relatively low fat food, since fat is removed from the top by chilling the extract after cooking and skimming. Chicken soup is simple to prepare, relatively cheap and nutritious.

6.3.4.8 Utilization of Giblets

The dressed whole chicken carcass is marketed along with giblets (liver, heart, gizzard and sometimes neck) which are sold as a package stuffed into the cavity of the carcass. As some of the consumers do not prefer the giblets and with an increasing proportion of chicken meat being converted to further processed items, large amount of giblets are either discarded or used in pet food. These giblets can he effectively utilized in processed meat products. Incorporation of skin, gizzard and heart are standardized for emulsion based meat products. Acceptable quality pickles from chicken gizzard have been developed.

6.3.4.9 Chicken Liver Products

Chicken liver accounts for about 2% of live weight, is a nutritious and versatile meat and has great potential to be used as a raw material for processing into many different products. However, its unique flavour and texture do not always find favour in product preparation and thus special care is required to make it palatable. Chicken liver is found suitable for processing marinated (e.g. fried liver, baked liver. tandoori liver, grilled liver, micro-waved liver and liver curry) products. Proper processing may overcome the dark brown colour and soft texture problems for making acceptable liver products.

6.3.5 Egg Processed Products

A great deal of work has been done in India to standardize the processes for manufacturing convenience egg products such as whole egg, albumen and yolk powder, albumen flakes, canned eggs, dehydrated scrambled egg mix, omelete mix and pickled quail and chicken eggs. Some of the processes developed have been commercially exploited. New innovative egg products are frozen omelets, scrambled egg mix cooked in hag, scrambled eggs, egg in muffins, hard cooked eat roll, egg crust pizza, fruit juice egg drink, egg substituted with albumen and other ingredients to make cholesterol free.

6.3.6 Fish Processed Products

There is a negligible processing of fish in India and fish is generally harvested and sold as fresh. Processing of fish is mainly confined to the fish eating countries. One of the most common types of product is Surimi. It is a Japanese word which refers to a food product typically made from white-fleshed fish (such as pollock or hake) that has been pulverized to a paste and attains a rubbery texture when cooked. The most common Surimi products in the Western market are Chikuwa. Kamaboko, Yong tau foo and Fish balls.

6.3.7 Suggestions for Commercialization of Meat products in domestic and Export Markets

- The meat products should be produced within affordable cost to the target group of consumers for market sustainability.
- Newer products require some subsidization during their early phases of introduction till these products find wide acceptability among the consumers.
- Traditional batch type processing should be shifted to continuous processing using modern food processing machinery to increase the production and quality of the product and to enhance the profits. Large scale processing of meat products with automatic processing equipment

would find relevance to market products in metropolitan cities and for exports.

- Meat processing is labour intensive and therefore, promoting small scale ventures with simple technology would find higher relevance in Indian situation with lower labour costs.
- Product quality should be ensured through HACCP and TQM methods of quality control during production and marketing. Quality management staff must he trained to maintain standards all the way.
- Knowledge on new formulations, process optimization, appropriate packaging materials as well as refrigeration facilities is essential requirements for enhancing the quality of traditional meat and poultry products. Special training centres need to be created for the traditional food industry with the support of the State and Central Govt.
- Processing of protein rich and low fat meat products like balls, koftas, tikka, cutlets, tandoori etc. have vast export market potential.
- There is an urgent need to improve product marketing of small meat industries especially in competition with the large Indian and global companies.
- A financing system should be created through banks, private and public sector on easy terms to establish small meat processing industries.

The fresh as well as processed meat, chicken, egg & fishes are high quality protein sources and need to be promoted for better health of the people so that they can perform better and deliver high quality work outputs.

Chapter-7

AGRICULTURAL AND LIVESTOCK WASTES AND BYPRODUCTS PROCESSING

7.1 Introduction

In the process of production, processing and utilization of agricultural biomass, there is a variety of agricultural wastes generated in different farming systems and agro-processing industries requiring an economic utilization in order to enhance overall agricultural productivity & profitability and at the same time protecting the environment from pollution and degradation. Production of food grains, oilseeds and industrial crops like cotton and sugarcane result in a lot of biowastes in the form of crop residues and processing byproducts. Similarly, horticulture and livestock farming also generate substantial residues and byproducts. These agricultural wastes are used for feed, fuel, manure, paper industry, particle board, packaging material, insulation, mushroom growing, building materials, and others. Many pharmaceuticals and chemicals can also be prepared from agricultural waste. Production, processing and utilization of crop residue and processing byproducts are specific to each commodity.

7.2 Sugarcane

It is an important industrial crop of India. Average yield is 65 t/ha & the total annual production is about 300 Mt. Sugarcane is an efficient synthesizer of solar energy and produces high biomass per hectare, comprising 70% water, 15% fibre, 12% sugar and 3% other ingredients. The whole sugarcane plant is composed of tops, stalk, rind & dried leaves. Table 7.1 gives the present utilization of sugarcane & its byproducts. 15- 20% of total biomass synthesized in the form of roots, tops, leaves & bagasse is known as harvest co-products or wastes.

Table 7.1 Various Parts of Sugarcane and its Utilization

Parts of sugarcane and by products	Present utilization
Cane tops	Mostly used as animals feed as such or after mixing with other nutrition
Roots	Ploughed back in the field to provide organic matter or dug up for utilization as agro-fuel.
Leaves and trash	Collected, compacted and transported to factory for utilization in the boiler as an agro-fuel. The calorific value of sun-dried cane trash is nearly double than that of conventional bagasse with 50% moisture. It is also used at some places as fodder for animals.
Bagasse	It is 30-35% of sugarcane crushed and has 50% fibre and 50% moisture. It is used for cattle feed, paper and particleboard. About 45 Mt of bagasse is available in India/year. It also has potential for the production of bio-oil for use in gas-turbine engine, diesel engine, boilers, etc. For bio-oil production, the bagasse is decomposed into a combination of soil-char, gas, vapour and aerosols through fast pyrolysis process and when cooled, most volatiles condense to a liquid referred to as bio-oil. It is a dark-brown free flowing liquid.
Boiler ash	Boiler ash from bagasse is about 0.1% of the cane processed. It contains about 8% potassium (K20) and is used as fertilizer.
Press mud	Sugar factories also produce about 10 Mt of press-mud (filter cake) during refining of juice, every year. It is 3-4% of cane and has about 70% moisture and contains 30-35% organic carbon and 7-15% wax. It is generally applied to the soil. Press-mud can be used for bio-gas generation and for making cane wax. Sugarcane has about 0.125% wax on its outer hard cover to prevent escape of moisture from the plant.
Molasses	It is about 3-5% of total can weight. Molasses contains about 30% sucrose and 16-20% reducing sugars besides N, P & K. It is industrially important for the production of

	rectified spirit and a number of other chemicals. It takes about 24h for completion of fermentation process. The fermented wash (molasses + water) is distilled in distillation columns to separate alcohol and spent wash. Alcohol so produced has nearly 5% moisture and is called rectified spirit which is used in chemical industry for the manufacture of various chemicals. The purified rectified spirit produced after further distillation is called ENA and is used for the manufacture of potable liquors. India produces 10-12 Mt of molasses, and 1600 Mt of alcohol, annually.
Ethanol	The rectified sprit on dehydration (5% to 0.5% moisture) produces dehydrated alcohol known as ethanol and when it is mixed up to 10-12% in petrol can be used in automobiles effectively. The existing Indian specifications allow mixing of ethanol up to 5% in petrol and the Mixed product is known as gasohol and can be used in petrol engine. The spent wash in biomethanation plant produces biogas which is used as fuel in boilers. The distillery effluents can be used for irrigation after treatment

7.3 Cotton

Cotton is mainly cultivated for its lint which is the most sought after textile fibre on account of its inherent ecofriendly and comfort characteristics. Cotton crop gives an average lint yield of 450 kg/ha. The byproducts of cotton crop are linters, seeds and cotton stalk. The total biomass production in cotton cultivation is about 4 t/ha consisting of lint, 0.5t; seed, 1.5t and stalk, 2.0 t. Seed contains about 20% oil, 35% hull, and 45% meal. The bulk of cotton seed is used as cattle feed and most of the cotton stalk is used as fuel. As a result, precious products like cotton stalk, seed, linters, hull, oil, and proteins go under utilized which otherwise could have fetched much needed additional returns to cotton farmers (Table 7.2)

Table 7.2 Uses of Different Fractions of Cotton Crop

Constituents	Uses
Stalk (2t/ha)	Mushroom cultivation, domestic fuel, particle board, pulp & paper, cellulose powder, corrugated boxes for F & V transport, etc.
Cotton seed, hull & meal	Bio-enriched cattle feed, peptos for fermentation industry.
Ginning wastes	Compost, absorbent cotton, pulp & paper
Textile mill wastes	Biogas from willow-dust & biomanure

Cotton stalk is rich in cellulose, hemicellulose and lignin. Hence, it can be used profitably for the cultivation of edible oyster mushroom, preparation of particle boards, binderless boards, pulp & paper, and cellulose powder. The byproducts obtained from cottonseeds are linters, seed hulls and meal. These could be used profitably in high grade pulp for cattle feed and in protein concentrates and hydrolysates.

