



**CSIR–National Institute of Science,  
Technology and Development Studies**



**S&T APPLICATIONS TO PEOPLES' PROBLEMS (STAPP)**

**AGRI Food**

## Project Information

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## Acknowledgement

This Policy Advocacy benefitted from comments from a variety of sources, especially from CSIR laboratories. The analyses presented are based on mostly secondary sources (websites); while we have made sincere efforts to refer to all these sources, it is possible we have missed some.

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## **S & T APPLICATIONS TO PEOPLES' PROBLEMS (STAPP)**

The CSIR-NISTADS effort on S&T Applications for Peoples' Problems (STAPP) identifies peoples' problems grouped into broad topics where S&T can provide effective solutions, contributing to speedy socio-economic transformation. The identification is made objective as far as possible, using traceable parameters like the number of persons affected, geographical coverage, socio-economic strata and the severity; however, there is need for more extensive data and deeper analysis in the process of identification and prioritization.

This report provides a discussion on packing, price, shelf life and wastage of Agro Food in India; technologies used worldwide in this field. The report also outlines the programs and policies that have been initiated for improvement in this direction.

## Macro Socio-Economic Analysis

Food plays an important role in India's economy. In 2012, this \$200 billion industry<sup>1</sup> made a significant contribution to economic and social growth, employing more than 3 million people in organized segments and micro, small, and medium-sized enterprises (MSMEs), with a significant impact on local economies.

The agro-food processing industries cover a wide range of activities utilizing farm, animal and forestry based products as raw materials. There are certain traditional agro-based industries such as rice and flourmills, sugar, khandsari and gur manufacture, edible oils and the processing of plantation crops like tea, coffee and cashew nuts. Moreover, there are somewhat modern food processing industries such as dairy products, confectionery, marine products, horticultural and vegetable products as well as meat and poultry products. In addition, there is also a limited extent of processing of agro-wastes and by-products of main agro-based industries. Due to this wide range of activities, there is a lot of diversity in the nature of problems and issues relating to the sub sectors of agro-food processing industries. The food industry has been a vital link between the agriculture sector and final food consumption. The industry includes primary and secondary processing for sectors such as dairy, fruits, vegetables, and grains.

The industry shapes consumer habits, drives efficiency, and helps keep inflation in check. It affects urban and rural consumers in many ways, from addressing basic nutrition needs to providing options for indulgence<sup>1</sup>.

The sector is poised to enter a sweet spot with an unprecedented opportunity for explosive growth. The country is perceiving the favourable coming together of several demographic factors: rising disposable income,

added young people, and growing urbanization. This is expected to result in a substantial rise in food demand over the next few years. At the same time, factors such as growing awareness, health consciousness, the need for convenience, and improving lifestyles are shifting consumers toward processed and packaged foods.

Agro-food processing industries have the potential to generate employment directly, in production activities and also, indirect employment through its forward and backward linkages. This engagement would be in rural areas where these industries have to be located near the source of raw materials, especially perishable agricultural products.

These industries would help in reducing post-harvest losses and wastes as well as in using by-products more efficiently. This can increase farmers' income by getting them superior prices and also consumer welfare by growing the availability of agricultural consumer goods.

**Low shelf life:** The shelf-life of a food can be defined as the period for which it will hold an adequate level of eating quality, from a safety and sensory point of view. It is significant to realize that food items are assorted, complex and active systems in which microbiological, enzymatic and physicochemical reactions are simultaneously taking place. These have key consequences in relation to flavour, texture and shelf-life. It is vital to guess the shelf life of food. There are few strong factors in this process largely- Formulation, Processing, Packaging and Storage conditions. All these aspects are critical but their relative importance depends on the particular food item. An understanding of the interplay between these features is basic to shelf-life estimation and testing.

To get information of a food's expected shelf-life, one must realize the concerted series of

biochemical/physicochemical reactions taking place. It is also significant to recognize the mechanisms accountable for spoilage or loss of desirable individuality for example texture, flavour, odour and nutrients.

With better understanding of the fundamental mechanism of reactions, food scientists are able to quantify and model the data on the related biochemical/physicochemical changes taking place in foods for estimating the period for which they will hold an acceptable stage of eating quality from a security and sensory perspective. Selecting a suitable, consistent approach to modelling quality loss of a food product is a significant major step in estimating shelf-life. The second step is to find the key factors which are influencing the shelf life of food<sup>2</sup> as detailed below.

**Aspects affecting shelf life:** A typical post-harvest chain comprises of a number of stages for the movement of harvested output from the field to the final retail market. The losses incurred at each step differ depending upon the organization and technologies used in the food supply chain. Produce decay begins as soon as a yield is harvested. For example, in less developed countries where the supply chain is less mechanized, larger losses are incurred during drying, storage, processing and in transportation (Hodges, Buzby, and Bennett, 2011)<sup>3</sup>. The main factors that affect shelf life include style of handling, humidity and temperature abuse and ethylene exposure<sup>4</sup>. One UC Davis study<sup>5</sup> concluded that a peach with all above controls maximized can last approximately 28 days. If the same product is subjected to storage space higher than the optimal 32°F, its shelf life is reduced to almost 50%. Accordingly, if one adds in the remaining factors of ethylene exposure, inadequate humidity and improper handling, a peach may only last between 1 to 2 days.

Solutions that provide tools and data to

precisely control monitor and document these factors during storage and transport can effectively deal with these issues.

**Handling:** If a harvest/produce (fruit or vegetable) is inappropriately handled throughout harvest and is damaged or bruised, this may cause the food to spend more energy faster than undamaged produce dipping its shelf life. In addition, if harvesting condition is not hygienic, bacteria has the chance to thrive as bacteria feeds off of stored energy. Inappropriate handling practices lift water loss and respiration, providing ways for bacteria or mould to take root. Furthermore, damage invites degeneration and contamination. Produce that is bruised or damaged by human handling are more prone to decay. Examples of improper post-harvest handling factors that can influence shelf life comprise:

- Washing produce with contaminated water
- Transportation in contaminated boxes
- Vehicle juddering causes produce damage.

Also, damage to produce due to improper handling causes the discharge of large amounts of ethylene, shortening shelf life.

**Temperature and Humidity:** These play a significant role in shelf life and are directly linked. For example, if a cold room temperature increases by only 2°F the relative humidity drops something like 7% which cut off produce shelf life by about 50%. Leafy greens last 4 times longer when stored in a room with 95% relative humidity than in a room with 80% relative humidity. It is significant for growers and shippers to notice that a by-product of respiration is heat. Which means a truck with an ambient temperature of 32°F may have produce registering 2°-4°F higher. Therefore, monitoring the ambient temperature may not be enough. Optimal storage and transfer of fruits and vegetables varies by product with finest

temperatures ranging from between 32°F with 90 - 95% relative humidity for strawberries and 55-59°F with 85-90% relative humidity for grapefruit. Using methods to observe and analyse both product temperature and humidity during their processes allows handlers to enhanced shelf life.

Ethylene is a produced by plants and released as a colourless, odourless gas which the plants employ to regulate their own growth, flowering, ripening and aging. It surges cellular respiration, which in turn increases metabolic rate. Once any produce has been harvested, this increase in respiration will shorten shelf life. Ethylene also causes plant cells to lose water, leading to dehydration, drying, and shrivelling. It reduces a lot of advantageous nutrients and leads to loss of leaves and flowers. It also changes the taste and odour of fruits and vegetables.

