Workshop on
Post Harvest Technology
and
Value Addition in Haryana

Haryana Kisan Ayog
Government of Haryana

Post Harvest Technology and Value Addition in Haryana

Proceedings of the Brainstorming Workshop
Held on
9, June, 2014
at
CCSHAU, Hisar, Haryana – 125004

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Foreword

The management of post harvest 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 post harvest management practices including poor value addition. According to one estimate, post harvest losses in fruits and vegetables in India are about Rupees 2 lakh crore. 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).

Better post harvest management practices, technological interventions and innovations, value chain development, improvement in infrastructure can play a significant role in reducing post harvest losses. With the increasing investment in agricultural development in Haryana, in particular the investments to improve horticultural production and productivity, post harvest 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 security, reducing the post harvest losses, improved market opportunities for enhancing farmers' income.

Although many good post harvest 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. Wide diversity in needs and conditions, limited R&D capacity, resources, institutions, weak agricultural extension systems, poor infrastructure, inappropriate policies, low profitability, inadequate financial resources, poor access to capital, lack of information etc are the other constraints for low adoption.

It gives me great pleasure that a large number of scientists working on post harvest management and value addition in different sectors of agriculture had participated in a workshop organized by HKA on 9th June, 2014 at CCS Haryana Agricultural University, Hisar and presented technical papers and discussed a wide range of issues covering almost all aspects of post harvest management and value addition. I believe that proceedings and recommendations of the workshop will undoubtedly prove useful to all those concerns with post-harvest management and value addition in Haryana.

(R. S. Paroda)

Member Secretary
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Acknowledgement

The Haryana Kisan Ayog constituted a working group on "Post Harvest Technology and Value Addition in Haryana" under the chairmanship of Dr. Nawab Ali, Former DDG (Engineering), ICAR. The members of the working group are Dr. R.K.Gupta, Director, Central Institute of Post Harvest Engineering & Technology, Ludhiana, Dr. D.V.K. Samuel, Head, Agricultural Engineering Division, IARI, New Delhi, and Dr. S.S. Dhawan, Former Head, Department of Food Science & Technology, CCS Haryana Agricultural University, Hisar with Dr. K.N.Rai, Consultant, Haryana Kisan Ayog as the nodal officer with the group. In its attempt to get feedback from different stakeholders, the group held several meetings and also organized a brain storming workshop on 9th June, 2014 with active participation of senior scientists and officers from CCS HAU and LUVAS, Hisar. The programme was hosted by CCSHAU, Hisar and provided all facilities for its organization. The proceedings of this workshop are an outcome of the wide range of deliberations during this workshop and presentations made by scientists and experts.

We are indebted to Padma Bhushan Dr. R.S. Paroda who inspired and supported us for organizing this workshop. We thank Dr. Nawab Ali, Chairman Working Group, for his guidance in organizing this workshop and delivering the presidential address. Our thanks to Honorable Maj. General Shrikant Sharma, Vice-Chancellor, LUVAS for addressing the workshop as its Chief Guest and his active participation in the deliberations. My Special thanks are due to Dr. S.S.Siwach, Director of Research, CCS HAU and Dr. M.K.Garg, Former Dean College of Agricultural Engineering, CCS HAU, Hisar for their untiring support and cooperation. I also thank Dr. Ravindra Sharma, Director of Research, LUVAS for his help and participation in the workshop. I also thank scientists of CCS HAU and LUVAS for their presentations, sincere participation and valuable suggestions. My appreciation is also due to Dr.K.N.Rai and Dr. Gajender Singh for putting in all out efforts in organizing this workshop.

My sincere thanks are due to our other consultants Drs. R.B.Srivastava, S.K.Garg and Research Fellows Drs. M.S.Jakhar, Sandeep Kumar and Ms. Vandana for their sincere efforts and help in making this workshop a great success. I also thankfully acknowledge the efforts put in by the technical and non-technical staff of the Ayog for making the workshop successful.

(R. S. Dalal)

Table of Contents

Background

Post-harvest losses of crops and livestock products are of crucial importance to food security and income generation opportunities of the farmers. In India post harvest losses continue to be extremely high. According to one estimate post harvest losses in fruits and vegetables in India is about Rupees 2 lakh crore. Physical grain losses in case of cereals, pulses and oil seeds range from 10 to 20 percent. Similar post-production loss percentages are estimated for milk and other crops. In spite of such huge post harvest losses only 7 percent of the total agricultural produce is put to processing and value addition. Better post-harvest handling and management practices, value chain development, infrastructure, technology and technological innovation can play a significant role in reducing these post-production losses. With the increasing investment in agricultural development in Haryana, in particular investments to improve agricultural productivity, post-harvest handling and management needs to improve in order to reap the full benefits for food security and reducing post-harvest losses and improving market opportunities will have a direct impact on farmers' food security and incomes.

Although many good post-harvest management technologies exist, their adoption by smallholder farmers and other value chain actors has been limited due to a range of supply and demand side constraints, including: broad diversity of needs and conditions; limited R&D capacity, resources, institutions; weak agricultural extension systems; limited engagement of the private sector (local, small and medium enterprises (SMEs), and multinational corporations (MNCs)) and end users in innovation, manufacturing, and dissemination; poor infrastructure, inappropriate policies; low profitability of technology innovation; inadequate financial resources; lack of access to capital; lack of information etc.

Some of the constraints to proper post harvest management are: inadequate information and skills in harvesting and post harvest handling, lack of appropriate and low-cost infrastructure, high transportation costs, poor access of farmers to markets and integration of marketing channels, poorly developed processing sector, non-utilization of agricultural waste, unfavorable policy support and inadequate investment in R&D. Small farmers with limited access to markets as well as financial resources are discouraged from adopting improved post harvest management techniques.

Much work is being done by the institutions and stakeholders to address these constraints. However, investment in post-harvest technologies is limited and post-harvest technology commercialization projects are often conducted as ad-hoc or isolated efforts. As a result, adoption of relevant technologies is limited and significant value continues to be lost as a result of post-harvest losses. Little information sharing means that little is known about the factors that contribute to successful adoption at scale as well as what can be done to overcome some of the core barriers.

About 80 percent of the farmers are small and marginal; therefore, there is a need to identify constraints particularly affecting them, develop suitable strategies for overcoming the constraints, and identify areas of cooperation to facilitate sharing of information, resources and produce for the benefit of farmers and consumers. Besides, there is a need to share success stories of post harvest management in the region that can serve as models for other regions.

In view of these developments the objective for a Post-Harvest Technology and Value Addition initiative is to accelerate commercialization and increase successful adoption of post-harvest technologies that can help smallholder farmers increase their incomes by facilitating progress at key steps along the commercialization pathway.

Proceedings of the Brain Storming Workshop on Post Harvest Technology & Value Addition held at CCSHAU, Hisar on 9th June, 2014

Brain storming workshop on Post-Harvest Technology and Value Addition organized by Haryana Kisan Ayog was held on 9th June, 2014 at the Lecture Hall, Directorate of Human Resource Management, CCS HAU, Hisar. About 100 Scientists from the CCS HAU, Hisar and LUVAS, Hisar participated and took part in the deliberations. The following members of the WG on Post Harvest Technology & Value Addition and that from Haryana Kisan Ayog (HKA) attended the Brain Storming Workshop on 09 June, 14.

- Dr. Nawab Ali, Former DDG (Engg.), ICAR
- Dr. R.K. Gupta, Director, CIPHET, Ludhiana
- Dr. D.V.K. Samuel, Head, AED, IARI, New Delhi
- Dr. S. S. Dhawan, Former Head, CFST, CCSHAU, Hisar
- Dr. R. S. Dalal, Secretary, HKA, Panchkula, Haryana
- Dr. K.N. Rai, Consultant, HKA, Panchkula, Haryana
- Dr. Gajender Singh, Research Fellow, HKA, Panchkula
- Dr. Sandeep Kumar, Research Fellow, HKA, Gurgaon

The participants of the Brain Storming Workshop on PHT & VA in Haryana were welcomed by Dr. R.S. Dalal, member-Secretary, Haryana Kisan Ayog. He also briefed about the purpose of this workshop and said that the suggestions of the Workshop would be put-up to the Govt. of Haryana for approval and necessary follow-up actions so that farmers of the State could derive nutritional & economic benefits from their produces & products.

The honorable Vice-Chancellor, LUVAS, Hisar, Major-General Shri Kant, SM, VSM (Retired), in his address, said that in spite of many-fold increase in production & productivity of agricultural and livestock produces, malnutrition still exists in India and it need to be alleviated, as early as possible, using appropriate technology to process and develop value added livestock produce based products for nutritional and health security of the people while taking care of the changes in their dietary habits. He also said that the contribution of livestock sector in the Gross Domestic Product (GDP) of the State is substantial and appealed to the Government for a matching grant to this sector.

Dr. Nawab Ali, Former DDG (Engg.), ICAR and the Chairman of the Working Group on PHT & VA, during his presidential Address, said that to achieve house-hold food and nutritional security in India, agro-processing in the production catchment need to be encouraged using commodity and location specific appropriate post-harvest technology for processing and value addition to agricultural and livestock produces and an economic utilization of crop residues and processing byproducts. This would facilitate socio-economic development of the rural-sector, minimize post-harvest losses, provide better quality nutritious food to consumers at an affordable price and also improve soil and animal health resulting into sustainable higher agricultural productivity. Dr. Ali also emphasized on the production of agricultural commodities such as soybean, horticultural crops and livestock farming including fishery which provide better quality nutrition and supplementary income to farmers for their day-to-day requirements.

Dr. M.K. Garg, former dean, College of Agricultural Engineering and Technology proposed the vote of thanks. Local Print media, Dainik Jagaran and Navchhor covered the opening session of the Workshop.

There were two technical sessions of the workshop. The technical sessions were chaired by Dr. Nawab Ali and co-chaired by Dr. S.S.Siwach and Dr. Ravindra Sharma.

There were 12 speakers who spoke on the present status and the future strategies on the post-harvest technology of various agricultural commodities and livestock produces. It covered grains (cereals, pulses and oilseeds); horticultural crops including flowers & mushrooms; spices & condiments; aromatic & medicinal plants; dairy produces; meat, poultry & fish; animal waste management; agribusiness management; and impact assessment of post-harvest technology. It was followed by concluding remarks of the Chairman and vote of thanks. The various topics and speakers are listed below:

Grain Processing: cereals, pulses & oilseeds

- Dr. Raj Bala Grewal, Dean, PGS, CCSHAU, Hisar

Post Harvest Processing of Milk for Value Addition –Present Scenario and Future Prospects

- Dr. R.S. Dabur, HOD, LPT, LUVAS, Hisar

Agri-Business Management – an Overview

- Dr. Atul Dhingra, Dept of Business Management, COA, CCSHAU, Hisar

Marketing and Packaging of Fruits & Vegetables

- Dr. J.K. Sandooja, Prof & Head, Dept of Botany and Physiology, CCSHAU, Hisar

Herbal Food Products

- Dr. Saleem Siddiqui, HOD, CFST, CCSHAU, Hisar

Post Harvest Technology and Value Addition of Aromatic and Medicinal Plants

- Dr. I.S. Yadav, HOD, Medicinal, Aromatic & Under-Utilized Plants, CCSHAU, Hisar.

Post-Harvest Handling and Marketing of Mushroom

- Dr. Surjeet Singh, Professor, Dept of Plant Pathology, CCSHAU, Hisar

Post-Harvest Handling of Flowers and Marketing

- Dr. S.K. Sehrawat, Professor, Dept of Horticulture, CCSHAU, Hisar

Post-Harvest Technology and Value Addition in Spices

- Dr. S.K. Tehlan, Scientist, Dept of Vegetable Sciences CCSHAU, Hisar

Post Harvest Processing of Meat, Poultry and Fish

- Dr. D.P. Sharma, Professor, LPT, LUVAS, HIsar

Impact of Post Harvest Technology: A Case Study of Agro Processing Centers

- Dr. Anil Dixit, CIPHET, Ludhiana

Slaughter House Waste Management

- Dr. Sanjay Yadav, Asstt. Prof., LPT, LUVAS, HIsar

Important recommendations emerging from the discussion held on the presentations made are summarized below.

Important Recommendations

Farmers should be educated about higher value realization for their produce through grading, cleaning, sorting, packaging, quality production, and secondary agriculture. State should facilitate value addition through such activities.

- Dairy accounts for more than 30 % of agricultural income in the state. The product diversification by Haryana Dairy Development Cooperative Federation should be developed on the line of AMUL in Gujarat through financial help from government.
- There should not be vat on refrigerated poultry meat. This process is meant to avoid distress sale during peak production period and to minimize cost of production.
- There should be minimum support price for milk on the pattern of cereals and pulses.
- Modernization of slaughter houses as per international standard.
- Efforts should be made for establishment of packaging facilities in major fruits and vegetable growing areas like for tomato in village Padana, Karnal and for Kinow at Sirsa.
- Dairy sector in Haryana has not seen the kind of progress commensurate with state's potential. Presently the share of organized sector in milk marketing is 28 percent, within this cooperative sector accounts for only 5 percent. There is a need for improving functioning of milk collection centers and establishment of small processing units at village level.
- The State should encourage massive investments from within the country and FDI to bring more capital, technology and managerial skills of international standard in value chain development. It would be helpful in strengthening forward and backward linkages, creating a proper farm to fork infrastructure through direct purchase from farmers.
- Processing needs special attention through incentives, special packages, training in processing and production of processing specific quality produce, establishment of service centers and facilitate marketing of small scale agro-processing industries products. Farmers should also be helped in the selection of varieties suited to the processing units. Emphasis of agro-processing units should be on multiple commodities complexes rather than individual commodity approach.
- Create collection centers and refrigeration facilities for fruits and vegetables in producing areas.
- Electricity charges at par to agriculture for small scale agro-processing units.
- Efforts should be made for establishment of Mushroom processing facility in PPP mode.
- The recent initiative to reduce security deposit for firms entering into contract farming from 15 percent to 5 percent is a welcome step. The firms of national and international repute should be exempted fully from such deposits.

Rationalize taxation structure on farm produce to check diversion of marketed surplus to neighboring states and keep taxes at moderate level to attract agri-business to state markets. Effort should also be made to avoid multiple taxations as in case of cotton and it's by product.

GRAIN PROCESSING: CEREALS, PULSES AND OILSEEDS

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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 and can be grown under a wide range of agro-climatic conditions. These grains can also be processed properly for value addition and human consumption. Majority of food grains undergo only primary processing and it play important role in value addition. However, the value added produce varies with the degree of processing and it is further enhanced with processing of the products. Therefore, the potential for agro-processing industries is to be viewed in totality of possibilities and not merely the processing of main products. In India, agro-based industrialization has gained momentum during the last few years and the degree of processing has been intensified to get the value added products for domestic and export market. Value addition refers to decrease in losses during post-harvest handling, increase in processing facilities and the storage, and marketing of processed foods. Through primary and secondary processing the raw food materials are made edible and through tertiary processing they are made ready to eat. By and large at each stage of processing, value is added to the products. In our country, larger portion of net value addition from agro-industries is derived from unregistered cottage and small units.

Cereals are not only an important subsistence crop in the developing countries but are also an important cash crop for commercial purpose. The principle cereals grown in the world are wheat, rice, corn, barley, oats, rye, sorghum and millets. Our major cereal crops are wheat and rice followed by corn and pearl-millet. The production of major cereals has increased dramatically over the years due to improved methods of agriculture and use of high yielding varieties (Table 1). 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 183.70 lakh tonne during the year 2011-12, registering an increase of more than seven times as compared to a meager 25.92 lakh tonne production in 1966-67. The Wheat and Paddy crops have played a major role in pushing up the agricultural production. The production of Wheat and Rice (the main cereal crops of the State) has increased significantly. The production of Wheat and rice was 111.17 and 39.76 lakh tonne during 2012-13, registering 10.4 fold increases in Wheat and about 17.8 fold increases in Rice production as compared to 10.59 and 2.23 lakh tonne production, respectively during 1966-67.

In last decade, we have moved from an era of scarcity to one of plenty and have achieved self sufficiency. The rice and wheat emerged as the second and

fourth largest 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 only. Because of improper storage conditions and inadequate storage facilities a large percent of losses of cereal grains occur in storage godown. The current scenario depicts that there is need to divert the surplus raw produce towards the processing and value addition.

Processing of grains for value addition

Value addition refers to decrease in losses during post-harvest handling, increase in processing facilities and the storage, and marketing of processed foods. Through primary and secondary processing the raw food materials are made edible and through tertiary processing they are made ready to eat. By and large at each stage of processing, value is added to the products. In our country, larger portion of net value addition from agro-industries is derived from unregistered cottage and small units.

Majority of food grains undergo only primary processing and it play important role in value addition. However, the value added produce varies with the degree of processing and it is further enhanced with processing of the products. Therefore, the potential for agro-processing industries is to be viewed in totality of possibilities and not merely the processing of main products. In India, agro-based industrialization has gained momentum during the last few years and the degree of processing has been intensified to get the value added products for domestic and export market e.g. in case of wheat;

Domestic market: Fortified atta, bread, biscuits, vermicelli, pasta products (noodles, macaroni, spaghetti) and pizza base etc.

Export: Pasta products and biscuits

By product processing: Straw board paper, Bran for high fiber value added products.

Nutritional value and utilization of cereals

Cereals are the staple food for majority of the global population. In the world as a whole, only 5% of starchy staple food comes from root crops, whereas the rest is from cereals. They supply bulk of food consumed by human, as these are cheapest and excellent source of food energy and can easily meet more than 50% of daily protein requirement of an adult specially in developing nations.

In general, cereal grains contain about 10-14% moisture, 58-72% carbohydrates, 8-13% protein, 2-5% fat and 2-11% indigestible fibre (Table 2). In addition cereals are an excellent source of vitamins and minerals. Moreover, cereals contain less fat, rich in polyunsaturated fatty acids which are healthier. Recent researches suggest that for reducing calories from fat, people should be encouraged to replace fat with cereals as these are low in fat and high in fiber content.

Table 2: Nutrient composition of cereal grains (% on DM basis)

Cereal grains	**Moisture**	Carbohydrates	**Protein**	**Fat**	Crude fiber	Energy (Kcal/100 g)
Wheat	12.8	77.2	11.8	1.5	1.2	346
Rice	13.7	78.2	6.8	0.5	0.2	345
Corn	14.9	66.2	11.1	3.6	2.7	348
Barley	12.5	69.6	11.5	1.3	3.9	336
Pearl millet	12.4	67.5	11.6	5.0	1.2	361
Sorghum	11.9	72.6	10.4	1.9	1.6	349

Cereals are being utilized in the diet in diversified manner depending upon the taste preferences and cultural influences. Table 2 shows the main uses of cereals which indicate that most cereals can be used for most purposes. These can be boiled as such or can be made into variety of products.

Table 3: Utilization of cereals

Cereals	Whole	Porridge	Leavened Bread	Unleavened Bread	Snacks, Breakfast	Starch, glucose	Beer, spirits
Wheat	√	√	√	√	√	√	√
Rice	√				√		√
Corn	√	√		√	√	√	√
Barley	√	√		√			√
Rye		√	√				√
Pearl millet		√		√			√
Oats		√		√	√		√
Sorghum		√		√	√		

The cereals can be processed into variety of value added products. Some of the value products which can be prepared after processing of cereals are:

1. **Good quality flour:** Flour is one of the form in which wheat and other cereals are utilized for preparation of various traditional, baked, fried and other products. For value addition, one aim should be to expand the flour milling industry. There is great scope for preparation of **specialty flour** such as bread flour, biscuit flour, cake flour, *chapatti* flour, nutritious flour, **fortified flour** etc. The expansion of flour milling industry will not only provide additional employment but also help to get remunerative prices to farmers and stabilize wheat production in the country. There is scope to export flour to neighboring states as well as needy neighboring countries. Similarly good quality flour of other cereals such as pearl millet, oat, barley with reasonable shelf life if available in local market can add variety and improve the nutritional profile of population and hence, will be a value addition to these cereals. Problem of shorter shelf-life of millet flour could be sorted by hydrothermal treatment and they complement wheat or maize flour in formulations.

2. **Baked products:** Bakery products are becoming increasingly popular in India not only among urban population but also among rural population. A good quality baked products if available at competitive price can help in value addition of surplus wheat. Indian wheat is quite suitable for preparation of different bakery products i.e. hard wheat suitable for bread making and soft wheat for cakes, biscuits, cookies etc. The large variety of bakery products suits to the purchasing power of people of different economic groups i.e. bread, rusks, buns etc. have found acceptance among poor household, however, cake, pastries, variety bread, crackers have captured the attention of affluent section of society.

Further, improved good quality nutritious baked products can be prepared by supplementing other cereals or pulses to be use as health food. These products can add variety and improve nutritional profile of the population. Though, there is great scope of bakery products in the domestic market, the export of quality and novel baked products to other countries can fetch large profits to strengthen the agro-economy of the country.

3. ***Extruded products:*** Food extrusion is a versatile high temperature, short time (HTST) process which has become established for the continuous manufacture of new and traditional products. Extrusion can be used to produce directly formed or expanded cereals. Expanded ready-to-eat cereals are manufactured from mixture of cereal flour and starch combined with small amount of malt, fats, sugar and salt. In India many extruded foods are prepared from rice, wheat and corn. With the advent of mechanical cooker extruder, extruded pellets which need frying before use and ready to eat, nutritious expanded and spiced products can be prepared with cereals and legume blends. Durum wheat is used in the production of extruded products like macaroni, sphaghetti, vermicilli, noodles etc. Rice pellets can be customised in terms of colour, shape, and size, composition and their cooking characteristics can also be tailor-made such as instant rice pellets, as quick-cooking rice pellets, or as a product for admixture to natural rice. Manufacturing of such products has a great scope as these products are convenient to use and offer variety of products.
4. **Shelf-stable traditional products:** In traditional Indian cuisine, the use of wheat flour is mainly in the form of *chapaties* and other products such as *paranthas, poories*, naan etc. As more and more women are getting engaged in job outside home the scope of invasion of pre-cooked products with long shelf life in the Indian cuisine is quite bright.
5. **Shelf stable traditional sweets and savoury products:** There are a large variety of cereal based sweets and savoury snacks across the length and breadth of the country. Products like *samosa*, *mathi*, *shakarpara*, *namakpara*, *gujiya*, *kachori*, *mattar* etc. are popular snacks. Some of the ready-to-eat good quality snacks can be hygienically prepared and packed.
6. **Convenient food mixes:** Development of good quality ready mixes for some of the traditional and other products such as upma, rawa idli, sooji

halwa, semalina vermicill, dhokla, cake, weaning and supplementary mixture etc. can be prepared using simple processing. These have reasonably good shelf life (6 months – one year) due to low moisture content. Some of the food mixes are commercial available and other such mixes can be developed from various cereals for value addition. Similarly, ready to cook rice, khichari, dalia, and other similar products can be prepared to utilize cereals for value addition.

7. **Functional foods:** Cereals such as barley have been reported to contain β-glucan which have been reported to impart health benefits beyond nutrition. Similarly, oats, pearl millet being rich source of dietry fibre, phytochemicals and other minor components have been reported to have desirable properties. It is anticipated that rapid growth in the functional foods market will continue well into the next decade.
8. **Breakfast foods:** Cereals are being processed for preparation of variety of breakfast foods. Traditional hot cereals that require cooking are sold in the market as processed raw grains. Similarly, instant traditional hot cereals, which require only boiling in water to complete their preparation, ready to eat cereals and cereal mixes for breakfast, are some of the value added products developed from cereals.
9. **Other cereal products:** Quick cooking rice, canned rice, expanded rice, rice bran oil, rice flakes, puffed rice, corn starch, syrups, popcorn, corn oil, germ oil, gluten etc., are some of the value added products which can be prepared from cereals after processing.

Nutritional value and processing of pulses for value addition

India is the major producer of pulses in the world. A number of varieties of pulses are grown and consumed in a variety of food products after suitable processing. Conventional pulses like gram, green gram, black gram and lentil are being grown continuously, but their yield has been almost static during the last 25 years. Area as well as production of pulses is decreasing (Table 4). Legumes have a special place in human diet because they contain nearly 2 to 3 times more protein than cereals. The protein content of most pulses ranges from 17-25 per cent. The high lysine content makes these legumes, an excellent enhancer of protein quality of cereal based diet. The nutritional value of legumes is not just confined to their usefulness as a source of vegetable protein. They are good source of carbohydrate (54-60%) contain appreciable amounts of several important minerals and vitamins. Pulses have exceptional potential for alleviating nutritional deficiencies in developing countries, as these are rich and less expensive source of protein and are potential supplier of several other important nutrients. But these are also endowed with several anti-nutritional & flatulence factors and requires long cooking time. Attempts have been made to develop suitable processing techniques to remove the anti-nutrients, and improve nutritional quality and cook ability.

In past two decades or so numerous investigations have been done to improve the nutritional quality of pulses with respect to their chemical composition but relatively less attention has been paid to the processing aspects that affect the overall utilization of the food pulses. Two very important processing considerations

are the product development and consumer acceptance of the product. These are greatly influenced by the primary processing practices such as hulling, decortication, pearling etc. and inherited grain characteristics such as size, shape, colour and chemical composition of grain. The storage conditions and any pretreatments received during processing also influence the product quality. Under adverse storage condition grain legume can develop hard-to-cook defects, depending upon genotypes and cultural practices. The secondary processing technologies such as roasting, steaming, germination, fermentation and extrusion cooking have been reported to be beneficial for enhancing nutritional value and utilization of pulses. Both primary and secondary processing techniques are important in determining the product quality for value addition and utilization of pulses for human consumption.

In India, pulses are consumed in a variety of forms depending on cultural and taste preferences, substantial amounts of pulses are consumed after milling to dehusk and split the cotyledons. In India 'dhal' is prepared by cleaning the seeds, tempering with water until the seed coat has loosened. About 80 per cent of pulses produced are commonly consumed in form of 'dhal' curry or the processed food items. Grain legumes are sometimes ground into nutritious flour and used in bakery products and snacks. Deep fried products such as *seviya, bhujia, bundi, papad* etc. from pulses (chickpea, lentil, black gram, green gram) are very popular with consumers. Isolated pulse proteins are now used commercially in many food applications because they offer economical, nutritional and/or functional advantages while maintaining the desirable sensory qualities necessary for consumer acceptance.

Pulse milling is an important agro-based industry in India next only to rice and wheat milling. Pulses are de-hulled to improve their appearance, texture, cooking quality, palatability and digestibility. The split pulses are not affected by insect pests during storage. Estimates indicate that about 30% of the production of pulses is retained by the farmers and is processed in rural sector using traditional techniques. The grain characteristics are such that husk is 10 -16 % and hence the potential dhal recovery of 84 - 90% is possible. The available commercial milling gives low recovery (65-72%) and high milling losses. The milling losses alone contribute to 15-20%, which comes to around 1.5 million tonnes. There is need to standardize the wet and dry milling process of pulses to reduce the milling losses.

With technological advancement, understanding of chemistry and functional properties of the macro-molecules present in the pulses, number of acceptable food products can be developed. Efforts are required to explore the suitable processing technologies for development of the various pulse based value added products such as:

1. Quick cooking dhal: For value addition, greater emphasis should be given for marketing the new products of legumes. The most serious draw-back in the utilization of food legumes is their long cooking time. In this context, quick cooking dhal, or instant dhal of grain legumes seems to have good market potential. Special soaking solutions containing inorganic salts or use of enzymes treatment has been employed to decrease the cooking time. Development of quick cooking pulses using

suitable chemicals and enzymes as softening agents should receive the increasing attention of the food scientists.