Seed cotton is processed in ginning industry and the baled lint is processed in textile mills. The wastes of ginning can be used for preparation of absorbent cotton, high grade pulp and compost. The textile mill wastes can be used for the production of biogas/compost depending upon the quality.

Use of cotton byproducts offers an attractive proposition to generate additional income to farmers. Cotton stalk being a renewable lingo cellulosic material, its promotion as a substitute for forest timber is likely to have a direct impact in arresting the environmental degradation. Scientific extraction of cotton seed oil need to be encouraged in India to recover valuable byproducts such as linters, hull & meal which could profitably be put to value-addition.

7.4 Paddy

Paddy is produced, processed, cooked and consumed. It is a staple food of over half of the world population. Paddy production in India is about 140 Mt. with an average yield of 3 t/ha. However, the total biomass production is about 7.5 t/ha as per details given below:

- Total biomass = 7.5 t/ha
- Crop residue = 4.5 t/ha
- Paddy grain = 3.0 t/ha

Grain-straw ratio and harvest index of semi-dwarf and tall varieties of rice are given in table 7.3. On milling, cleaned paddy gives 22% husk, 6% bran and 72% rice. Byproduct of paddy-rice system and their uses are given in Table 7.4.

Table 7.3: Physical Composition of a Dried Paddy Plant

Type of rice	Physical composition%	Harvest index (Grain/Grain+Straw)
Semi-dwarf	• Grain, 46-50(48) • Straws, 35-42(38.5) • Stubble, 6-13(9.5) • Rachis, 3-5(4)	0.43-0.58 (50.5)
Tall Varieties	• Grain, 46-50(48) • Straw, 32-38(35) • Stubbles, 27-31(29) • Rachis, 2-3(3)	0.17-0.44 (30.5)

Table 7.4: Byproducts of Paddy in India

Byproducts	Uses
• Crop residues (Roots , stubbles, and straw)	Roots and stubbles are incorporated in the soil; straw is used for cattle feed , thatched roof , packaging, rope, mushroom cultivation, compost, etc
• Husk	Fuel, poultry litter, building material, packaging, silica, soil amendment, etc.
• Bran and polish	Cattle & poultry feed, edible oil, baby food, dietary fibre, rice bran protein concentrate etc.

7.5 Soybean

Soybean is a legume rich in protein (40%) & oil (20%) and also contains about 23% carbohydrates, reasonable amount of minerals and vitamins. Total production of soybean in India is about 12 Mt. with an average productivity of 1100 kg/ha. Total biomass production is about 3t/ha. Consisting of grain, 1t/ha and stalk, branches, leaves etc., 2t/ha. Soybean harvest index is 30-35%. It is mainly cultivated for oil, protein & lecithin. It provides approximately 60% of vegetable protein and 30% of oil in the world. The major byproducts of soybean production and processing are crop stalk (residue), hull and soy meal. Its present & potential uses are given in Table 7.5. Oil yield is about 18% & soy meal is 82%.

Table 7.5: Crop Residue and Processing Byproducts of the Soybean

Crop residue & processing byproducts	Uses
Crop residue, 65% of total biomass production	Fuel , particle board , feed (leaves & fine branches)
Hull , 10% of grain	Animal feed , fuel,etc.
Soybean, 82% of cotyledons	Food, feed, pharmaceuticals & other industrial products.
Lecithin, 01% of crude oil	Food emulsifier, pharmaceuticals, paints & varnishes, etc.
Okara & Whey, 15% of grain in making dairy analogs	Dietary fiber, SCP, citric acid , enzymes, alcohol, aqua-feed, etc.

There is a need to create an awareness about soybean processing products and byproducts which can be used for a wide range of food, feed, pharmaceutical and

industrial products. It would also help in controlling environmental pollution and soil degradation.

7.6 Horticulture

A variety of byproducts and waste-water are generated during horticultural crop processing (Table 7.6 & 7.7). Almost all of these have a high organic load and therefore, require extensive treatment prior to disposal. Hence, the best strategy is to utilize these for gainful purpose to derive revenue and also to prevent environmental pollution.

Table 7.6 : Fruits and Vegetables Wastes & Byproducts

Fruits/Vegetables	Byproducts generated
Fruits	
Apple	Pomace, cull fruits
Banana	Peel, stem, plant residue (leaves, flower, pseudostem)
Citrus fruit (orange ,lime, lemon)	Peel, pomace, seeds, cull fruits
Grape	Pomace(skin, seed & stem)
Guava	Peel & seeds
Jackfruit	Thick rind, seeds
Mango	Peels, pulpier waste and kernel
Papaya	Peels & seeds
Peach, plum, apricot, olive, nectarine & cherry	Stone
Pineapple	Peels, core, crown, stem, leaves, mill juice
Pomegranate	Peels & pomace
Vegetables	
Asparagus	Trimmings
Leafy vegetable	Trimmings
Okra	stems
Onion	Trimming (heads & tail), peels
Peas	Trimming, pods, husk
Potato	Peels, coarse solids
Tomato	Skin, core, seeds

Table 7.7 : Gainful Utilization of Byproducts of Horticultural Crops

Byproducts	Utilizations, value added products
Peels	Biofertilizers, bioflavonoids, animals feed, biogass, single cell protein, herbal cosmetics, ethanol, natural colours, pectin, etc.
Pomace	Animal feed, biofertilizer, biogas, citric acid & its derivatives, flavor concentrates, vinegar, wine/ alcohol, etc.
Seeds/kernel	Animal feed, charcoal, fertilizer, food supplement, coagulant, seed oil & protein, tannins, etc.
Trimmings, pods, vines, husks	Animal feed, concentrates, soup stock, etc.
Banana stem and fibre, pseudostem, leaves, unripe fruits	Paper, animals feed, starch, fiber, bioplates, vegetable preparation, etc.
Citrus leaves	Essential oils for perfumery applications.
Jackfruit-rind	Jelly
Mango pulpier waste	Juice, wine, vinegar, biomass
Papaya skin	Latex for papain manufacture
Pineapple byproducts	Animals feed, fiber, candies, syrup, vinegar, citric acid, wine, sterols, etc.

India is 2nd to China in F&V production and enjoys an enviable position. F&V consumption in house-holds, restaurants, mandies leads to generation of byproducts and liquid wastes. Cooperative ventures for gainful utilization and/or biological treatment of these waste streams are warranted. Industrial processing of fruits & vegetables leads to huge production of byproducts and waste-water whose treatment for disposal/use is highly capital intensive and also involves constant recurring expenses, but there is no monetary return except in case of anaerobic digestion in closed reactors and biocomposting methods. It is, therefore, of vital importance to gainfully utilize the byproducts and waste-water streams of F&V processing industry using solid state fermentation which offers an easy, economical and potential for treating both, solid and liquid wastes as well as for gainful utilization of F&V processing industry wastes/byproducts.

7.7 Livestock

Raising of livestock's such as animals, poultry & fishes constitute an integral part of agricultural production system. An effect for optimizing the overall productivity of

farm animals and aqua-products would lead to an increased availability of high value livestock proteins. A positive shift towards the use of food of animal origin is an indicator of development. There is an urgent need for appropriate livestock management practices aiming at total elimination or at least minimization of wastes from livestock farms. Entering of wastes into streams, ponds, water-ways, sinkholes, drainage ditches and groundwater need to be checked and minimized. Preferably, a no discharge or zero-wastes system should be designed to take care of waste-water and contaminated stream water run-off on the farm itself rather than discharging off site.