One of the most harmful effects of ethylene is that it stimulates plant cells to enhance their production, which accelerates all of these undesirable affects associated with ripening, maturing, and decaying<sup>5</sup>, and thus shortening the time for shipping, storage, and sale. Pallets of produce experiencing any comprehensive period of shipment may arrive with damaged unsellable product. This is a growing anxiety for food handlers needing to remain competitive as the food distribution chain lengthens and costs of spoilage rise.

The key factors that contribute to extending the shelf life of produce are proper handling methods, careful monitoring and control of temperature and humidity and use of shelf life extension packaging methods.

**Proper Handling:** According to the National Center for Appropriate Technology (NACT), once produce is harvested it is essential to handle the produce carefully to avoid bruising or damage. This assures that the product arrives with a good exterior and free of decay.

Handling processes that will avoid destructive produce and extend shelf life include proper training for labour, handling produce, packing in the field if possible, avoiding high drops into containers, padding cartons and containers and not over loading or filling containers.

Preserving food using lower temperatures has been utilized for over many decades. Storing produce in cold temperatures with appropriate relative humidity levels protects fruits and vegetables from decay and bacteria. This extends the shelf life, which also extends the product's selling time. Transporting and storing produce at low temperatures slows the aging and respiration process of produce as well as minimizes moisture loss. In addition, the lower temperature decreases the probability of produce being affected by bacteria, yeast and moulds. Nowadays there are many commercial ways to monitor temperature and humidity. The most effective solutions utilize tools and data management methods that allow for fast and accurate access to the data produce handlers required to make significant decisions rapidly. Exposure to discontinuous cold and warm temperatures may enlarge the chances of decay as it results in produce accumulating moisture on the food's surfaces. Refrigeration rooms and transport should have passable air flow and insulation to assist in maintaining temperatures. In current times, technology provides cost effective and efficient facility temperature monitoring systems that can monitor temperatures and alert produce handlers of temperature excursions.

While storing or transporting produce, there is a need for a relatively high humidity to couple with temperature. Produce is made up of extensive quantities of water. Water content translates to freshness and fruits and vegetables are usually sold by weight. Water loss hence is an important factor in the shelf life of produce. The factors that influence water loss are temperature, humidity and air flow. To

maintain water produce need to be stored or transported in a high relative humidity range. Growers can use various strategy to conflict this issue including using humidification devices, pails of water with fans blowing air across them or wetting floors.

**Ethylene Exposure:** The effect of ethylene exposure has increased as a significant factor due to the enlargement of the average shipment and travel time for all produce from grower to buyer. This has intensified due to the fact that food must travel additional today, as a direct result of the enlargement of the food distribution chain. As a result of which, there is an increase in imports and exports, the transition to fewer and larger suppliers, and the proliferation of regional distribution centers where most superstore goods are being routed through. This expansion of the food distribution chain means produce is exposed to ethylene for longer periods. Combining low cost temperature monitoring with professional ethylene control packaging can defend produce and extend shelf life.

New packaging strategies have been developed to tackle the challenges of limiting ethylene exposure in transport. Modified Atmosphere Packaging (MAP) as it is generally known is a technology that attempts to manipulate the atmosphere surrounding the produce in such a way to decrease or abolish its exposure to ethylene.

### **Wastage of produce**

Agricultural waste, which includes both natural (organic) and non-natural wastes, refers to waste produced over a range of farming activities. These include dairy farming, horticulture, seed growing, livestock breeding, grazing land, market gardens, nursery plots, and even woodlands. It is likely that these wastes account for over 30% of worldwide agricultural productivity<sup>6</sup>.

One-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems. Economically avoidable food losses have a direct and negative impact on the income of both farmers and consumers<sup>7</sup>.

Agricultural litters are non-product outputs of production and processing of agricultural products that may hold material that can advantage man, but whose economic values are less than the cost of collection, transportation, and processing for advantageous use. Wastes is caused due to irrational application of intensive farming methods and the abuse of chemicals used in cultivation, which remarkably affects rural and the global environment.

The waste constitutes nitrogen, human and animal pathogens, medicinal, feed additives, salts, and certain metals. These, under uncontrolled conditions can be unfavourable to aquatic, plant, animal or human life. The most common method of dumping the waste is application to the land. Use of these wastes as animal feed also can be a pathway<sup>8</sup>.

Agricultural wastes are currently used for a number of applications through the '3R' strategy of waste management. Agricultural waste has a toxicity potential to plant, animals and human through many direct and indirect channels<sup>9</sup>.

**Agricultural waste generation:** Dr. Saumitra Chaudhuri Committee in 2012 constituted by the Planning Commission had indicated cold storage requirement of 61 million tonnes. The present capacity of cold storage in the country is estimated at around 32 million tonnes. The Central Institute of Post-Harvest Engineering

and Technology (CIPHET)<sup>9</sup>, has expected the annual value of harvest and post-harvest losses of major agricultural produces at national level to be of the order of ₹92,651 crore calculated using production data of 2012-13 at 2014

wholesale prices. Annual wastage of agricultural produce, milk, meat, marine and poultry products as assessed by CIPHET is shown in Table 1.

Table1: Annual wastage of agricultural products

| Commodity             | Losses during Transportation (%) | Losses during Farm Operations (including transportation loss)(%) | Losses during Storage (%) | Overall Total Loss (%) | Monitory value of the loss (in ₹ crore) |
|-----------------------|----------------------------------|------------------------------------------------------------------|---------------------------|------------------------|-----------------------------------------|
| Milk                  | 0.02                             | 0.71                                                             | 0.21                      | 0.92                   | 4409                                    |
| Meat                  | 0.00                             | 1.99                                                             | 0.72                      | 2.71                   | 1235                                    |
| Marine Fish           | 0.91                             | 9.61                                                             | 0.91                      | 10.52                  | 4315                                    |
| Inland Fish           | 0.17                             | 4.18                                                             | 1.05                      | 5.23                   | 3766                                    |
| Egg                   | 0.36                             | 4.88                                                             | 2.31                      | 7.19                   | 1320                                    |
| Poultry Meat          | 0.66                             | 2.74                                                             | 4.00                      | 6.74                   | 3942                                    |
| Cereals               |                                  |                                                                  |                           | 4.65-5.99              | 20698                                   |
| Pulses                |                                  |                                                                  |                           | 6.36-8.41              | 3877                                    |
| Oilseeds              |                                  |                                                                  |                           | 3.08-9.96              | 8278                                    |
| Fruits and Vegetables |                                  |                                                                  |                           | 4.58-15.88             | 40811                                   |

Source: Reference<sup>9</sup>

While tropical climate is favourable for growing crops, it also supports the generation and development of insects and weeds. This creates a high demand for pesticides to kill insects and protect against the spread of epidemic diseases; this need often lead to the abuse of pesticides.

As a result, most of the bottles and packages holding these pesticides are thrown into fields or ponds. According to an estimate by the Plant Protection Department (PPD), about 1.8% of the chemicals remain in their packaging, with potential to cause unpredictable environmental consequences such as food poisoning, unsafe food hygiene and contaminated farmland due to their possibly lasting and toxic chemicals. In addition, existing stagnant or unused pesticides and pesticide packages with residue from the original contents poses serious environmental

concern as could be stored or submerged incorrectly and may leak or enter the environment through osmosis.