2. Shelf stable fried products: Fried products form the largest group of convenience foods marketed in India. Both sweet and savory fried products are very much liked and consumed throughout the country. There is need to develop fried products with lesser fat contents.

3. Extruded foods: In India many extruded foods are prepared from rice or rice and legume flour blend. With the advent of mechanical cooker extruder, extruded pellets, which need frying before use and ready to eat expanded and spiced products can be prepared with cereal and pulse blends.

4. Fermented foods: Utilization of pulses for preparation of fermented foods such as *dosa, wadi* etc. has been in practice. Efforts have been made to prepare ready to prepare mixtures from pulse flour

5. Traditional sweets: Attempt has been made to incorporate 10-30 per cent of millet/ cereal flour in the preparation of sweets like laddu, basen burfi, jalebi etc. However, these aspects need further evaluation for commercial and export purpose.

6. Formulated/fabricated foods: Plant proteins have played an important role in the growth of fabricated foods. Pulse protein concentrate /isolates have been greatly used in formulated foods because of its ability to incorporate texture into them. Blends of protein will be key to good nutrition in formulated foods. Infant formulas based on protein isolates have been developed to aid in dietary management of infants allergic to milk protein.

7. Functional foods: Pulses have been reported to contain 'phytochemicals', which have been reported to impart health benefits beyond basic nutrition. It is anticipated that rapid growth in the functional foods market will continue well into the next century.

8. Novel foods: Attempt has been made to utilize legume, after proper processing in the preparation of certain novel foods such as noodles, papad etc. In arid-region, owing to plenty of solar radiation value addition through dehydration can be done.

10. Pulse protein based edible coatings and egg replacer: The use of pulse protein based protective coatings on various food stuffs has been investigated. Pulse protein products are being developed in recent years for use in place of egg albumin as a sole aerating agent.

11. Other value added processed products: Good quality roasted pulses or puffed/ parched pulses, instant convenient mixes, and production of Tannin Acryl Hydrolyses (Tannase) from pulse milling by-products etc. can be prepared.

Processing of oilseeds

Oilseeds are very important component of semi-tropical and tropical agriculture, providing easily available and highly nutritious human and animal food. Many also have industrial uses and are relatively easy to incorporate into locally manufactured products. The major oilseeds of India are groundnut, rape seed & mustard, linseed, sesame and castor. Groundnut and rape seed & mustard accounts about 85 percent of the total production of oilseeds in the country. Soybean,

sunflower, safflower, cotton seed and coconut are the other important oilseeds produced in India. Rapeseed & Mustard, Seasmum, Groundnuts are major oilseed crop of Haryana (Table 5). As the number of oil mills especially of mustard oil is increasing farmers are growing more and more rapeseed and mustard that's why the area and production is increasing year by year where as ground nut and seasmum production is very less.

Oil mills crush oil seeds and extract oil, 70% of which is sold in the open market. The remaining 30% is refined and sold as branded oil. After the extraction of oil, residual seeds are processed further by solvent extractors, to make solvent-extracted oil. Most of the solvent extracted oil is used to make 'vanaspati'.

The Indian edible oil industry is highly fragmented with a large number of small scale producers. The ghanis belong to the Small scale industries segment and usually serve the rural markets. The Indian edible oil industry can be classified into the following segments. Ghanis, small scale expellers, solvent extractors, oil refiners and vanaspati manufacturers.

Oilseeds contain from 20 to 50% oil, which is mainly present in the kernel part and is tightly bound within the cell surrounded by other constituents including polysaccharides and proteins. Mechanical action is required to either forcefully remove the oil out or make it more accessible to subsequent solvent extraction. Seed coats and cellular structures reduce accessibility and hinder the transfer process and being devoid of oil adsorb a part of oil and reduce the yield. The unit operations typically usually involve cleaning, cracking, conditioning (or cooking), and flaking. Depending on the process and the oilseed in question, process drying, conditioning and dehulling (or decorticating) may be employed, as may be expanders. After the preparation process, the prepared flakes are delivered to the extraction operation.

Different oilseeds, extracted oils and oil-free cakes or meals/flours are used for variety of edible and non-edible purposes. Major part of the oil is used for cooking purpose at domestic level. A large part of groundnut is used as roasted, fried or boiled kernel or boiled or roasted pods alone or in variety of salted and sweetened confectionery. Raw, fried or roasted Sesame seeds are generally used with jaggery or molten sugar as confectionery products or with roasted flour as domestic *laddoos*. Non-edible oils are used in toilet soaps, cosmetics, industrial and medical applications. De-oiled flour from oilseeds such as soybean and groundnut are utilized for human consumption. Some non-edible oilseed cakes are used in variety of animal feeds and feed formulations as protein sources. Rests of the cakes are used as nitrogen rich organic fertilizers for field application. Cakes are also used as fuel sources in oil producing factories.

Major Uses of oilseeds

Edible Oil – Baking, Frying, Creams & Spreads Shortenings, Confectionery, etc.
Non-edible oils – Industrial, Soaps, Varnishes, Cosmetics, medicinal, etc.
Whole kernel - Products from groundnut,
Sesame - confectionery products
Cakes & Meals - Flours as food, Animal feed, Fertilizer, Fuel and Manure.

Oil bearing materials, seeds or fruits are metabolically active and have sufficient moisture and nutrients required for microbial growth, hence are prone to

deterioration when these are stored at ambient temperature. High moisture content and high humidity in storage space, favor microbial growth especially the growth of molds. Their growth result into increased FFA levels and moldy appearance of the product. A variety of mycotoxins, especially the highly potent Aflatoxins are produced in oilseeds due to mold growth.

Therefore, the oilseeds need to be dried to a safe moisture level for storage before processing. Otherwise deteriorative changes will be significant and products will no longer remain fit for consumption and use. There will be high refining losses in oil processing due to presence of high content of FFA.

Drying may be carried out by open field sun drying or solar drying in specially designed dryers. Mechanical drying by commercial dryers at high velocities at mild temperature using hot dry air completes the process in shorter time. The dried oilseeds should be stored in low R.H. environment of about 74-75% R.H.

Sometimes it is advantageous to store the oilseeds before extraction of oil. The storage leads to improved oil recovery from oilseeds due to biochemical and chemical changes such as disorganization of cell and oil droplet membranes and denaturation of proteins. Degradation of chlorophyll during storage improves the color of extracted oil from oilseeds.

To improve oil extraction the divided material or the oilseeds before size reduction are conditioned with addition of some moisture for saturation of the solid surfaces to reduce their affinity for oil. A short heat treatment disrupts the membranes, consolidates oil droplets and denatures the proteins for easy extraction of oil.

Proper extraction of oil is carried out by application of pressure with some sorts of presses, e.g. hydraulic or screw press in a perforated box or containers, or by specially designed oil expellers using screw action for transfer and compression of material against narrow slits provided in the walls of barrel of screw press for forcing out the oil from the meal and transferring the oil-deficient cake at the end of expeller.

Solvent extraction using food grade short chain hydrocarbons like hexanes is more efficient in oil recovery from oilseeds and yields oil-free meals for food application. Different types of solvent extraction plants with reduced fire hazard and improved solvent recovery and efficient energy utilization have been designed for commercial application.

Crude oils have varieties of on tri-glycerides components such as FFA, Phosphatides (Phospholipids), gums, waxes, hydrocarbons, pigments, sterols, dust and feed particles, haze and turbidity causing materials and odorous compound in addition to fat soluble vitamin. These are removed by physical/chemical or physico-chemical processes. Various processes – degumming, refining, dew axing, bleaching, deodorization, etc., are included in overall refining process. Processes like winterization, fractionation, hydrogenation, inter-etherification and trans-estrification produce stocks with different physico-chemical characterstics for blending into products with desirable properties for various technological applications in food industry and domestic cooking.

Processing of oilseeds for oil production

Dehulling: To remove oil free/ deficient hulls/seed coat before extraction

Size reduction: To minimize path length for transfer of oil through seed (micrometer scale)

Flaking: To consolidate fine particles - 0.2-0.3 mm thickness

Conditioning: To free oil from membrane bound droplets and coagulate/ denature proteins for easy transfer of oil through seed tissue - 10-12% moisture/90^{o} C/ 15-20 min

Oil extraction: Release oil from oil bearing material by compression force or diffusion into solvent and separation from solids - Hydraulic/screw Pressing, Expeller/ Solvent

Refining: To remove sediments, gums, haze, non-triglycerides, color, odor, etc. by physical/chemical means

For use as food ingredient or feed, the meal needs to be stabilized against microbial, enzymatic and chemical changes during storage and remove toxic solvent.

Processing of Cake/meal

1. Drying to safe moisture
2. Solvent removal
3. Grinding to flour

Processing of Pods and Kernels

1. Roasting of groundnut pods or kernels
2. Polishing and grinding to butter (Peanut Butter)
3. Roasting or Frying of groundnut kernels & sesame seeds for confectionery

Haryana has made a significant contribution in agricultural production in the country. To make further headway in 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, 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 30716 persons with turnover of Rs. 11152.84 crores (Director of Industries and Commerce, Haryana as on March, 2012). Haryana is one of the largest exporters of rice, pickles, guar gum, cotton yarn and several other food products. There are large numbers 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, spices, bakery products, achar, pickle, chutney, dairy products, sugar, animal feeds and cold storage. The present status of grain processing industries is shown in table 6

In the continuing effort to give impetus to growth in this sector, the State Government is required to provide assistance for strengthening backward linkages 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 by-products 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 would 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 the grains including cereals, millets, pulses and oilseeds can be properly 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, value addition and improvement in the nutritional status of population in the developing countries, like India.

Table 1: Area and Production of Principal Cereals in Haryana

Year	Rice		Wheat		Bajra		Jowar		Barley		Maize		Total	
	A	P	A	P	A	P	A	P	A	P	A	P	A	P
1966-67	192.0	223.0	743.0	1059.0	893.0	373.0	270.0	49.0	182.0	239.0	87.0	86.0	2370.0	2029.0
1970-71	269.2	460.0	1129.3	2342.0	879.6	826.0	207.0	57.0	108.6	124.0	114.4	130.0	2708.0	3939.0
1980-81	483.9	1259.0	1479.0	3490.0	870.3	474.0	136.9	48.0	124.5	181.0	71.3	81.0	3167.7	5533.0
1990-91	661.2	1834.0	1850.1	6436.0	608.6	526.0	129.1	65.0	50.5	107.0	34.8	49.0	3337.3	9017.0
2000-01	1054.3	2695.0	2354.8	9669.0	608.3	656.0	109.4	23.0	44.1	118.0	15.4	34.0	4186.5	13195.0
2010-11	1243.3	3465	2504	11578	659.6	1183	70.8	38	37.3	130.0	9.6	19	4524.6	16413.0
2011-12	1235	3759	2522	13069	577	1177	65	33	42	153	9.0	24	4574	18321.8

A – Area in 000 hectares; P – Production in 000 tonnes

Table 4: Area and Production of Principal Pulses in Haryana

Year	Gram		Moong		Masar		Mash		Other pulses		Total	
	A	P	A	P	A	P	A	P	A	P	A	P
1966-67	1062.0	531.0	13.6	4.7	35.1	12.4	7.9	2.8	31.0	12.0	1150.0	563.0
1970-71	1063.2	789.0	22.5	9.4	26.8	10.8	8.9	3.7	37.5	18.9	1158.9	832.0
1980-81	721.9	455.0	4.1	2.9	27.4	13.1	12.5	7.6	28.9	23.9	794.8	502.5
1990-91	649.3	469.0	10.7	5.8	18.3	10.8	3.4	1.3	60.3	54.8	742.0	541.7
2000-01	124.5	80.0	5.3	1.2	6.5	5.2	1.5	0.3	19.2	13.1	157.0	99.8
2010-11	112	110	25	12.7	5	5.0	2	0.7	30	30.0	174	158.4
2011-12	79	72	15	7.0	6	6.0	2	0.8	22	21.0	124	106.8

A – Area in 000 hectares P – Production in 000 tonnes

Table 5: Area and Production of Principal Oilseeds in Haryana

Year	Rapeseed & mustard		Seasmum (Til)		Groundnut (nuts in shell)		Linseed		Total	
	A	P	A	P	A	P	A	P	A	P
1966-67	198.0	80.0	1.7	0.5	11.1	11.0	0.6	0.2	212.0	92.0
1970-71	129.8	89.0	1.8	0.6	10.4	8.9	0.5	0.3	142.6	98.8
1980-81	299.6	178.0	3.7	1.6	6.2	7.8	0.4	0.1	311.2	187.5
1990-91	473.8	634.0	6.1	2.0	2.6	1.9	0.1	0.1	488.5	638.0
2000-01	408.8	560.0	3.5	1.0	0.3	0.2	-	-	414.0	562.8
2010-11	509.7	953.0	3.3	1.4	2.3	2.4	-	-	521.0	964.9

A – Area in 000 hectares P – Production in 000 tonnes

Table 6: Sector wise statistics of food processing industries in Haryana as on March, 2012

Sr No	Sectors	Units	Investment in Rs. lacs	Turnover In Rs. lacs	No. of Labours employed	No. of labours/ units (L/U)	Investment in Rs. Lacs /Unit	Turnover in Rs. lacs /Rs. lac Investment
1	Wheat milling	69	2605.48	10554.93	632	9	37.76	4.05
2	Rice milling	525	220662.82	407482.55	15016	29	420.31	1.85
3	Pulse milling	18	612.29	5917.38	116	6	34.02	9.66
4	Oil processing	39	4678.78	40478.06	769	20	119.97	8.65
5	Bakary products	65	9698.39	46661.17	1722	26	149.21	4.81
	Total	**972**	**368054.00**	**1115283.58**	**30716**	**971**	**8216.42**	**67.45**

POST HARVEST PROCESSING OF MILK FOR VALUE ADDITION - PRESENT SCENARIO AND FUTURE PROSPECTS

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Introduction

Which is India's No. 1 crop? Is it rice or wheat? Well, neither. The right answer happens to be milk. The country's milk production is estimated to have touched 132.43 million tons (mt) in the year 2012-13, which is higher than the estimated 92 mt for rice and 75 mt for wheat. In value terms, too, a kg of milk is worth more than what you and I pay for a kg of simple rice and wheat. Milk is one product that generates cash income to farmers almost on a daily basis. Besides being a source of liquidity and insurance against crop failure, milk is the only produce where the farmer realizes 60-70 per cent of consumer price; against 20 per cent or so in fruits and vegetables. As per the fourth Dean's Committee report (2006) submitted to ICAR, it is estimated that 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. Again, it is striking that there are no commodity futures in milk powder or ghee, whereas the daily turnover volumes in NCDEX and MCX of guar seed, mentha oil, jeera or pepper run to hundreds (even thousands) of crores.

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) and will be carried out between 2012 and 2017.

Haryana is an agricultural state and the contribution of Agri sector to total GDP of state is 15 per cent whereas the livestock sector is contributing to the tune of around 39 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 as a whole. 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 agricultural GDP 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.

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 tons) in the state. Average milk production of Indigenous cow is 4.9 Kg, Exotic/ cross bred 7.9 Kg, Buffaloes 7.1Kg and Goats 0.8 Kg per day/animal. Buffalo has been an integral part of livestock 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 all 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.

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. At present the procurement price of milk is Rs 450 /kg fat that means 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 policy of the state.

Constituents	Buffalo	Cow
Moisture (gm)	81.00	87.50
Protein (gm)	4.30	3.20
Fat (gm)	6.50	4.10
Minerals (gm)	0.80	0.80
Carbohydrates (gm)	5.00	4.40
Energy calories (Cal)	117.00	67.00
Calcium (mg)	210.00	120.00
Phosphorus (mg)	130.00	90.00
Iron (mg)	0.20	0.20
Cholesterol content mg/g	0.65	3.14
PER	2.74	2.49
biological value	91.9	78.4
NPU	88.8	78.3
Absorption of fat	79.9	74.6

Most of the cow milk produced in the state is from Holstein Friesian / Jersey and their crosses which produce 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.

Issue-Is farmer would be spared from the registration / licensing policy under FSSA?

In view of the above facts the present article aims at highlighting 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 Operators in India to get Licensed/Registered with Food Safety Authority and old operators also have to register themselves up to 2014.

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 (Table 1) as it is rich 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. As such, Buffalo milk has special importance and priced higher. Buffalo milk also have the quantitative and qualitative better various milk constituents as mentioned above 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.

MILK PROCESSING:

Liquid milk Processing

Good hygiene is essential whether the animals are milked by hand or machine. This requires that:

a. The milkers' hands and clothes are clean and he or she is in good health.
b. The milking machine and milk storage equipment such as milk cans/churns are kept clean and are in good condition.
c. Immediately after milking, the milk must be cooled preferably to 4°C.This requires mechanical refrigeration or milk cooling tanks.

The fluid milk 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°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 our country, 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, 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 for 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.

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 the 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's why it is being marketed on a limited scale and the potential benefits of this technology cannot be fully exploited.

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 to 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 (20-43%) 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 industry 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.

Heat desiccated products

Approximately 6% of the total milk production is used for producing khoa, according to an estimate about 15 million tons of khoa is produced annually, valued at Rs 1,05,000 crores. It is used as a base material for a variety of popular sweet-meats, such as Burfi, 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 to 72% TS). 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.

Peda is a sweetened dried granulated khoa based product which is prepared by heating mixture of milk and sugar with constant stirring till solid texture is not obtained and then made a small balls of 25-50g sized. There are different types of pedas available such as saffron peda, plain peda, brown peda. It has a characteristic light brown color due to caramelization of sugar.

Burfi is another popular khoa based product. It is prepared by blending a pindi type of khoa with sugar syrup. The ingredients are kneaded together at 50ºC in a tray and allowed to set, followed by cutting into square pieces. Different types of burfies are prepared by addition of different additives such as pista, almond, coconut etc.

Gulabjamun is soft, sweet, granulated, slightly spongy, brown spherical milk based product. Generally, it is prepared by blending of dhap khoa, wheat flour and baking powder then kneaded and spherical balls are made which further fried in oil and finally dipped into sugar syrup.

Rabri is a partially concentrated and sweetened milk product containing several layers of clotted cream (Malai). It is quite popular in northern and eastern parts of the country. It involves standardization of buffalo milk to 6% fat, its simmering in a steam jacketed kettle at 90 0C, repeated removal of clotted cream (Malai) on the colder part of the kettle or to a separate container, concentration of milk to three fold after removing about 100 gm clotted cream from 1 kg milk and adding sugar @ 6% of initial milk to the concentrated milk. The clotted cream is finally added to the concentrated sweetened milk.

Technology has been developed for the large scale production of Khoa using thin film scraped surface heat exchanger (TSSHE). It involved standardization of buffalo milk to 6% fat, addition of sugar @ 6% to preheated (85-90^{0}C) milk and concentrating in TSSHE upto 70% solids.

Kheer is an Indian dessert and a heat desiccated sweetened, concentrated milk product obtained by the partial dehydration of whole milk together with sugar and usually rice (occasionally semolina). It has a creamy consistency and color, sweet taste with nutty and cooked flavor and soft textured. Whole milk is heat condensed by using periodically stirring up to its half volume then sugar is added @5%. The heating is continued until the desired consistency is reached. Finally, it packed and stored under refrigeration. Additives such as cardamom, saffron and edible camphor are added to improve flavor of kheer.

Kulfi is a popular Indian frozen dessert made from concentrated sweetened milk with or without added nuts and flavor and is known for its refreshing and delightfully sweet characteristics.

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 tonnes. Paneer is highly nutritious since it retains approximately 90% fat and protein, 50% minerals 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 from17-18%. 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 skim 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 lose their identity. Technology has been developed at LPT department (LUVAS) for manufacturing ready to serve spiced paneer using certain ingredients having dietary fiber.

The paneer curry developed at NDRI by hurdle technology had a shelf life of about a month at 30°C and more than 3 months at 15°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 skim 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 2 million tones and valued at Rs. 7000 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 filler for the preparation of a large variety of Indian delicacies namely, rasogolla, sandesh, cham-cham, rasmalai, pantooa, rajbhog, chhana-murki and many more such 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. For more details

you may see a review on “Indian Milk Based Sweets” Indian Dairy Man (March 2014).

Very few attempts have been made in this area of product diversification. Chhana obtained was broken into small pieces and transferred to a domestic mixer where it was made into a paste with the addition of water. For every 100 g of cow/buffalo chhana approximately 10 ml / 20 ml of water was added. Salt @ 1.0-1.5% was added during grinding. An acidifying agent was 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 was added @ 0.8-1.0 ml per 100 g of spread. NDRI standardized another protein-enriched table spread using chhana as base along with butter. Skim milk chhana and butter were 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 was added @ 2% (w/w). Based on the various physico-chemical and sensory attributes, use of 40% chhana was reported to be best suited for the preparation of spread.

Fermented Products

Practice of preserving milk by fermentation is a common household technology in India. The Indian medical treatise Sushruta Samhita 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 600AD. At 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 Leuconostoc species along with Lactobacillus acidophilus, L. bulgaricus, and S. thermophilus 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 bifidum, 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 probiotic lactobacilli viz*. L. acidophilus and L. casei* used to prepare dahi either alone or in combination with mesophilic dahi culture *Lactococcus lactis ssp. lactis biovar. diacetylactis*-60 and mixed dahi culture 167 (BO4). 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^{o}C for 9-

10 hours. After incubation dahi is stored at 4^0C (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. Numbers of probiotic organisms are $7.1xI0^{10}$ approx. Number of probiotic organisms ranged from $3.8\ xI0^{10}$- $4.24xI0^{10}$.

The processing parameters for manufacture of good quality fruit dahi using various fruits, such as mango, pineapple and banana have been standardized. Appropriate starter cultures have been employed to get desired flavour and consistency in the product. The rheological 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 30^0C.

Lassi is 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 fourparts 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. 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℃ 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 consist 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 blend with the required amount of sugar and flavor for obtaining shrikhand.

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 globules 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 (Mathur,1994).

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.

At Panchmahal Dairy, Godhra, a group of workers developed improved Method of Ghee making which include a serum separator and a spiro-heater in the process, at first, fresh raw milk is received at raw milk receiving dock RMRD of the main dairy plant, chilled and stored. This milk is subjected to cream separation after necessary filtration and warming to 55-60^{0}C in regeneration section of pasteurizer. Resultant cream is pasteurized in a high temperature short time (HTST) plant at 90-92^{o}C, chilled to 10-12^{o}C and stored in insulated, jacketed, cream storage tanks. This cream is then pumped to Continuous Butter Making machine (CBMM) wherein white butter is obtained. Resultant buttermilk along with serum from serum separator is chilled in a plate chiller and diverted for use in standardization of fresh milk. White butter is pumped via screw conveyor to spiro-heater where it is melted by circulating hot water. Melted butter is conveyed to tanks provided with agitator and hot water circulation jacket from where it is subjected to serum separation. Serum is separated, chilled in a plate chiller and pooled with sweet buttermilk for use in milk standardization. Melted butter with low moisture and high fat and serum solids is collected in a butter melting vat from where it is pumped to Primary Settling Tank

(PST) and then continuously to different Ghee kettles (boilers) for ghee manufacturing in a normal way during which residual moisture is evaporated at 113^{o}C. After some holding, ghee clarification is done at 95^{o}C through a ghee clarifier to remove fine particles of residue. Clarified ghee is pumped to ghee settling tanks where ghee is cooled with water circulation to 50^{0}C. At this stage, a sample is withdrawn for analysis with respect to chemical contents and physical attributes before allowing it for packing into retail containers.

Advantages of Modified Method of Ghee Manufacture:

- Steam saving
- Increased ghee production
- Saving in Fat and SNF
- Less load on ETP
- Hygienic condition
- Delight in working condition
- Water saving

As per an estimate, an annual saving amounting to Rs.190 lakhs/annum could be obtained by way of saving in fat/SNF, steam, electricity, man-power, water, hygiene, house-keeping, etc. The saving was calculated by considering 12000 kg/day of ghee making.

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 has been developed by LPT department of LUVAS.

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 preferable 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), 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 renneting 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:

Varieties for bulk users and customers:	Cheddar including processed cheese and cheese spreads and Mozzarella
Varieties for the connoisseurs:	Gouda, Edam, Swiss, Parmesan, Cottage etc.

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.

Future Prospects and Strategies

Due to several breeding programs to improve the productivity of buffaloes the milk production will bound to 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 our 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 foreseable. 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 immensely important.

The following issues need urgent attention to boost dairy industry and to meet obligations under the Food Safety and Standards Act-2006:

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

AGRI-BUSINESS MANAGEMENT – AN OVERVIEW

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Introduction

Agri-business management is management of agricultural business 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 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 supply chain from supplier to consumer.

Some experts believe that agriculture has now 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 fiber to consumers. Agri-business include not only those that form the land but also the people and firms that provide the inputs (for ex. Seed, chemicals, credit etc.), process the output (for ex. Milk, grain, meat etc.), manufacture the food products (for ex. ice cream, bread, breakfast cereals etc.), and transport and sell the food products to consumers (for ex. restaurants, supermarkets).

Important agri-business includes:

- Food Processing - Jams, Pickles
- Retailing/Marketing – Seeds, Pesticides
- Farm and advisory Services – Soil testing, Agri-clinics
- Poultry/Fishery/Meat/Apiculture/Seed business
- Dairy products – Milk, Butter, Cheese
- Maintenance/Repair/Hiring services
- Bio-fertilizers/Vermi-compost/Bio pesticides
- Fodder/Feed Processing
- Medicinal and Aromatic plants
- Floriculture
- Agriculture – Cereals, Organic products
- Contract farming/Orchards
- Commodity trading
- Agri-tourism/Nursery/Poly houses
- Farm machinery and equipments

Important decisions that are desired to be taken while setting up and starting an agri-business typically include:

- What and how much to produce?
- What kind and amount of resources required?

- What technology to use?
- How to buy and sell?
- How much money is required?
- Size, Location and layout of plant.

Basic structure and type of Agri-business units

Four basic structures are available for starting agri-business units:

- Sole Proprietorship – The business is started by a single person. More profits but more risks are involved.
- Partnership – Two or more persons may start the business. More money may be put in business. However, profits are shared.
- Corporation – A company may be started by a person. Company may take the form of private limited or public limited firm.
- Cooperative – A cooperative society may be formed to run the business. In this more money may be put in the business and responsibility is also shared.

Different types of Agri-business units include:

- Village & cottage industry--Population not exceeding 50000.
- Micro Enterprise: Investment in Plant and Machinery 25 lacs in manufacturing and up to Rs 10 lacs in equipments in service sector
- Small Scale Industry: Investment in Plant and Machinery is more than 25 lacs but does not exceed Rs 500 lacs in manufacturing and Rs 10 to 200 lacs in equipments in service sector
- Medium Enterprise: Above 500 lacs and up to Rs 1000 lacs in P&M in manufacturing and above Rs 200 lacs & up to Rs 500 lacs in equipments in service sector
- Women enterprises: SSI related service where share of the women as partner, shareholders, and directors is not less than 51%.
- Export oriented units--exports at least 30% of its production.
- SSSBE--An industry related service business enterprises with investment in fixed assets up to 5 lacs except land & building.

Financial Management

Financial management is the activity which is concerned with procurement and utilization of funds from various sources. These sources may be internal or external. Following are the main components of financial management:

- Sources of funds – Financial management advocates tapping of all sources of finance like debt, equity, own capital, loans etc. The aim here is to procure the funds at least cost.
- Working capital management – Day to day requirement of money is called working capital. One must estimate and make provisions for working capital.
- Standard costing – Determination of standard costs related to raw material, labour, and overheads etc. are tasks of standard costing. These costs are required to judge and control actual or real costs.