Recycling of livestock wastes employing technical innovations such as anaerobic digestion of wastes, use of earthworms as a bioagent and minimization of silage wastes. The principle of the polluter pays is now widely accepted with inbuilt mechanism of imposing taxes and financial penalties for any breach. The law must set standards for limits of pollutants together with specification for livestock farm buildings and equipment for safe waste disposal.

The scheme to relocate livestock production away from the cities can succeed provided transport costs are not prohibitive and infrastructures such as roads, markets, and cold storages are well developed by public sector investment. It will be wise to transport animal products rather than feed stuffs to urban agglomerates.

The problem of environmental pollution from swine production is quite acute because of high concentration of animals near the cities. It becomes necessary to avoid discharge of high BOD effluents into municipal drainage or water streams without proper waste treatment.

7.7.1 Animals and Poultry

Many abattoirs are situated in residential area, as the cities grew after wards around the slaughter house. Relocation of abattoirs away from the municipal areas and construction of suitable house structures with waste treatment and disposal facilities is essential to avoid pollution and fly menace. In order to promote a satisfactory level of safety, slaughter houses should be compelled to apply the minimum sanitary standards laid down by the health authority and pollution control boards.

7.7.2 .1 Slaughter House Waste Management

Products obtained from slaughtered animals other than meat are termed as slaughter house waste or byproducts, the terms byproducts and offal are used to denote those parts which are not included in dressed carcass. Animal byproducts are broadly divided in two categories viz. edible and non-edible byproducts. Those suitable for human consumption are edible and the rest are termed as non-edible. Variety meat is a term that is used in the meat trade for traditionally edible

byproducts, such as livers, brains, tongues, kidneys, tripe, stomachs, chitterlings, oxtails, checks meat, head meat, snouts. lips, hearts, pig's tails, etc. Non-edible byproducts are hides, skins, wool, fat, blood, bones, gall and urinary bladders, horns, hoofs, claws, teeth, fetus etc.

7.7.2.2 Effect of Slaughter House Waste on Environment

- The major environmental issues associated with slaughter house operations are the high consumption of water, the discharge of effluent with high BOD value, odour pollution and solid waste disposal.
- These wastes are mainly composed of water, fat and protein. Microbes under suitable conditions putrefy the proteinous matter, making it unsafe and unpalatable for use even in livestock feed. Fat becomes rancid by oxidation. Some wastes like blood and soft tissues such as meat and offals putrefy very quickly.
- Some of the slaughter house wastes are non-biodegradable and cannot be absorbed by ecosystem in natural course. If allowed to putrefy in open, some of them can be source of diseases and leaching of certain undesirable chemicals into life support systems. These may cause land, water and air pollution quite readily.
- Open dumping of slaughter house waste may cause diseases. Burning by using incinerator can add to the air pollution.
- If disposed in a water stream, these wastes, having higher oxygen demand can lead to the depletion of dissolved oxygen in water. The oxygen depletion from rivers/marine systems affects fishes and other aquatic life. Sometimes the deposits decompose an aerobically with heavy evolution of gases, mainly H_2S, causing deterioration in the taste and odour of water. The water is also liable to be infested with germs causing diseases in animals and human beings.
- Biological decomposition of organic matter available as slaughter house wastes may also cause release of some hydrocarbons such as methane & ethylene. In humans, hydrocarbons cause irritation of mucus membranes, bronchial construction and eye irritation. Some of these are reported to trigger development of lung cancer.

7.7.2.3 Utilization of slaughter house waste and byproducts

- Most of the slaughter house wastes/byproducts in India are either completely wasted or partially processed. As discussed earlier, their unscientific handling and disposal as solid wastes and liquid effluents results in air, water and soil pollution and also affect human and animal

life. However, if properly collected, processed and utilized, most of these waste products prove to be potential raw materials for animal, poultry and aqua feed, manure and fertilizer, cosmetics. pharmaceuticals etc.

- Presently, the livestock feed production is cereal based which results in livestock including poultry, fishes and pigs competing with humans for grains which otherwise can be partially replaced by slaughter house wastes.
- Slaughter house byproducts can also be exploited as pet and laboratory animal feed.
- Bones produced as slaughter house waste can be used to produce ossein, a protein of very high quality, used as a raw material for gelatine manufacturing. The by-products from the manufacturing process are di-calcium phosphate and calcium chloride, both having commercial value.
- Not only the solid wastes obtained from slaughter house but the liquid effluents which also affect the environment seriously can be utilized for irrigation after proper treatment. The use of some of the slaughter house wastes as manure is well established. These wastes can also be utilized for production of biogas.

7.7.3 Fishery

There is about one million tonnes of fishery wastes, every year from the domestic fish dressings and seafood processing plants. There is no organized collection of fish wastes from homes. Fish is generally sold as whole in the local markets, making it difficult to collect the valuable fish wastes which can be used for making a number of value added products such as fish meal, fish liver oil, fish silage, shark fin rays & earl essence, etc. Chitin and Chitosan are the two valuable products now produced in India from shrimp shell waste and are exported to earn valuable foreign exchange. Squalenes, a component seen in the liver oil of deep sea shark and biodegradable surgical sutures from the gut of fish, have emerged as two high value products from fish wastes.

During the pre-processing operation of the fish, prior to cooking and eating, a lot of waste is produced. These wastes include head, viscera, skin, scales, bones, shell, etc. The quantity depends on the type of dressing procedures followed. The yield of waste from domestic dressing may be around 10-15% depending upon the type & size of the fish. It may be around 40-45% in case of industrial processing of shrimp. On an average, the yield of fishery waste in India could be fixed about one million tones. This is a sizable quantity. However, its collection is a difficult proposition. In the developed countries, most of the fish is sold in dressed form through pre-

processing establishments, since waste disposal is difficult in cities, and the house-wives generally like a clean and ready to use material. Disposal and utilization of fish wastes are very important from public health point of view.

7.7.4 Observations and Suggestions

Observations: A substantial quantity of animal byproducts and liquid effluents are continuously produced in abattoirs as slaughter house wastes. Some of them are properly collected and processed in modern industrialized slaughtering complexes and meat processing plants which operate mostly in private sectors. However, majority of slaughter houses do not conform to the basic requirements and byproduct utilization and recovery from such slaughter houses is very poor. Illegal and unauthorized slaughter also takes place and byproduct recovery and waste treatment in such slaughtering is also poor. The byproducts produced from such slaughter operations, some of which are of edible grade, are of questionable quality. These are health hazard for consumer.

Suggestions: Slaughter house byproducts/wastes should be conserved at production site. Later they should be transported to ancillary units for further processing into various end products. A number of secondary industries such as manufacturing of crushed bones, bones glue. bone ash, horn and hoof meal, glue and gelatin, livestock mineral mix, livestock feed, leather, sausage casings, surgical and sports guts, gum tapes, soap, candles, etc may be established for utilization of slaughter house byproducts/waste. This two-tier approach will help in protection of environment and also provide substantial employment opportunities.

In order to successfully carry out the unit operations of meat industry without legal complication, pollution control steps need to be nesserly taken. To achieve this, proper disposal of solid wastes and liquid wastes must be carried out following different primary and secondary treatment methods depending upon the land area and facilities available in the meat plant or slaughter house. These effluent treatment method will not only minimize the pollution hazards but also can be very useful in recovering and recycling of the slaughter house or meat plant wastes for economic returns and are thus quite useful for sustainability of the meat industry.

There is a substantial wealth in agricultural and livestock wastes and byproducts. If, efficiently utilized for soil amendment, livestock feed, biofuel and industrial applications, these would result in high employment and economic returns to farmers as well as to small and medium scale entrepreneurs. Such initiatives would enhance agricultural and livestock productivity benefiting all those involved in value-addition chain as well as the nation.

Chapter – 8

AGRIBUSINESS MANAGEMENT

8.1 Introduction

Agri-business is the management of agriculture produce/products marketing with the objective of earning profits by satisfying the needs and wants of consumers taking into account the wellbeing of society and environment. The basic objective is income generation through agricultural production and marketing of commodities, products and services through sustainable and ethical means. Its domain covers all agricultural and related management activities having commercial objective covering the entire food chain from production to consumption.