Fertilizers play an important role in maintaining the productivity and quality of plants. Inorganic fertilizer is inexpensive and characterized by high productivity. However, many farmers apply more fertilizer to their crops than the amount plants need. The severe consequence of such excessive application is that it is used to the point of abuse to surge the annual agricultural output. The rate of absorption of such fertilizer compounds (nitrogen, phosphorus, and potassium) varies depending on the land characteristics, plant types, and method of fertilization. Among the fertilizer excess, a portion is retained in the soil, a share enters ponds, lakes and/or rivers as a result of

either surface runoff or the irrigation system adopted, polluting surface water; a portion enters the ground water, and a segment evaporates or becomes de-nitrated, triggering air pollution.

**Wastes from Livestock Production:** This includes solid waste as manure and organic materials in the slaughterhouse; wastewater as urine, cage wash water, wastewater from the bathing of animals and from maintaining sanitation in slaughterhouses; air pollutants such as  $H_2S$  and  $CH_4$ ; and odours. The pollution caused by livestock production is a serious problem since most of them are usually built around residential areas. Air pollution includes odours emanating from cages resulting from the digestion process of livestock wastes; the decay of organic matter in manure; animal urine, and from redundant foods. The intensity of the smell depends on animal density, ventilation, temperature, and humidity. The proportion of  $NH_3$ ,  $H_2S$ , and  $CH_4$  varies along with the stages of the digestion process and depends on organic materials, the components of foods, microorganisms, and the status of the animals' health.

This untreated and non-reusable waste source can generate greenhouse gases and have negative effects on the fertility of the soil farther causing water pollution. In livestock waste, water volume accounts for 75–95% of total volume, while the rest includes organic matter, inorganic matter, and species of microorganisms and parasite eggs. The germs and substances can spread diseases to humans and cause many negative effects on the environment.

**Waste from Aquaculture:** The growth in aquaculture has led to an increase in the use of feeds for improved production. The amount of feed used in a system is the most important factor in determining the quantity of waste

generated. One foremost category is metabolic waste which could be dissolved or suspended. In a properly managed farm, approximately 30% of the feed used will become solid waste. Feeding rates are dependent on the ambient temperature. Increase in temperature results in amplified feeding which causes augmented waste. Water flow patterns in production units are important for waste management as a proper flow will minimize the fragmentation of fish faeces and allow for rapid settling and concentration of the solids. This can be critical because a high percentage of non-fragmented faeces can be quickly captured which will greatly reduce the dissolved organic waste.

**Waste utilization routes:** Agricultural waste utilization technology must either use the residues rapidly, or store the residues under conditions that do not cause spoilage or render the residues unsuitable for processing to the desired end product. There are a number of applications to which these wastes can be used as follows.

*Fertilizer Application:* The utilization of animal manures for fertilizer has a definite impact on input energy requirements at the farm level. Manure could supply 19% nitrogen, 38% phosphorus and 61% potassium in chemical fertilizer. However, fertilizer use of manures from large confinement is associated with high energy costs for transport, distribution, storage facility requirements, odour problems and possibility of groundwater contamination. The poultry manure contains high phosphorus which has positive effect on the growth and productivity of crops. It is also effective when combined with mineral phosphorus fertilizer for farm use. Adding manure to soil increases its fertility because it increases the nutrient retention capacity (or cation exchange capacity), improves the physical condition, the

water holding capacity and the soil structure stability.

**Anaerobic Digestion:** Methane gas can form from agricultural wastes mainly manures. This is best suited for heating purposes as in broiler operation, water heating, grain drying, etc. The anaerobic digestion of agricultural waste to form methane-rich gas is a two-step microbial fermentation. Initially, acid-forming bacteria break down the volatile solids to organic acids which are then utilized by methanogenic organisms to yield methane-rich gas (Figure 1).

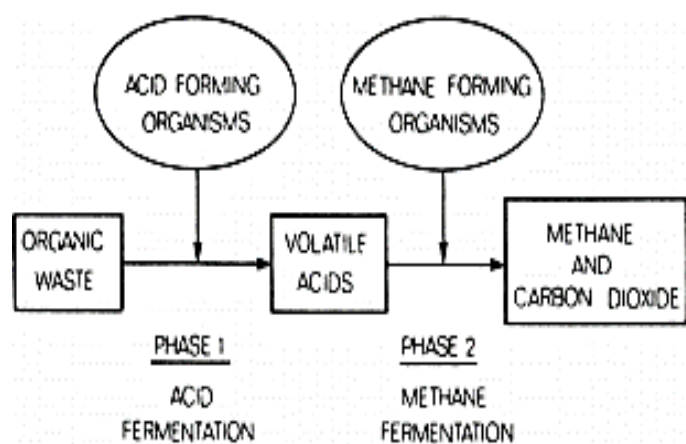


Figure 1: Methane production by two-stage microbial fermentation

Source: - Reference<sup>10</sup>

The composition of the typical gas produced is: methane, 50-70%; CO<sub>2</sub>, 25-45%; N<sub>2</sub>, 0.5-3%; H<sub>2</sub>, 1-10% with traces of H<sub>2</sub>S; and the heating value of gas is in range 18-25 MJ/m<sup>3,11</sup>.

Some of the major disadvantages of the system are high capital costs and the explosive properties of the methane gas. However, the advantages far outweigh the aforementioned disadvantages. Anaerobic digestion makes the treatment and disposal of large poultry, swine and dairy waste feasible, minimizing the odour problem. It stabilizes the waste and the digestion sludge is relatively odour-free and yet retains the fertilizer value of the original waste.

**Adsorbents in the Elimination of Heavy Metals:**

Excessive release of heavy metals into the environment due to industrialization and urbanization has posed a great problem worldwide. Unlike organic pollutants, the majority of which are susceptible to biological degradation, heavy metal ions such as copper, cadmium, mercury, zinc, chromium and lead ions do not degrade into harmless end products. The presence of heavy metal ions is a major concern due to their toxicity to many life forms. Studies on the treatment of effluent bearing heavy metal have revealed adsorption to be a highly effective technique for the removal of heavy metal from waste stream and activated carbon has been widely used. In recent years, agricultural wastes have proven to be a low-cost alternative for the treatment of effluents containing heavy metals through the adsorption process. The low cost agricultural waste such as sugarcane bagasse, rice husk, sawdust, coconut husk, oil palm shell, neem bark etc., for the elimination of heavy metals from wastewater have been investigated by various researchers.

**Pyrolysis:** In this, agricultural waste is heated up to a temperature of 400-600°C in the absence of oxygen to vaporize a portion of the material, leaving a char behind. This is considered to be a higher technology procedure for the utilization of agricultural wastes. Others are hydro-gasification, and hydrolysis. They are used for the preparation of chemicals from agricultural waste as well as for energy recovery. Preparation of alcohols for fuel, ammonia for fertilizers, glucose for food and feed are important for agriculture. Pyrolysis of agricultural waste yields oil, char and low heating value gas.

**Animal feed:** In most developing countries, the problem with animal feed is limited availability of protein sources, though great efforts are made to find alternative supplements. Crop residues have high fibre content and are low in

protein, starch and fat. Consequently, the traditional method of increasing livestock production by supplementing forage and pasture with grains and protein concentrate may not meet future meat protein needs. Use of the grain and protein for human food will compete with such use for animal feed. These problems may be circumvented by utilizing residues to feed domesticated animals<sup>10</sup>.

*Packaging and Preservation:* Packaging food basically refers to wrapping in some form to guard the produce through storage, transport and distribution. In general, packaging prevents foods from spoiling, losing value and losing volume through leakage or spillage.