- Capital Budgeting decisions – Utilization of money into capital items and projects are termed as capital budgeting decisions.
- Accounting – Keeping track of money matters a lot. This activity is called accounting.

Finance is needed at all stages of commercial agriculture and agri-business. Seeds, fertilizers, equipments, water, electricity, labour etc. are needed in most of the processes attached with agriculture. Procurement of these requires money.

Many sources of finance may be tapped. Some of these are mentioned below:

- Own capital – Farmers or the companies may utilize their own money/savings.
- Money lenders – Loans from village and city money lenders may be taken.
- Commission agents/grain market operators – They also provide loans to farmers.
- Commercial banks – Nationalized, private, and regional rural banks also provide money in terms of loans.
- Co-operative banks/societies – They also provide loans and credit.
- Subsidies & Government incentives – State agriculture department, Khadi board etc also provide incentives and subsidies

As per extant policy, certain targets have been prescribed for banks for lending to the Micro and Small enterprise (MSE) sector. In terms of the recommendations of the Prime Minister's Task Force on MSMEs, banks have been advised to achieve a 20 per cent year-on-year growth in credit to micro and small enterprises, a 10 per cent annual growth in the number of micro enterprise accounts and 60% of total lending to MSE sector as on preceding March 31st to Micro enterprises.

In order to ensure that sufficient credit is available to micro enterprises within the MSE sector, banks should ensure that:

(a) 40 per cent of the total advances to MSE sector should go to micro (manufacturing) enterprises having investment in plant and machinery up to Rs. 10 lakh and micro (service) enterprises having investment in equipment up to Rs. 4 lakh.

(b) 20 per cent of the total advances to MSE sector should go to micro (manufacturing) enterprises with investment in plant and machinery above Rs. 10 lakh and up to Rs. 25 lakh, and micro (service) enterprises with investment in equipment above Rs. 4 lakh and up to Rs. 10 lakh. Thus, 60 per cent of MSE advances should go to the micro enterprises.

Public sector banks have been advised to open at least one specialized branch in each district. The banks have been permitted to categorize their MSME general banking branches having 60% or more of their advances to MSME sector, as specialized MSME branches for providing better service to this sector as a whole. As per the policy package announced by the Government of India for stepping up credit to MSME sector, the public sector banks will ensure specialized MSME branches in identified clusters/centers with preponderance of small enterprises to enable the

entrepreneurs to have easy access to the bank credit and to equip bank personnel to develop requisite expertise. Though their core competence will be utilized for extending finance and other services to MSME sector, they will have operational flexibility to extend finance/render other services to other sectors/borrowers.

Traditional Marketing V/s New Marketing Thinking

The traditional view says that the firm proceeds to make something and then to sell it. In this view, marketing takes place in the second half of the value delivery process. This view has the best chance of succeeding in economies of scarcity. Consumers in these kinds of situations are not fussy about quality, features, or style. But this view of the business process will not work in more competitive economies where people face abundant choices and exercise discrimination.

The second view, therefore, is in vogue that places marketing at the beginning of the business planning process. Instead of a make and sell view, the business process consists of choosing the value, providing the value, and communicating the value. The first phase, choosing the value, represents the 'homework' that decision maker must carry out before any product exists. The marketing staff proceeds to segment the market, select the appropriate market target, and develop the offer's value positioning. The formula – segmentation, targeting, positioning (STP) – is the essence of marketing. Once the business unit has chosen the value to deliver to the target market, it is ready to provide the value. The tangible product and service must be specified in detail, a target price must be established, and the product must be made and distributed. The task in the third stage is to communicate the value. Here sales-force, sales promotion, advertising, and other promotional tasks are used to inform the market about the products and services.

(b) The modern view

The time has now come to focus on the modern view of the marketing. This approach may be very useful in case of rural and agricultural produce

New Vistas of Marketing

In this age of cut throat competition, no marketer or company can ignore to leave even a single customer. Marketers, therefore, have to invent and use new tools and techniques of marketing. Normally a company or marketer use integrated marketing approach in which all possible ways of marketing goods and services are used. Companies seldom rely only on a single mode of reaching a customer.

Besides traditional ways, new ways have also emerged and are becoming popular day by day. Some of these new ways are as follows:

(a) Internet Marketing/E-commerce – Marketing through internet is becoming popular day by day. The access to internet has made this possible. Internet has created opportunities for buyers and sellers alike. In internet marketing, companies or persons display and sell their products on their websites or portals. There are exclusive marketing sites also where many companies are selling the products of other manufacturers. Amazon.com, Flipkart.com

and Indiatimes.com are among the popular ones. These may be used to agribusiness units to display and sell their products.

(b) Network Marketing – In this mode of marketing, products reach the ultimate buyers through network of members. The customers get product at less price and members of network get commission for their efforts. Amway, Sterling, and RCM are famous network marketing companies.

(c) Catalogue marketing – In this type of marketing effort, goods are sold through catalogues. Catalogues are distributed to the customers and customers demand items from the catalogues and goods are then supplied to them. Many health equipments, sports gear, and food items are sold this way.

(d) Tele-shopping networks – Here, the products are displayed on television channels. Customers may order the products by mail, sending the item code and demand draft and goods are delivered to them.

(e) Event marketing – Many companies organize special events like electronic product melas, consumer product melas, grand sales etc. where various products are displayed by different manufacturers and sold.

(f) Organized retailing/super-markets/malls - Organized retailing is expanding very fast in India. Many supermarket chains and malls are now present in India. These chains and malls sell wide range of products under one roof.

New Modes of Marketing for Ruralites

The people in rural areas are mostly involved in works related to farming, food processing, handlooms, handicrafts and other cottage industries. These people are also very skilled in producing high quality decorative items, cosmetic items, edible items and various utility items. These products reflect the local culture, tradition and indigenous knowledge handed down over centuries and is generally produced from the raw material that is easily available in the area. The products developed by these people are generally sold in the local markets to the people mainly belonging to the same or surrounding locality or sometimes even to the visiting tourists. To sell the products to remote or urban markets, the producer has to depend on the middlemen. The middlemen generally collect the products and also information about these products, such as how it is made, how it can be used, how it should be maintained etc., from these producers and market it in urban centers. In return, the rural producers get a very meager amount, in comparison to the profit they actually make out of selling the product.

Many government agencies and NGOs have come forward with many strategies for the promotion of these products. They have established number of haats or markets in urban areas and sometimes exhibitions are arranged to showcase the products. But the sustained availability of such outlets with sound distribution channels is not assured. The present scenario is that the rural market is more or less saturated for these products due to lack of innovation which is due to limited local demand. At the same time, they are unable to expand their customer base to urban and global markets, mainly because they have neither the means to reach the markets nor do they have the salesman skills in organized manner, to articulate well in the customer's language. The middlemen and government

agencies/NGOs are also able to play only a limited role, particularly in publicizing the products in global markets. At the other end of the spectrum is the potential customer who has both the desire as well as the capacity to pay but who has no knowledge about even the availability of these products, let alone access to them. This calls for finding new marketing modes to reach the customers. At the same time new markets and linkages for reaching these markets have to be explored.

(a) E-marketing - Information and Communication Technologies (ICTs) have enabled various information or content to be placed over internet in order to share it all over the world. Today, huge information is available over the internet in text or document form like market prices, poverty alleviation government schemes, hospital, weather, educational institutes' directory, telephone directory and much more. While urban netizens increasingly upload content available with them due to greater awareness on part of urban centric organizations, what is still ignored or not available is local content available with and for rural communities. Local content is invariably available in the form of indigenous knowledge that has been inherited by the community over centuries. One important aspect of this indigenous knowledge is the content about the various products that the rural communities produce. These products are part of the village economy that used to have various industrious facets and one of the important elements was rural artisans, their creative space and economics associated with it.

Sharing this information with the global community and displaying various products on websites or portals is the first step towards introducing an effective e-Commerce solution for rural produce. Individual or group websites may be created to display and market the products.

(b) Rural Bazars – Rural Bazar is a simple, web based e-Commerce solution that allows efficient and cost-effective showcasing and marketing of rural products. Though primarily designed to work as an e-commerce solution, RuralBazar addresses some of the issues related to rural areas. In view of the limited (or practically unavailable) e-readiness in rural areas, their first and foremost requirement is to publicize content about their products to the potential customers using internet. RuralBazar facilitates this by simply allowing the rural communities to share content about the products and associated metadata with search facility. Detailed information about the products can be shared with global community along with high quality pictures. As a showcasing site, RuralBazar does not allow any online order placement. Along with information about the products, it also shares contact information about the producers so that the potential customers can directly contact them.

The RuralBazar has two internet-enabled interfaces. The first interface (also called Site Manager) is meant to be used by community representatives (such as SHGs, NGO and other civic organizations engaged in community development) for managing producers' profile, products profile, prices/discount management, order management etc. The second interface, which is public/home page of RuralBazar website, showcases the products to customer on internet. In RuralBazar, a product can be classified according to three broadly defined categories purpose of use, raw material used or product type. These broadly defined categories can further have any

number of catalogs. Also one of the important features of RuralBazar is creation of data entry operators' login, who will be able to enter data sitting at district or block level using the RuralBazar Site Manager interface. The implementing or community support agency (government or NGO or SHG or Rural Local Body or civic organization) can collect the information about the available rural products and categories products according to the broadly defined product categories and catalog. Then this categorized information can be stored and showcased using the RuralBazar. The Rural development department of government of Tamil Nadu launched Ruralbazar (http://www.ruralbazar.tn.gov.in) website to strengthen the marketing of products produced by rural people in July, 2003. The site presently showcases more than 700 products created by Self Help Groups (SHG).Goa http://www.ruralbazargoa.nic.in/ and Tripura http://www.purbasha.nic.in/ have also undertaken similar initiatives.

(c) Agri-Tourism - Agri-tourism is "a commercial enterprise at a working farm, ranch, or agricultural plant conducted for the enjoyment of visitors that generates supplemental income for the owner."

Agri-tourism and nature-tourism enterprises might include:

- Outdoor recreation (fishing, hunting, wildlife study, horseback riding).
- Educational experiences (cannery tours, cooking classes, or wine tasting).
- Entertainment (harvest festivals or barn dances).
- Hospitality services (farm stays, guided tours or outfitter services).
- On-farm direct sales (u-pick operations or roadside stands).

Agri-tourism is a subset of a larger industry called rural tourism that includes resorts, off-site farmers' markets, non-profit agricultural tours, and other leisure and hospitality businesses that attract visitors to the countryside.

Rural Tourism differs from agri-tourism in two ways. First, rural tourism enterprises do not necessarily occur on a farm or ranch, or at an agricultural plant, they do not generate supplemental income for the agricultural enterprise.

(d) Contract Farming/Manufacturing - Ruralites may market their produce through contract farming or contract manufacturing. If they have to market agricultural produce then they may go for contract farming by entering in contract with a big company. Similarly if they are manufacturing any item then also they can do that for a big organization. This may save the promotion and distribution costs and they don't have to search for the market.

(e) Commodity Exchanges - With the establishment of Multi-commodity Exchange (MCX) and National Commodity and Derivative Exchange (NCDEX), it has now become possible to trade in commodities and derivatives. Farmers may now get good return by selling their produce on these exchanges.

Problems of Agri-business Units

Mentioned below are a few problems faced by agri-business units:

- Weak capital base and lesser access to capital market
- Improper planning, budgeting and control
- Lacking basic infrastructure – storage, transportation
- Old/outdated technology
- Poorly placed in market situation

- Lack of information like market and demand
- Promoters lack specialization
- Lacking managerial & professional skills
- Branding and advertising

Why Units fail?

Mentioned below are a few reasons that lead to the failure of small scale units:

- Inordinate delay in sanction of credit limit
- Need based lending not extended
- Big units deliberately promote ancillaries
- Gets payment on the whims & fancies of big units
- Disadvantageous position of raising funds

Institutions that may help

Government, institutions and other agencies help agri-business units through various schemes, subsidies, loans, insurance, and by providing training and know how etc. Mentioned below are a few central, state and industry level institutions and associations that help agri-business units.

Central level institutions:

- Small-scale Industries Board (SSI Board)
- Khadi and Village Industries Commission (KVIC)
- Small Industries Development Organization (SIDO)
- National Small Industries Corporation Ltd. (NSIC)
- The national Science & Technology Entrepreneurship Development Board (NSTEDB)
- National Productivity Council
- National Institute for Small Industry Extension & Training (NISIET)
- National Institute for Entrepreneurship and Small Business Development (NIESBUD)
- Entrepreneurship Development Institute of India (EDII)
- National Bank for Agricultural and Rural Development (NABARD)
- Small Industries Development Bank of India (SIDBI)
- Housing and Urban Development Corporation Ltd. (HUDCO)
- Export Promotion Councils (EPCs)
- APEDA/MPEDA

State level Institutions

- Directorate of Industries (DIs)
- District Industries Centers (DICs)
- State Financial Corporation's (SFCs)
- State Industrial Development Corporations (SIDCs)
- State Industrial Investment Corporation (SIICs)
- State Small Industrial Development Corporations (SSIDCs)

Industry Associations

- Confederation of Indian Micro and Small & Medium enterprises (FISME)
- Confederation of Indian Industry (CII)
- Federation of Indian Chambers of Commerce & Industry (FICCI)

- PHD Chamber of Commerce and Industry (PHDCCI)
- Associated Chamber of Commerce & Industry of India (ASSOCHAM)
- Federation of Indian Exporters Organization (FIEO)
- World Association for Small & Medium Enterprises (WASME)
- Federation of Associations of Small Industries of India (FASII)
- Laghu Udyog Bharti (LUB)
- Indian Council of small Industries (ICSI)

MARKETING AND PACKAGING OF FRUITS & VEGETABLE CROPS

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India having varied agro-climatic conditions produces wide range of tropical, subtropical, temperate and Arid zone fruits in all seasons in one or other parts of the country. During last few years' considerable emphasis has been given to the production of horticultural crops in our country. Accordingly area under fruit production has risen and productivity/ha has increased. Today India has emerged as world leader in fruit and vegetable production. There is considerable gap between production and net availability of fruits and vegetables. This is mainly on account of post harvest losses in our country due to lack of elaborate harvesting equipment, collection centers in major producing areas, commercial storage facilities and lack of cold chain. Total losses in fruits range from 20-30% in different fruits. These losses vary from fruit to fruit, varieties, storage conditions and quality.

Causes of losses: Fruits are highly perishable commodities as it contains 80-95% water. Even 5% loss of water in fruits due to transportation leads to shriveling and fruits become unmarketable. Further large unit size, high respiration rate, soft texture, susceptible to bruising, rotting and senescence limit the shelf life of these commodities. Transpiration and respiration are major cause of deterioration in the fruits. These losses can be reduced to great extent by harvesting fruits at proper stage, proper method of harvesting, sorting, application of pre and post harvest treatments, packaging, transportation and appropriate marketing. Important sites where post harvest losses are noticed in India are farmers' field 15-20%, packaging 15-20%, and transportation 30-40%.

Post Harvest Losses are very high in developing countries than developed countries because of following reasons

1. Poor Concept of post harvest technology to the farmers
2. Lack of collection centre
3. Lack of refrigeration facilities at various points.

Benefits of Reducing the Post Harvest Losses

a) Supply of horticultural products can be significantly increased without bringing additional land into production.
b) The problem of garbage disposal and consequent pollution will reduce.
c) Scares and costly inputs will be more cost effective in economic terms.
d) Consumer needs will be satisfied and better nutrition will be insured with the same amount of non renewable resources.

Marketing of fruits & Vegetables

Marketing is the activities involved in moving the produce from the site of production to the consumer. Dixie gave the following two definitions of marketing "the series" of services involved in moving a product (or commodity) from the point of production to the point of consumption and marketing involves finding out what your customer want and supplying it to them at a profit. Perishables include fruits, vegetables and ornamental flowers. It is fastest growing industries in agriculture. Horticulture Marketing has diversified, exciting field with unlimited opportunity because of difference in water content, different layers on the surface of fruits and different morphology in different fruits. So there is a need to look out each and every commodity of horticulture with different point of view. Success of Horticulture Farmers really lies with the good marketing. Marketing of perishable crops becomes increasingly important as the standard of living and crop production increases. In certain societies the production of fresh fruit and vegetables is currently lower than the market requirement. This result in a seller's market, where the farmer can sell the entire crop which are grown and there may be little incentive to supply high quality crop to the market, whereas in other society crop production or potential crop production, is greater than the demand. Farmer is increasingly studying the market to determine its requirements. In countries, where markets are not well regulated, this results to fluctuating supplies, because the farmer may see the same opportunity and also change, result in an oversupply. This can lead to low prices and farmers ceasing to grow that crop. This leads to shortage and the cycle repeat itself.

Many perishable crops are seasonal and their value or selling price varies throughout the year. Orderly marketing can be achieved in certain cases by storing the crop from the harvest season to season of scarcity. Many different marketing systems have been used in both developing and developed countries.

Why Strategic Market Planning is a hot topic

Marketing of fresh fruits and vegetables has become a hot topic in order to fetch the foreign-exchange but it is strategies which are to be planned for a successful market. This is because of globalization of agricultural marketing where farmers are free to sell their produce to different countries rather than only to friendly countries. Secondly, in the retail-sector because of increase in per-capita income, there is more demand for fresh fruits and vegetables in all developed and developing countries. Consumer's attitude has changed as per the changing requirement taking into consideration the health consciousness and vitamins & minerals availability in the fruits and vegetables as compared to cereals. Consumers have more preference to consume fruits and vegetables because they feel that it is a part of the balance diet and without it proper growth of the body is not feasible so the demand for fruits and vegetables have increased in the market but during the production time there is glut in the local market and prices of the fruits and vegetables fall down.

Major Steps in Marketing Horticulture Products

1. Production:

It is First step in process of marketing. For successful marketing emphasis should be laid on production of quality fruits. Quality fruits attracts customer, creates permanent linkage in producer & consumer. For production of quality fruits proper attention is needed by farmer on all cultural practices from start of formation of fruits to its maturity. It requires balanced nutrient at right time, proper humidity & proper management so that quality of fruits can be maintained even after harvest.

International Market

There is lot of fluctuation in the prices of perishables in the international market. Farmer has to be on-line in order to know the prices of various commodities in the international market so that he is able to export his produces at the desired places in order to fetch the better prices. He will also be able to understand the demand of that country about the quality and type of the fruit. No doubt, this will help us not only to raise the economy of that farmer but it will also help the nation to earn the foreign-exchange. This type of marketing will also avoid the glut of fruits and vegetables in the country in the production season of that fruit. This will automatically reduce the various losses which are happening due to glut of fruits and vegetables in the market. This type of marketing can be done by the Cooperative system or by the group of the farmers in the guidance of trained persons who have knowledge of various bars in the export and can handle the situation as per the demand of the country where the fruits and vegetables are exported. In such type of marketing the farmer has to be more careful about the stage of harvesting, proper packaging, pre-cooling and proper transportation up to the airport so that the fruits are reached on the terminals in a good condition acceptable to the consumer of that country.

Competitive Strategy

In horticulture sector in order to command the market, first and the foremost factor is to exploit the quality of fruits in order to demand the higher prices from the consumers. The producer has to explain the consumer that the quality of the fruit is better according to size, colour, taste and better contents so that the consumer can pay higher prices for it. Secondly, the producer should reach in a forward tone in the market in order to capture the retailers so that the producers are not squeezed from the middle-man.

Retail Marketing: Marginal & Small farmers should adopt retail marketing because farmer is directly approachable to consumer and middle man is avoided. This help to achieve better price of commodity to producer & less price to consumer & also fresh fruits and vegetables to consumer directly. For this purpose there are many way out. One easiest way is concept of Apni Mandi where farmers bring his produce directly to common place & consumer also reach there to purchase it. Common place acts as platform for both producer & consumer without commission agents.

Points for Roadside Market

1. Depends on type of consumer, buying habits.
2. 1st impression for customer should be impressive.
3. Surrounding area should be neat & clean with beautiful landscaping.
4. Packing should be attractive & different sizes for different type of customers.
5. Market should have good visibility of entry& exist gates.
6. It should be congenial to stand over there for customer.
7. Price should be uniform, genuine, fair & competitive.
8. Salesman should be attractive & should have capability to attend the customer.
9. If possible some logo of farm.
10. Provision for overnight care of perishables.

SUGGESTIONS TO IMPROVE TERMINAL MARKET

1. Operational area must not be congested.
2. Considerable open area duly guarded should be an inherent feature of every terminal market.
3. Well connected by roads/train and effective communication system.
4. Adequate steps for future expansion should be taken into account in the beginning of setting up such terminal markets.
5. Facilities of cold storage should be available in all major terminal markets.
6. Important bodies like NAFED, super Bazar, Mother Dairy and other marketing institutions of state Govt. should be an integrated part of such terminal markets.

Main aim of Packaging

1. Protect commodity during storage, transportation, distribution, deterioration (Physical, Chemical or Biological) losses.

Packaging is generally done at point of production, processing or at distribution centre. So, it is last link in the chain of production and first in chain in storage, marketing and distribution.

Characteristics of Ideal Packaging

i) It serves as an efficient handling unit for customers and dealers.
ii) It serves as convenient ware house or storage unit.
iii) It should protect fruit from mechanical injury.
iv) It should reduce the wastage of moisture loss.
v) It should keep fruits in clean and hygienic manner.
vi) It should be convenient for transportation and service.
vii) It should be attractive to customers in different modes.
viii) It should be economical in every respect.
ix) It should have height adjustment in such a way that fruits of lower stack don't get pressed by upper stack.
x) It should provide adequate ventilation to fruits to avoid storage and transportation loss.
xi) It should have retailer acceptance to increase turnover and sales at profit.

xii) It should be acceptable in all marketing areas.

xiii) It should fulfill Govt. compliance problem, manufactures responsibility for safety and regard of consumer health, welfare and essential interest.

xiv) It should specify company, its product and image.

Advantages and Disadvantages of Various Packaging Materials

Wooden Boxes

Advantages: 1. Long distance transport
2. Good stacking strength
3. Weather resistant
4. Easy to handle

Disadvantages: 1. Loss of renewable sources & ecological changes
2. More Losses Sizes- 48.5X20X36.0 cms- Petti
45.0X30X30 cms, 48.5X20X22.5 cms- Dabba

Plastic Era: **1.** Corrugated plastic cartoons (Polypropylene boxes)
2. Plastic Basket-20-25 Kg

Advantages- (1) Easy stacking (2) Durable (3) Reused
(4) Reduced damage (5) Less storage Space (6) Uniform Stacking

Disadvantages **1.** High Cost

GUNNY BAGS

Advantage **1.** Easy to handle 2. Cheap

Disadvantage 1. More rotting 2. No stacking

CARD BOARD BOXES

Advantages: (1) Minimum weight (2) Easy handling & stacking
(3) Ventilation by punching (4) Recycling
(5) Printing for label & attractive (6) Consume less material
(7) Internationally accepted (8) Easy Packing

Disadvantage:

1. More Cost 2. Cannot withstand moisture

HERBAL FOOD PRODUCTS

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The consumer's interest in healthy nutrition has changed considerably. Earlier, good nutrition meant avoiding products with high calorie, salt and fat content. Today, more attention is being paid to positive/preventive nutrition owing to the increased choice of food products with the desired functional components and contents. Value-addition of regular foods by medicinal and aromatic plants to make them herbal foods is gaining popularity, especially to an industry which has for long remained traditional. According to a recent report by Chauhan *et al.* (2013), the total market for nutraceuticals in India is growing at 21 percent per annum. It is currently valued at INR 44bn (€621 m), but could be worth more than INR 95bn in four years.

Many researchers have standardized the process and developed various types of value added food products. Food products have been developed by adding herbal ingredients (only edible medicinal and aromatic plants) those are important from nutritional and therapeutic point of view. The demand of herbal based food products namely herbal bakery and confectionery products, herbal dairy products, herbal beverages and herbal meat products, 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. This will stop our running to hospitals or taking chemical drugs which have side effects and also very much costly not affordable by the majority of the people. Hence, the prime need of the hour is to make value added herbal food products for solving the health problems and major ailments of the people.

A. Processing of herbs for preparation of herbal products to fortify the food

Medicinal principles are present in different parts of the plant like root, stem, bark, heartwood, leaf, flower, fruit or plant exudates. These medicinal principles are separated by different processes; the most common being extraction. Processing of medicinal plants includes harvesting, cleaning, washing, grading, cutting, drying, grinding, extraction, processing, storage and packaging.

The following techniques for preparation of herbal products to fortify the foods have been reported by Bandyopadhyay *et al.* (2006).

(a) **Herbal paste**-Herbs are cleaned, blanched properly and then ground in a grinder to get a fine and smooth paste.

(b) **Herbal powder**-Herbs are normally dried in a tray drier at 60 C ± 5^{o}C temperatures for 5-6 h. The dried herbs are crushed in a grinder and strained to obtain fine uniform size powder.

(c) **Freeze drying**-Herbs are first frozen in a deep freezer at -80^{o}C for 24 h. The frozen samples are then placed in a freeze drier for drying. The dried herbs now ground and strained to obtain fine particle size powder.

(d) **Solvent extraction**-Ethanol/food grade hexane is used to extract the phytochemical from the herbs. After extraction, the solvents are evaporated and herb's extract is used in preparation of many foods, sweets, beverages, etc.

The most commonly used process is the herbal paste and mechanical dried herbal powder. Among the paste and tray dried herbal powder, the paste can retain more nutritional and antioxidant properties than that of powder. Freeze drying and solvent extraction techniques are laborious and expensive.

B. Herbal Food Products

1. Herbal bakery and confectionery products

Herbal bread using aloe vera- An attempt was made to assess the feasibility of *Aloe vera* barbadensis gel as a supplement in white bread formulation. The levels of *Aloe vera* gel and processing parameters for the preparation of white herb bread were optimized by conducting sensory acceptability studies. The optimum processing conditions recommended by Singh & Singh (2009) for white herb bread were; yeast 3 g, salt 2 g, sugar 5 g, water 40 ml, shortening 3 g, aloe vera gel 20 g, white flour 100 g, baking temperature 220^{0}C and time 25-28 minutes. Desirable loaf volume 517.5 ml, specific loaf volume 3.3 ml/g with good crumb grain, creamish white colour, velvety soft and elastic texture, golden brown crust, wheat taste and pleasant fermentation aroma were observed in developed herb bread. The shelf life of bread wrapped in polypropylene (50 gauges) was found satisfactory up to 5 days at ambient condition (35±2^{o}C, 40±5 % RH).

Herbal bread using cumin-was developed using cumin and it was found that samples with cumin added form the dough in a shorter time compared to control variant without cumin added. The quality parameters studied (H/D report, volume, porosity) were superior compared the control variant in the case in which cumin was added in proportion of 5% in the variant with cumin added in infusion form (Maiti *et al.,* 2007).

Herbal biscuits using mint - Effect of incorporation of different forms of mint on different quality attributes such as texture, color and sensory characteristics of biscuits were studied by Bajaj *et al.* (2011). The study dealt with the use of mint *(Mentha spicta* L) as a source of natural antioxidant in different forms viz., powder, extract, and pure menthol for its application in biscuits. The selected levels were as follows; 1% mint powder (MNT-P), 500 mg mint extract (MNT-E), and 100 ppm pure menthol (MNT-M) for incorporation in biscuits. MNT-P variation received significantly higher ($P \leq 0.05$) scores in terms of texture, taste and mouth feel. The results indicate that MNT-P biscuits were highly acceptable compared to MNT-E and MNT-M biscuits.