As of now, agriculture has evolved into agribusiness and has become a vast and complex system that reaches far beyond the farm to include all those who are involved in bringing food and fibre to consumers. Agribusiness includes not only those that farm the land but also the people and firms that provide the inputs like seed, chemicals, credit etc., process the output such as, milk, grain, meat etc., manufacture the food products namely ice cream, bread, breakfast cereals, etc. and transport and sell the food products to consumers, restaurants, supermarkets, etc.

Important agri-business includes production, processing and marketing of plant and livestock based produces and other allied activities (Table- 8.1)

Table – 8.1 Important Agribusiness Activities

Activities	A brief description
Production Agriculture	Growing of field crops, horticulture, floriculture, aromatic & medicinal plants, spices & condiments, plantation, etc.
Livestock Farming	Dairy, poultry, fishery, meat, animals, etc.
Post-production agriculture	Handling, Transporting, Drying. Storage, processing, marketing, etc.
Inputs Supply and Services	Seeds, fertilizers, chemicals, machine & tools, maintenance, hiring, agriclinic, soil testing, etc.
Contract and/or cooperative farming	Specialized agriculture for processing and/or marketing and to take the benefit of scales, etc.

8.2 Types of Agribusiness

It may be run by a single person, generally known as an agri-entrepreneur, in partnership mode involving two or more persons; cooperative and as a corporation/company. Various agribusiness activities are village & cottage industry, micro-enterprises, small scale industries, medium enterprises, women enterprises, export oriented units & so on.

8.3 Financial Management

It is concern with procurement and utilization of funds from various sources such as internal or external. The main aspects of a good financial management are: Sources of funds, Working capital management, Standard costing, Capital budgeting and Accounting.

Finance is needed at all the stages of commercial agriculture and agri-business for inputs such as seeds, fertilizers, equipment, water, electricity, labour, etc. Procurement of finances required may be tapped from sources such as: Own capital, Money lenders, Commission agents, Market operators, Commercial banks and Cooperative banks.

Public sector banks have been advised to open at least one specialized branch in each district and permitted to categorize their micro, small, medium enterprises (MSME) as specialized MSME branch, provided 60% or more of their advances go to MSME sector.

8.4 Marketing and Profit Sharing

The people in rural areas are mostly involved in activities related to farming, food processing, handloom, handicrafts and other cottage industries. They generally sell their produces & products in the local market. To sell their products in urban market, they depend on the middlemen who purchase at low cost from producers and sell it to urban consumers at higher prices but the share of rural producers in the consumer money is very low.

As of now, many governmental agencies and NGOs have come forward with many strategies to promote marketing of agricultural produces and other rural based goods to urban consumers giving a better share of the profits to rural producers. These arrangements need to be encouraged and promoted for the marketing of agricultural, livestock and other produces of the farmers.

Chapter-9

GUIDELINES FOR ESTABLISHING AGRO-ENTERPRISES

9.1 Introduction

Haryana is a predominantly an agricultural economy and most of its population lives in villages and earns its livelihood through agriculture. Every human being on the planet earth wants prosperity, happiness and security. To achieve these goals, diversification and modernization of agriculture for higher productivity and equitable distribution of food commodities and other necessities of life are needed. Rural people migrate to urban areas for employment and better amenities of life, because such opportunities are presently not available in rural areas but could be created through the development of infrastructures such as road, electricity, health, education, mechanization of agriculture and appropriate post harvest management and value addition to the harvested biomass in the production catchments. Such facilities in rural sector would contribute towards enhancement of per capita food availability and employment resulting into rural prosperity and better living for both, rural and urban people.

9.2 Agro-Processing Centre

Integration of production agriculture with on-farm processing is needed to have higher and sustainable production, productivity and better quality end products for domestic and export markets. It, therefore, demands establishment of Agro Processing Centers in the production catchments itself to facilitate backward linkage with farmers, have fresh and best quality raw food materials for processing and value addition, minimize material movements, check migration of rural people to urban areas for jobs and thereby reduce pressure on public utilities in urban areas. Such center would be a very strong tool for rural reconstruction and its upliftment. It would help in reducing rural-urban disparity and ensuring household food and nutritional security for all at an affordable cost. The technology is available but political will and commitment is required to implement the programme to shape a new state in the new millennium where every one would be healthy and happy. It is in the interest of the state and its people. The action programmes to implement agro-processing in the production catchment are:

- Continued monitoring of status of processing and utilization of different crops/ commodities, processes, quality assurance, energy audits and economic competitiveness.
- Development and promotion of on-farm storage and rural warehouses for perishables, semi-perishables as well as durables that minimize storage and associated losses, enable growers/herdsmen/fishermen having capacity to negotiate with forces of marketing, provide off-season goods to local people at low rates and raw materials to entrepreneurs/industry with dividends to both.
- Study of postharvest physiology, senescence, ripening, respiration etc. of different crops varieties and commodities as influenced by time, temperature, humidity, mechanical injuries/ interaction, etc.
- Development of HACCP and food safety measures for different commodities and products and developing mechanisms to apply and certify them, setting up of referral laboratories and human resource development capacities in goods biosafety.
- Harnessing biotechnology and genetic engineering that enhance shelf life, quality, and nutritive value; protection against postharvest insects, pests and mycotoxins; improve products market appeal and product recovery, and ultimately make the products economical and globally competitive.
- Modernization and cost reduction of cleaning, grading, sorting, milling, processing and packaging equipment for food grains, oilseeds, horticultural crops, animal products and fish; noise and pollution control and effluent treatment and management.
- Modernized packages of technology and machines for processing and utilization of different agricultural commodities/crops and their residues and that of under utilized plants into products that are in demand as well as developing processes and pilot plants for high value futuristic products or their intermediate stages needed by the industry.
- Development of processes and processing machinery for diversified products from commercial crops like cotton, sugarcane, guar, etc.
- Development and adaptation of color sorter for removing discolored fractions in milled rice, dal and fruit sorting lines.
- Development and commercialization of convenience diet and specialty foods having good nutrition and low-cost.

Looking into the present agricultural production and post-production scenario in Haryana, the most appropriate action for employment generation in rural sector is primary processing and value addition in production catchments. Technology for establishing such agro-processing complex in rural areas is available in India and requires to be adopted and should be demonstrated through pilot plants. This will not only help in reducing post production losses, generating employment opportunities in rural sector and higher income to farmers but also provide better quality products to the consumers at reduced rates. This will also lead to the economic utilization of byproducts enriching animal health through feed, and soil via composting. Thus, agro-processing in production catchments will benefit people, livestock and the mother earth.

A substantial amount of postharvest losses could be prevented if appropriate agro-processing centers having backward linkage with farmers to ensure constant supply of quality raw food materials are established and operated. Profit generated through value addition must also be shared with farmers who are only people in the world to create wealth every year, in the form of food, fibre and other commodities necessary for human survival. It can bring a sea change in rural areas, where about 65% population lives, in respect of economy, health and happiness.

A wide range of tools, machines and equipments are used in post-production agriculture. The globalization of trade may compel many agro processing industries to rely on an imported technology at a high cost and the advantage of such technology may be availed by a few who have an exclusive business interest. Majority of agriculture-based enterprises will continue to depend upon indigenous technology and, therefore, R&D through public support has to be strengthened to become globally competitive and serve small-scale food processing sector of the country.

9.3 Starting an Agro-Enterprise

An economic activity, run and managed by an individual or a group of people is generally known as an enterprise and the one who is able to organize, manage and assume the risk of running an enterprise is called an entrepreneur. Where agricultural/livestock based produces/raw materials are used by an entrepreneur/enterprise, it is known as an agro-enterprise. The enterprise may be of different scales, micro, small, medium, large, etc. The micro and small enterprises are those in which the major operational and management decisions are made by one person. An enterprise in which owner operates independently or hires a few regular employees, say up to five, is often referred to as micro-enterprise and those enterprises in which as many as twenty five workers are employed are often called small scale enterprise.