Food preservation has become a part of life of common man, and is unavoidable owing to many reasons. Some food such as fruits and vegetables are available in specific seasons, while other foods are more abundant in other season. In some places there is a surplus production of a food product, whereas in others there might be inadequate supply. Food can also be perishable and semi-perishable including juicy fruits, vegetables, mangoes, tomato, and papaya. Consequently, humans adopted certain techniques to preserve such seasonal foods intact for later use. Food preservation is important to accomplish the food supply needs of a developing country like India. It also ensures that the food is available and its supply is maintained throughout the year.

A key question related to preservation and packaging of food is the factors that cause spoilage and deterioration in food. The main aspects are bacteria, yeast and moulds as well as enzymes, temperature and biochemical changes in the foods. Food preservation techniques are planned to prevent these spoilage changes and impart a keeping quality or shelf life to the processed foods. Packaging

prevents food from becoming spoiled due to impact or crushing, contaminated by insects and micro-organisms, or affected by moisture, air or odours<sup>12</sup>.

After harvesting the raw materials, there are many unit operations concerned before packaging- cleaning, grading, disposal of unwanted material and stabilization of the enzymatic, biochemical and microbial spoilage. Packaging is an essential part in processing and preservation of foods. It can influence physical and chemical changes, including migration of chemicals into foods. The property of temperature changes and light can be modified through packaging. The flavour, colour, texture as well as moisture and oxygen transfer is influenced by packaging.

*Cold conservation-* Cold is used to slow down or stop the spoilage of foods.

- Cool storage (5-12°C) Cartons and bulk bins
- Cold storage (0-5°C) Flexibles
- Frozen storage (-18°C and below) Semi rigids

*Heat conservation-* Heat is used to inactivate organisms or enzymes of spoilage significance in the foods.

- Blanching (100°C) further processing needed
- Pasteurization (60-75°C) Sanitary sealed containers.
- Commercial sterilization (110-130°C) Hermetic metal or glass containers
- Aseptic processing (130°C and above) Hermetic and sterile containers

*Fermentation Preservation* slows down spoilage factors through the production of alcohol or acids which upkeep conservation. This technique is often combined with pasteurization.

- Alcoholic products (e.g., beer, fruit wine)

- Acid products (e.g., vinegar, pickled vegetables).

*Reduction of Available Water-* Many spoilage factors require the presence of moisture in order to operate. When this existing water is removed then better preservation can be achieved.

- Concentration and evaporation Flexible
- Drying by solar or mechanical means Semi rigids and
- Salt is increased (e.g., fish) Rigid containers with barrier properties
- Solids level is increased (e.g., chutney/jams)
- Freeze-drying (e.g., prawns, mushrooms)

*Pickling or Curing Preservation-* These methods can be used together with smoking and with refrigeration as a combined form of preservation.

- Pickled or cured foods
- Usually a flexible barrier package, or cans (e.g., beef or ham cured with nitrite salts)
- Plus, refrigeration

*Chemical Preservation-* Used to inhibit the spoilage factors and to complement other food preservation techniques.

- Benzoic acid (fruit drinks) Flexible Semi rigid and rigid packaging
- Sorbic acid (cheese)
- Sulphur dioxide (fruit drinks)
- Antioxidants (fats and oils)

*Gas Environment-* Control done to inhibit post-harvest deterioration, often used together with refrigeration.

- Carbon dioxide gas (meats, fruits) usually flexible Barrier materials
- Nitrogen and carbon dioxide blanket (fats, oils)
- Vacuum (cheese and meat, poultry)
- Ozone gas (cheese storage)

*Combination methods-* Various preservation techniques may be successfully combined to reduce spoilage factors to acceptable levels. These include combinations of those listed, together with the following techniques.

- Antibiotics (nisin in cheese) Rigid Semi rigid and Flexibles
- Ultraviolet light (water)
- Food irradiation (spices sterilization)
- Ultrasonic (emulsions)<sup>13</sup>

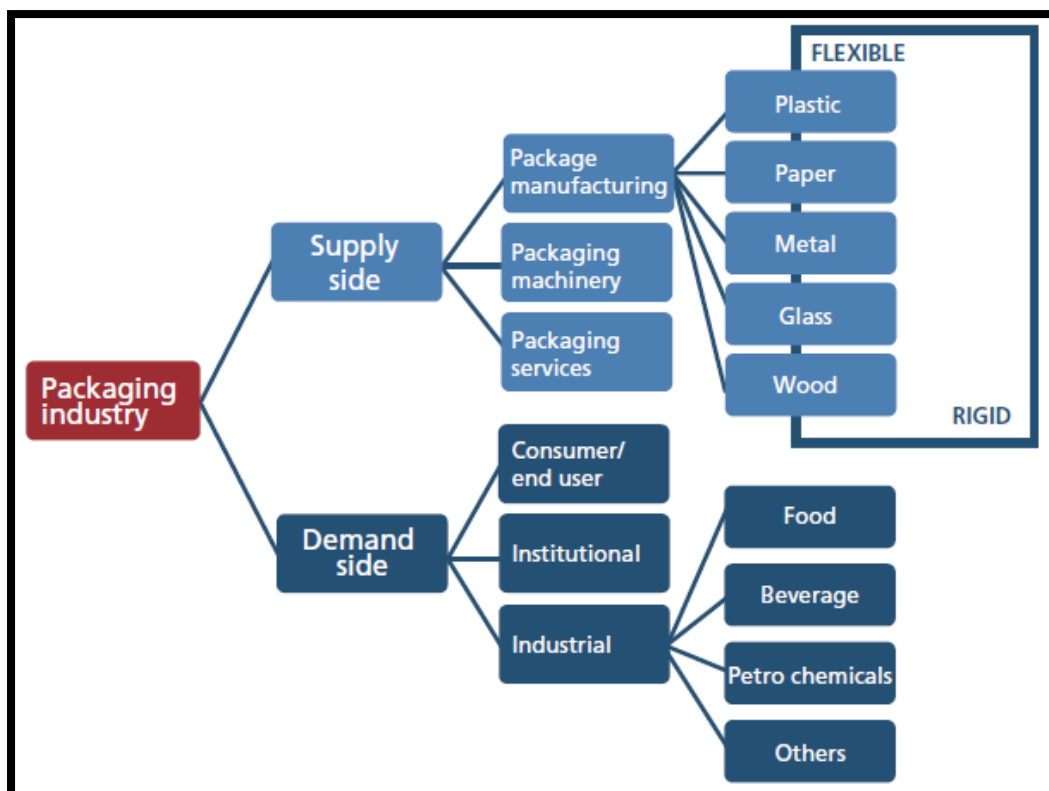


Figure 2: The packaging process, Source- Reference<sup>14</sup>

**Cost of Distribution:** Main purpose of the Government's price policy for agricultural produce aims at ensuring remunerative prices to the growers for their produce with a view to encourage higher investment and production. Agricultural prices cover prices of agricultural products (output prices) and of requisites for agricultural production (input prices) at different stages of marketing Towards the end, minimum support prices for major agricultural products are announced each year which are fixed after taking into account, the recommendations of the Commission for Agricultural Costs and Prices (CACP). The CACP while recommending prices takes into account all-important factors-

- Cost of Production
- Changes in Input Prices
- Input/output Price Parity
- Trends in Market Prices
- Inter-crop Price Parity
- Demand and Supply Situation

- Effect on Industrial Cost Structure
- Effect on General Price Level
- Effect on Cost of Living
- International Market Price Situation
- Parity between Prices Paid and Prices Received by farmers (Terms of Trade).