Herbal cakes- Medicinal herbs (anise, black cumin, rosemary and sage) were used as natural antioxidants and antimicrobial to increase shelf-life of some bakery products. Essential oils and phenolic compounds of selected herbs and BHT were added to cake and determined peroxide value during storage and sensory

evaluation. The cakes were formulated into ten formations i.e. without additive (control), BHT (200ppm), 200, 400, 800 and 1000 ppm essential oils and phenolic compounds of anise, black cumin, rosemary and sage. This study shows that essential oils and phenolic compounds extracted from medicinal herbs remained functional as antioxidant and antimicrobial on bakery products (Amany *et al.,* 2012).

Herbal flour confectionery using stevia- A method to produce flour confectionery for low-calorie products and foods with alternative sweeteners was developed by Dorokhovych *et al.* (1998). The method of producing the confectionery included preparing the emulsion including a sweetener, kneading dough, forming it and baking dough products. The method was distinguished by using a stevia leaf extract (5% of the dough's total flour mass) as a sweetener. The stevia extracts substitute sugar and give a reduction in food caloric content.

2. Herbal dairy products

Some edible medicinal plants like lemon grass, tulsi, ginger, meethi neem (curry leaves), pudina (mentha), cardamom, etc. have been used to manufacture milk and milk products. Various dairy products such as salted spiced buttermilk, whey-vit, flavoured milk, ginger ice-cream, panchamrit, medicinal ghee and whey based mango herbal beverages are relatively new development in the dairy field. These products help in curing of physiological disorders, certain diseases and other inborn defects of metabolism in children, young ones and old persons (Choudhary *et al*, 2006).

Herbal burfi with stevia as sweetner- herbal burfi with different levels of khoa (95, 90 and 85%, w/w), stevia powder (5, 10 and 15%, wlw), 2% safed musli powder and other minor ingredients based on sensory trials have been developed by Goyal and Samsher (2008). Herbal burfi samples prepared with 90% khoa, 10% stevia powder and 2% safed musli powder ratio were found the best. This ratio scored highest overall acceptability. Less microbial growth ($2.557x10^5$ cfu/g) was noticed in those sample having 85% khoa and 15% stevia powder. Other physico-chemical qualities of this ratio were also found satisfactory.

Herbal sandesh- Standard composition for preparation of herbal sandesh sweet has been developed by Bandyopadhyay *et al.* (2006). Ashawagandha (*Winthania sommifera*) - 55O mg; Satavari -400 mg; Kapikachu-100 mg; Tulasi (*Osimum sanctum*) -250 mg; Purified Shilajeet (*Black bitumen*) -250 mg were used for preparation of herbal sandesh sweet.

Herbal probiotic dairy products- Some functional foods, which are therapeutically efficient for the human body, can be obtained by combining the milk and the medicinal plant extracts. A study was done to evaluate the growth of probiotic bacteria in milk supplemented with medicinal plant extracts, in order to fabricate a probiotic dairy product named *CATINOLACT*. This dairy product was obtained from cow milk, sea-buckthorn (*Hippophae rhamnoides L.*) and liquorice (*Glycyrrhiza glabra L.*) extracts. The fermentation process was made at 42ºC, for 5 hours, using a lactic probiotic bacteria culture ABY 3 (*Bifidobacterium* species, *Streptococcus thermophilus*, *Lactobacillus acidophilus*, *Lactobacillus delbrueckii* subsp. *Bulgaricus*). It was observed that the *CĂTINOLACT* product had been preserving its functional

properties during storage ($1 \cdot 10^8$– $1 \cdot 10^9$CFU/mL probiotic bacteria) (Gabriela and Alina, 2009). Similarly, a new probiotic product named *ROSALACT* has been prepared by Mocanu *et al.* (2009) from pasteurized milk with medicinal plants extracts (rosehip extract and liquorice extract) using a mixed culture of probiotic bacteria ABT 5. The probiotic dairy product *ROSALACT* followed to combine the beneficial effects of probiotic bacteria with the therapeutic virtues of medicinal herbs. Some probiotic dairy products are being marketed in India by company Yakult.

3. Herbal beverages

Herbal health beverage is a unique formulation of whole plants or plant parts having medicinal and nutritional properties which act as nutraceutical. Today, there are many types of herbal beverages available in the market, which are fortified with medicinal plants. Some of them are as follows:

Herbal aonla drink- Aonla fruit juice prepared by adding equal volume of water, adulasa and shatavari leaf juices, and ginger rhizome extract were employed along with mint (menthol) to prepare herbal health beverage. The extracts and juices were mixed in different proportions. Mint extract was added @ 0.4 – 0.6 mg/100 ml. The mixture was fortified with sugar, enough for maintaining 16^o Brix TSS, boiled for 5-7 min., cooled, sealed in bottles and stored at low temperature. The beverage with 90.5 % aonla, 4% ginger, 5% adulasa and 2% shatavari extracts/ juices with 0.5 mg/100 ml mint was found to be more appropriate health drink with pH 4.2, deep yellow to yellowish colour and pleasant taste (Khapre *et al.,* 2010).

Herbal plum beverage- The plum pulp beverage with spice extracts like mint (0.40%), ginger juice (0.50%), cumin (6.25%), cardamom (0.25%) and black pepper (0.10%) having TSS of 45^o Brix has been developed by Joshi *et al.* (1993). The products with added spice extracts showed considerable improvement over those without spice extracts especially with respect to taste and aroma.

Herbal carbonated beverages- Carbonated citric acid and phosphoric acid containing beverages (citrus and cola types) were prepared by Chang and Cook (1983) with 0.10 % of stevioside or rebaudioside A without any preservative. Unsweetened carbonated beverages were made and stored along with the stevioside or rebaudioside A sweetened carbonated beverages in order to determine possible effects due to non-sweetener components in the beverages.

Herbal beverage using the concentrated fruit juices (cranberry, raspberry, black currant and other) and medicinal herbs (tea and dried elderberry fruits) as raw materials was developed by Owczarek *et al.* (2004). The beverage proposed as good sources of antioxidants supporting the organism defence system against oxidative stress.

Herbal squash- Blended juices of kinnow mandarin and ginger in the ratio of 0:30, 5:25, 10:12, 20:10, 25:5 and 30:0, respectively were mixed to prepare squash from these blends by Nath *et al.* (2005). Total soluble solids were fixed at 40 to 40.5^o Brix. Among the blended squash, the ratio of 25:5 scored the highest in terms of sensory attributes.

Ready to serve mango Ashwagandha beverage- A process has been standardized by Chakkar *et al.* (2006) for the extraction of therapeutic component from the roots of Ashwagandha, to develop mango pulp/juice based ready-to-serve

beverage fortified with Ashwagandha extract. Mango based ready-to-serve beverage fortified with 0.05% Ashwagandha extract, contained 8.22 mg ascorbic acid per 100 ml juice.

Aloe beverage- An aonla beverage containing 8.0 per cent aloe juice, 0.08 per cent compound stabilizer, 6.0 per cent sucrose, 0.18 per cent citric acid, 0.05 per cent agar and 0.15 per cent carboxymethyl cellulose has been developed by Kurion and Sankar (2007).

Herbal orange based beverage using stevia and safed musli-A method has been developed by Goyal and Samsher (2008) to process the stevia *(Stevia rebaudiana)* leaves and safed musli *(Chlorophytum borivilianum)* roots for production of the herbal beverage. The leaves were dried and ground to prepare stevia powder and then 50 g stevia powder mixed with 1.5 litre of water and boiled for 30 min to get 1.3 litre extract. Safed musli extract was prepared from wet roots. For the preparation of herbal beverage, orange juice was used as base material. Various quantities of orange juice (80, 85 and 90%, v/v) and stevia extract (10, 13, 16 and 19%, v/v) were selected on the basis of trial runs and fortified with 2% safed musli extract. The combination of 90% orange juice and 10% stevia extract with 2% of safed musli extract got highest overall acceptability.

Functional beverage using hill lemon and basil - Barwal *et al*. (2009) analysed quality of functional drinks prepared from hill lemon (*Citrus pseudolimon*) and basil (*Ocimum sanctum*). Twelve functional drinks were prepared from different combinations of hill lemon juice (5 to 10 %) and basil (tulsi) extract (5 to15 %) and changes in their physico-chemical and sensory qualities during storage were evaluated. The drink prepared by using 5 per cent hill lemon juice and 10 per cent basil extract with 14^{o} brix TSS without exogenous addition of acid and synthetic flavor was judged best. The developed drink had storage stability for six months.

Stevia-mint-tea- Singh and Verma (2009) developed standardized and evaluated stevia-mint-tea. Stevia (*Steviarebaudiana*) -mint tea was developed using 14.9% dried stevia leaves, 17.9% dried mint leaves, 56% Arjuna (*Terminalia arjuna*) tree bark and 11.2% safflower (*Carthamus tinctorius*) petals.

Ready to serve whey based mango lemongrass beverage-Nutritionally rich and therapeutically value added soft herbal beverage with the combination of 12% mango pulp, 8% sugar, 48% water, 32% whey and 1.5% lemongrass distilled (LGD) was developed by Sahu *et al*(2005). The above combination was more acceptable and showed extended shelf-life due to addition of LGD, which has antimicrobial and antioxidative properties.

Whey based banana herbal beverage- Yadav *et al.* (2010) carried out a study on the development and storage of whey based banana herbal beverage with the incorporation of *Mentha arvensis* extract (0 to 4%). The amount of banana juice and sugar were fixed at 10 ml and 8 g, respectively per 100 ml of the beverage. Whey quantity varied from 72 to 84 ml for each 100 ml of the beverage depending upon the concentration of mentha extract. The organoleptic scores and overall acceptability of the beverage improved with increase in Mentha extract from 0 to 2 %. Addition of 3 and 4 % Mentha extract decreased the beverage quality as beverage scored lower

organoleptic scores. The overall acceptability of the beverage was desirable up to 15 days of storage at refrigeration temperature.

Whey-based mango-pudina beverage- The formulation of a whey-based mango-pudina beverage, prepared with 0 to 4% (v/v) pudina (Japanese mint, *Mentha arvensis*) extract was developed by Sirohi *et al.* (2005) was investigated. Quantity of mango pulp and sugar were fixed at 15 ml and 8 g, respectively, per 100 ml of the beverage. Whey quantity varied from 73 to 77 ml for each 100 ml of the beverage depending on the quantity of pudina extract. Addition of 3 and 4% pudina extract did not improve the beverage quality as beverages scored lower values of sensory score than that of the beverage containing 2% pudina extract, but they exhibited better storage life.

Herbal fruit munch-Two appetizers i.e., fruit munch and ginger munch (containing various ingredients) based on fresh and powdered ginger as the active ingredient have been developed by Wadikar *et al.* (2010) using response surface methodology. The two appetizers were found to be shelf stable for 8 months in metalized polyester pouches under ambient conditions and beneficial to soldiers in the high altitude areas.

Ashgourd-mint leaves beverage- Ashgourd (*Benincasa hispida*) and Mint leaves (*Mentha spicata*) juice were blended (75:25) to obtain a beverage that have functional properties as well as nutritional value (Majumdar *et al.,* 2008). The physicochemical, microbiological stability and sensory characteristics of the ashgourd-mint leaves blended juice in glass bottle at room temperature (28C±2^{0}C) remained acceptable for 6 months.

4. Some other value added herbal food products

Herbal Protein rich Tofu- Tofu, a non-fermented soybean product rich in high-quality protein and isoflavones has a very short-shelf life. Aqueous extract of *Ocimum sanctum* (tulsi) was added during the preparation and storage of tofu to prolong its shelf life. Tofu with tulsi extract had 76.4% moisture and was softer than control. Not much difference in mesophilic count was observed between control and treated samples during storage; however, treated tofu was organoleptically good until the end of the study with less lipid-peroxidation and exhibited 50% (4.7 units) less protease activity than control (9.6 units) after 7 d. By using extracts of naturally available, easily cultivable tulsi, the shelf life was successfully extended to 7 to 8 d from 3 to 4 d of normal storage without refrigeration (Anbarasu and Vijayalakshmi, 2007).

Herbal meat products- Meat is prone to both microbial and oxidative spoilage and therefore it is desirable to use a preservative with both antioxidant and antimicrobial properties. Mint extract alone had good antioxidant activity but poor antimicrobial activity, while chitosan alone showed poor antioxidant activity with excellent antimicrobial properties. Therefore, the potential of chitosan and mint mixture (CM), as a preservative for meat and meat products was exploited by Kanatt *et al.* (2008). Addition of chitosan to mint extract did not interfere with the antioxidant activity of mint. The shelf life of pork cocktail salami, as determined by total bacterial count and oxidative rancidity, was enhanced in CM-treated samples stored at 0–3^{o}C.

C. Regulations and Future Potential

A person wishing to use an herb in food should be able to provide proper botanical identification of the plant by genus and species with information concerning the specific part of the plant used, the amount and method of consumption and documentation of the history of consumption. A generally regarded as safe (GRAS) affirmation should be assured; otherwise it runs the risk to be an illegal food additive. A herb or botanical (extracted product form herb) with no history of common use in food is not allowed without clinical tests.

The following information should be included on the labels of all herbal foods:

- The name of the herbal supplement
- The name and address of manufacturer or distributor
- A complete list of herbal ingredients
- Serving size, amount and active ingredient

For decades, Food Adulteration Act, 1954, Fruit Products Order, 1955, Meat Food Products Order, 1973, Vegetable Oil Products (Control) Order, 1947, Edible Oils Packaging (Regulation) Order 1988, Solvent Extracted Oil, De- Oiled Meal and Edible Flour (Control) Order, 1967, Milk and Milk Products Order, 1992 etc. regulated dietary supplements as foods to ensure that they were safe and wholesome and that their labeling was truthful and not misleading. In 2006, the Indian government passed Food Safety and Standard Act (FSSA) to integrate and streamline the many regulations covering nutraceuticals, foods, and dietary supplements. The Food Safety and Standards Authority of India (FSSAI), Food Safety and Standards Regulations, 2011 (Part I and Part II) deals with Food Products Standards and Food Additives.

Manufacturers must follow good manufacturing practices to ensure that herbal foods are processed carefully, meet quality standards and retain the active ingredient in right and required amounts after processing and storage. These regulations are intended to keep the wrong ingredients and contaminants, such as pesticides etc. out of herbal foods, as well as make sure that the right ingredients are included in appropriate amounts. The incorporation of the identified need-based herbal plants in food products is thus essential and need of the day for the larger interest of the people and food industry. The aspects like good manufacturing practices, quality, safety, efficacy, application of general health laws, labeling and legal requirements, etc., however, should strictly be followed.

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POST HARVEST TECHNOLOGY AND VALUE ADDITION OF AROMATIC AND MEDICINAL PLANTS

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World Health Organization (WHO) has estimated that at least 80% of the world population rely on traditional systems of medicine for their primary health needs. These systems are largely plant based and over 21000 plant species are useful in the preparation of medicines. Due to the growing awareness about side effects and complications of chemical and synthetic medicines, cosmetics and health supplements, usage of herbal products has gained importance both in the Eastern and Western Worlds. This is the proper time for India to make relentless efforts to take substantial cultivation and share in current herbal market. The uncontrolled collection and sale of large quantities of plant material from the forest leads to destruction of many forest plants. Local communities, traditional medicinal herbalists and herbal medicine vendors collect roots, bark and whole shrubs. This is a serious problem. Cultivation of medicinal plants especially high value medicinal plants is creating new dimension in the field of agriculture. The medicinal plant industry puts together the various facets of this multi-disciplinary industry and its global interest. Indian herbal industry is at blooming stage; however cultivation of medicinal plants is not so easy. Indian farmers are facing various problems in cultivation of medicinal plants because of lack of proper agro-technology, high fees for packages developed by various organizations, lack of reliable and standardized technology package, lack of planting material, market potential and system, cultivated vs wild plants, organic farming techniques, etc. Knowledge of post-harvest processing technology of plants for the extraction of chemicals and preparations of active formulations is still needed. For this purpose one has to take help of research organizations, private institutes, farmers, NGO's public sector institutes etc. for better technical know-how of cultivation and post-harvest techniques of medicinal plants.

PROCESSING, VALUE ADDITION AND UTILIZATION OF MEDICINAL PLANTS

Processing, Value Addition and Utilization of Medicinal Plants gave formal recognition to traditional medicine and recommended the association of traditional healers in the national healthcare program. The future is demand challenging task with enormous opportunities for India in the fast changing global economy as far as production and trade of natural raw materials are concerned. There has been an unparalleled growth to 60 per cent of the plant derived medicinally useful formulations, drugs, cosmetics, food and health care products. India is the third largest producer and consumer of medicinal and aromatic plants after China and

Cambodia. Due to lack of processing facilities, medicinal plants provide a raw material for the production of pharmaceuticals, nutraceutical, herbal cosmetic and perfumery preparation is blooming. Demand for these herbs is increasing progressively in consumer oriented cosmetic, herbal food products and pharmaceutical units. There is a great demand of medicinal plants (raw material) in national and international market.

PROCESSING OF MEDICINAL PLANTS

Development of primary processing and secondary processing techniques of these medicinal plants is one of the most important parameter to attract the farmers to grow these plants commercially. Primary processing means, semi processing of medicinal plants at the farm level or at small scale level to provide quality raw material to large industries. These include drying, sorting, washing, extraction etc. The medicinal plants are of varying nature. Different parts of the plants such as leaves, bark, roots or tubers, whole plant and extract of these plants are useful to make drugs. Therefore the post harvest processing technology of each herb is different and requires different machines. The machines and unit operations used to process other agricultural and chemical products can be used for processing medicinal plants by making suitable modifications and adjustments of processing parameters in the existing machines. The post harvest processes and the machines must be designed scientifically and carried out in such a manner that the chemical and medicinal contents of the material are not affected qualitatively as well as quantitatively.

Problems in processing of medicinal plants

(1) Poor harvesting and post-harvest practices,
(2) Inefficient processing techniques leading to low yields,
(3) Poor quality control procedures,
(4) High energy losses during processing,
(5) Lack of current good manufacturing practices,
(6) Lack of high quality equipments and trained personnel,
(7) Lack of facilities to fabricate equipment locally and
(8) Lack of access to latest technology and market information.

The following processes are commonly carried out after harvesting to increase their storability, up gradation of the quality of raw material and for their value addition.

Cleaning and washing: Cleaning and/or washing are particularly important when the medicinally useful parts are roots, rhizomes or other underground parts. The prime aim is to remove adhering dirt. In some cases as for example in Bramhi etc. the whole herb is washed. Leaves of plants like Aloe vera are also washed before further processing. The washing is done in washers by spraying water under pressure on these parts of the plants to remove dirt, soil and other contaminating material.

Grading: Grading classifies the produce based on certain parameter that essentially reflects the quality. These parameters are size, length, thickness, colour etc. The roots of some plants are graded as per their length and thickness and colour.

Unwanted material is also removed from leaves of some plants. The grading is done by specific machines or manually. Produce of superior grade fetches better price.

Peeling: Peeling offers value – addition particularly in case of those underground drugs in which bark is devoid of medicinal activity. Peeling imparts elegance to the product. Safed musli, Satawar are the example which fetches higher price in the peeled form. Special peelers are designed to peel the particular herb.

Drying: Drying is the most important operation in processing. The main aims behind drying the plant material are to bring down moisture content to pharmacologically acceptable level and to make it resistant to enzymatic as well as microbial degradation to maintain its chemical quality for a longer time. Drying also reduces the volume of the material, facilitates its pulverization or grinding and thus is favourable for its packing and transportation. Drying is generally not done when the plant material is to be processed further for extraction of volatile oil in case of tulsi, lavender, Aloe vera, aromatic plants, mint etc. The method of drying and temperature of drying depends on the chemical nature of plant material, prevailing climatic conditions, quantity of raw material to be dried. Material containing thermo labile active constituents needs special care.

Following are the different methods of drying

Natural Drying: It is most commonly used method for drying the plant material and is time consuming. Natural drying is of two types, direct sun drying and shade drying.

a) **Direct sun drying**: It is preferred when plant constituents are stable at higher temperature and are not photosensitive. Different parts like leaves, seeds, roots and rhizomes are spread in a thin layer on clean area free from dust and animals directly under the sun. The material is occasionally turned over to ensure uniform drying.

b) **Shade Drying**: It is preferred when the constituents of plants are susceptible to thermo and photo degradation. Drugs containing volatile and essential oils are dried under shade. When the material is dried under shade the place must be clean and properly ventilated. Shade drying generally retains the original colour and aroma of the plant material. Solar dryer direct type and indirect type are designed to enhance drying of the plant materials.

Artificial Drying: It is advised for drying large scale cultivation. Its main advantage is rapid drying with better control of process variables and is weather independent. However depending on the selected method and material it requires different equipments.

a) **Oven or Trey Drying**: The plant materials, which contain non-volatile and heat stable chemical constituents, are dried by this method. It is also used when certain enzymes in the plant material need to be deactivated. Hot air at the desired temperature is circulated through the dryer which evaporates the moisture. Dryers of different design and load capacities are available.

b) **Vacuum Drying:** Plant materials which are prone to degradation of active chemical constituents at higher temperature (more than 50ºC) are dried by this method. Moisture is removed from the material under reduced pressure at a faster rate.

c) **Dehumidify air drying**: The drugs containing volatile oils are dried by circulating dehumidified ambient air through the plant material. The vapour pressure difference between air and material removes the moisture from the material.

d) **Spray drying:** This method is used to concentrate or dehydrate plant constituents in liquid form. Liquid aloe gel, pectin's, tannins, paupine extract are dried to powder form by this method. The drying is much faster.

Pulverization or Grinding: Pulverization of crude drugs offers many advantages over their natural form. It facilitates packaging and transportation. Blending of different herbs to produce a drug can also be done by grinding. Different types of grinder viz. burr mill; hammer mill; ball mill; roller mill of different capacities are used to grind specific raw material. The product temperature in their grinder can increased during grinding in traditional grinding machine. Normal grinding is not recommended in herbs containing volatile and thermo degradable compounds.

Cold grinding: The materials containing volatile and thermo degradable compounds are ground by this process. The product temperature by this method does not increase and the loss of volatile aromas is minimized by grinding in cold grinders.

Processing technology of some medicinal plants

Stevia *(Stevia rebaudiana)*: Mostly commercial processing of stevia leaves occurs in Japan. Extraction can be categorized based on solvent, solvent plus discolouring agent, absorption chromatography, ion exchange and selective precipitation of individual glycosides. The extraction process involves four steps aqueous or solvent extraction, ion exchange, precipitation or coagulation with filtration, then crystallization and drying. Ultra filtration method is recently used. Drying of the woody stems and the soft green leaf material is completed immediately after harvesting utilizing a drying wagon. Depending on weather conditions and density of loading it generally takes 24-48 hrs to dry stevia at 40^0C-50^0C. As estimated 21,500 kg of green weight is dried down to 6,000 kg of dry weight. Dry leaves are stored in plastic lined card board boxes sealed, strapped and labeled for further processing.

Ashwagandha *(Withania somnifera):* Ashwagandha roots are separated from the aerial part by cutting the stem 1-2 cm above the crown. Roots are washed and spread in sun for some time, dried in shade and then cut into the 3-10 cm sized pieces and again they should be dried in shade. The roots pieces are graded in three grades i.e., **a)** 7 cm long and 1.5 cm thick, **b)** 5 cm long and 1 cm thick, **c)** 3-4 cm long and less than 1 cm thick. Then the roots are packed in airtight polyethylene bags.

Isabgol *(Plantago ovata):* Isabgol is important for its seed and husk which have been used in indigenous medicine. When the crop turns yellowish and the spike turns brownish (about 110-130 days after sowing), crop will be ready for harvesting. The plants are cut at the ground level or uprooted if the soil is loose textured. These plants are threshed, winnowed and the seeds repeatedly sifted until clean. Seeds are fed to a series of sellers; in each seller the grinding pressure is adjusted to remove only the husk. Husk is separated by fans and sieves at each seller and ungrounded materials is sent the next seller. The whole seed may be marketed or the husk may be sold separately.

Safed musli *(Chlorophytum. borivilianum):* For marketable produce, freshly roots bunches of safed musli, roots are uprooted in last week of September to second week of October. Heap is prepared in shade and covered with gunny bags. Bunches are turned after 4 to 5 days and again covered with gunny bags. After 4 to 5 days the tubers are separated from the bunch and skin is removed by putting pressure by finger and thumb. Then white fleshy roots are washed and dried in sun/partial shade for about 5-10 days. Dried roots are packaged in the polythene lined bags for market.

Mulhatti *(Glycyrrhiza glabra):* The fresh harvested roots contain 50-60 % moisture. They should be dried in sun for 2-3 days and then in shade for next 10-12 days. Thus, the dried roots should not posses more than 10% moisture. The roots should cut into pieces of 1-2" and they are graded depending on the thickness and packed in the polythene lined bags for market.

Extraction

Extraction can be categorized based on solvent, solvent plus discolouring agent, adsorption chromatography, ion exchange and selective precipitation of individual glycosides. The extraction process involves four steps aqueous or solvent extraction, ion exchange, precipitation or coagulation with filtration, then crystallization and drying. Ultra filtration method is recently used

General Understanding of Herbal Extracts Preparation

With some trouble and time consuming, preparation of natural remedies at home is usually much more economical and also of good quality than purchasing manufactured products. They can also be much more effective when prepared properly by following traditional preparation methods. In the extraction of natural products, removal of primary/secondary metabolites of interest from natural sources takes place. This involves exposing of cells containing metabolites with extracting solvents. Once cells are ruptured, the actual extraction process is performed using techniques that depend on the chemical properties of the compound(s) of interest. Water-soluble compounds and protein are extracted in water or buffers. Organically soluble compounds are extracted with organic solvents. The method to be adopted for the extraction of a compound or a group of compounds should ensure that the extraction of the desired compound take place without undergoing their decomposition, polymerization or summarization. Cold extraction is recommended for thermo labile compounds like volatile oils, alkaloids and proteins. Hot extraction is more efficient, where the plant material is boiled in a solvent for a stipulated period. Soxlet's extraction is the ideal choice for hot extraction where with minimum solvent, complete extraction is affected.

Usual Forms of Herbal Extracts/Remedies

Various forms of herbal extracts viz. infusion, decoction, strong decoction, tinctures, syrups, infused oils, essential oils, ointments, creams, mist, maceration etc. are commonly used by herbal practitioners for medicinal effects. As discussed above, the method of preparation of herbal extracts depends upon the type of plants/plant parts to be used and the active ingredient present in it. However, general methods of preparation of various types of herbal extracts are given below:

Infusions: Infusions are typically used for delicate parts of the herbs i.e. flowers and leaves etc. Preparing an infusion is much like making a cup of tea. Water is brought

just to a boil and then poured over an herb (or combination of herbs), it is covered and allowed to sit/steep for 10-15 minutes or so. It can be prepared in the drinking cup (by just pouring the heated water over the herb in the cup) or by dropping the herb into the pot in which the water was heated. It is also recommended to use distilled or purified water when extracting medicinal plants. Regular tap water can contain chlorine and other chemicals which might have an interaction or chain reaction with one or more of the many chemicals found in plants. The ratio of herb to water can vary depending on the remedy, the plant, and whether cut herb or powdered herb is used. Generally for using 1 teaspoon of powdered herb or 3 teaspoons of more bulky cut herb, 150 ml of water is sufficient. Always cover the cup containing the infusion with a lid to prevent delicate chemical constituents/essential oils from evaporating, and always make an infusion fresh daily. It can be taken hot, warm, or cold.