There is a convergence of thought at all levels that development and application of appropriate postharvest technologies leading to the establishment of Agro-Processing Centers (APCs) in the production catchments and owned & operated by targeted beneficiaries, individually or collectively, are must. It has greater potential for employment and income generation than production agriculture. It can help in stabilizing market prices through removing vulnerabilities of perishable by transforming them into semi-perishables or durables or through appropriate postharvest infrastructure that hold safely the perishables agricultural commodities for table use. De-urbanization has come to be a developmental goal in order to improve the lot of the rural people. It is now well recognized that agro-livestock produce based industrial development, even at the small and cottage industry levels, is critically important to the expansion and diversification of the agricultural and livestock sectors. Agribusiness is defined as the science coordinating and supplying agricultural inputs for production, processing, and marketing of food, feed, fibre and other necessities of life for human survival and living.

The broad categories of agriculture and livestock based food processing enterprises are grains; fruits & vegetables; plantation crops; bakery & confectionery; milk & milk products; meat & poultry; fisheries and see foods; alcoholic beverages and so on. Agriculture engages most of the population and therefore, no enterprise will be better than agricultural produce based endevours for rural development. However, with few exceptions, the agro-industrial sector remains rudimentary, underdeveloped and largely without significant institutional, technical and financial support. Being mindful of the pitfalls and obstacles to agro-processing related development, it may be instructive to understand the concept of establishing agro-processing center and economic analysis associated to boost up this sector to increase income generation and sustainable rural development.

9.3.1 Guidelines

Starting of a business to earn profit is the main concern of an entrepreneur. There are several problems related to socio-economic, political, financial, administrative and technical nature for establishing agricultural enterprises for rural people. The entrepreneurs would be required to handle systematically the complex nature of the problems and their interactions. The following are some basic steps to start an agro-enterprise.

9.3.1.1 Planning

- Setting up system boundary conditions with correct definition.
- Collection of reliable data.
- Designating in-house project team.

- Determination of functions to satisfy the objectives.
- Decision making about the reliable equipment, instrument and machines.
- Realistic estimation in renovation requirement and decision taking for future modernization and expansion.

9.3.1.2 Execution

- Selection of location
- Creation of confidence among the beneficiary
- Satisfying the social factors
- Finance allocation/searching availability
- Proper utilization of available space
- Overcoming the problem of licensing the plant/centre
- Creation of industrial/business environment in rural areas/ villages

9.3.1.3 Installation

- Installation of the machines according to the plan and processed chart.
- Avoiding interference of instrument, cables, walls etc. in installation of machine.
- Getting connection of power (electricity) and water lines.

9.3.1.4 Production

- Training the entrepreneur to operate the machine.
- Production of the processed products and overall management of the center.
- Correct planning and schedule for production and development of feasible control procedure.
- Deciding the need and quality of the product to be processed.
- Proper testing and demonstration of all equipment to the prospective users.

9.3.1.5 Implementation

- Testing of mechanical control.
- Attending to the repair and maintenance needs.
- Ensuring availability of raw materials.
- Transport.
- Deciding the demand of the products.
- Storage of raw materials and processed products.

- Getting cooperation of financing agencies.
- Registration of products under food acts.
- Keeping correct amount of asset and proper distribution of profit.
- Creation of management information system.
- Problem measurement efficiency.
- Collective decision and cooperation of beneficiary.

9.3.1.6 Marketing

- Creation of market.
- Meeting the demand.
- Production of superior and economical products.
- Gearing to face market competition.
- Avoiding delay in marketing.

9.3.2 Product Selection

The selection of suitable products for small-scale manufacture and then the process by which to make them, require very careful consideration. It is not sufficient to assume that simply because there is surplus raw material each year that a viable food processing venture can be created to use up the excess. There must be a demand for the processed product, which has been clearly identified before a process is set-up.

9.3.3 Appropriate Technology

Appropriate food technology implies, affordable, locally produced, locally repaired, reliable technology that has a suitable scale and complexity of operation for the people who will operate it. It would help increase income and improve income distribution. However, the knowledge. of the appropriate technology alone will not ensure its adoption. Proven prototypes may be needed for demonstration and those who are convinced of the effectiveness of a technology may need financial support to acquire and promote it. This in turn may require the collaboration of national food research institute and or university food science and technology department for development and testing of technology for local needs.

The consequence of introducing a new technology is largely unpredictable. It is true that potentially adverse effects of a new technology on poor produces can be predicted to some extent and therefore avoided by careful studies before a project is implemented. But the larger number of factors that in play during a technological change prevent an accurate prediction of the final outcome and of who will benefit. There is, therefore, a need for sensitivity and understanding of the social and cultural content in which, the introduction is planned. The criteria that will help to decide

whether to recommend a technology are complex and inter-related but are likely to include the following:

- Technical effectiveness.
- Relative cost of equipment and any ancillary services required.
- Operating cost and overall financial profitability.
- Health and safety features.
- Conformity with existing administrative or production conditions.
- Social effects such as displacement of a work force.
- Training and skill levels required for operation, maintenance and repairs.
- Environmental impact such as pollution of air or local waterways.
- Flexibility to perform more than one function.
- Compatibility with other parts of the process.

However, it must be stressed that each of these factors is an aid to judgment by staff on the spot and not simply a checklist. Each will have a different weightage in different circumstances and there can be no simple solution to the difficult task of weighing up all the factors in a particular situation and making the best-fit from the available technologies.

9.3.4 Problems and Constraints

Raw materials are seasonal and some of them are highly perishable, making food business difficult. Foods are biological material whose composition varies as a result of the action of weather, pests and diseases. This means unpredictable supply and cost of raw materials. Even after processing, foods do not keep indefinitely. The shelf life of processed food can vary from a few days to several months or years. The distribution and sales methods used by the entrepreneur must be suited to the expected shelf life of the food and carefully organized so that customers receive the food before it spoils.

Packaging is an important means of controlling shelf life of food but there are problems in finding suitable packaging materials in rural areas of the developing countries. This is one of the most important constraints on small scale food processing. The technically advanced plastic films, cartons and cans usually have to be imported and are very expensive. Traditionally packaged foods do not perform well technically and are often perceived by customers as inferior. This put the small-scale entrepreneur at a marketing disadvantage compared to equivalent imported products.

Food is the only commodity that people buy every day and eat. Hence, in all food processing activities there is an over-riding concern to avoid food poisoning.

Processors and processing methods must meet strict standards of cleanliness and production control to avoid the risk of harming or even killing their customers by allowing the growth of food poisoning organisms in their products. Thus, the small-scale food processors have to operate under such multiple complex technical constraints. In the majority of the developing countries, the bulk of food processing enterprises are on a small scale and are located in the informal sector. They are rarely formed into associations and have little economic power or ability to seek such assistance as may be available. They often need intermediaries, such as extension agents, to guide them to appropriate solutions for their own individual products. The larger, formal food processing sector may receive government support in the form of subsidies, foreign exchange allowances, price stabilization, or guarantees and access to specialist advice. In contrast, the small-scale informal sector has no political influence; despite its combined voting power, and is therefore subject to the vagaries of the national and/or international economic climate.

The major goals of postharvest technology at rural threshold should be:

- Minimization of harvest and postharvest losses, improving net availability and net returns to the growers.
- Capacity to handle and hold the produce without excessive losses at affordable cost to negotiate with the forces of marketing avoiding distress sales.
- Transforming the perishables into semi-perishables or durables for better marketing and also for value addition.
- Creation of rural agro-processing enterprises that meet needs of the rural people at the least cost and market surplus after value addition for additional income and employment.
- Improve livelihood base of rural people through entrepreneurship development and upgradation of skills.
- Provideing fresh and processed products at reasonable rates to the consumer.
- Appropriate packaging and marketing of minimally processed and value added products through cooperative, super market, and other retail outlets.

Since food processing technology is commodity and location specific, it would be better to start the enterprise in the guidance of a R&D Centre of a National/State Research Organization/Institution or NGO, etc. It is so, because such R&D organizations or relevant NGO have the expertise which may be helpful in technical, financial and marketing matters.

9.6 Suggestions

Postharvest technology is commodity and location specific. The present requirement is to adopt/develop/refine the need based and market driven PHT and equipment for loss prevention, processing and value addition to raw food/feed materials of plant and animal origin for household consumption and national and international markets. To achieve this, the specific recommendations are:

- Establish and operate agro-processing centers in the production catchments to minimize losses and transform the raw food materials into palatable and nutritive edible products at an affordable price by one and all.
- Make better use of crop residues, processing by-products and waste in eco-friendly and' economically rewarding mode.
- Hygiene and quality standard specific for domestic and export markets for fresh and processed products need to be met.