Cost of production is the most substantial factor and it takes into account all operational and fixed demands<sup>15</sup>.

Government organizes Price Support Scheme (PSS) of the commodities, through various public and cooperative agencies such as FCI, CCI, JCI, NAFED, Tobacco Board, etc., for which the MSPs are fixed. For commodities not covered under PSS, Government also arranges for market intervention on specific request from the States for specific quantity at a mutually agreed price.

**Agricultural Cost Distribution:** Agricultural

prices are important economic variables in a market economy. Price relationships have a significant influence on decisions relating to the type and volume of agricultural production activity. They provide a measure for reaching judgment on policy formulation and administrative and executive action. Being crucial for purposes of decision-making in the sphere of economic activities, price data become important. Their collection and compilation, therefore, deserve attention no less than that given to obtaining information on other socio-economic characteristics. The scheme to be embraced in the compilation of price statistics must, therefore, be significantly determined in relation to their end uses. Since the agricultural producer is both a seller of his produce as well as a buyer of agricultural production requisites, agricultural prices cover not only the prices "received" by farmers ("output" prices) but also the prices "paid" by farmers ("input" prices). The farmer is also, of course, a buyer of consumer goods for use in his own household.<sup>16</sup>

**Price competitiveness:** Agricultural prices, marketing and global trade are significant spheres of agricultural policy for the governments. These factors, to a large level, settle the prices at which farmers sell their produce and at which clients buy food for consumption and manufacturers buy inputs for manufacturing their foodstuffs. Hence, Government policy and operational mechanisms have evolved over time to fix remunerative prices to farmers for chief agricultural crops, normalize markets and determine the direction of foreign trade policy. The agricultural price policy primarily focused on providing food at reasonable prices to consumers. It was only with the Agricultural Price Commission (1965), set up to counsel the Government on a normal basis to develop an integrated price structure, that maintaining the

stability between farm price and consumer price became a main aim. The later modifications in 1980 and 1986 shifted the spotlight of agricultural price policy.

- i) From maximizing agricultural production to developing a production pattern helpful of general economic development needs;
- ii) To make farm sector more exciting, productive and cost effective. The current instruments of agricultural price policy comprise minimum support prices, market interventions, buffer stock operations, distribution of food grains through public distribution systems, the support of producers, cooperatives, and regulation of agricultural trade and formation of agricultural marketing infrastructure.

Agricultural marketing faces a lot of challenges like lack of reforms in the State Agricultural Produce Market Committees (APMC) Acts, lack of private sector competition, lack of appropriate grading and packaging at the farm level, non-issue of sales receipts and invoices, post-harvest losses etc. Against this backdrop, the Government has initiated many reforms, as well as the creation of an e-trading stage for a national agriculture market. Likewise, with the escalating share of agricultural commodities in overall exports/imports, trade policy has been amended from time to time in response to domestic accessibility and the price situation.

The association in food and agricultural commodity prices is a result of the complex interaction of demand and supply forces trained by domestic and international policies and market situations. At the same time as short-run supply shocks are often held accountable for the price rise, equally responsible are long-run demand and growth, and moderately inelastic food supply conditions owing to little investment. Increasing climatic variations like uneven and untimely rainfall in certain parts of the country, further emphasize the pressure on food prices.

The changes in food prices at the comprehensive and retail level are captured in the progress of the Wholesale Price Index (WPI) and Consumer Price Index (CPI). In the WPI (Base: 2004-05), food inflation is generally classified into food articles and food products, with a mutual share of 24.31%. The CPI measures changes in the retail prices of food items over time. As per the new sequence of CPI (Base: 2012) released by the Central Statistics Office (CSO)<sup>1</sup>, the “food and beverages” group has 54.18%, 36.29% and 45.86% weight in the rural CPI, urban CPI and the CPI (combined), correspondingly. With the decision of the Reserve Bank of India to secure its monetary policy stance on the headline CPI (combined) inflation rate from April 2014 onwards, food inflation, which has a weightage of 46% in the index, plays an essential role in shaping the overall growth prospects of the economy. The tempo of food inflation as measured by the WPI and CPI moderated since July 2014, after staying high steadily during the past two years. While the wholesale price raises rate for all commodities stood at 2% during 2014-15, prices of food articles and food products rose by 6.1% and 2.4%, correspondingly, aggregating to an overall food inflation rate of 4.9%. The retail prices of food items beneath the new series of CPI also witnessed a descending trend in the second half of 2014-15. This moderation in inflation was mostly on account of low international commodity and oil prices, passive demand, supply-side interventions by the Government to tame inflationary tendencies and a proactive monetary policy by the Reserve Bank to anchor inflationary expectations. During 2015-16, while largely inflation (WPI) remained negative, the rate of food inflation witnessed a sharp increase since August 2015, mainly due

to an exceptional rise in the prices of pulses. During the period, as against an average rate of 2% food inflation, the prices of pulses rose by about 40%. Likewise, the retail prices of pulses, as calculated by the CPI (combined), increased by around 30% during 2015-16, as compared to an average increase of 5% in the largely food and beverages group. The major increase in inflation in the case of pulses was credited mainly to a shortfall in production owing to unfavourable climatic conditions and partly due to the statistical base effect.

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<sup>1</sup> <http://www.mospi.gov.in/central-statistics-office-cso-0>