Decoctions: Similar to an infusion but instead of flowers and leaves the harder parts of the herbs are used such as the roots and bark etc. Fruits, roots and barks being thicker and less permeable than the aerial parts of medicinal plants, do not liberate their active principles by simple infusion. It is necessary to simmer these parts in boiling water (about 20 min.) in order to extract their medicinal constituents. The material should be cut or broken into small pieces. In order to avoid losing volatile constituents, use a lid over the simmering pan. After cooling down and separating the solid from the liquid, decoctions can be taken hot, warm, or cold.

Strong Decoctions: Depending on the type of plant material used, strong decoctions are prepared in two general ways. The first involves boiling the mixture longer. This is usually done when working with larger woody pieces of bark. Longer boiling time, up to 2 hours or more, is sometimes necessary to break down, soften, and extract the larger pieces. Alternatively, when smaller woody pieces are used yet a stronger remedy is wanted, the decoction is prepared as above (boiling 20 minutes), then it is allowed to sit/soak overnight before straining out the herb. When straining, again, make sure to press on the cut herb pieces in the strainer to get as much moisture/decoction out of the herb pieces.

Tinctures: A tincture is an extract of alcohol (ethyl alcohol) and water mixture which is used when plants have active chemicals that are not very soluble in water, and/or when a larger quantity is prepared for convenience and wanted for longer term storage. Many properly prepared plant tinctures can last several years or more without losing potency. The percentage of alcohol usually helps determine its shelf-life: the more alcohol used, the longer the shelf life. Sometimes the percentage of alcohol and water is unique to the herbs that are used as some active ingredients are more soluble in alcohol and others more soluble in water. To prepare a tincture with a shelf-life of at least one year, 40% alcohol and the balance distilled water is generally required. Never use methyl alcohol, methylated spirits, isopropyl alcohol or any other kind of unknown spirit to make tinctures. For the preparation of tincture, dip/soak the woody pieces of plant(s) for about 2 weeks in the mixture of alcohol and water of appropriate ratio. Shake the bottle/jar at least once daily while allowing it to soak. At the end of two weeks, filter the tincture through a strainer to remove the plant parts (pressing hard on the plant material to get as much liquid out as possible)

and pour into a fresh clean glass container/bottle with tight fitting lid or cork. For storing the tincture, use of dark colored bottle (like a recycled green/amber wine bottle) is to be preferred. Seal the container and store at room temperature away from direct sunlight. The tincture can be placed directly in the mouth for immediate absorption, or placed in a small amount of water or juice. If a person dislike the alcohol content (or want to give the remedy to a child), place the dosage in about 50 ml of very hot water so that most of the alcohol will be evaporated in the hot water in a minute or two. Let cool it before taking.

Syrups: With some rare exceptions, like peppermint that is a familiar flavoring agent in tooth paste and chewing gum, infused or decocted herbs are not palatable, especially for children. In order to disguise their taste, infusion and decoctions can be mixed with honey or unrefined sugar from cane. These syrups combine the soothing action of these solvents to the medicinal properties of the infusions and decoctions resulting in additional benefits specially for treating cough and sore throats.

Essential Oils: Essential oils are the volatile oily components of aromatic plants, trees and grasses. They are found in tiny glands located in the flowers (neroli), leaves (eucalyptus), roots (calamus), wood (sandal) and resins (frankincense). Essential oils are extracted by four main methods: steam distillation, expression, solvent extraction and effleurage. In the first method the oil is extracted by the action of hot steam and then selectively condensed with water from which it is separated. In the second method the oil is extracted by pressure or centrifugation. In the third method, herb is soaked in suitable organic solvent so that the oil is dissolved in the volatile solvent which on evaporation leaves a heavily natural wax substance called concrete. When separated from the wax, the resulting liquid is called an absolute, the most concentrated form of aroma available. Effleurage is a longer process involving the dissolution of the oils in animal fat and its separation using alcohol. Although essential oils main usage is in cosmetics and perfumery, many of them do have proved therapeutic properties.

Ointments: Ointments are prepared like hot infused oils in which herbs are simmered in beeswax or fats containing no water. After separating the simmered herbs by squeezing and cooling, the result is a solid mixture of the wax or fat with the medicinal constituents of the plant. Petroleum jelly, soft paraffin wax and bees wax are some common bases used. Ointments form an oily barrier on the surface of injuries and carry the active principles to the affected area.

Creams: Creams are mixtures of oils or fats with water. Since water and oils are not miscible, it is necessary to add an emulsifying agent that avoids their separation. Medicinal properties are added to creams when they are made with tinctures, infusions, oil infusions, essential oils or decoctions. Creams are permeable allowing the skin to breathe and sweat. Their water content and some additional hydrophobic agent like Glycerin promote the hydration and cooling of the skin.

Mist: Mist is a combination of water and fresh or dried herbs made as an infusion but left to sit in a covered container for 1 to 3 hours. Mists can also be made with essential oils and a small amount of alcohol for emulsifying and preservation. Different herbs can be used for the preparation of a mist depending on its purpose. It could be used as an air freshener or for disinfecting areas of the home. A mist could

also be used to refresh oneself after a long hard day by spraying the face, or it could be used to soothe irritated skin. Lavender mist is good for skin care and is very refreshing when feeling tired, just mist the face. It has mild anti-bacterial properties useful after cleansing the face to inhibit bacteria, which can cause pimples. Lavender will also promote regeneration of healthy cells which would be good for cuts, burns, sunburn and sores. Also when inhaled, lavender mist will soothe and calm.

Macerations: This method of preparation is certainly the easiest. The fresh or dried plant material is simply covered in cold water and soaked overnight. The herb is strained out and the liquid is taken. Normally this is used for very tender plants and/or fresh plants, or those with delicate chemicals that might be harmed by heating or which might be degraded in strong alcohol.

Poultices and Compresses: Many herbal remedies are applied directly to the skin as poultices - usually on rashes and wounds and as topical pain-relieving remedies. Poultices are prepared in various ways. Sometimes just enough hot water is poured over dried or fresh plant material to soften them. Then the wet herbs are placed directly on the skin or between two pieces of cloth and laid on the skin. A light cotton bandage to bind the poultice to the area is generally used. Compresses are simply soaking a cloth in a prepared infusion, tincture or decoction and laying the cloth onto the affected part of the body/skin.

Vapour Baths and Bathing Remedies: Medicinal plants are added to bath water and the patient is soaked in it. The skin is a wonderful organ capable of absorbing plant chemicals (and even synthetic chemicals) directly through the skin, and into the underlying fat tissue, then into the bloodstream. Since fresh plants are generally used for bathing remedies, therefore, it should be chopped or crushed first before adding to the bath water. In the alternative, 500 to 750 ml of a strong decoction or infusion can be added to bath water and sit in it for at least 10 minutes. Similarly, steam containing infusion/decoction of suitable herbs can be inhaled for respiratory problems.

STORAGE OF MEDICINAL PLANTS OR CRUDE DRUGS

Medicinal plant materials must be stored under specified conditions in order to avoid contamination and deterioration. Avoid formation of moulds, which may produce aflatoxins. Materials that need to be stored at temperatures 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 a 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, packing 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.

Requirement of packaging materials

The general requirements of packaging materials are as follow

1. Economical or low cost
2. Impermeable as glass or metal or of acceptable permeability to moisture, gases, volatile solvents etc.
3. Non reactive-relatively inert with no extraction, exchange or interaction
4. Easy to manufacture in a wide range of shapes, preferably by a number of manufacturing processes.
5. Easy to decorate and /or print by a range of processes
6. Good production line efficiency-performance, with the minimum of rejects or wastage.
7. Effective as a pack (container and closure), i.e., easy to open and reclose and use if multi dose; or open if single dose, whilst meeting any special requirements such as child resistance, tamper evidence or resistance, etc.
8. Easy to produce and maintain clean
9. Preferably readily available both in terms of source of supply for raw materials and as a converted item component from several suppliers.
10. Environmentally friendly
11. Able to optimize use of space when stacked or during transportation.

Types of Packing Materials

The common types of packaging materials currently available are given below:

1. **Glass:** It can be found as several variants such as treated soda glass, soda glass and non parenteral.
2. **Metals:** A variety of metals including tin plate(tin coated mild steel) tin free steel, aluminum, aluminum alloys are widely used in packaging, being found as rigid containers, collapsible containers, aluminum foils, metalized coatings etc.
3. **Plastics:** There are five economical materials for rigid type of containers i.e., those based on polyethylene (PE), polypropylene (PP), Polystyrene (PS), PVC and polyester.
4. **Elastomeric materials**: Elastomers can be found as a wide range of basic materials (i.e. natural rubber, synthetic polyisoprene, neoprene, nitryl, butyl, including bromo-and chloro butyl, ethylene propylene Diane modified (EPDM), acid silicone elastomers).

General Tips on storage of raw drugs

1. Enough and right space –dry and free from dampness or humidity.
2. Prevention of rodents, insects and birds etc.
3. Separate area for different categories of raw drugs e.g. hygroscopic, volatile Materials etc.
4. Storage space should allow free movement of people and equipments.
5. Separate sections for “approved”, “rejected” and “untested” raw drugs.

6. Separation of physically similar looking raw drugs so that identity does not get mixed up.

7. Labeling raw drugs as per the following format:
   Name of the raw drug
   Part (seed, bark, leaf etc)
   Date of arrival and consignment no
   Time of collection
   Geographical region of collection
   Name of the supplier
   Inspection report (approved, rejected and untested)
   Test report no and date
   Best use before date (stage for retesting)
8. Keep authenticated samples as "reference standards" for each drug in stores.
9. Use raw drugs on a first in first out basis (FIFO)
10. Place packed raw drugs on wooden or plastic pallets. Keep one raw drug in one pallet.
11. Use appropriate packing material for storing raw drugs.

Always avoid:

1. Storing in open spaces
2. Storing on the surface directly
3. Storing alike raw drugs in close vicinity.
4. Using inappropriate packing material.
5. Storing the material for long time.
6. Keeping the material exposed to heat and moisture.
7. Storing inadequate processed materials.

VALUE ADDITION OF SOME IMPORTANT MEDICINAL PLANTS

Plant materials are used throughout developed and developing countries as home remedies, over-the-counter drug products and raw materials for the pharmaceutical industry, and represent a substantial proportion of the global drug market. It is therefore essential to establish internationally recognized guidelines for assessing their quality. The World Health Assembly has emphasized the need to ensure the quality of medicinal plant products by using modern control techniques and applying suitable standards. Value addition of the medicinal plants is very much essential for commercial exploitation as well as the medicinal value of the raw drugs. Even authenticated plant material may not be of desired quality and strength and not conforming to the physicochemical parameters or the concentration of the active constituents or marker compounds as per the pharmacopoeias standards or the consumer / industry requirements. Such material is liable to be rejected or accepted at very low price causing not only economic loss to the cultivators or collectors of the medicinal plants but also entails doubtful efficacy or the potency of the raw drug in the alleviation of the human suffering. Value addition of the medicinal plants can be achieved directly by improving the quality of the cultivated or collected plant material

and indirectly by quality assurance of the plant material or the semi-processing of the material to a value added product.

I. **Direct Value Addition**

Collection in the proper seasons: Seasonal variation in the concentration of secondary metabolites 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 at different stages of plant growth. This need to be very much considered and the collection of the material should be made in the appropriate season.

Harvesting and processing of the plant material: 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.

Grading and sorting: 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.

Cleaning: Any soil, stones, sand, dust and other foreign inorganic matter must be removed before medicinal plant materials are cut or ground for testing.

Packaging: 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.

II. Indirect Value Addition

Quality testing for purity and strength

Testing for the Physico-chemical standards (Moisture, FOM, Ash Content, Extractives)

Moisture: An excess of water in medicinal plant materials will encourage microbial growth and also causes deterioration following hydrolysis. This is especially important for materials that absorb moisture or deteriorate quickly in the presence of water. The test for loss on drying can be carried out either by heating to 100-105 ^{0}C or in a desiccators over phosphorus pentoxide for a specified period of time.

Foreign matter: Medicinal plant materials should be entirely free from visible signs of contamination by moulds or insects, and other animal contamination, including animal excreta. Macroscopic examination can conveniently be employed for determining the presence of foreign matter in whole or cut plant materials. However, microscopy is indispensable for powdered materials.

Foreign matter consists of any or all of the following

Parts of the medicinal plant material or materials other than those named with the limits specified for the plant material concerned;

Any organism, part or product of an organism, other than that named in the specification and description of the plant material concerned;

Mineral admixtures not adhering to the medicinal plant materials, such as soil, stones, sand and dust.

For some medicinal plant materials where the foreign matter may closely resemble the material itself, it may be necessary to take a pooled sample of the plant material and apply a critical test, either chemical, physical or by microscopy. The proportion of foreign matter is calculated from the sum of portions that fail to respond to the test.

Ash content: Ignition of medicinal plant material yields total ash constituting both physiological (from the plant tissue) and non-physiological (extraneous matter adhering to the plant) ash. Acid insoluble ash represents sand and siliceous earth.

Extractives: It is the amount of soluble constituents (active or otherwise) extracted with solvents like alcohol and water from a given amount of medicinal plant material. It is employed for materials for which as yet not suitable chemical or biological assay exists.

Thin layer chromatography (TLC) identity test for the active / marker compounds.

Quantitative assay of the active/marker compounds

Pesticide residues: Medicinal plant materials are liable to contain pesticide residues, which accumulate from agricultural practices such as spraying and treatment of soils and fumigation during storage. Since many medicinal preparations of plant origin are taken over long periods of time, the intake of residues from medicinal plants should not be more than 1% of the total intake from all the sources including food and drinking water.

Microorganism: While a large range of bacteria and fungi form the naturally occurring micro flora of herbs, aerobic spore forming bacteria frequently predominate. Current practices of harvesting, handling and production may cause additional contamination and microbial growth. The determination of Escherichia coli and moulds may indicate the quality of production and harvesting practices.

Certification of the quality

III. Semi-processing of the medicinal plants to value added products

Powder: Thoroughly cleaned and dried plant material is powdered in a pulveriser and sieved to obtain a homogenous powder of the desired particle size.

Tablets/capsules: The homogenous powder is mixed with a suitable binding agent and compressed to a tablet or filled into a capsule of desired dosage.

Extracts: The dried and clean plant material free from foreign organic matter substitutes or adulterants 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 a soxhlet extractor under reflux for hot extraction. The extracts are distilled under reduced pressure at low temperatures to remove the solvent and the concentrated extracts are spray dried. These extracts can be also standardized to a required strength of the active/marker compounds. This simple or semi-processing of the medicinal plant material adds to the value many fold.

Processing, Value Addition and Utilization of Medicinal Aromatic Plants

The aromatic plants have very ancient history in use for several purposes. The oriental countries of South, South East and East Asia, and countries on both sides of Mediterranean Sea have been known to gather aromatic materials from their natural flora and used in culinary, flavouring of food and beverages and perfumery purpose. The practice of embalming mummies goes back to 5200 years in Egypt and

India has perfumery tradition that goes to 5000 years to Indus valley civilization. A number of plant species are used as folk medicines for curing the diseases

Value added herbal food products

Many researchers have standardized the process and developed various types of value added food products. Food products developed by adding with herbal ingredients (only edible medicinal and aromatic plants) those are important from nutritional and therapeutic point of view. Now a day, 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 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.

Techniques for preparation of herbal products to fortify the food

The following techniques for preparation of herbal products to fortify the foods have been reported (a) "**Herbal paste**-Herbs are cleaned, blanched properly and then ground in a grinder to get a fine and smooth paste; (b) **Herbal powder**-Herbs are normally dried in a tray drier at $60^{o}C \pm 5^{o}C$ temperature for 5-6 hrs. The dried herbs are crushed in a grinder and strained to obtain fine uniform size powder; (c) **Freeze drying-**Herbs are first frozen in a deep freezer at $-80^{o}C$ for 24 hours then the frozen samples are placed in a freeze drier for drying. The dried herbs are grind and strained to obtain fine particle size powder; (d) **Solvent extraction**-Ethanol/food grade hexane are used to extract the phyto-chemical from the herbs. After extraction, the solvents are evaporated and herb's extract is used in preparation of many foods, sweets, beverages etc. The most commonly used process is the herbal paste and mechanical dried herbal powder. Among the paste and tray dried herbal powder, the paste can retain more nutritional and antioxidant properties than that of powder. Freeze drying and solvent extraction techniques are laborious and expensive.

The method of producing the confectionery includes preparing the emulsion including a sweetener, kneading dough, forming it and baking dough products. The method is distinguished by using stevia leaf extract (5% of the dough's total flour mass) as a sweetener. The stevia extracts substitute sugar and give a reduction in food caloric content. Increased demand for low-calorie products and foods with alternative sweeteners has been reported. Intense sweeteners avoid the problems of health risks associated with caloric sweeteners.

Some edible medicinal plants like lemon grass, tulsi, ginger, meethineem, (curry leaves), pudina (mentha), cardamom, etc. can be used to manufacture milk and milk products.

Various dairy products such as salted spiced buttermilk, whey-vit, flavoured milk, ginger ice-cream, panchamrit, medicinal ghee and whey based mango herbal beverages are relatively new development in the dairy field. These products help in curing of physiological disorders, certain diseases and other inborn defects of metabolism in children, young ones and old persons. Sugar-free or reduced-sugar foods and beverages are popular in the United States and other countries. Steviol

glycosides A is purified from stevia leaves and is accepted for use in the United States as sweetener. The availability of a variety of safe sweeteners are beneficial to consumers because it enables food manufacturers to formulate a variety of good-tasting sweet foods and beverages that are safe for the teeth and lower in calorie content than sugar-sweetened foods. Herbal burfi with different levels of khoa (95, 90 and 85%, w/w), stevia powder (5, 10 and 15%, wlw), 2% safed musli powder is being prepared. Herbal burfi samples prepared with 90% khoa, 10% stevia powder and 2% safed musli powder ratio were found best. This ratio scored highest overall acceptability. Less microbial growth (2.557x105 cfu/g) was noticed those sample having 85% khoa and 15% stevia powder. Other physico-chemical qualities of this ratio were also found satisfactory.

India has long heritage for use of herbal products as food supplements. Functional foods are becoming very popular in international markets. These foods are used for correction and maintenance of heart, bone and immune system. A large number of medicinal plants containing antioxidants, proteins and immuno modulator contents are used to prepare functional herbal foods.

Herbal beverage: Today, there are many types of herbal beverages available in the market, which are fortified with medicinal plants. The plum pulp beverage with spice extracts like mint (0.40%), ginger juice (0.50%), cumin (6.25%), cardamom (0.25%) and black pepper (0.10%) having TSS of 450 Brix obtained highest organoleptic score (16.4 out of 20). They also found that the products with added spice extracts showed considerable improvement over those without spice extracts especially with respect to taste and aroma. Carbonated citric acid and phosphoric acid containing beverages (citrus and cola types) were prepared with 0.10% of stevioside or rebaudioside A without any preservative. Unsweetened carbonated beverages were made and stored along with the stevioside or rebaudioside A sweetened carbonated beverages in order to determine possible effects due to non-sweetener components in the beverages. They studied the effect on stability in carbonated beverages for long term storage. The beverages were chemically, microbiologically and organoleptic, ally monitored periodically up to 5 months. Herbal beverage, using the concentrated fruit juices (cranberry, raspberry, black currant and other) and medicinal herbs (tea and dried elderberry fruits) as raw materials has been developed. The beverage proposed as good sources of antioxidants supporting the organism defense system against oxidative stress. Blended juices of kinnow mandarin and ginger in the ratio of 0:30, 5:25, 10:12, 20:10, 25:5 and 30:0, respectively were mixed to prepare squash from these blends. Total soluble solids were fixed at 40 to 40.50 Brix. Among the blended squash, the ratio of 25:5 scored the highest in terms of sensory attributes. Nutritionally rich and therapeuticalty value added soft herbal beverage with the combination of 12% mango pulp, 8% sugar, 48% water, 32% whey and 1.5% lemongrass distilled (LGD) was developed . The above combination was more acceptable at 9-point Hedonic scale with extended shelf-life. This may be due to addition of LGD which has antimicrobial and antioxidative properties. Mango based ready-to-serve beverage fortified with 0.05 per cent Ashwagandha extract contained 8.22 mg ascorbic acid per 100 ml juice. Aloe beverage includes 8.0 per cent aloe juice, 0.08 per cent compound

stabilizer, 6.0 per cent sucrose, 0.18 per cent citric acid, 0.05 per cent agar and 0.15 per cent carboxymethyl cellulose.

For the preparation of herbal beverage, orange juice was used as base material. Various quantities of orange juice (80, 85 and 90%, v/v) and stevia extract (10, 13, 16 and 19%, v/v) were selected on the basis of trial runs and fortified with 2% safed musli extract. The physico-chemical, microbial and sensory quality attributes of these products were evaluated during storage. The combination of 90% orange juice and 10% stevia extract with 2% of safed musli extract got highest overall acceptability. These medicinal plants will add to the export potential of the nation. We have to link the indigenous traditional knowledge with the modern technology. Ayurveda is a holistic system of medicine in India and with proper guidance and technical development; we can change our food and lifestyle so that every Indian staying in villages, urban and city areas, becomes healthy and can undertake health challenges for all.

Marketing facilities should be opened amidst the growers in the villages with support price and agro-processing centers within the reach of the growers. The drug and cosmetic industries should have opened the facilities for contractual farming of the need-based herbal plants along with supply of critical inputs and suitable buyback policy of the materials from the framers. The cultivation and conservation of the identified need-based herbal plants is thus essential for the larger interest of the humanity. This will stop our running to hospitals or taking chemical drugs which have side effects and also very much costly not affordable by the majority of the people. Herbal medicines are not at all alternative system of treatment; it is the original Indian system of health security since ages. Hence, the prime need of the hour is to make use of medicinal plants for solving the health problems and major ailments of the people.

POST HARVEST HANDLING AND MARKETING OF MUSHROOM

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The fallout of the green revolution coupled with fragmentation of land holdings due to increasing population pressure and the challenges thrown in the wake of changing economic scenario has sharply lowered the profit margins of the farmers. The farmers and rural youths, at large, failed to venture on the enterprises allied to agriculture due to lack of knowledge and/or motivation. Our farmers age-old concept of mixed farming (of crops and livestock) based on multiple uses of inputs and recycling principles ought to be enlarged in its scope by incorporating modern enterprises like mushroom cultivation etc.

Mushrooms represent microbial technology in which agro- residues are converted into valuable food and mushroom are important source of quality protein, minerals and various novel compounds of medicinal value. Mushrooms do not compete for land and are considered to be the highest protein producers per unit area and time due to utilization of vertical space and short crop cycle and coupled with their indoor cultivation the water requirement is also less. Mushroom farming today is being practiced in more than 100 countries and its production is increasing at an annual rate of 6-7%. Trade in mushrooms has gained importance in recent years for two main reasons, the global shift towards vegetarian food and recognition of mushroom as a functional food. China leads in mushroom production and is reported to grow more than 20 different types of mushroom at commercial scale and mushroom cultivation has become China's sixth largest industry.

Presently, India produces 1.2 lakh tonnes of mushrooms and growth rate, both in terms of productivity as well as production has been phenomenal. India has registered twenty-fold increase in production of mushrooms in the last four decades, even though, button mushroom continues to occupy a prominent place and contributes about 85% of the total mushroom production of the country. India can emerge as a major player in mushroom production in wake of availability of plenty of agricultural residues and labour. Integrating mushroom cultivation in the existing farming systems will not only supplement the income of the farmers but also will promote proper recycling of agro-residues thereby improving soil health and promoting organic agriculture. The cultivation method for different mushrooms suited to Haryana conditions have also been standardized by the University.

The cultivation of mushroom on large scale has been adopted in the recent years by the farmers of Haryana because the economic returns are much higher compared to other agriculture crops.

The studies of seasonal mushroom farms undertaken in Haryana indicated that 35% of total investments is on fixed inputs while 65% is on variable inputs. In the

fixed investment, major share is spent on construction of mushroom sheds, whereas, in the variable costs, maximum proportion is spent on labour (approx. 28 %) followed by substrate/compost ingredients (approx. 23%). A perusal of studies revealed that net returns per kg of mushroom produced was Rs. 10.50 on an average on average selling price of Rs. 40.00 per kg. Since benefit cost ratio over variable cost and total production cost were greater than one the mushroom production is a highly profitable proposition.

Major part of mushroom produced in the state is sold in Delhi market through commission agents and is also sold directly either to the processing firms or the traders. But these are not transparent and the farmers remain at the receiving end. The marketing cost of mushroom is quite high and costs such as washing, weighing, packing etc have necessarily to be incurred by the farmers. The major marketing costs are commission charges and transportation (approx. 75%). These charges can be rationalized through collective efforts of farmers and government.

Mushroom growers also pointed out the unauthorized charging of commission fee for selling their mushroom from designated 'farmers' sheds' where they are not supposed to pay any commission charges.

Direct marketing of mushroom by farmers to processing firms and traders also involves manipulative and unethical practices by them like reduction in predetermined contract price on flimsy excuses of quality and delay/even default in payments. When prices are low, they do not purchase from the contracted farmers.

Keeping in view the farmers' vulnerability, they have to put the joint or group efforts and these may or may not be formal but should be the practical one.

The quality at competitive price' is the key to success and farmers have to make an assertive shift from 'production mode' to 'production with quality mode' by applying latest production and marketing techniques. Vertical integration of agri. and food markets from farm to firm is the best way to achieve efficiency and serve the interest of each stakeholder in the chain i.e. the farmer, the processor, the retailer and the consumer. There is no organized assistance available for marketing of mushrooms in India. Every export-oriented unit has its own individual arrangement for marketing, and the mushrooms are preserved in brine and canned in large containers of 3 - 5litres (or bigger) capacity for export. A long-term strategy has to be developed to help the industry.

As India itself is a big market, vigorous extension activities are required to make the people aware of mushrooms, which can help in developing market in India itself. This is the key of the success of Chinese mushroom industry as they consume more than 80% of mushroom produced by them. Mushroom revolution is going to happen as a result of the improved productivity as well as vast increase in the number of environment controlled and seasonal growing units. The share of the button mushroom is bound to decline with more and more specialty mushrooms becoming available for seasonal cultivation. With the increased production, there is every likelihood that an organized mushroom marketing channel is established. A significant quantity of mushrooms is likely to be utilized for production and consumption of the value added products, as compared to present trend of fresh mushroom utilization. The venture will also be designed and directed towards

complete recycling of the agro-wastes for production of food (mushroom), feed (cattle feed), fuel (biogas) and fertilizer (organic manure).

Majority of the farmers are cultivating mushrooms only during particular seasons. Farmers in the plains of North India cultivate white button mushrooms during winter only and stop the mushroom cultivation during summer and dismantle their temporary growing houses. It is also paradoxical to note that India is largely a tropical country and we mainly cultivate temperate mushroom. The tropical and sub tropical mushrooms like oyster (*Pleurotus* spp.), paddy straw (*Volvariellavolvacea*.), milky (*Calocybeindica*), reishi (*Ganoderma* sp.), wood ear (*Auricularia* spp.) etc. are not cultivated on a larger scale. Hence, the continuous cultivation of different mushrooms depending on the season is certain to increase the economic returns of the mushrooms growers. Round the year cultivation assumes much significance especially for rural livelihood security.