The combined net result of establishing and running a successful rural based agro-enterprise would be gainful employment and income augmentation of rural people and thereby, enhancing their life quality.

Chapter-10
OBSERVATIONS AND SUGGESTIONS

Observations

10.1 Agriculture is one of the oldest livelihood activity practised over the centuries and for its betterment. Indian farmers have consistently tried to make this occupation more efficient and cost effective which has resulted in improving farming and thereby ensuring better livelihood options. Farm women are playing a commendable role, especially in postharvest management and value addition, to a large number of field crops, vegetables, fruits, dairy, poultry and fishery sectors, etc.

10.2 The WG was informed by the Rice Miller that taxes like Marketing Fee (MF) and Rural Development Fee (RDF) in rice milling industry are more in Haryana as compared to the neighbouring states of Punjab, Delhi, UP and UK. A comparison is given below:

States	Application rate of fee			Remark
	MF, %	RDF, %	Total, %	
• Haryana	2	2	4	UP & UK exempt MF & RDF of 2.5% for exporters.
• Punjab	Nil	Nil	Nil	
• Delhi	1	-	1	
• U.P.	2	0.5	2.5	
• Uttra Khand	2	0.5	2.5	

Haryana is the only state in which rate of MF & RDF is much higher and also there is no development fee on the export of rice. It was also informed to the WG that the Government of Punjab has recently announced New Fiscal Policy-2013, according to which the State would provide fiscal incentives for setting up of rice milling industry in Punjab, as under:

- VAT and CST incentives for units with Fixed Capital Investment (FCI), up to 50% of FCI.

- 100% exemption from payment on Electricity Duty on Power, including captive power consumption; payment of stamp duty; and property tax.
- 50% exemption from payment of Market Fee, Rural Development Fund and Infrastructural Development Cess.

It is therefore, suggested that such fiscal incentives may also be provided to the rice milling industry in Haryana. Also, it was felt by the WG group that there is a need of trained rice-mill floor workers to get higher yield of better quality rice. Hence an appropriate rice mill technician training centre may be established at CCSHAU, Hisar or at any relevant place giving Diploma/ Certificates in rice milling and allied activities.

10.3 In order to have higher and sustainable agricultural productivity to meet the food and nutritional requirements of the growing population and to provide remunerative price to the farmers, diversification and intensification of agriculture are needed along with fixation of minimum support price (MSP) and procurement policy not only that of cereals but pulses, oilseeds & horticultural produces also. Crops like groundnut, soybean, sorghum, sunflower, guar, castor and pigeon pea are the potential crops which can be promoted under diversification.

10.4 Marketing of agricultural and livestock produces and products are as important as production. It is the market where prices are determined and the fate of farmer's produce and ultimately his income is decided. Lack of proper marketing infrastructure and rigidity of the Agricultural Produce Markets Act (APMA) are the factors responsible for poor return to farmers, especially in case of perishable commodities such as fruits, vegetables & livestock produces. The agricultural marketing system should, therefore, be more efficient and pro-farmer and at the same time beneficial to the consumers.

10.5 The State has identified the Food Processing and Agro Based Industry as a thrust area. In Haryana, more than 972 food processing and Agro-based industries in large and medium sector, have been setup with an investment of about Rs. 3680.54 crores and these industries are providing direct employment to over 30716 persons with an annual turnover of Rs.11152.84 crores. A large number of SSI units have also come up in the State are food processing industries. Haryana is one of the largest exporters of rice, pickles, guar gum, cotton yarn and several other food products. There are a large number of units in the State which are engaged in manufacturing and export of processed vegetables, noodles, dalia, tomato puree, fruit juice, confectionery items, soft drinks etc. The Industries department is the nodal agency of the Government of Haryana, responsible for developing a strong

and vibrant food-processing sector. Key objectives of this sector are achieving maximum value addition and byproduct utilization, creating increased job opportunities particularly in rural area, enabling farmers to reap the benefits of modern technology, and creating surpluses for export.

10.6 Strengthening backward linkages between the processed food industry and farmers who work for primary agriculture, horticulture, milk, meat, poultry, fishery and other production system. Establishment of food processing industrial parks, research and packaging, and utilization of byproducts of the primary food production system and that of the food processing industry are needed. The tremendous potential of the food processing sector in both, the domestic and the export market, is now required to be tapped by the Govt. with the aim of resource optimization.

10.7 The food processing industry in Haryana mainly comprises of rice milling (525 units), wheat milling (69 units), bakery products (55 units), dairy products (62 units), achar, pickle, chutney (23 units). The ratio of turnover and investment was maximum in case of spice industry followed by pulse milling, dairy products, achar, pickle, chutney and bakery products.

10.8 Agriculture and livestock farming in Haryana has a great potential for higher employment and income generation through its diversification and commercialization provided primary and secondary processing of harvested biomass of plant and animal origin is done in the production catchment and there is a strong link with domestic and export markets.

Suggestions

10.9 There is a need for the revision of APMA and creation of specialized market for perishables like fruits, vegetables, flowers, dairy products, fishery and poultry products with cold chain, primary processing & packaging facilities supported by information technology (IT) driven market intelligence. Farmers may be allowed to sell their perishable produces directly to the retailer and/or consumers.

10.10 Agricultural prices are often volatile and farmers are not so well organized to regulate supply of their produces. The need is, therefore, to fix minimum support price for major agricultural commodities with effective procurement system. MSP should be at least 1.5 times to the cost of production. There should be a dedicated system of procurement and prompt payment to the farmers.

10.11 In order to avoid distress sale of agricultural commodities during harvest season and/or at times when farmer need immediate cash, there is a need to develop pledged storage or warehousing facilities, at nominal rates, around a

cluster of villages or markets with the provision of negotiable receipt as well as loan at low interest rates (03-05%).

10.12 Contract farming is an important means of linking farmers to the market and safeguarding them from wide price fluctuations. Contract farmer would invariably cultivate specified crop/variety under strict supervision and management of the contractor/industry. However, it requires proper check and balance through an appropriate regulation issued by the government. A memorandum of understanding (MOU) needs to be worked out and used with provision of dedicated disputes settlement mechanism.

10.13 There is a need to have Farmer's Market (Kisan Bazaar) in the State with proper facilities for marketing & storage. The farmers bringing their own produce to Kisan Bazaar be extended free marketing space. Marketing Board could be mandated to establish a few Kisan Bazaar to begin with. Such facilities would help farmers not to be exploited by the traders. It also brings farmers/producers and consumers in direct contact and both would be benefited.

10.14 Aggressive programmes for training of rural youth, especially farm women, in postharvest handling and value addition of the locally available agri-produces would help in minimizing post-production loses and in linking, rural communities to markets for generating higher income.

10.15 There is a need to set-up sanitary & phyto-sanitary and quality testing laboratories, preferably in production catchment/zone in each region to test and certify farm produces/products (agri-produces, organic foods, medicinal plants, dairy products, forest produce, etc.) produce by the local agri-entrepreneurs.

10.16 Documentation and use of available knowledge relating to medicinal uses of local herbal plants need to be done, to strengthen this area, there is a need to develop processing facilities for preparing primary products and drugs from locally available medicinal plants, especially to treat common ailments.

10.17 Machinery & equipment required for small dairy farm mechanisation, primary level milk processing and value addition need to be identified, tested, multiplied and made available to needy farmers on subsidized rate.

10.18 In the absence of postharvest facilities in the production catchment, most of the produces of the farmers are sold as raw material leading to reduced return on investment and no employment opportunities to rural youth.

10.19 Linking farmers with processing industry through appropriate mechanism such as contract and/or cooperative farming and automation of operations in

agricultural marketing such as primary processing (cleaning, grading, drying, storage, etc.) should be done so that farmers get better return on investment. Participation of private sector in handling, storage and supply chain in collaboration with farmers needs to encouraged.