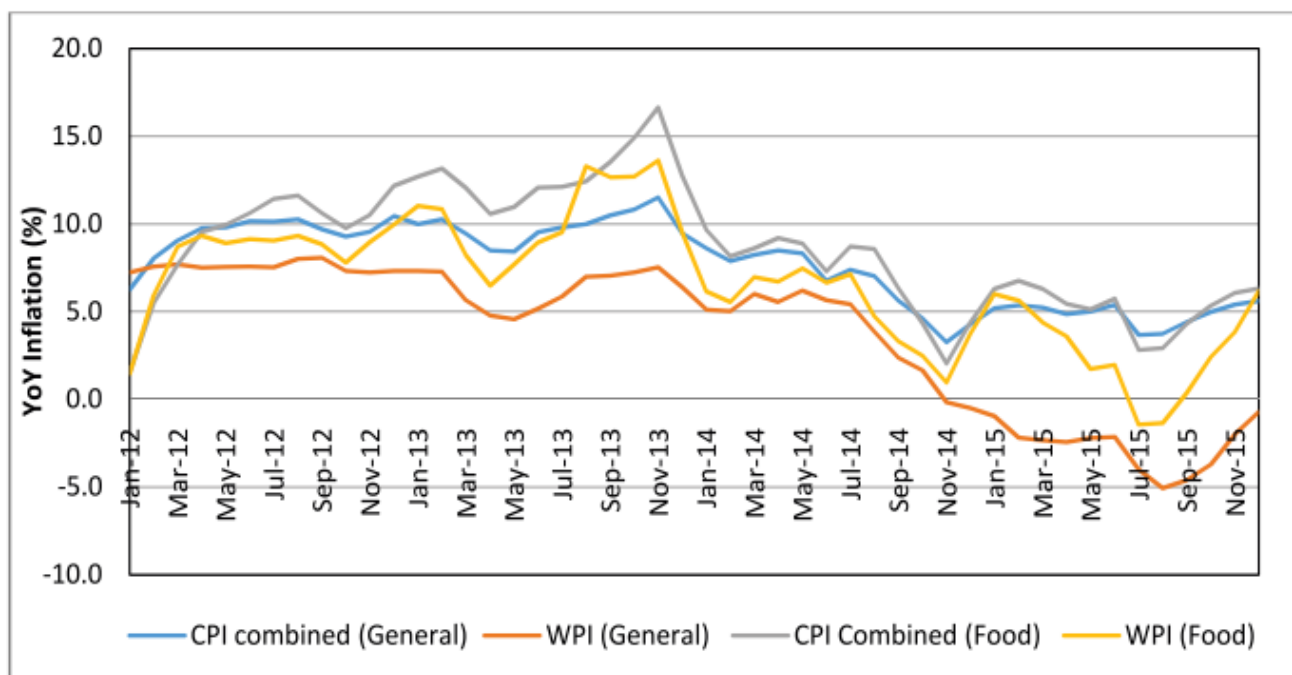


Figure 3:- Month-wise Trends in Food Inflation

Source: DBIE, RBI various reports

During the last few years, three categories of food commodities contributed significantly to food inflation<sup>2</sup>—fruits and vegetables, milk and egg and meat and fish. A variety of studies have shown that the pressure on food inflation has been changing from conventional food items, like cereals, to high-value and protein products such as fruits and vegetables, pulses, milk, egg, fish and meat, as a result of increase in per capita income. The National Sample Survey Office (NSSO) studies on household consumption spending clearly brought out the shifting pattern of spending from cereals to high-value foods. During 2015-16 (Apr-Dec), pulses accounted for the bulk of food inflation,

followed by milk and milk products and condiments and spices. The share of cereals, fruits and vegetables and other food articles, though, witnessed a sharp turn down during this period. It is to be noted that while the shift in consumption patterns towards a protein rich diet is a usual happening, the inelastic demand for certain crops has accentuated inflationary tendencies. For example, the price of arhar (tur) and urad increased considerably in the latter half of 2015-16, while the prices of other crops witnessed only a reasonable increase. This may be partly credited to the inability to diversify the pulse basket to include other crops like chana and field peas in the event of price rise.

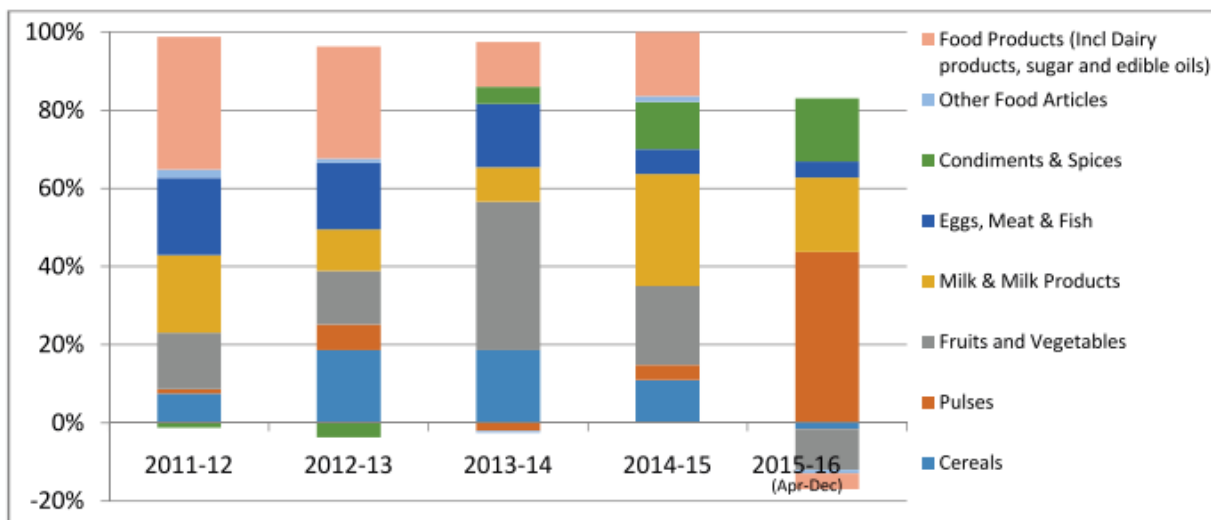


Figure 4: Percentage Share of Major Food Groups in Total Food Inflation<sup>3</sup> (Food Articles and Food Products)

<sup>2</sup> <https://makanaka.wordpress.com/tag/food-inflation/>

<sup>3</sup> Various Reports on <https://www.rbi.org.in>, CSO

**Way Forward-** In view of the increase in the prices of pulses, intensive efforts have been made by the Government. While imports of pulses have been used as a price stabilization measure to meet the present crisis, steps have also been made to find a long-term key for demand-supply imbalances through price and technical interventions. These include- share of more than 50% of funds under the NFSM for the development of production of pulses; creation of a buffer stock of pulses; developing short-duration, drought-resilient varieties of pulses; and given that incentives for farmers by enhancing the minimum support price (MSP). The low-price flexibility of demand for certain pulse crops has also contributed to the important increase in prices of pulses during 2015-16. Thus, efforts are needed to provoke diversification in the pulse basket of consumers through widespread campaigning, using print and visual media. Further research on the impact of inelastic demand patterns on the overall inflationary pattern would be helpful for developing successful policy interventions.

Moreover, price stabilization efforts containing structure up of well-organized supply lines have been pursued, keeping in sight the high unpredictability and seasonal variations in the prices of horticulture produce. As these commodities are mainly perishable in nature, further enhancement is needed in cold storage, processing facilities including creation of infrastructure for logistics, buffer stocking of onion in the dehydrated form, canning of fruits and freezing of vegetables. Suitable policy intervention can assist in dropping price volatility to a large extent, by enabling planned retail, and private investor participation in creating supply chain infrastructure from the farm gate to the consumer. In this view, cooperation with superior economies for sharing of resources—material and technological, counting innovative models and

best practices—will play a vital role.

### **Government Initiatives**

It has been the endeavour of the Government to encourage country's food processing industry to diminish wastage of agricultural produce and minimize post-harvest losses. The Ministry of Food Processing Industries (MoFPI) is implementing various Central Sector Schemes, namely

- Mega Food Parks.
- Integrated Cold Chain, Value Addition and Preservation Infrastructure
- Setting up/ Modernization of Abattoirs and
- Scheme for Quality Assurance, Research and Development and Other Promotional Activities.

There are two academic cum research institutes viz. National Institute of Food Technology, Entrepreneurship and Management (NIFTEM) and Indian Institute of Food Processing Technology (IIFPT), both of them offer B.Tech, M.Tech and PhD programmes and undertake research in food processing including reduction in post-harvest losses.

In addition, National Horticulture Mission (NHM) and National Horticulture Board (NHB), under Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare are also providing assistance for setting up cold storages under their respective schemes to diminish post-harvest losses<sup>17</sup>.

## TECHNOOLOGY LANDSCAPING

Pre/Post-harvest protocols for extension of shelf-life: Disinfestation, handling, packaging of Fruits.

Orchard management pre- harvest care with spray treatments to control fungal and insect damages to the fruit, optimum stage of maturity for harvest, handling, packing-house operations such as grading, washing, post-harvest dip treatments, packing in specially designed CFB boxes, precooling, stacking in reefer containers, optimum storage temperature and humidity management inside the reefer container and post transportation ripening conditions.