Button mushroom: Button mushroom compost is prepared using variety of base materials like wheat straw, paddy straw, sugarcane bagasse, chicken manure, various cakes and brans, as per their availability in different regions of the country. In most of the northern and central parts, wheat straw is widely used whereas in the eastern and southern parts, paddy straw is used which is available in abundance. Sugarcane bagasse is used in western, central and some other places. Poultry manure, an important component meeting the nitrogen needs, is available throughout the country, which- is generally used in short method of composting. Growers following long method of composting generally use chemical fertilizers in place of poultry manure for balancing the nitrogen requirement in the compost. Poultry manure is a carrier of nematodes and competitor moulds and hence, is not preferred for unpasteurized compost. Haryana farmers have successfully adopted low cost technologies developed by CCS HAU (involving thatched structures, bed cultivation and prolonged cropping using compost prepared by long method) for seasonal cultivation and contribute over 10,000 tons of mushrooms annually.

The cultivation technique of white button mushroom involves four major components viz. composting, spawning, casing and care during cropping. This mushroom requires an indoor temperature between 15 to 25^0C i.e. 22-25^0C (vegetative growth) and 14-18^0C (fruiting). In North India, it can be grown conveniently during October to February under natural conditions. The compost is prepared by mixing various raw materials (wheat/paddy/brassica straw) in specific proportions either by long or short method of composting. Since preparation of compost by short method requires specialized unit which is not feasible for small and marginal farmers; hence, only long method, which takes 28 days is being used. The wheat straw can be replaced by paddy or brassica straw depending on the formulae to reduce the cost of cultivation. Spawn is available in polypropylene bags. Casing, generally, a mixture of FYM and garden soil/ field soil is used. But a mixture of burnt rice husk and garden soil/ field soil (1:1) has been found to be cost-effective at CCS HAU, Hisar. As burnt rice husk needs no sterilization, only garden/field soil is sterilized. Temperature around 25^0C till one week after casing is most desirable and subsequently temperature should be 14-18^0C and relative humidity of 80-90% in the mushroom house during entire fruiting period. Mushroom is to be picked in button

stage; and for marketing generally packaging is done in polythene bags containing 200 g mushrooms and few holes are made in the packets to avoid condensation of the moisture in the bags.

In western countries generally the environment controlled growing is prevalent while seasonal growing is still practiced in some parts of the South- East Asian countries. But in India both the production systems viz. seasonal and controlled environment growing are in vogue. Hence, efforts for improvement of both the systems would continue in our country. Environment controlled growing of button mushrooms may not be fully successful in our country if implemented as such without bringing in necessary modifications needed for Indian conditions. The following aspects need attention:

(i) Seasonal mushroom farming

- Microbial stimulants and enzymes for accelerated and improved compost.
- Development of compost formulations for different parts of the state/country keeping in view the cost and availability of raw materials.
- Non-chemical methods of pasteurization may be developed using physical processes like solarization, sonic bombardments, microwaves, etc.
- Development and improvement in the design of growing houses for optimum yields by utilizing the low cost structures made from locally available materials.

(ii) **Environmentally controlled mushroom farming**

- Shortening composting period by total indoor/single phase composting by use of enzymes and microbial stimulants
- Development of environment friendly composting process - use of bio-filters to eliminate emission of undesirable gases; restricted use of chicken manure in dried and odour free form.
- Search for newer and improved casing materials, which may be made into ready to use thin sheets or rolls for easy and uniform application.
- Better environment management for improvements in yield and quality, introduction of cheaper but more efficient and grower-friendly control systems.
- Introduction of mechanization and automation, as in the years to come labour will become costlier. Mechanical or robotic harvesting together with single flushing or reduced flushing strains will be common.
- Designs for small, medium and large integrated as well as specialized units for composting, processing and spawn production.

Oyster and milky mushroom: Cultivation of oyster mushroom in Haryana has tremendous potential, which is yet to be fully harnessed. This mushrooms looks like an oyster so it is called as oyster mushroom and locally it is known as Dhingri. Its cultivation technology is very simple and easy as for its cultivation no special compost preparation and casing is needed. During the year its many crops can be taken. Its production is more than the white button mushroom. It can be consumed fresh as well as it can be sun dried for future use. Milky mushroom; due to its robust size, milky white colour, flavour and long shelf life has attracted attention of both consumers and prospective growers. Its nutritive value is also at par with other edible

mushroom. The cultivation method is similar as that oyster mushroom, except that it requires casing. For the promotion of these; efficient low-cost region-specific growing systems and species for seasonal and round the-year commercial cultivation should be developed and use of spent substrate for recycling as manure or cattle feed.

Specialty mushroom: Diversification of mushroom portfolio in the state and the country is required for round-the-year cultivation of different mushrooms to ensure environment and employment sustainability. Promotion of medicinal mushrooms *Ganoderma lucidum* and *Grifola frondosa*, which are very popular medicinal mushrooms and have great demand in the international market. These can be cultivated under natural conditions on small as well as industrial scale.

Spawn: It acts as the seed, and is the most crucial input for successful cultivation of mushroom. However, in India the spawn industry is an un-organized venture and needs research support in the years to come so that it may attain quality standards and competitiveness comparable to multi-national companies. Development and enforcement of spawn standards in the country should be done at the earliest in the interest of mushroom growers.

Post-harvest Technology: The mushrooms being high in moisture and delicate in texture cannot be stored for more than 24 hours at the ambient conditions prevailing in India. As far as processing technologies are concerned, sun-drying of mushrooms is one of the simplest and oldest methods followed by the growers from the time immemorial. Due to the difficulties in drying of some of the mushrooms, preservation technologies like cabinet drying, canning, pickling, freeze-drying and irradiation treatment of mushrooms have developed to improve the shelf life and consumption of mushrooms. In the peak period of harvesting the gluts in the market can be checked by adopting appropriate post harvest technologies.

Increased productivity demands proper post harvest infrastructure to enhance shelf life and marketability. Short shelf life of mushroom poses unique problems in packaging, marketing and preservation of mushrooms. In developed countries, it is the 'state of the art' technology, which is in practice like modified atmosphere packaging (MAP) or controlled atmosphere packaging (CAP). However, in our country, 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 material
- 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.

Utilizing Spent Mushroom Substrate: 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.

POST HARVEST HANDLING OF FLOWERS AND MARKETING

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In the past couple of decades the cultivation of flowers is becoming a profitable enterprise and the market for cut flowers has become a global one. The ever rising domestic market and high export value of cut flowers has led to dramatic increases in production in India. Production of cut flowers and foliage can be highly profitable in those areas possessing an ideal growing environment and low labour costs. Floriculture has emerged as a viable diversification option in the agri-business. It is a rapidly expanding dynamic industry recording a growth rate of more than 15 per cent per annum in the last two decades. Rapid urbanization, increased income levels and changes in social values resulted in increase of domestic market both for modern (cut flowers) as well as traditional (loose flowers) flowers significantly. Improvement in the general level of well being in the country and increased affluence particularly among the middle class is also another reason for increase in the volume of local flower market. The quantum of Indian floricultural exports, although, increased manifold since early nineties, still there is huge scope to become a key player in the world flower trade. The floriculture industry in India is characterized by growing traditional flowers (loose flowers) and cut flowers under open field conditions and protected environment conditions respectively. The costs of establishing production in the field or even in plastic houses are relatively modest, and harvest may start within a few months of planting. Because of this global production system and marketplace, and the high perishability of cut flowers, air transport has been the transport system of choice. At present, the area under flower crops in India is 167000 ha with production of 9.87 lakh MT of loose flowers and 4798 million numbers of cut flowers (NHB Indian Horticulture Database 2009-10).

Flowers are highly perishable unlike other agricultural crops. Whether cut or intact, flowers are complex plant organs, in which loss of quality of stems leaves, or flower parts may result in rejection in the market place (Kader 2003). The loss of quality may result from one of several causes, including wilting or abscission of leaves and/or petals, yellowing of leaves, and geotropic or phototropic bending of scapes and stems (Stimart and Brown 1982). Owing to poor keeping quality the post harvest losses in floriculture are significantly higher than any other sector (Paliyath, 2009). Although there has been significant increase in the area, production and productivity of flower crops in the last two decades, there is an urgent need to minimize the huge post harvest losses in terms of the value of the produce which are estimated to be 30-40 per cent of farm value.

Maintaining quality in flowers depends on an understanding the factors that lead to deterioration. The post harvest quality of flowers depends upon mainly three factors.

1. Pre harvest factors 2.Harvest factors 3.Post harvest factors

Pre-Harvest Factors:

Genetic or inherent make up: Post harvest lasting quality of flower species and cultivars vary considerably due to differences in their genetic make-up. Flower post harvest life depends on carbohydrate reserves, stomata functioning, presence of secondary thickening in flower peduncles, lignifications etc.

Growing conditions: Post harvest behaviour of flowers is determined by the pre-harvest conditions under which crop has been grown viz. light, temperature, relative humidity, fertilization, irrigation, diseases and insect pests etc. High light intensity causes dropping of leaves and abscission of petals. Flower crops are also specific in their temperature requirements. Flowers also require adequate nutrients for good longevity. High nitrogen doses should be avoided as they increase susceptibility to diseases. Flowers damaged by pathogens, insects and pests also show high ethylene production resulting in poor vase-life.

Harvest Factors: Right time, method and stage of harvest is of considerable importance for long vase life of cut flowers. Each plant material has its own best harvest stage and this can vary depending on the use of, and market for, the plant material. Flowers should always be harvested at an optimum maturity stage. Flowers cut too immature fail to open properly whereas those cut too open, wither quickly. The best time to harvest is the coolest part of the day and when there is no surface water from dew or rain on the plants. The stems should be cut with sharp knives or secateurs. Hardwood stems should always be given slanting cut to expose maximum surface area to ensure rapid water absorption. The flowers of rose, carnation, gladiolus, tuberose, daffodils, lily, iris, freesia and tulip should be harvested at bud stage since their buds continue to open in water. Harvesting of flowers at bud stage is always preferred as their buds have long vase-life, are less sensitive to ethylene, easy to handle during storage and transport and are less prone to diseases and pests.

Post Harvest Factors

Water relations: The termination of life of the harvested flowers depends on water uptake and transport, water loss and the capacity of the flower tissue to retain its water. A water deficit and wilting develop, when the transpiration exceeds absorption of water. The rate of water uptake of cut flowers depends on transpiration pull, temperature and composition of solutes. Disruption of water columns in stem vessels by air embolism and resistance to water flow in stems, also develop water deficit. Acidification of water and addition of wetting agent and flower food in the holding solution markedly improve water uptake of cut flowers.

Respiration: The rate of respiration depends on quantity of carbohydrates available in the harvested flowers and temperature. With higher temperature, there is faster rate of respiration and burning of the tissue. Consequently, the life of flowers is shortened.

Relative humidity: It has bearing on the transpiration rate. Higher the humidity in the air less is the transpiration rate and vice-versa.

Growth regulators: Post-harvest life of flowers can be controlled by growth regulators. Water relation changes associated with flower senescence are also

influenced by growth regulators. Cytokines delay senescence of some cut flowers. Depending upon the concentrations, GA in some cases promotes longevity of flowers, while this is also used in bud opening solution.

Preservative solutions: Preservatives are used to extend the vase life of flowers by improving flower opening, flower size shape and colour. The constituents of floral preservatives are water, sugar biocide and antiethylene compound. Antiethylene compounds in preservative solutions reduce the action of ambient ethylene as well as autocatalytic production of ethylene by fresh cut flowers (Serek *et al*., 1994). Fresh cut flowers respond to various biocides like 8-HQC, 8-HQS, silver thiosulphate and silver nitrate (Ichimura and Hiraya. 1999).

Pre-cooling and Storage: Pre-cooling is essential for removing field heat from flowers. This is done either by forced air cooling or hydro-cooling to bring down temperature from 20^0-30^0C to 1^0C in a relatively short period. Other methods are room cooling and vacuum cooling. Flowers can be stored for a longer period at low temperature. There are two methods of cold storage-wet and dry.

Packing and transporting: Packaging ensures garden fresh of flowers to the consumers. Lower rate of transpiration, respiration and cell division during transportation, are essential for long storage life and keeping quality. Before packing, flowers should be dried. Packing must ensure protection of flowers against physical damage, water loss and external conditions detrimental to transported flowers. Boxes made of corrugated fibre boards are good. Flowers sensitive to geotropic bending must be transported in an upright position. The flowers should be transported at an optimal low temperature. The relative humidity of the air during pre-cooling and shipment of cut flowers should be maintained at the level of 95-98%. Lack of light during prolonged transportation particularly at high temperature causes yellowing of leaves in many flowers. Shipment of flowers is usually done by truck, air and sea.

Improvement of the post harvest life of cut flowers

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 flowers stem after it has been cut, allowing it to be withdrawn single-handedly from the bench. At no time should harvested flowers be placed on the ground because of the danger of contaminating the flowers with disease organisms.

Precooling: Pre-cooling 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.

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 (Jones *et al.,* 1993). Pulsing is beneficial especially for flowers destined for long storage period or long distance transportation.

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.

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 boxes or sleeves. Packaging must ensure protection of flowers against physical damage and for this cotton or news paper can be used as cushion.

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 (LP) storage method can be used to enhance the post harvest life of flower.

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.

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.

MARKETING OF FLOWERS

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 –

Channel I -Producer –Commission agent-Retailer–Consumer (in large metro market)
Channel II - Producer – Wholesaler – Retailer – Consumer
Channel III - Producer – Contractor – Retailer – Consumer
Channel IV - Producer - Retailer – Consumer
Channel V - Producer - Consumer (Local market)

In general, marketing of flowers is not well developed and well organised. 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 organisation with minimum intermediaries. Floriculture crops require intensive cultivation and have high income potential. Therefore, they generate good employment in rural area.

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POST HARVEST TECHNOLOGY AND VALUE ADDITION IN SPICES

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India is known as the "Home of Spices" and produces a large number of spices. About 60 spices such as pepper, cardamom, ginger, turmeric, coriander, cumin etc are grown in the country. India exports only a small quantity of spices (10% of the total produce) to 137 countries in the world. The rest is consumed in the Indian market, as there is an immense domestic demand. The average production of spices in India is over 63.24 lakh tons and area under cultivation of spices is approximately 35.411akh ha. Spices are high value export oriented crops and India is a major exporter of spices and spices products. During the 2012-13, a total of 6, 99,170 t of spices and spice products valued Rs.11171.16 crore (US$2040.18 million) has been exported from the country as against 5, 75,270 tons valued Rs.9783.42 crore (US$ 2037.76 million) in 2011-12, registering an increase of 22% in volume and 14% in value. In the quality front, the major consuming countries like Europe and USA are demanding more and more quality compliance by the producing countries. To meet this challenge we have to equip ourselves to produce, process and market high quality spices, with internationally accepted food safety standards. Hence precautions has to be taken from the harvesting, primary processing which includes, threshing, washing, blanching, drying, cleaning, grading and packaging in order to meet the standards. The improvements in post harvest processing, mechanisation and value addition in major spice crops are presented here.

1. Black pepper

Harvest in Black pepper starts when one or two berries turn yellow (Purseglove *et al.* 1981). The spikes are nipped of by hand and collected in bags. Three models of pepper harvester were fabricated and evaluated on the basis of efficiency in the cutting action and easiness in operation (Aneeshya *et al.* 2013). The most efficient and user friendly was the second model due to its light weight, easiness in operation and minimum loss. Recent advances in product diversification have necessitated harvesting of the berries at different stages of maturity (Natarajan 1981). The primary processing in black pepper involves threshing, blanching, drying (sun drying or mechanical drying), grading and packing.

a) Threshing, Blanching, Drying

Harvested green spikes are heaped for a day, before threshing for easy separation of the berries. Spikes with fully matured and green stage, fully ripened stage and partly dried stage will be available in the harvested lot. The labourer separate them into various lots, *viz.,* berries, spikes suitable for threshing, ripe ones for production of white pepper and partly dried ones for direct drying. Threshing is

done by manual trampling. Traditional manual processing has given way to mechanization in majority of the processing stages. Mechanical threshers are used now to improve the quality of the product and to increase the efficiency of operation. Threshers developed by various agencies are compared (Amaladhas & Korikanthimath 2003). The quality of the black pepper can be improved by blanching, a simple treatment of dipping the mature berries taken in perforated vessel in boiling water for a minute before drying. Pepper has moisture content of 60 to 70% at harvest, which should be brought to safer levels of 10-12 per cent by adequate drying. The green colour of matured pepper is due to the presence of chlorophyll pigment. During drying, enzymatic browning sets in and the phenolic compounds are oxidized by atmospheric oxygen under the catalytic influence of the enzyme phenolase and eventually turn black. Sun drying is the conventional method followed in order to bring the moisture content below 10%. The average dry recovery varies between 33-37% depending on the varieties. Recently, various types of dryers such as solar and mechanical dryers have been developed by different agencies which are highly efficient for drying pepper. Solar tunnel drying in a cylindrical tunnel shaped drying chamber of size 2 m x 3 m to a height of 2m for drying 100 kg pepper was reported by Thirupathi & Visvanathan (2008). A natural convection reverse air flow mechanical drier developed by Regional Research Laboratory, Trivandrum are used by the farmers and small scale industries for drying of black pepper. Models of varying capacities operated either electrically or by burning agricultural wastes can also be used for drying. An electrically operated drier of 100 kg capacity has been developed by TNAU, Coimbatore (Sreenarayanan *et al. 2003).*

b) Cleaning and grading

Cleaning and grading are basic operations that enhance the value of the produce and help to get better prices. The dried pepper is cleaned to get rid of the extraneous matter such as dirt, stalks, leaves etc. Magnetic separator is used to remove metallic contamination such as iron fillings and stray nails. Vibratory conveyors with inclined decks in combination with air classification are used for efficient de-stoning of spices. Broken pepper and light pepper grades are separated pneumatically. Pinheads which come along with garbled pepper are separated by sieving. Cleaning on a small scale is done by winnowing and hand picking which removes most of the impurities. Grading of black pepper is done by using sieves and sifting black pepper into different grades based on size. TNAU has developed a hand operated cleaner cum grader suitable for cleaning and grading operations (Thirupathi and Visvanathan, 2008). At an operating speed of 25 rpm, the unit had a maximum effectiveness of 66.4% and capacity of 430 kg/h.

c) Packaging and Storage

Whole pepper is generally packed and transported in gunny bags and polyethylene lined double burlap bags. The bags are arranged one over the other on wooden pallets after laying polypropylene sheets.

2. Cardamom

Cardamom, known as the 'queen of spices', is one of the highly prized spices of the world. As the flowering continues over a long period several pickings are needed. Harvesting should be taken up only at a time when the capsules reached

the maturity stage. Immediately after harvesting on each day, capsules are washed to get rid of dirt and treated with 2 % washing soda (Sodium Carbonate) for 10 minutes to retain green colour and reduce mould growth in RCC tanks. The treated capsules are spread in a single layer on portable drying trays for draining of water and later for drying.

a) Curing

Cardamom curing or drying is the process in which the moisture content of green cardamom is reduced to 8-12%. Cardamom capsules should be subjected to drying within 24-36 hours of harvest to avoid deterioration. Drying is one of the important unit operations as it determines the colour of the end product, which is the attractive and most important quality character. There are mainly two types of drying *viz.* sun drying and artificial drying. In sun drying it is difficult to obtain good green colour and requires 5-6 days or more depending upon the availability of sun light. Artificial drying can be done either by electrical or conventional flue pipe drier.

b) Garbling

The dried cardamom is then subjected to garbling. Garbling is the process of removal of flower stalks from the dried cardamom. Traditionally this is achieved by rubbing the cardamom capsules against coir mat or wire mesh and winnowed to remove any foreign matter. An oscillatory type semi mechanical garbling unit developed by Tamil Nadu Agricultural University, Coimbatore has a capacity of 2-3 kg per batch whereas the rotary type garbler will take about 2-3 minutes to garble one batch of about 5 kg. Its capacity is 100kg/h and the efficiency was 98% (Sreenarayanan et *al. 2003).*

3. Ginger

India and China are the world's largest producers and exporters of ginger. In India, domestic market prefers fresh green ginger for culinary uses while two other types of dried ginger i.e. bleached and unbleached are also produced for export purpose. The fresh ginger immediately after harvest is subjected to washing, which is performed to remove dirt, residues of farm chemicals and other foreign materials.

a) Peeling and drying

After washing the ginger rhizomes are subjected to peeling operation. The outer skin of ginger is scrapped off with a bamboo splinter or wooden knife having pointed ends. Iron knife is not recommended as it may leave black stains on the peeled surface, affecting the appearance, or may lead to colour fading. During peeling, it should be ensured that the cortical parenchyma, which is rich in essential oil bearing cells, are not removed or cut as it would cause loss of volatile oil and thereby, decrease the aroma of the peeled rhizome. The scrapped or peeled rhizomes are again washed well and dried in sun for a week or more and then rubbed again to give a polish. A mechanical brush type ginger peeling machine has been developed by Rajasthan Agricultural University. The peeling efficiency of the machine was 85% and the capacity was 200kg/h *(Agarwal et al.,* 1987). *Another* mechanical ginger peeler was developed with its peeling drum made of diamond cut mesh (Jayashree & Visvanathan 2013) which has a peeling efficiency of 59%. The sun dried ginger is brown in colour, more or less irregular wrinkled surface and when broken, shows a dark brownish colour. However, it is reported that the quality of dry

ginger cured in the bright sun is better than the quality of ginger cured in a closed oven with artificial heat.

b) Polishing

Polishing of dried ginger is done to remove the wrinkles developed during drying process. In the indigenous method the dried ginger is rubbed against a hard surface. However, hand or power operated polishers similar to turmeric polishers are also employed for the purpose of polishing dried ginger. In the case of hand operated polishers an output of 5-6 quintals per day of 8 hours is obtained with the help of two persons. The dried ginger rhizomes are manually graded. The machines of various capacities to pulverize dried ginger from 25 kg per batch to continuous powdering of 2-3 t/ day for large scale production are available.

c) Cleaning and grading

Once the ginger is dry it is cleaned, sorted and graded. Grading takes into consideration the size of the rhizome, its colour, shape, extraneous matter, the presence of light pieces and the extent of residual lime (in the case of bleached ginger). Two types of Indian dried ginger entering the International market are Cochin and Calicut ginger, named after the two major production centres in Kerala. Both Cochin and Calicut gingers are graded according to the number of fingers in the rhizomes: grade-B, three fingers; grade-C, two fingers and grade-D, pieces. In addition to these well known types of Indian ginger, another type, Calcutta ginger, is occasionally seen in the market.

4. Turmeric

Maturity of the crop is indicated by complete drying of the aerial plants including the base of the stem. The leaves and stem are cut close to the ground. Two days earlier to digging out the rhizomes, irrigation is given. In case of ridge method of planting, plough is used to lift the rhizomes. Otherwise the rhizomes are dug out with manually. The harvested rhizomes have to be cured within 2-3 days after harvest for securing maximum out turn. In the turmeric growing regions of Tamil Nadu, mechanical harvesting of turmeric is being practiced. Tamila Nadu Agricultural University (TNAU), Coimbatore has developed a power tiller operated mechanical turmeric harvester with a capacity to harvest 0.6 ha per day (TNAU, 2009a). Tractor drawn turmeric harvester mounted on 35-45 hp tractor with a capacity to harvest 1.6 ha per day have been developed by TNAU (TNAU, 2009b). The tractor mounted harvester may be adjudged as the best mechanical harvester for saving of time and reduced the percentage of damaged rhizome apart from the removal of drudgery in harvesting of quality rhizome.

a) Post harvest operations

The harvested turmeric rhizomes before entering into the market is converted into a stable commodity through a number of post harvest curing processes like boiling, drying, polishing and colouring. Curing of turmeric is taken up within 3 or 4 days after harvest. The fingers and mother rhizomes are separated and are cured separately, since bulbs take longer time to cook. The recommended practice is to use clean water for boiling turmeric rhizomes in mild steel or galvanized iron pans and takes about 60-90 minutes. Boiling destroys the vitality of fresh rhizomes, avoids the raw odour, reduces the drying time and yields uniformly coloured product. Boiling

of turmeric rhizomes is carried out till froth forms and white fumes come out of the boiling pan with a characteristic odour. Boiling is considered complete by pressing a pointed stick in to the rhizomes with slight pressure. The other indications for completion of boiling process are softness and easy breaking of rhizomes when pressed between the fore finger and thumb and a yellow interior instead of red one. The cooked fingers are heaped on a cleaned drying floor and left undisturbed for 4-5 hours and later sun dried for 10-15 days by spreading in 5-7 cm thick layers on bamboo mat or on the drying floor. Tamil Nadu Agricultural University (TNAU), Coimbatore, has developed an improved turmeric boiler using steam boiling technique (Visvanathan *et al.,* 2002). The capacity of the boiler is about 200 - 300 kg per batch and 40q per day of 8 hours. Fuel used is 70-75 kg of agricultural waste materials. Curing of turmeric for 60 min by steam cooking was considered optimum to produce quality dried turmeric with minimum losses. The use of large scale steamer for boiling large quantities of turmeric rhizomes at farm level was also available (Visvanathan 2008).

b) Polishing

Poor appearance of dried turmeric is improved by smoothening and polishing the outer surface by manual or mechanical rubbing. Manual polishing gives rough appearance and dull colour in the dried rhizome. A mechanical polisher for turmeric has been developed in the Agricultural University at Andhra Pradesh, India (Sukumaran & Satyanarayana 1999). The unit consists of 88 cm diameter mild steel drum with meshes and is operated by a 2 hp electrical motor. The drum speed Is maintained at 30-32 rpm and the capacity of the polisher is about 600-700 kg/h. A pedal operated hexagonal drum having six polishing plates of size 30 x 60 cm has been developed at QUAT (Pal *et al.,* 2008). The capacity of the polisher is 100 kg/h and 6% polishing is achieved.

c) Cleaning, grading, packing and storage

Turmeric of commerce is described in three ways- fingers, bulbs, and splits. Very little grading of the spice is done at the growers end. Cleaned and graded material is packed generally in new double burlap gunny bags and stored over wooden pallets in a cool, dry place protected from light.

5. Seed spices

Out of 20 seed spice crops cumin, coriander, fennel, fenugreek, dill and ajwain contribute more than 95 per cent towards area and production. Cumin and fennel are dominant seed spices of Gujarat while coriander and fenugreek are important in Rajasthan. India exports raw as well as value added items to nearly 70 countries in the world and meet around 45% of the global demand and earns Rs. 361.5 crores of foreign exchange. For exporting the seed spices, quality is the most important criterion. The quality of seed spices is assessed by mean of its intrinsic (Moisture, volatile oil, oleo resins content, major chemical constituents) as well as extrinsic (size, appearance, colour) quality. The produce must be safe, free from any health hazards substances and contaminants. The contaminants can be classified into three categories.