10.20 Opportunities are emerging for agri-business and entrepreneurship in domestic and global market leading to income generation through appropriate agriculture and postharvest management. India's geographical situation gives it a unique advantage of connectivity to Europe, Middle East and South-East Asia. To ensure a consistent progress in agriculture, a stable policy for processed and value added agri-products is required for enabling to move up the value chain in domestic and export markets of agricultural commodities. This would ensure better realization to farmers, minimization of post-harvest losses, employment generation through food processing industries and more investment in creation of infrastructural facilities such as cold chain for perishable commodities in agriculture, dairy and fish sectors.

10.21 Establish and operate agro-processing centres in the production catchment to minimize losses and transform raw food commodities into palatable safe and quality edible products. There is a need for better and economic utilization of crop residues & processing byproducts.

10.22 Postharvest management and branding of products are crucial for profitability. In Indian food industry, the primary processing accounts for almost 75-80% of value addition. For making entry to global market, the State food industry will have to move to secondary and tertiary processing and for this the industry and entrepreneurs would need technological support. The research institutions have to come out with commodity specific appropriate added products through processing along with eco-friendly, recyclable and biodegradable packaging in harmony with national and international standards for promoting export to earn more.

10.23 There is a need for creation of specialty agricultural hubs with production, processing, storage and marketing facilities for exports.

Chapter - 11

RECOMMENDATIONS

Haryana has made a substantial progress in enhancing agricultural and livestock production and productivity. However, the economic benefits from higher production are not percolating to the farmers as the major share of high prices paid by the consumers for various food commodities is being pocketed by the middlemen. Also, the use of excessive chemicals to enhance agricultural and livestock productivity, has resulted in poor soil health and its fertility, leading towards decreasing quantity & quality of nutrients contained in such agricultural & livestock produces. In the long-run, the deficiency of micro-nutrients in such food commodities itself, may lead chronic diseases, which express over a period of 10-15 years or more, and by which time/situation, consumers may not have any other choice but to resort to costly medication to receive the deficient micro-nutrient(s) as medicines in various forms. The need is to address these issues through appropriate technology, policy and financial supports. Accordingly, following recommendations are made:

Technical

11.1 There should be an agro-processing centre (APC) at Punchayat and/or Block/Tehsil level(s) owned and operated by farmers cooperative and/or NGO, or governmental agencies such as Haryana Agro-Industries Development Corporation. Such APC should have facilities for digital weighing, cleaning, grading, drying, storage, processing of field crops and infrastructures and gadgets for cooling, grading, cold storage and refrigerated transport for horticultural produces for retail marketing to urban consumers through Haryana State Cooperative Supply and Marketing Federation Limited (HAFED). Other required logistics need to be provided and managed. Workers of APC need to be trained at CCSHAU, Hisar and provided technological support, as & when needed.

11.2 Agricultural wastes and processing byproducts generated at APC need to be converted into livestock feed and those wastes & byproducts, which are not suitable for feed, be transformed into compost and sold to farmer at a reasonable price to improve livestock & soil health, respectively, resulting into higher yields & better quality nutrition.

11.3 Academic and Research establishments like CCSHAU, Hisar and LUVAS, Hisar may develop unique value added products using agricultural & livestock produce of Haryana, which meet national & international standards. Branding of such products with registered trade mark & logo, including organic and biotech products, scented & aromatic rice, baby corn, mushroom, honey, vegetables, fruits, biofertilizer, etc. would attract staekholders from domestic and export markets. Such efforts would help farmers, agro-industries and other agro-enterprises in competing in marketing and enhancing their income.

11.4 Hands on training of farmers, rural youth including women, and other farm workers in postharvest management of field crops, horticultural produce, dairy, poultry and fishery, etc. in the production catchment, would help in minimizing postproduction losses, production of value added products as an skilled workers at agro-enterprises and thereby their overall income.

11.5 Strengthening of technology transfer system using ICT and provision of incentives and awards to farmers and extension workers for a faster transfer/adoption of technology involving KVKs, State extension agencies, NGO, etc. be done.

11.6 Production of specific agricultural commodities having better processing quality and product recovery need to be strengthened through contract farming and backward linkage with farmers.

11.7 Automation of operations in agricultural marketing such as cleaning, grading, storage, etc. should be done so that farmers get better return on investment and proper hygiene could be maintain thereby minimizing noise and dust pollution in the market and nearby surroundings.

11.8 Exploitation of livestock production in Haryana in terms of food industry for milk, meat, poultry (broiler & eggs), feed, etc. offers a great scope and has an inherent capacity for revenue generation through value addition and marketing. Shifting of handling and processing of surplus milk from unorganized sector to the organized sector holds key to sustained profitability of dairy farming. Buffalo meat production & export hold an unparalleled opportunity for the State and will serve as fast track for animal improvement. Rural broiler and egg production can serve as a transforming agent for the poor in terms of health & nutrition.

Fiscal

11.9 To make farmer, producer-cum-processor, technological and financial supports need to be provided and also help in marketing of his/her value added products.

11.10 There are a number of taxes like marketing fee (MF) and rural development fee (RDF), etc. to be paid by a rice miller in Haryana whereas such taxes are not there in the neighbouring state of Punjab and lower taxes in other nearby state like Uttar Pradesh, Uttrakhand and Delhi. Such taxes need to be minimized and kept at least, at par, with neighbouring states.

Policy

11.11 Haryana has a good potential for the export of value added agricultural commodities and to realize this, a stable policy for food processing is required to ensure better realization to farmers, minimization of postharvest losses, employment generation and more investment in creation of infrastructures for production and postproduction agriculture.

11.12 There is a need of introducing high capacity sugarcane harvester-chopper in cooperative sugar mills to harvest the crop of a member farmer and bring it immediately to the factory for better sugar recovery and to avoid drudgery of manual sugarcane harvesting, bundling, transportation etc. by the farmers.

Appendix-1

HARYANA KISAN AYOG
Government of Haryana
Anaj Mandi, Sector – 20, Panchkula-134116

NOTIFICATION

No. HKA/13/1263-69 **Dated, Panchkula, the: 03/12/13**

The Chairman, Haryana Kisan Ayog is pleased to constitute the following working group on Post Harvest Technology and Value Addition for Haryana:

1. Dr. Nawab Ali, Former DDG(Engg.), ICAR - Chairman
2. Dr. R.K.Gupta, Project Co-ordinator, AICRP, PHT, Ludhiana - Member
3. Dr. DVK Samuel, Head, Agric. Engineering IARI, New Delhi - Member
4. Dr. S.S.Dhawan, Former Head, FST, CCSHAU, Hisar - Member

Terms of Reference:

The working group will study and make recommendations on the following issues pertaining to Haryana:

- Review of current status and appropriateness of existing storage and processing facilities and suggest measures to overcome the existing gap.
- Possible options for efficient on-farm storage and rural warehouses for perishables, semi-perishables as well as durables that minimize storage and associated losses, in order to enable primary producers negotiate better and earn higher income.
- Identifying low cost technologies for post harvest processing and value addition at rural level.
- Options for harnessing technological advancement that enhance shelf life, quality, and nutritive value and provide protection against post-harvest losses due to insects, pests and mycotoxins.
- Modernization and cost reduction of cleaning, grading, sorting, milling, processing, packaging and proper storage for food grains, oilseeds, horticultural crops, animal products, fish etc.
- Use of modernized processing and packaging options which can help in better utilization of agricultural commodities/ crops and their residues while ensuring that they meet international standard to make our produce/ products globally competitive.
- Suggest research for development needs in the field of post harvest management, including requirements for infrastructure and human resource development.

Other Terms and Conditions:

1. On submission of report, the members will be entitled for a lumpsum honorarium of Rs. 25000/- each, whereas the chairman will be paid an honorarium of Rs.50000/-.
2. Members of working group will be paid TA for attending meetings on actual basis and an honorarium of Rs. 2000/- for each meeting.
3. The Commission will bear the cost on typing, printing etc. and for conducting the meetings. in case if any meeting is to be held by the group elsewhere, the expenses will be paid on actual basis.
4. The working group should submit its report preferably in six months from the date of this notification.

Note: From Commission side, Dr. K.N.Rai, Consultant will be the nodal person providing needed Technical backstopping, whereas Dr. R.S. Dalal, Member-Secretary will extend required administrative support.