### Technologies for shelf-life extension

Minimal processing, Fumigation, Thermal/non-thermal processing, Biotechnological approach, Packaging<sup>18</sup>.

**Wastage of produce-** Technology is varying the way we can progress our world every day. A large part of that is improving food that would go to waste and making fixed that all of our resources are put to good use.

- The cloud-based software connects organizations like food producers, food banks, and pantries. Spoiler Alert helps these groups track their food—specifically what they throw away or donate.
- Tracking produce through technology is an outstanding way for farmers to know when crops are at their finest. Matt Bokor recently reported that the web-based application Tri-Farm allows producers in St. Lucia to enter crop data, which is then turned into a real-time graph. This technology can assist in reducing the area's agriculture importation bill as well as creating more employment in farming<sup>19</sup>.
- Another connected technology aiming to help smaller and rural farms with challenges like

drought, degraded soil, and other methods that lead to low crop production is Farm from a Box. 70% of the world's food comes from small farms, so it's crucial that these producers diminish such issues. *Farm from a Box* are customized shipping containers that are complete with smart farm technologies that facilitate agricultural productivity. This includes renewable power and information and Communications Technology equipment—everything that a farmer may require to grow crops with resilience<sup>20</sup>.

- To optimize everything from water and energy use to guidance on farm management Cisco has helped to connect each Farm from a Box unit with Wi-Fi capabilities and an IoT system<sup>21</sup>.

**Packaging and Preservation:** Recently, it has been possible to export famous Indian mango to USA using the technology of Radiation processing for restructuring costs of bulk commodities in export markets, and for selling value added packaged commodities directly in retail markets. India has one of the world's largest domestic exporter of cereals, pulses, their products, fruits and vegetables, sea foods, and spices. In India radiation processing of food can be undertaken both for export and domestic markets. For export, food could be processed for shelf-life extension, hygienization, and for overcoming quarantine barriers.

Radiation processing can be used for disinfestation and storage of bulk and consumer packed commodities for supply chain management and retail distribution. The viability of using radiation processing on a commercial scale has been demonstrated through the two technology demonstration units set up by the department of Atomic Energy.

- A technology demonstration unit, primarily for hygienization of spices, is being operated by the Board of Radiation and Isotope

Technology (BRIT) at Vashi, Navi Mumbai since 2001.

- Another technology demonstration unit named KRUSHAK (Krushi Utpadan Sanrakshan Kendra) has been operational at Lasalgaon near Nashik in Maharashtra since 2003 for low dose applications including sprout control in bulbs and tubers and disinfection of agricultural commodities for quarantine and storage purposes.

The interest of the entrepreneurs in the technology has steadily grown over the years. Even if a part of our total food produce is to be processed by radiation, it will necessitate installation of several new facilities.

Another technology which will allow meat to remain fresh at higher temperature for longer period of time span is given by the Indian Institute of Packaging (IIP), Mumbai. It was noted that the life of buffalo and goat meat is not more than three to seven days but by using this technology the life of these products last upto thirteen days. In this system they change the composition of nitrogen, oxygen and carbon dioxide which is the main constitute of air within the packaging<sup>22</sup>.

According to India's Agricultural and Processed Food Product's Export Development Authority (APEDA) the new packaging system prolongs the shelf life of food products by slowing down their natural respiration, and offer an affordable solution to meat traders seeking to ensure exported meat remain fresh within India's domestic supply chain and regional export<sup>22</sup>.

### **Packaging for Ready-to-Cook Vegetables**

Technologies have been developed for production and packaging of several popular Indian vegetables in sachets for retail marketing. Protocols have been standardized

for modified atmosphere packaging and storage of minimally processed vegetables in ready-to-use form. The processing involves washing, peeling, trimming, cutting, treatment with appropriate and permitted preservatives, removal of surface moisture, packing in polymeric film pouches of suitable permeability and storage under refrigeration.

- Technologies for handling, packaging and transportation of pineapple: Post harvest treatments to control spoilages have been standardized for long distance domestic transportation.
- Technology protocols for shipment of fruits: This involves selection of appropriate pre- and post-harvest procedures including orchard management, pre-harvest care to control fungal and insect damage, packing in specially designed CFB boxes, etc. The development of Controlled Atmosphere Packaging (CAP) protocol for export of Alphonso mangoes by ship is one example.

**CSIR Initiatives:** Various laboratories of CSIR have come together to work in mission mode in focus areas – milk and beverages, edible oils and food storage. The food safety mission, called FOCUS, aims to bring together industry giants like Amul, ITC and FCI on board to create a robust system and translate science in to the best practices.

### **CSIR-Central Food Technological Research Institute (CFTRI)**

The institute deals in foods and food processing, and is currently a major international player in this sector. It has the mandate to develop post-harvest technologies for efficient protection, conservation and processing of agricultural produce with focus on developing export-oriented value-added products from horticultural and plantation crops. Besides, its mission is to design and fabricate prototype food processing machinery

and to assist food industry through consultancy, contract research and other technical support services. CFTRI has qualified for International Standards Organization (ISO) Certification. It has also achieved the distinction of getting the NABL accreditation from the National Accreditation Board for Testing and Calibration Laboratories, DST, in the fields of chemical and biological testing.

#### **CSIR– National Institute for Interdisciplinary Science and Technology (NIIST)**

Optimum utilization of regional / national resources. In food technology sector, the institute has undertaken agro-processing of and value- addition to spices, coconut, oil palm, cassava, etc.

#### **CSIR-North East Institute of Science and Technology (NEIST)**

Development of technologies based on the immense natural wealth of the North-Eastern region. It has developed agro-technologies for citronella, lemongrass and edible mushrooms<sup>23</sup>.

#### **CSIR-Institute of Chemical technology (IICT)**

The institute has extensively worked on high rate biomethanation of organic waste and patented two high rate biomethanation technologies for the treatment of organic solid waste known as self-mixed anaerobic digester (SMAD) and anaerobic gas lift reactor (AGR) and commercial plants based on these patents are working near Hyderabad, Ahmadabad, Bellary and Hubli in India for the treatment of organic solid waste.

The primary goal of the research endeavors of CPC division, CSIR-IICT, is to develop green globally competitive, environment friendly and commercially viable technologies for the market driven agro products and organic intermediates. Organic process development

has been a strong suit of the group, which has generated viable methods for the industrial scale syntheses of several important agro chemicals, resulting in cash flow to the institute in the form of royalties and consultancy. The division is also involved in the development of bio-pesticides, which along with synthetic pesticides form a vital cog in the integrated pest management program. They are also involved in the organic materials research as well as in the drug design and development. In addition, the divisional scientists train master students every year. Keeping in mind the problems faced by the globe in general and the country in particular, CPC division has been working to effectively combine organic chemistry with process technology, crop protection, drug design and sustainable energy.

#### **CSIR-DSIR-MFPI**

Management of Tribal Areas (MATA), Manipur is the first plant in India in membrane area by CSIR-DSIR-MFPI. Operational for Orange and Pineapple juice concentrates. A Micro- Filtration and Ultra filtration technology is used for clarification and concentration by evaporation using hot filling or HTST bag-in-barrel. The technique is also used for filtering of Black Tea and Honey etc.