1.	Physical contaminants	Immature or shrivelled seed, berries, insect infested product, presence of live or dead insect
2.	Chemical contaminants	Added colour material, preservatives, antioxidants, fumigants, aflatoxins, pesticides/insecticide residue.
3.	Microbial contaminants	Presence of Salmonella, *E. coli,* yeast and mould

a) Stage of harvest

Harvesting is one of the major important factors that determine the quality of the produce. The major deterioration and post harvest losses takes 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 170-175days 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 harvesting is usually done in the morning hours to avoid shedding losses.

b) Threshing of seed spices

Traditionally, threshing of seed spices is performed by treading the crop under the tyre of tractor or by stick beating and then the threshed stocks is cleaned by winnowing in natural air stream or in the artificial air streaming the processed products. The new modified threshers were tested in the adopted villages for threshing of cumin and fennel crop by CRSS, Jagudan and it was found that net saving of Rs.3.25 and Rs.3.00 per kg for cumin &fennel threshing respectively can be obtained as compared to traditional method.

c) Drying

Sun drying is usually adequate to dry to produce but there is a chance of contamination of the material by dust and dirt and volatile components will be lost. Mechanized drying could enhance the quality of the produce. At CRSS, SDAU, Jagudan low cost poly solar drying method was the best for faster drying (32 hr) as compared to other drying methods. Shade drying is the best to maintain green colour of fennel. Higher net return (Rs.75.50/ kg) was obtained in low cost poly solar dryer as compared to shade drying method (Rs.64.84/ kg) and open sun drying (Rs.58.80 / kg).

d) Cleaning /Grading

Various machines are used for special functions. Spiral separator is used to separate round seeds and flat seeds. Magnet drum/pulley is used to separate iron particles. Magnet seed separator/electrostatic seed separator is being used to

separate identical weed seed from product. Electronic colour sorters are used to separate discoloured seed to enhance colour value of final product. Gravity separator/destoner is to separate undesirable material on the basis of gravity.

e) On farm processing through mobile seed processing unit

Value addition at farm level is urgent need of the time because major deterioration and post-harvest losses occurs at this stage. The Mobile Seed Processing Unit was demonstrated by Centre for research on Seed Spices, Jagudan in adopted villages under NAIP Component-II "Value chain in Major Seed Spices for Domestic &Export Promotion" project for on farm processing of Fennel &Cumin crop. Average higher price of Rs.725 and Rs.491 per quintal, respectively for fennel and cumin was 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 unit are also established in nearby villages. A mobile agro processing unit developed at CIPHET 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 burn mill, vertical burr mill etc. could be installed and operated by a DG set. These mobile processing machine 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.

f) Packaging and storage

To standardize proper packaging materials for coriander an experiment has been tried with following eleven packaging materials for bulk and retail packing at CRSS, Jagudan. For bulk package jute bag, jute bag with LDPE lining, HDPE bag, HDPE bag with LDPE lining, Paper bag each with 50 kg capacity, LDPE, HDPE, PP, PET+LDPE laminate, metalized PET +LDPE laminate. From the above packaging treatment, paper bag is found best followed by jute bag with LDPE lining in case of bulk packages (50 kg bags) while in the case of consumer packages (500 gm), metalised PET + LDPE laminate is found best followed by PET + LDPE laminate. The whole dried seeds are usually packed into jute or poly bags and stored in cool dry places at 25℃-28℃ room temperature. Bio deterioration due to storage fungi and storage pests will occur if the moisture of the produce is more than 10%.

Value added products from spices

a) Black pepper

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, 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, Cry ground 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.

(b) Cardamom

Major products of cardamom are bleached cardamom, Decorticated seeds and seed powder, Cardamom volatile oil and Cardamom oleoresin. In addition to this, CFTRI, Mysore has developed the following products: Encapsulated cardamom, cardamom tea, cardamom coffee and cardamom soft drink mix.

(c) Ginger

Ginger powder, ginger oil, Ginger oleoresins, encapsulated ginger, Ginger preserves and salted ginger are the value added product from ginger.

(d) Turmeric

Major value added products are Ground turmeric, Turmeric oil, Turmeric Oleoresin and curcuminoids,

(e) Seed spices

In seed spices value addition may be adopted in following way:

1. Ground spices:

The ground 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 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.

2. Spices extractives

Spices extractives can be categorized into three groups:

Essential oils

These are major flavouring constituents of spices, highly concentrated about 75-100 times than the fresh spice

Coriander: Major component of volatile oil is linalool (67.7%) followed by alphapinene (10.5%), arnma- terpinene (9.0%), geranyl acetate (4.0%), camphor (3.0%) and geraniol (1.9%). Minor components include beta-pinene, camphene, myrcene, limonene, p-cymene, borneol etc. Indian coriander oil differs from European oil possessing a lower linalool contents and comparatively higher linalyl acetate contents.

Cumin: The main constituent is cuminaldehyde and three other aldehydes up to 70%. Dominant monoterpenes hydrocarbons (total about 50-55%) are b-pinene, g-terpinene and p-cyrnene, plus myrcene a-and b-phellandrene and limonene, with minor amounts of sesquiterpenes hydrocarbons (Baser et al 1992). Cumin oil is

sometimes adulterated with synthetic cuminaldehyde, which is difficult to detect. The oil is a raw material for the production of thymol.

Fennel: Fennel seed oil, usually traded as fennel oil, is mainly obtained by steam distilling whole or crushed fruit with a yield of 1.5-6.5%, and more recently by supercritical carbon dioxide extraction. In general, oil content is greatest in European and lowest in Asian varieties. The main constituents are trans-anethole (60-65%, but up to 90%), fenchone (2-20%) estragol (methyl chavicol), limonene, camphene, a-pinene and other monoterpenes, fenchyl alcohol and anisaldehyde. Oil produced in Nigeria from fennel of Indian origin had 80% anethole content but no fenchone.

Fenugreek: Major constituents are the dihydroactinidiolide,2-3- dihydrobenzofuran and l-heanol totaling 7-9% with 20 other constituents at less than 3% and the remainder below 1%. The furanone derivative, sotolon, is reportedly mainly responsible for the characteristic fenugreek odour.

Oleoresins

Oleoresin represents the complete flavour and non-volatile resinous fraction present in the spices. The aroma and taste fractions are proportionally blended to constitute the 'true essence' of the natural spice. The oleoresin can be obtained in a single step by elimination of the steam distillation process.

Derivatives of essential oil and oleoresins

They include plated encapsulated forms of spice extractives, seasonings in dry carrier such as dextrose, salt or Rusk powder. They impart the strength of good quality freshly ground spices and can be easily incorporated in the food.

3. Curry Powders/blends and mixes

Curry powder is an indigenous seasoning made from various spices (coriander, cumin, fennel, fenugreek are common) constitute the raw materials used in quality curry powder. The ingredients of curry change according to different needs. The colour, form and taste of various curries are in accordance with the custom of various nations and regions. Consumers all over the world demand different curry powder. The export trade in curry powder at present is dominated by India. Curry powder is made from a blend of several spices, the number vary from a minimum of 5 to more than 20 depending on end uses.

4. Consumer packed Spices

The exported spices are consumed in three main segments namely, industrial, institutional and retail. Different packaging media are used according to the consumer's preference. The packaging has gained considerable importance as it increases the shelf life of spices. The development of new and improved plastic films, aluminium foil, laminations, high speed film sealing machines etc. has created new opportunities for packaging the spices as instant spices, spices pastes, spices powder etc. By exporting consumer packed spices, higher unit value for the same quantity can be earned. The price of such retail spice packs is higher between 50-100 per cent as compared to prices of bulk spices.

5. Organic spices

Exporters specializing in organic production have been successful in achieving the international standard prescribed for spices. The growing demand for organic crop products has led to the development of international trade for organic

spices.

Post harvest operations like harvesting, procession, packing, extraction and development of value added products etc play a major role in maintaining 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 aflatoxins and salmonella contamination of our spices and spice products. The present deficiency in on farm primary and secondary processing of spices need to be bridged for quality up gradation 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.

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POST HARVEST PROCESSING OF MEAT POULTRY AND FISH

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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. In developing nations, the production and consumption of meat is increasing keeping pace with levels of affluence. Meat, poultry, eggs and fish are source of high quality of animal proteins, vitamins and minerals. Besides they are also known for their satiety characteristics.

The livestock sector is an important component of Indian agricultural sector. Livestock sector not only provides essential proteins and nutritious human diet through milk, eggs, meat etc., but also plays an important role in utilization of non edible agricultural byproducts. Livestock also provides raw material/by products such as hides and skins, blood, bone, fat etc. India has a vast livestock population and efficient utilization of these resources including production and utilization of livestock products is important to earn increased profits and sustain livestock production activities.

Meat production in India

Total meat production in India is estimated at 6.27 million MT, occupying 5th in rank in world's meat production accounts for 2.21% of the total world meat production (283.7 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 7.64 lakh tons in 1970-71 to 6.27 million tons 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 is Rs 79,889 crore including skin and hides, while the export value of meat and meat products worked outs to be more than Rs 6,000 crore in the year 2009-10. Export earnings from buffalo meat touched Rs 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 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 revolutions which have been aptly called "green", "white", "yellow" revolutions etc. However, "red/pink" revolution in form of meat production and processing is yet to

happen in India. There are many reasons for the slow growth rate of the Indian meat industry. Some of these could be reflected as:-

1. Quality of animals available for slaughter.
2. Negative attitude of public in general toward consumption of processed meat.
3. Socio-religious considerations.

Livestock sector of Haryana

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 50% of crop agriculture 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%.

Meat Production

The meat production in the state 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. 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.

Constraints

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 grossly unhygienic and poorly maintained with no facilities for disposal of waste products and processing of uneatable parts 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.

Feed lots should be established to raise quality meat animals. 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

Egg Production

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.

Constraints

There are no 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 being mainly sold in Delhi.

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 Hyline, 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 had increased and are also meeting the demands of neighboring states. The broiler farms are more widely spread and are present all over the state.

Constraints

Diversified poultry farming 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 dominated 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.

Fishery sector

The role of fisheries 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 metric tons during the year 1966-67 which has now increased to 105529.50 metric tons in 2013-14 in spite of depletion of fish population in natural water bodies.

Despite limitation of water resources in the state, Department of Fisheries 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.

Processing of meat and poultry 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.

Advantages of processed meats

- Processing aids to provide value added variety and convenience meat products to consumer.
- It offers better utilization of different cuts and edible byproducts.
- It facilitates incorporation of non-meat ingredients for quality and economy.
- It promotes employment, entrepreneur ventures and exports and also minimizes imports.
- Value addition is an important avenue for efficient utilization of tough meat which results in increased demand and higher returns.

Processed meat products

A variety of emulsion based products such as sausages, patties, meat balls, rolls, kababs, cutlets, Tikka, loaf etc. have been developed utilizing meat and its byproducts in India.

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 from 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.

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, roasts, 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 fiber enriched products has been standardized by the department.

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 enhancing the shelf life. Product will be juicier as natural juices are retained. Department has developed enrobed patties using rice flour and gram flour with lower cooking loss, improved texture and sensory characteristics.

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.

Traditional poultry meat products

Traditional food plays an important role in human diet. The art of processing is passed 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, enrobed and battered products are attracting greater consumer response.

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.

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.

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 processing. These giblets can be 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 by the department.

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.

Processed egg products

A great deal of work has been done in our country 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 bag, scrambled eggs, egg in muffins, hard cooked egg roll, egg crust pizza, fruit juice egg drink, egg substituted with albumen and other ingredients to make cholesterol free.

Processed fish products

There is 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 type 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

Economics of value added poultry products

Availability of adequate raw materials at reasonable cost and distribution and marketing at minimum cost contributes favourable to the economics. Sale price depends on the economic status of consumers and the product aimed at. Low cost facilitates wide range of consumers. All efforts have to be made to keep production cost at minimum with selection of appropriate formulations, processing conditions and infrastructure facilities. Addition of polyphosphates within the prescribed limits has been found to result in immense benefits such as higher product yield, better

palatability and keeping quality in Indian situation of meat handling.

Suggestions for commercialization of meat products in domestic and export markets

1. The meat products should be produced within affordable cost to the target group of consumers for marketing sustainability.
2. The success of any product ultimately depends on its economic viability. Sometimes even economical process may not be self supporting. Hence, newer products require some subsidization during their early phases of introduction till these products find wide acceptability among the consumers.
3. 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 cites and for exports.
4. Though, automatic machines are being developed for a variety of products, yet meat processing is labour intensive and promoting small scale ventures with simple technology would find higher relevance in Indian situation with lower labour costs.
5. In processing plants, product quality should be ensured by following HACCP and TQM methods of quality control during production and marketing. Quality management staff must be trained to maintain standards all the way.
6. Knowledge of 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 centers need to be created for the traditional food industry with the support of the State and Central Govt.
7. Processing of protein rich and low fat meat products like balls, koftas, tikka, cutlets, tandoori etc. have vast export market potential.
8. 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.

IMPACT OF POST HARVEST TECHNOLOGY: A CASE STUDY OF AGRO PROCESSING CENTERS

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Introduction

Technology led growth is sustainable, otherwise subjected to diminishing return. Agro processing centre (APC) is set of techno-economic activity which encompasses all operations from the stage of harvest till the material reaches the end users in the desired form. APC is now regarded as the sunrise sector of the Indian economy in view of its large potential for growth and likely socio economic impact. APCs have potential for generating income and employment opportunities in production catchment, while stimulating economy by way of value addition to farm produce on one hand and avoiding distress sale, preventing post harvest losses and reducing transaction cost on another. The available evidences suggest that the benefits accrued are not just unidirectional that merely satisfies processers by way of higher monitory returns but multidimensional in terms of establishing the linkages of farmers with other stakeholders including processors, industry, retailers and consumers. An investment of rupees one crore is able to create 18 jobs directly and 64 indirectly in the organized sector and 20 jobs in the unorganized sector across the food supply chain (Anonymous, 2010). In India, in food processing unorganized sector still dominates, i.e., around 42% (MoFPI, 2012). Agro processing generates employment opportunities within sector and more opportunities in service sector (Chand *et al.,* 2006). Further, Singh *et al*. (2007) and Srinivas *et al*. (2009) have summarized that APC in hilly region of Uttarakhand is economically viable and generate direct and indirect employment, which may have good bearing on checking migration from hills. APC in the production catchment has twin obvious advantages of enhanced income from value addition of farm produce and as a means to provide gainful rural employment (Nanda, 2011).

Recognizing the importance of APC, AICRP on Post Harvest Technology has been promoting APCs by providing financial help (in some cases), proper planning and guidance followed by monitoring. More than 82 APCs have been established by AICRP on PHT centers in different parts of the country depending upon the marketable surplus, consumer demand and type of commercially available equipments. Most of these APCs have been operating successfully for a number of years. This paper discusses the success story of one APC (established in village Rode, Punjab) and analyzes the economic impact and other social and personal benefits of APCs (established by AICRP on PHT) at national level. Also estimates the labour intensity and labour efficiency in agro processing centers.

Methodology

In an effort to collect quantifiable data, some specific indicators, according to broad areas of (1) technical efficiency, (2) economic feasibility and (3) social acceptability were developed, taking into account the basis of earlier studies of Pandey and Mruthyunjaya (2004) and Rovere and Dixon (2007). These indicators were translated into two schedules (Annexures I and II) in this study, Schedule-I is for getting feedback from APC beneficiaries/users and Schedule-II is for obtaining response of Research Engineer (RE)/ Principal Investigator (PI) of the cooperating centre who had contributed towards establishment of APC. AICRP on PHT has established 82 APCs in 17 states of India and the primary data were collected (during 2008-09 and 2009-10) from 21 purposively selected Agro processing centers (APCs), which consist of 8 states, viz. Assam, Karnataka, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu and Uttarakhand (Table 1). The data pertain to various aspects of input (fixed capital, labour, cost of raw material, source of power, etc.) and output (value of final product and byproducts, and custom hiring charges) were collected and utilized for calculation of net benefits. The detailed computation of economic benefits has been presented for one APC in village Rode. However, the economic impacts of selected 21 APCs have been presented in abridged table so as to economize the space.

The economic feasibility tests such as Benefit- Cost Ratio (B/C), Internal Rate of Return (IRR) and Pay Back Period (PBP) and Break Even Point (BEP) were calculated as follows.

Benefit-Cost Ratio (BCR) $\sum\left[(B_t)/(1+r)^t\right] / \sum\left[(C_t)/(1+r)^t\right]$

Where, B_t denotes the benefits in the year t, C_t is the cost in year t and t is the time period, and r is the discount rate (rate of interest).

Pay Back Period (PBP) : Fixed Capital/ Profit

Break-Even Point (BEP) : [Fixed cost/ (Fixed Cost + Annual profit)] x 100

In addition, intangible benefits accrued as a result of establishment of APC were observed and recorded precisely.

Table 1 Number of Agro processing centers established and surveyed

Name and address of the AICRP on PHT centers	Number of APC esta-blished	APC selected for data collection		Year of establish ment
		No.	Name and address of APC surveyed	
PKV Akola (Maharashtra)	3	3	Mahadeo Sansthan APC, Hiwarkhed (Akola)	2002
			Organic APC, Nimkhed (Amaravati)	2004
			Arjun APC, Deoli Wardha)*	2007
VPKAS Almora (Uttarakhand)	1	1	Takula APC (Almora)	2005
UAS Bangalore (Karnataka)	16	4	Aradeshalli APC (Bangalore rural) #	1989
			Honaganahalli APC(Mandya)	2001
			Babigrama APC (Mandya)	2003
			Kuthinagere (Ramanagara)*	2003
CIAE Bhopal (Madhya Pradesh)	1	-	-	
ANGRAU Bapatla (Andhra Pradesh)	1	-	-	
OUAT Bhubaneswar (Orissa)	6	2	Jaya Durga food products, Bramheswar Patna (Khurda)#	2000
			APC Mandalasahi (Gajpati)*	2006
TNAU Coimbatore (Tamil Nadu)	4	1	Atchaya APC, Women SHG, Madukkarai (Coimbatore)*	2005
CCS HAU Hisar (Haryana)	1	-	-	
JNKVV Jabalpur (Madhya Pradesh)	3	-	-	
AAU Jorhat (Assam)	4	1	Seuj Krishi Samabai Samiti, Allengmora (Jorhat)	2002
JAU Junagadh(Gujarat)	2	-	-	
CPCRI Kasaragod (Kerala)	1	-	-	
IIT Kharagpur(West Bengal)	1	-	-	
PAU Ludhiana (Punjab)	25	6	APC Lalton Kalan (Ludhiana)	2001
			APC Lande (Moga)	2003
			APC Rode (Moga)	2005
			APC Konkekalan (Ludhiana)	2006
			APC Vander Jatana (Faridkot)	2006
			APC Daddahood (Ludhiana)	2007

GBPUA&T Pantnagar (Uttarakhand)	2	1	APC Fatta Bangar (Naintial)	1996
RAU Pusa (Bihar)	1	-	-	
UAS Raichur (Karnataka)	3	-	-	
IGKVV Raipur (Chhattisgarh)	1	-		2010
YSPUH&F Solan (Himachal Pradesh)	2	-	-	
KAU Tavanur (Kerla)	2	-	-	
MPUAT Udaipur (Rajasthan)	2	2	APC Sansera (Rajsamand)*	2002
			APC Segwa (Udaipur)	2003
Total	82	21		

** APC run by women and women SHG, # APC engaged in fruits and vegetable processing, Other APC are engaged in processing of cereals, pulses, oilseeds, spices, etc.*

Further, labour intensity, defined as the labour employed per unit of fixed capital, has been worked out using the following criteria adopted by Gupta (1990) and also by Bharti et al. (2005).

Labour intensity (LI) = W_i / ₹ 50000 of Fixed capital

where, W is the no of workers (man days in a year) in i^{th} APC.

LI < 0.22 for very low labour intensity
LI = 0.22 to 0.37 for low labour intensity
LI = 0.37 to 1.11 for medium labour intensity
LI = 1.11 to 2.22 for high labour intensity
LI > 2.22 for very high labour intensity

In order to ascertain the status of labour intensity in the selected 21 APCs, five classifications give above were adopted and weighted average ranks were assigned. Since these agro processing centers have been established in different years, fixed capital was inflated or deflated to make them comparable at 2004-05 prices by using implicit GDP MP Deflator.

Labour productivity has also been estimated as a ratio of Gross Value Addition (GVA) to number of workers (man years). In other words, it is the output per labour man year. GVA is the net benefit before depreciation.

Labour productivity/ efficiency (LP/LE)

LP/ LE = GVA/ W_i

Where, GVA is Gross Value Addition (net benefit before depreciation)

LP < ₹ 25000 for very low
LP = ₹ 25000-50000 for low labour productivity
LP = ₹. 50000-100000 for medium labour productivity
LP = ₹ 100000-200000 for high labour productivity
LP > ₹ 200000 for very high labour productivity

Results and Discussion

Economic Impact of Agro Processing Centers (APC)

The concept of APC models was pioneered by AICRP on PHT, which is appreciated and being emulated by some of the national (IFFCO, CII) and international (World Bank) organizations. AICRP on Post Harvest Technology have been promoting Agro processing centers by providing technical guidance followed by monitoring. The impact of APC established by AICRP on PHT at national level was examined from economic and social perspective. The idea behind it was to check capital and human drain from rural to urban area while making available primary processed materials in the production catchment itself and reducing post harvest losses.

The socio-economic analysis of one Agro Processing Complex located at village Rode, district- Moga (Punjab) has been carried out and discussed in detail. The success story of an entrepreneur Mr. Santole Singh (age - 38 years, education-higher secondary) is interesting and tells how his business of agro processing has attained growth over a period of time. Basically, Mr. Santole Singh was an agriculturist and engaged in the business of livestock, particularly buffalo trading and milk marketing, before establishment of APC in the year 2005. He had suffered from a serious financial setback in buffalo trading business. While the family was on the stake of livelihood threat, with the motivational force of the Research Engineer and other staff of AICRP on PHT, Ludhiana centre coupled with financial support from Khadi Board of Punjab and financial institutions, he had been able to establish an agro processing centre in his village Rode. The detailed cost economics of APC Rode is presented in Table 2. It is evident from the results that within a short span of 5 years, APC Rode has achieved a remarkable growth in terms of improvement in savings, enhancement in the physical capital (installation of new spice grinder) and further extension of the activities by opening a provisional store and fancy shop adjoining to APC. Provisional store and APC are being managed by male members whereas fancy/cosmetic store is managed by female members of the family.

Proper distribution of work among family labour and forward integration are apparent from the model. Besides, four workers are hired on wage basis. Most of the work is done on custom hiring basis but raw material (agricultural produce) for at least one to two months are being purchased at the time of harvesting season. The customers are satisfied with the quality and they do not have to wait for processing of their produce (especially wheat), and therefore, they simply exchange their raw material with final products. Moreover, the consumers prefer to purchase other household items from their shops while coming for processing their produce.

Table 2. Estimated Cost and Benefits of APC, Rode

1	**Criteria for cost and benefits**				
	Life of machines, year				10
	Annual rate of interest				12%
	Repair and maintenance				5%
	Building with drying yard, Rs /month				Own
2	**Principal equipment cost**				
	Equipment/ machine	Capacity (q/day) raw material	Rate of custom processing (₹ /q)	Working days in a year	Cost of the machine (2005) (₹)
	Flour Mill (Roller) (02 Nos)	35	170	340	175000
	Traditional chakki	16	100	340	25000
	Mini Rice Mill	10 to 15	150	120	100000
	Oil expeller and filtration unit	2 to 4	250	240	90000
	Masala grinder (with motor), installed in 2008	3.0	-	120	40000
	Electric motor	25 hp	-	-	65000
	Installation charges and construction of foundation	-	-	-	180000
	Total (Rs.)		-	-	675000
A.	**Annual fixed cost (Rs.)**				182250
B.	**Variable cost**				
a	Cost of raw material, mustard (40 q @ ₹ 3000/q)				120000
b	Cost of raw material (haldi, mirch, dhaniya etc.) 36 q, average prices, ₹170/ kg				612000
c	Unskilled labour-04 @ ₹ 4500 per person				216000
d	Electricity @ ₹ 20000/ month				240000
e	Packaging and packaging material				25000
f	Miscellaneous (telephone, etc.)				30000
	Sub-total (a to f) (₹)				1243000
C.	**Total cost (A+B), ₹./year**				**1425520**
D.	**Returns (June 2009 to May 2010)**		Quantity processed (q)	Rate/ Profit (₹/q)	Total returns (₹ /year)
	Flour mill				
	Improved chakki atta (custom basis)		6400	170	1088000
	Traditional chakki (custom basis)		2000	100	200000
	Wheat bran (byproduct)		168	750	126000
	Subtotal - I				**1414000**
	Mini rice mill				

	Rice Milling (custom basis)	1200	150	180000
	Rice bran @ 4% (byproduct)	48	1000	48000
	Rice husk @ 25% (byproduct)	450	280	126000
	Subtotal - II			**354000**
	Baby oil expeller			
	Milling of mustard (custom basis)	40	250	10000
	Oil extraction from 40 q mustard (profit basis)	14	7000	98000
	Mustard cake	26	1500	39000
	Subtotal-III			**147000**
IV.	**Masala grinder** (haldi, mirach and dhaniya), (raw: 36q)	35.28	2400	**846720**
	Total returns (I+II+III+IV)			**2761720**
E.	**Net returns (D-C), Rs/annum**			**1336200**
	Economic feasibility indicators			
	i) Benefit cost ratio			**1.93**
	ii) Payback period (years)			**1.5**
	iii) Break-even point (%)			**59.95**

Note: The firm gate sale price of mustard oil is ₹ 70/ kg, instead of litre
Source: Nanda (2011)

The APC has earned annual profit of ₹ 13.36 lakh during 2009-10 and benefit cost ratio of 1.93 and payback period of 1.5 years is reasonably good. The opinion of the entrepreneur's family was ascertained and found high level of satisfaction. They also informed that APC had good impact even on the health of their dairy animals.

Likewise, the net returns to entrepreneurs as a result of establishment of APC were calculated and presented in Table 3. The annual profit from APC ranged from ₹33,600 in case of APC Madukkarai, Tamil Nadu to ₹1.58 crore in case of APC Nimkhed, Maharashtra (Table 3). On an average net profit per APC was estimated to the tune of ₹12.29 lakh per annum. However, to reach a logical conclusion, both the extremes/outliers (i.e., highest and lowest profit) were avoided for analysis and the average net benefit was recalculated to ₹ 5.24 lakh per annum. Total benefits accrued to the entrepreneurs were estimated by multiplying number of APCs with adjusted average net benefit after avoiding the extreme values. It is evident from Table 4 that APC has generated Rs. 4.30 crore per annum net returns to the entrepreneurs and ₹ 8.20 crore to society (consumers/retailers).

The indirect benefits to society are realized through saving resultant of enhanced recovery and additional income to persons who are engaged in the supply of raw material to APC, marketing of value added products from APC and also reduction in logistic cost to the consumers and/or retailers. The estimates of Peterson *et al.* (2006) suggest that new investment in small size agri-food venture in Michigan have strong indirect impact in terms of income (indirect income @ 2.5 times of direct income) and employment (generate indirect employment @ 1.8 times of direct employment).

Table 3. Annual profits from selected APCs (2009-10)

Sl. No.	Name of APC	Annual profit (₹) (2009-10)
1	APC Allengmora, Assam	120283
2	APC Aradeshalli[@], Karnataka	248140
3	APC Honaganahalli[@], Karnataka	56628
4	APC Babigrama[@], Karnataka	142116
5	APC Kuthungere[@], Karnataka	160163
6	APC Nimkhed, Maharashtra	15831000
7	APC Hiwarkhed, Maharashtra	139000
8	APC Deoli[@], Maharashtra	515453
9	APC Bramheswarpatna[@], Orissa	632891
10	APC Mandalasahi[@], Orissa	180014
11	APC Rode, Punjab	1336200
12	APC Lande, Punjab	1192060
13	APC Konke kalan, Punjab	1066345
14	APC Lalton kalan[@], Punjab	927140
15	APC Daddahood, Punjab	756440
16	APC Vander Jatana, Punjab	1140200
17	APC Segwa, Rajasthan	104050
18	APC Sansera[@], Rajasthan (Udaipur centre)	75795
19	APC Madukkarai, Tamil Nadu	32500
20	APC Takula[@], Uttarakhand	330675
21	APC Fatta Bangar, Uttarakhand	842400
	Total profit (Rs.)	25829493
	Average profit (Rs.)	1229976
	Average profit after avoiding the extremes (highest and lowest profit), Rs.	524526

Source: Nanda (2011).