RSDalal

Member-Secretary
Haryana Kisan Ayog

Endst. No./ HKA/13/1263-69 **Dated, Panchkula, the: 03/12/13**

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5. The Financial Commissioner and Principal Secretary, Govt. of Haryana, Agriculture Department, Chandigarh.
6. Vice-Chancellor, CCSHAU, Hisar
7. PS to Chairman, Haryana Kisan Ayog

RSDalal 03.12.13

Member-Secretary
Haryana Kisan Ayog

Appendix-2

List of Machinery Manufacturers and Suppliers
Agro Based Food Processing Industries (ABFPI)

Sr. No.	Name & Address of Manufacturer/Details of Machinery/Equipment Supplier	Details of Machinery/Equipment
01.	Sifter International, 83, Sector -6, Industrial Area, Faridabad-121 006. Ph: 0129-25240450, 25242597 Fax: 0129-25240150 E-mail: sifter@ ndb.vsnl.net.in. Web Site: wwwsifterindia.com	Complete Plant Supplier on turn-key basis for Tomato Processing, Spice Plant, Energy Food, Fruits, Juices & Concentrates etc.
02.	Bajaj Machine Private Limited D-14, Lajpat Nagar-II, New Delhi -110024 Ph-011-26320055, Fax-011-26319406 E-mail-bajaj@del3.vsnl.net.in web site- www.bajajagro.com	Complete plant supplier for food processing machine including canning machine, juice extraction machine and bottling equipment.
03.	B.Sen Berry and Company 65/11, Rohtak Road, Karol Bagh, New Delhi 110 005. Ph- 011-25721105,25723553	Fruit processing equipments including double seaming, pulper, steam jacketted kettle reforming machine, automatic can closing machine, potato peeler, hydraulic juice press.
04.	FMC Asia-Pacific Inc., Krision House, Saki Vihar Road, Saki-Naka, Mumbai-400072. Phone- 91-022-8500395,28502504 Fax-91-022-28500398	Complete Fruits and Vegetable Plant, Comprehensive Line of Equipments for Tomato Processing including Peelers, Choppers, hot break systems. Pulper/finishers, evaporators, heat exchagers, aseptic flash coolers, aseptic filers and systems and many more.
05.	Freezing Industries Pvt. Ltd., 7/17,Kirti Nagar Industrial Area, New Delhi-91-011-25447509, 25413119 E-mail-freezeking@vsnl.com. Web site: www.freezeking.com.	Exclusive manufacture of most modern cold chain system for ice-cream, frozen foods, dairy producers and fruits and vegetables.
06.	Sun Dye Chem, B-4/3092, Vasant Kunj, Aruna Asaf Ali Marg, New Delhi- 70. Ph-1126122196,26122197 Fax-91-011-26122488	Food grade additives, food colours, food chemicals

07.	Techno Process Consultants,D-26, Green Park (Main),New Delhi-110016. Ph-011-26518862, Fax-011-26850045.	Processed food products flavors.
08.	The Manager/Incharge, Bhola Industries, Gujarat Ginning Mills Compound, 1 New Weaving Shed, Outside Premgate, Ahmedabad -380 016 (Gujarat).	Power Ghani
09.	The Manager/Incharge, Rihal Engg Works, Goraya, Jallandhar (Punjab).	Power Ghani
10.	M/s. Amrut Engineering Works, Old Shakti Compound, Behind Vihar Cinema, Pratap Nagar Baroda- 390 004 (Gujarat).	Expeller, Filter Press, Decorticator.
11.	M/s. Oriental Expeller Industries, 3-B-13, Ramesh Nagar, New Delhi-110015.	Expeller, Filter Press, Decorticator.
12.	M/s. Swastik Foundary and Engineering Works, Opp. Dhandari Kaland Railway Station, G.T.Road, Ludhiana-141 003 (Punjab).	Expeller, Filter Press, Decorticator.
13.	M/s. Gharanjit Singh and Co. G.T.Road, Ghaziabad-201 001 (Uttar Pradesh)	Expeller, Filter Press, Decorticator.
14.	M/s. Elgi Equipments Limited, 1-8-98/A-4, First Floor, University Road, Vidyanagar, Hyderabad-500 044 (A.P.)	Packaging Machine
15.	Win Pack, P.K. Engineering Ind. Private Limited, Unit No.22, and Wr.I.D.A. Mallappur Estate, Hyderabad- 500 762.	Packaging Machine
16.	M/s. Samarpan Fabricators Limited, Ajay Deep House, 240 Poarin Nariman Street, Fort, Mumbai-400 001.	Packaging Machine
17.	M/s. Metlex (India) Private Limited 78,Krishna Nagar, Post-Safdarjang Enclave, New Delhi-110 029.	Packaging Machine
18.	M/s. Spik (India) Private Limited 15/2, Mile Stone, Mathura Road, Faridabad-121 002 (Haryana)	Packaging Machine
19.	M/s. Kiran Engg. Works, P. B. No. 20,G. T. Road, Batala, Punjab.	Paddy Cleaner with Dust Blower, Paddy Separator, Paddy Dehuskar, Rice Polisher,Final Rice Polisher, Bran Processing System,Sieves Aspirator.
20.	M/s. Devraj & Company,Krishna Sudama Road, Mori Gate, Firozpur City, Punjab	Paddy Cleaner with Dust Blower, Paddy Separator, Paddy Dehuskar, Rice Polisher,Final Rice Polisher, Bran Processing System,Sieves Aspirator.

22.	M/s. D. P. Pulxen Feed Works, 12, Nagindas Master Road, Extension, Behind Museum, Fort, Mumbai - 23.	Poultry feed/Cattle feed Grinder 15 H.P.,Horizontal screw conveyour 2 H. P., Batch Prin Ribbon blender 1 tone capacity,Poultry feed/cattle feed mixer 7.5 H.P., Sealing Machine.
23.	M/s. D. P. Pulveriser, 12 Nagendas Master Road, Fort, Mumbai - 400023.	Masala Scheme Pulveriser, Packing Machine, Sieves, Weighing Balance.
24.	M/s. Arihant Engineering Works, 124, G.N.T. Market, Dhar Road, Indore, M.P.	Pulveriser, Packing Machine, Sieves, Weighing Balance.
25.	M/s. Punjab Engineering Works, D-71,Industrial Area, Mohali, Punjab.	Pulveriser, Packing Machine, Sieves, Weighing Balance.
26.	M/s. Gujarat Engineering Enterprises, 31/1, Payga Estate, State Bank of India, Jahangirabad, Bhopal-462 001, M.P.	Namkeen/Farshan Unit Sev. Ghatia Machine, Kneading Machine, Pulveriser, Packing Machine, Pan & Drum, Weighing Balance.
27.	M/s. Arihant Engineering Works, 124, Guru Nanak Timber Market, Dhar Road, Indore-452 001. M.P.	Besan Manufacturing Scheme Besan Pulveriser, Grader with winnover, Sieves, Weighing Balance.
28.	M/s. Northern India Flour Millers, Sultan Wing Gate, Amritsar.	Wheat Grinder, Sieves, Packing Machine, Grader with winnover.
29.	Reliance Engineering Works, House No. 4065, Sector 46, Chandigarh - 47.	Ice Cream Cones Scheme Ice Cream cone making machine with motor, Mixing Machine, Other equipments, sieves, water tank, buckets, Weighing balance.
30.	M/s. Kiran Engg. Works, P. B. No. 20, G. T. Road, Batala.	Grader with winnover, Cleaner, Weighing Balance, Packing Machine.
31.	Process Machinery & Equipment Pvt. Ltd., 144, Ashutosh Mukerjee Road, Kolkata - 25.	Pest Press Machine, Mixer, Weight, Gas Cooker & Iron drums, Motor 5 H.P.
32.	M/s. Khandelwal Engineering Works, Bahadurganj, Dist. Shahajahanpur -242 001 (U.P.)	Complete Plant Machinery/Equipment and its parts of Khandsari.
33.	M/s. National Sugar Industries, Opp.- Block Development Office, De lhi Road, Meerut-250 002, UP.	Complete Plant Machinery/Equipment and its parts of Khandsari.
34.	M/s. Kirloskar Brothers, Udyog Bhawan, Tilak Road, Pune-411 002, Maharashtra.	Bullock & Power Driven Crushers.
35.	M/s. Vishwakarma Engineering Works, Aji Industrial Estate, G.I.D.C, Plot No.375, Rajkot, Gujarat.	Bullock & Power Driven Crushers.

PHOTOGRAPHS

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