Note: [@]the net benefits were calculated for the year 2008 but converted at 2009-10 prices, using ratio of food price inflation for the year 2008-09 (4.3%) and 2009-10 (9.7%). The data on food price inflation were collected from Economic Survey 2011-12.

Table 4. Impact of APC established by AICRP on PHT Centers

(In ₹ crore/ year)

State	No of APC established by AICRP on PHT	Net returns to entrepreneurs	Benefits to consumer / society**	Total benefits	Direct employment generation (thousand man days)	Indirect employment generation (thousand man days)
1.	2.	3.	4.	5.	6.	7.
India	82	4.30	8.20	12.50	78.72	118.08

Note: Basis for calculation: for (3)- average net returns to the entrepreneur @ Rs.5.24 lakh /unit given in Table 3, (4) Indirect benefits to consumer/society @ Rs.10.0 lakh as a result of APC in production catchment, (6) one APC generate direct employment of 4 man days for 240 days, (7) Indirect employment to workers and marketing agencies@ 6 man days for 240 days

Our rudimentary estimate put forward that one APC is able to contribute towards saving of ₹ 10 lakh per annum indirectly to the society, which is nearly double to the direct income of an entrepreneur. Further, on an average, one APC provide direct employment to 4 persons and indirect employment to 6 persons (1.5 times of direct employment) for a period of 240 days in a year. It is estimated that 78,720 and 1,18,080 man days of direct and indirect employment were generated as a result of APCs established by AICRP on PHT (Table 4). A good number of inspired APCs demonstrate its multiplier effect in terms of adoption. The demonstration effects are more pronounced in the state of Punjab. The state of Punjab is agriculturally advanced and famers are early adopters and have risk bearing capacity. Overall, the APCs established by AICRP on PHT centers have contributed significantly towards income and employment generation.

Social and other benefits

Consumers were found to be benefited in terms of availability of better quality of the processed products in their vicinity. A preliminary/pilot survey was conducted and found that consumers are quite satisfied with the quality. The reasons attributed were (i) chances for known adulteration are negligible, as villagers themselves established APCs and they do not wish to incur social punishment, and (ii) most of the processing work is done on custom hiring basis in the presence of customers. In some cases, however, consumers do not wait for processing of their produce (especially wheat), they simply exchange their raw material with final products and pay the processing charges. However, processing of mustard/ oilseeds, spices and horticultural produce are generally undertaken on profit/ loss basis, i.e. purchase of raw material and sale of both final and by-products at prevailing market prices.

Forward integration is apparent from the model, which not only enhanced the income of the entrepreneur but also favored the social interaction with and among the consumers (fellow folks from neighboring villages). Moreover, the consumers prefer to purchase other household items from adjacent shops (many a times extension or subsidiary of APC) while coming for processing their produce. Social benefits were captured in terms of promoting cooperative and SHG approach (APC run by a group), women empowerment (APC run by women), and proper distribution

of work and utilization of family labour (APC run by individuals). Establishment of internet facilities in the rural area to facilitate fast communication and sale of produce in national and international market is also evident in some APCs in Maharashtra and Karnataka. Interestingly, as a result of establishment of APC 'Seuj Krishi Samabai Samiti' in village Allengmora near Jorhat, the real estate values in the surrounding increased to a considerable extent and other business activities developed at a rapid pace centered around this APC. Further, entrepreneurs' family have shown high level of satisfaction with the present work, profession and the quality of their life, and some of them have even informed that health of their dairy animals have improved after the establishment of APC.

Labour Intensity and Productivity in APC

Labour intensity

An agro-processing industry can be labour intensive (Sharma, 1983 and Venkaiah, 1987) or it may be capital intensive (Chengappa, 2004), depending upon the factors such as scale of operation, level of mechanization and nature of raw material (produce) or final processed product. The results (Table 5) depict that labour intensity was found predominantly low (8 APCs) to medium (10 APCs). State-wise inspection of average scores also showed low to medium labour intensity prevailing in the 21 APCs selected for the study (Table 6).

Table 5. Classification of labour intensity in selected APC (n=21)

labour intensity	Range (labour employed per ₹ 50,000 of fixed capital)	No. of APC
Very low	Below 0.22	1
Low	0.22 to 0.37	8
Medium	0.37 to 1.11	10
High	1.11 to 2.22	2
Very high	Above 2.22	0

Table 6. State wise classification of labour intensity in APC

State representing APC	Number of APC	Labour intensity in APC (No.)				Average score
		Very low	Low	Medium	High	
Score		[1]	[2]	[3]	[4]	
Assam	1		1			2.0
Karnataka	4	1		2	1	2.7
Maharashtra	3			3		3.0
Orissa	2		2			2.0
Punjab	6		3	2	1	2.3
Rajasthan	2		1	1		2.5
Tamil Nadu	1		1			2.0

Uttarakhand	2			2		3.0
Total	21	1	8	10	2	2.7

Labour Productivity

Labour intensity is not enough for gainful employment opportunities but labour employed must be efficient and productive to justify its employment. Labour productivity is an indication of productive efficiency that measures the relationship between an industry's output and the labour hours used in producing that output (Holman et al., 2008). The labour efficiency has been estimated as a ratio of Gross Value Addition (GVA) to number of workers per annum, and the level of labour efficiency has been further classified into five categories as given below.

These categories were assigned ranks of 1 to 5 and thereafter weighted average score was obtained (Table 7). The labour efficiency of APCs in Punjab was rated as highest (average score of 4.2). Very high labour efficiency has been noticed in Maharashtra (2 APCs), Punjab (2 APCs) and Uttarakhand (one APC). Proper allocations of the labour and efficient marketing strategies adopted by the entrepreneurs are the two obvious reasons for higher productivity. On the contrary, the labour efficiency of women owned APC in Tamil Nadu and Rajasthan was found between very low to low, indicating inadequate linkages with market for sale of their final product (Nanda et al, 2013).

Table 7. Classification of labour productivity

		Labour efficiency (GVA per labour), No. of APC					Average score
State representing APC	Total number of APC	Very low ₹ <25000	Low ₹ 25000-50000	Medium ₹ 50000-100000	High ₹ 100000-200000	Very high ₹ >200000	
Score		[1]	[2]	[3]	[4]	[5]	Scale of (1 to 5)
Assam	1				1		4
Karnataka	4		2	2	1		2.8
Maharashtra	3	1				2	3.7
Orissa	2			1	1		3.5
Punjab	6			1	3	2	4.2
Rajasthan	2		1	1			2.5
Tamil Nadu	1	1					1.0
Uttarakhand	2			1		1	4
Total	21	1	3	6	6	5	3.7

Conclusions

APC is found suitable, convenient and economically viable model to capture huge potential for processing of agricultural commodities. The impact of APC is found to be more pronounced in the state of Punjab and hence, it is suggested that Haryana should also promote APC in production catchment, as agro climatic conditions of both states are similar. Overall the labour productivity in APC, as indicated by Gross Value Addition per unit of labour ranged between medium to high. Very high labour productivity was found to be associated with better communication facilities and market linkages. Our results suggest that market promotion for processed food in rural and semi-urban areas may have positive implication on labour productivity in APC, besides, generating indirect employment opportunities. The replication of this model throughout the country in general, and Punjab and Haryana in particular, can bring prosperity in rural areas.

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SLAUGHTER HOUSE WASTE MANAGEMENT

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Introduction

Products obtained from slaughtered animals in slaughter houses other than meat are termed as slaughter house/animal by-products. The terms by-products and offal are used to denote every part which is not included in a dressed carcass. Animal by-products are broadly divided in two categories viz. edible and inedible by-product. Those suitable for human consumption are edible and the rest are termed inedible.

Variety meat: It is a term that is used in the meat trade for traditionally edible by-products. These include livers, brains, tongues, kidneys, tripe, stomachs, chitterlings, sweet breads, oxtails, cheeks meat, head meat, snouts, lips, hearts and pig's tails.

Inedible byproducts: These by-products include hides, skins, wool, fat, blood, bones, gall and urinary bladders, horns, hoofs, claws, teeth, fetus etc.

Slaughter house waste: Waste term is applied for those by products of slaughtered animals which have least or marginal utility and uneconomical recovery. It is a common saying in developed meat industry that everything from the slaughtered animal except its cry can be utilized. The slaughter houses in India including Haryana lack most of the required infrastructural facilities. Illegal and unorganized slaughtering also takes place in different parts of the country and state. Byproduct recovery in such slaughter operations is poor leading to generation of waste. Those by products which cannot be collected and utilized properly due to lack of technical knowledge, poor infrastructure also form slaughter house waste. In our country, a very large proportion of products like feathers generated from poultry processing are not efficiently utilized and are treated as wastes, hence the term slaughter house waste is quite often used to describe them.

Animal waste may be defined as carcasses or parts of animals, including products of animal origin not intended for direct human consumption. The typical inedible wastes of slaughter houses available in our country include hides and skins, horns and hoofs, hide and skin trimmings, blood, bones, udder, ruminal contents, intestines, rectum, penis, fetus, oesophagus, urinary and gall bladders, uterus, pig bristles and body hairs, poultry offal's, condemned meat etc. In the meat industry, the slaughtering process is the largest contributor to liquid waste. Because of legal restrictions and environmentally conscious consumers, the treatment of residues and wastes has emerged as a major concern in meat industry.

Classification of slaughter house waste

Slaughter house wastes are mainly classified into two major categories –

1. Liquid waste (Effluent) and 2. Solid wastes.

1. **Liquid waste:** includes waste water from meat plant or slaughter house which is generated during slaughtering, dressing and processing of slaughtered animals.
2. **Solid waste:** these are further classified into two categories as-
   (i) **Type-I waste:** Vegetable matter such as rumen, stomach and intestine contents, dung.
   (ii) **Type II waste:** Animal matter such as inedible offals, tissues, meat trimmings, waste and condemned meat, bones.

From the environment point of view, the slaughter house wastes can be divided in two categories.

(i) Wastes which do not easily putrefy and do not pose serious problems in their conservation, *e.g.,* horns, hoofs and hairs.
(ii) Wastes which putrefy at a very fast rate, *e.g.*, soft offals and blood.

Generation of slaughter house waste

The components left unrecovered simply form solid wastes. Waste generation is largely influenced by the facility for recovery of by-products. It also depends on customs of consumer community. Ruminal, stomach and intestinal contents essentially form solid waste. Besides this, stomach and large intestine are also disposed of as waste in most of the slaughter houses. Soft meat pats such as lungs and pancreas are collected in large slaughter houses for sale to poultry feed processing units, whereas these offals are disposed as waste in medium and small slaughter houses. Horns and hooves are generally collected for sale. The solid and liquid waste generated in the bovine, goat and sheep and pig slaughter houses is shown in table 1 and table 2 respectively.

Table 1: Solid waste generated from processing of different species of animals in slaughter house

Animal	Quantity of Solid Waste		
	Kg/ Head	Kg/ TLWK*	% of Animal weight
Bovine	83	275	27.5
Goat/sheep	2.5	170	17
Pig	2.3	40	4

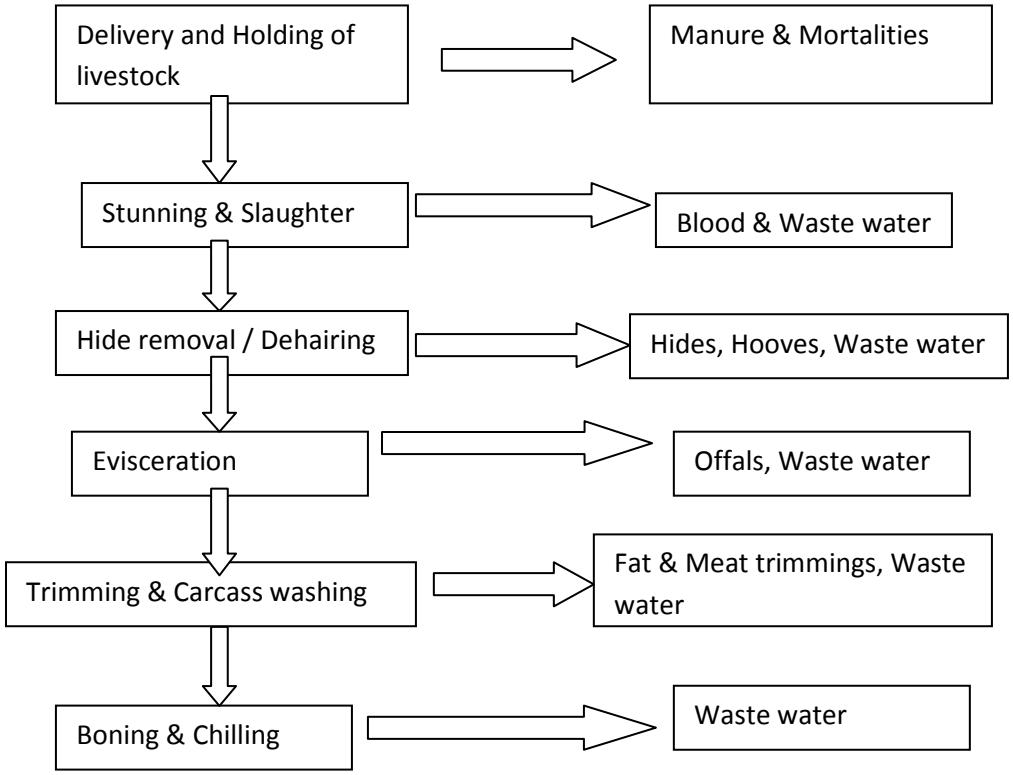
*TLWK: - Tonne of Live Weight Killed

Table 2: Waste water generated from processing of different species of animals in slaughter house

Species of animals	Waste water generated (Litres/animal)
Cattle	1200 – 5000
Sheep & Goat	200 – 800
Pig	250 – 1000

Slaughter house wastes are generated during different meat processing operations in slaughter houses as shown in figure 1.

Figure 1: Generation of slaughter house wastes:



Characteristics of slaughter house waste

Slaughter house waste is constituted by a large amount of highly polluting waste water, semi-solids and solids. Municipal sewage (sanitary sewage or domestic sewage) contains about 2% solids whereas slaughter house/meat plant wastes may contain up to 10% solids. These wastes are called strong sewage because their biochemical oxygen demand (BOD) and chemical oxygen demand (COD) values are very high. BOD varies from 1000 to 3000 mg/litre. Abattoir/meat plant waste is typically organic in nature due to the presence of blood, fat, manure and undigested stomach contents. A high percentage of this waste is capable of being decomposed. Grease, fat and oils are also present in meat plant effluent. These substances tend to coat treatment systems, block pipes, pumping systems and screens. They reduce oxygen transfer and can seriously reduce the efficiency of aerobic treatment systems. Fluctuation in pH of waste occurs due to the presence of caustic and acidic cleaning agents. Nitrogen occurs in three forms in effluent: organic nitrogen salts and dissolved ammonia gas. Ammonia in solution is toxic to aquatic life; the maximum discharge to sewers is 40 mg/litre. High nitrate concentrations in natural water

encourage algae and other plant growth, thus blocking water courses. The maximum level in potable water is 0.5 mg/litre.

Waste handling situation in India

In India there are 3600 registered slaughter houses and most of the slaughter houses are unorganized. Illegal slaughtering also takes place in different part of country. Slaughtering is done under unhygienic conditions so that by products collected from these slaughter houses have least or marginal utility with uneconomical recovery. Many slaughter houses are much smaller and widely scattered. To equip such units for effective processing of waste is really a challenge. So there is need to upgrade old slaughter houses on modern lines for overall improvement in sanitation and hygiene and wholesome meat production.

On the other hand, some export oriented abattoirs which are mostly handled by private sector have effluent treatment and waste disposal facilities.

For modernization of existing slaughter houses, the Ministry of Agriculture, Government of India provides assistance to the States. Financial incentives are also provided by the Ministry of Non-conventional Energy Sources for setting up of biogas plants and high rate biomethanation plants under its programs on energy recovery from urban and industrial wastes and biogas management programs.

Effect of slaughter house/ Animal waste on environment

1. 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.
2. 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.
3. 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.
4. Open dumping of slaughter house waste may cause diseases. Burning by using incinerator can add to the air pollution.
5. 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 anaerobically 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
6. 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.

Utilization of slaughter house waste/byproducts

1. Most of the slaughter house wastes/by-products in our country 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 effect 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.
2. Presently, the livestock feed production is more 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.
3. Slaughter house by-products can also be exploited as pet and laboratory animal feed.
4. 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.
5. 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.

Solid waste management

All most every by-product of slaughter house can be utilized. However, various circumstances do not always permit by-product recovery. The reasons may be inadequate quantity of materials, lack of markets, cost of processing etc. In such instances, they simply form part of waste lot for which different methods of processing and disposal have to be considered, which are given below:-

1. Rendering system
2. Composting
3. Biomethanation/ biogas
4. Incineration method
5. Burial method

The last method is mainly used for treatment and disposal of condemned materials.

1. Rendering

Rendering is a process in which there is recovery of fat from animal material by heating or processing of carcass with heat or steam so as to obtain a nearly sterilized material without loss of nutrients.

Dry rendering: also called as **batch method.** Most of the animal tissues destined for animal feeds are processed by the dry-rendering method or by modifications of this method. The conventional dry-rendering cooker or dry melter is a horizontal, steam-jacketed tank equipped with an internal agitator. These tanks normally have a capacity of 8 to 10 quintals. After the tank is loaded, steam is turned into the jacket to heat the contents. Cooking breaks down the fat cells of animal tissue so that the fat is released as the material is dehydrated in the rendering process. As the moisture is evaporated the temperature rises to 110-116^{0}C (230-240^{0}F), at which point practically all of the moisture has been driven off and the fat liberated from the tissues. The steam is then turned off and the warm fat and protein residues dumped in to a percolating pan where the free fat is drained out. The remaining protein material is either pressed or extracted with solvent to reduce the fat content. Pressing the cracklings results in a finished product containing 6-12% fat, the quantity depending upon the amount of pressure applied. The solvent generally used for extracting animal by-products is heptanes. By Solvent extraction, the cracklings may be reduced to a very low fat content.

Dry rendering is advantageous as yield is nearly 20 % higher than wet rendering because proteins present in water are not discarded. Also there is saving of labour and steam.

Crackling or greaves: when all fat is removed during the process of rendering then the residual protein called crackling is ground and used for animal and poultry feeds. Dried and fat free crackling are ground to recover meat meal and meat and bone meal.

Wet rendering (tankage production): In this process the raw material is loaded in a tank along with small amount of water and steam is injected directly into the bottom of the tank. The temperature of the water and of the fatty tissues is rapidly raised and is maintained at the temperature of steam until fat cells are ruptured and the fat is released. Free fat floats to the surface, and when cooking is stopped it may be drained or skimmed off. Then water is removed and finally the wet protein residue (tankage) is left.

The wet protein residues are then pressed to remove more fat and dried. The cook water containing a considerable amount of dissolved protein is evaporated to recover liquid stick which may be added to the solid protein residues during drying to make tankage

2. Composting

All slaughter house waste can be used for compost making. Compositing is widely used method for organic waste disposal while it also has potential as an effective method of treating waste prior to land application. The agriculture residue and dung from the lair age, ruminal and intestinal contents, blood, meat cuttings, floor sweepings, hair, feathers, hide trimmings can be stabilized by composting. The process kills pathogens, converts nitrogen from unstable ammonia to stable organic forms, reduces the volume of waste & improves the nature of waste.

For preparation of compost stack, alternate layers of type I waste and type II waste should be built up to a height of 4 to 5 feet. The heap should preferably be

laid direct on the ground. It is advisable to put a layer of about 6-inch of course material, such as maize or millet stalks, banana stumps, straw, grass, small twigs etc. underneath in order to achieve proper ventilation. Higher temperature in compost keeps rats, dogs or other vermin away. In tropical climate, the temperature inside the heap will go upto 75^{o}C killing the bacteria, larvae and checking the entry of undesirable pests.

The ruminal and intestinal contents provide sufficient moisture for a start of bacterial activities. Mesophilic and thermophilic bacteria are involved in composting and there succession is important in the effective management of composting process. To achieve optimum conditions for the bacteria, moisture and proper aeration must be maintained from start to finish. At least two turnings are required to obtain a uniform compost material. The first turning is normally advised after 2 to 3 weeks and the second turning after 3 to 4 weeks. The total time required is about 90 days.

Advantages of composting

1. It is cost effective.
2. It produces less effect on the environment.
3. It creates less offensive odour.
4. Finished product does not contain any phytotoxic substance.
5. It causes good soil aeration when used as manure in fields.

3. Biomethanation/ biogas

Biogas is normally produced by anaerobic decomposition of slaughter house waste to produce biogas, largely methane. It has non luminous flame and is used for lightening, cooking. A biogas producing plant comprises of three components:

(i) Digestor – a tank wherein fermentation causes production of gas.
(ii) Gasometer – a gas storage tank
(iii) Pipes- for gas distribution at desired points

A digestor is made up of bricks as a circular cylinder. In small plants, gasometer is an inverted iron movable cover of digestor itself which rises or descends according to the gas it contains. The entire assembly has to be water and gas proof. The receptacle or inlet feed the digestor with animal blood, urine, dung, ruminal contents. These nitrogenous waste undergo anaerobic fermentation. As a result, biogas consisting of nearly 60 % methane, 30 % carbon dioxide and traces of hydrogen, carbon monoxide etc is produced.

4. Incineration

Incineration is a controlled combustion process for destruction of combustible wastes. The wastes after combustion are converted to gaseous constituents and a non-combustible residue. The gases are released to atmosphere and the residue is usually disposed to landfill. In incineration, waste is burnt at temperatures between 850 ^{0}C and 1100 ^{0}C in specially designed combustion chambers. Proper temperature control, mixing and turbulence are necessary for effective combustion.

Capital cost and recurring expenses of incinerator are high. If incineration facility is not available then incineration done by preparing incineration pit or trench of 0.5 meter deep which is filled with wood or straw and after complete combustion pit should be filled with mud.

5. Burial method

It is most common method used for disposal of condemned materials. Burial pit should be dug 2 meter deep. Highest part of carcass should be at least 1.5 meter below the level of terrain. Once the carcass is in grave, the skin is slashed & drenched with crude phenol. Carcass should be covered on all sides with quick lime. Deep burial and quick lime covering will prevent the dogs/ jackals from digging up the carcass.

In case of Anthrax, all natural orifices of carcass plugged with cotton soaked in 5% cresol and body wrapped in similar bag.

Waste water/Effluent management

Effluent management or treatment methods are broadly divided into two categories -Primary treatment and Secondary treatment

(A) Primary effluent treatment

Primary treatment involves methods that remove solids and this is done by passing all the effluent water through screen, filters, floatation/sedimentation basins and grit chamber.

(i) **Screen** – series of inclined bars placed across the water flow. Solid materials retained by screens are removed and disposed by burning or incineration. Mesh size is 50 to 1000 mesh/inch^2

(ii) **Grit chambers** – these are shallow rectangular tanks in which velocity of flow is checked so that grit will settle carrying with it some of the organic material.

(iii) **Fat trap** – it is in the form of a tank or grease trap where solids settle at the bottom of the tank while grease and fat rise to the surface. These fat and grease are removed from the surface.

(iv) **Dissolved air floatation technique (DAF):** DAF works on the principle that air dissolved in a solution under pressure will come out from the solution if the pressure is released. Micro-bubbles thus formed will tends to adhere to solids particles and increase the tendency for the particle to float. The specific gravity of the aggregate particle is then lighter than water and floats to the surface where it can be skimmed out. The rate of removal is a function of particle size. Coagulants such as ferric chloride, lime and polymer may be added to increase particle size, thereby increase the efficiency of removal. Properly operating air floatation tank can remove 70 to 90% of the grease, 50-65% of the suspended solids and 20 to 35% of BOD.

(B) Secondary effluent treatment

Secondary Treatment is carried out using biological treatment systems which involve maintaining under controlled conditions a mixed culture of microorganisms

which utilize the continuous supply of organic matter present in the effluent to synthesise new cells. Pond systems are commonly used for the secondary treatment of meat industry effluent. Secondary treatment can remove more than 90% of the organic matter in effluent and one of the following methods can be applied:

(a) Anaerobic treatment: It is carried out in totally enclosed system to prevent the entry of air. It will result in a fast reduction of organic material with the production of biogas. With a BOD higher than 2000 mg/litre this method becomes advantageous. The system operates as a two stage fermentation process in which the stages occur simultaneously with in the digester.

During the first stage, bacteria break down complex organic substances into simpler compounds, the most important being volatile fatty acids (VFA). In the second stage, methanogenic organisms utilize the VFA to yield methane and carbon dioxide. Maintaining the pH at around 7.0-7.2 is very important. Over production of VFA will lower the pH and stop the process, which can be difficult to re-start. Anaerobically treated effluent requires further aerobic treatment before it can be discharged into water courses.

(b) Aerobic treatment: aerobic treatment can be carried out by any of the following methods.

(i) **Lagoons:** Lagoons are scientifically constructed ponds usually 3 to 5 feet deep in which sunlight, bacteria, algae and oxygen interact. These are commonly used for treating wastes from meat and poultry plants where low cost land is available. Generally warm, clear and sunny conditions are favourable for successful operation of lagoons. A symbiotic phenomenon is found in these ponds. Organic material effluent is oxidised by bacteria into simpler compound and CO_2. The CO_2 is utilized by algae for their growth and also produce oxygen which is further utilized by bacteria to oxidize organic material. Algae utilize CO_2 in presence of sun light. So cloudy weather lower the efficiency of aerobic lagoons.

(ii) **Activated sludge process:** In this process there are two tanks- the aeration tank and final settling tank. In the beginning of process the waste stream following primary treatment is brought to the aeration tank where mixing and aeration are uniformly provided by mechanical mixers or pressurized air diffusers. Following aeration, the mixed liquid is allowed to settle in the final settling tank. The clear supernatant in this tank is chlorinated and discharged to the receiving water, while concentrated sludge is separately collected.

Once the process has started, a portion about 30% of activated sludge from final settling tank brought to aeration tank which speeds up the action of aeration tank because the activated sludge is heavily landed with activated bacteria which actively convert organic matter into harmless inorganic matter.

(iii) **Trickling filters:** A Trickling filter is simply a bed of stones 3-10 feet deep through which the sewage passes. The sewage is applied to filter either through

a network of pipes or by spraying from rotating horizontal pipes. In this system, there is assimilation of organic matter into growth by aerobic bacteria in the form of a surface fauna. These filters can achieve upwards of 90% reduction of BOD and removal of suspended solids.

(C) Final treatment of effluent: After primary and secondary treatments of abattoir effluent, liquid and solids (sludge) are treated separately before their release. The liquid effluent is disinfected by the addition of chlorine. Usually chlorine gas is injected into the effluents 15 – 30 minutes before the treated water is discharged into any water source.

Before its release, the effluent should posses a certain minimum standards as below:

PH	:	6-9
BOD (mg/l)	:	50
COD (mg/l)	:	250
Total suspended solids (mg/ml)	:	50
Oil & Grease (mg/ml)	:	10
Nitrogen (mg/L)	:	10
Total phosphorus (mg/L)	:	5
Coli form bacteria (MPN/100ml)	:	400

Conclusion

A considerable quantity of animal by-products 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 by-products produced from such slaughter operations, some of which are of edible grade, are of questionable quality. These are health hazard for consumer.

Slaughter house by-products/wastes should be conserved at production site. Later it 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 on the units operation of meat industry without legal complicacy, pollution control steps are quite inevitable. To achieve this, proper disposal of solids waste and liquid wastes must be carried on 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 waste for economic return, thus quite useful for sustainability of the meat industry.

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