## TECHNOLOGY OUTLOOK

### Low shelf life

#### Method of Obtaining Fodder Additive or Fertilizer

Mixing, grinding, heat treatment and drying the mixture in the tank with rotating blades, and withdrawal of organic substances vapor released into the filter during the drying are performed. A plant component is represented by alcohol and brewing industry waste in the form of dry distiller's grains, which are taken in equal proportions by weight with scales. The mixture is treated in the container with rotating blades to the residual mass fraction of water in the scales of no more than 30-35%. The treated mixture is fractionated. The distiller's grains enriched after cleaning the scales with protein components of fish origin are used for obtaining a feed additive or a fertiliser. It reduces the process duration while increasing the shelf life of the final products<sup>24</sup>.

### Approaches to extend Shelf Life

**Temperature and Humidity Tools:** There is a diversity of tools to monitor ambient and food temperatures and to examine produce shelf life. These comprise temperature tools to monitor produce and environmental conditions including thermometers, thermo-hygrometers, data loggers, and wireless facility temperature monitoring systems and devices to gauge produce firmness, and sugar content.

- For measuring ideal temperature at any stage of food handling Flash Check Jumbo Display Digital Probe Thermometers are present<sup>25</sup>. The thin needle tip probe has a tremendously fast

response time for measuring the internal pulp temperatures.

- Non-contact infrared thermometers, Trace quickly inspect the food products without damaging packaging or contamination since no probes are used.
- Digital Thermo-Hygrometer displays equally temperature and humidity and can be used with internal or external temperature sensors. Thermo-hygrometers are useful for monitoring environmental circumstances such as storage areas, greenhouses, and transportation units.
- FlashLink USB Data Loggers are used provide precise easy to read temperature monitoring for both in transit or storage use.
- The DeltaTrak Penetrometer™ is an instrumental gauge that uses puncture pressure to determine the firmness of produce. The meter provides a quick practical method of determining the ripeness or maturity of produce.
- The Brix Meter is an accurate optical tool that measures the sugar content of foods by using a sample of liquid from juices, soft drinks, canned foods, honeys, concentrates. This device can be used to verify ripeness of fruit and/or the sugar concentration of any liquid.

**Packaging Tools:** PrimePro EAP® or Ethylene Adsorption Packaging is a fresh technology that falls into this class of modified atmosphere packaging methods.

- PrimePro EAP® pallet covers, carton containers and sheets are plastic polyethylene products containing a proprietary additive that removes ethylene from the air surrounding the fresh produce to slow down the process of ripening and decomposing of the food. This also

prevents the growth of anaerobic bacteria on the fruits and vegetables.

- DeltaTrak's Air Repair Ethylene Absorber products can considerably reduce injurious levels of ethylene gas. They are composed of high efficiency, activated aluminium beads impregnated with potassium permanganate. The beads large surface area allows for maximum absorption capability. Loose weave packaging material ensures optimum airflow and oxidation of ethylene and other contaminant gases<sup>25</sup>.

**Storage of Agricultural Products:** This includes putting them into the store and the air ventilation. Porous removable cassettes are additionally mounted on the walls, and porous pallets are laid on the floor. The ventilation is carried out with air passed through the filter filled with natural zeolite. Wherein the cassettes and the pallets are filled with natural zeolite with the clinoptilolite content of not less than 60% and the fraction size of 0.5-1.5 cm. The effect of this is absence of mould and rot during the shelf life<sup>26</sup>.

**Method for extending the shelf life**  
Methods for extending the shelf life of crops e.g., roots, tubers, bulbs, corms, rhizomes and similar commodities, involve washing the crops (e.g., ginseng roots) in an aqueous solution containing 50 ppm to 500 ppm sodium hypochlorite. Subsequent steps include coating the crops with an aqueous solution comprising chitosan and at least one organic acid (e.g., lactic acid, levulinic acid, acetic acid), and placing the crops in modified atmospheric packaging. The shelf life of crops can be extended by up to about 38 weeks<sup>27</sup>.

**Legumes and Solid-Seed Plants Seeds**

## Germination

Group of inventions relates to agriculture, in particular, to seed studies, and can be used during legumes and solid-seed plants preparation for sowing. Method of legumes and solid-seed plants seed germination stimulating, which involves mechanical scarification, seeds scarification process is carried out on linen fabric or metal grid. Seeds scarification process is carried out for 1.5-5.0 minutes. Method implementation device consists of manual scarifier and foundation base, wherein foundation base contains: its upper and lower parts in form of frame attached to each other with fasteners, replaceable: metal grid or linseed cloth on solid pad. Manual scarifier consists of scarifier handle on plastic housing, holder plate, rubber gasket, solid shim, abrasive paper. These developments are aimed at improvement of seeds scarification quality, longer shelf life of wound seeds, simplified design of scarification seeds device<sup>28</sup>.

## Ready-To-Use Mushrooms with Enhanced Vitamin D Content and Improved Shelf Life

This consists of handling of mushrooms to enhance their vitamin D content while preserving characteristics typically associated with fresh mushrooms. The technique involves exposing fresh mushrooms to a UV source having wavelengths in the UV-B range at a dose level in the range of about 0.02 J/cm<sup>2</sup> to about 1.5 J/cm<sup>2</sup>. In some embodiments, the exposure time can be few seconds. In some cases, the UV source is operated at a power in the range of about 1 Watt per linear foot to about 50 Watts per linear foot<sup>29</sup>.

**Wastage of produce:** There are methods devised for producing fertilizers and feed

supplements from agricultural and industrial wastes. Integrated waste treatment and fertilizer and feed supplement production methods to be implemented at organic waste source sites, at remote treatment sites, or partially at the organic waste source site and at a remote location, whether in small or large-scale operations. The methods are appropriate for retrofitting existing organic waste sources and for treating the organic waste generated by a single source or by a plurality of sources. These methods provide reduction of emissions of acrid and greenhouse gases, effluents that meet discharge standards and that can be used in wetland and irrigation projects; organic based, granular, slow release NPK fertilizer of standard composition and size that can be supplemented with micronutrients and soil amendment materials and whose composition can be adjusted to meet demands and needs of specific markets; methane-rich biogas recovery for its subsequent use for heating, for power generation or for catalytic and synthetic processes, and feed supplement including feed supplement for cattle. The methods comprise steps for --

- Separating suspended and dissolved materials,
- Preventing gas emissions and capturing gases, and
- Minimizing waste disposal.

Fertilizer base is formed by combining waste with a phosphate precipitating agent, a base, a flocculent, and optionally with an ammonia retaining agent and a densifier, later separating and drying the precipitate<sup>30</sup>.

### Removal and recovery of nutrients from digested manure

The main phase involves sorting out waste from an anaerobic digester into digested

liquids, digested solids, and biogas. Further actions are as:

- precipitating solids and stripping ammonia from the digested liquids.
- injecting an exhaust stream of carbon dioxide drawn from the co-generator into the digested liquids to reduce the pH and raise the temperature.
- recycling the stuff back to the anaerobic digester for use in diluting in coming solid wastes.
- passing of the excess ammonia stripped from the digested liquid through the digested solids to recover nitrogen through absorption with the resulting solids being usable as a bio fertilizer with a high nitrogen content.
- capturing the biogas for use in a co-generation system<sup>31</sup>.

### Packaging and preservation

#### Preserving Agent for Feed Preservation

This technique relates to the equipment for processing feed grain with the preserving agent before placement it for storage, and can be used in feed production. This is aimed at simplification of the structure of the dosing supply device of powdered preserving agent and improvement of the workflow efficiency. The device comprises a container for the preserving agent with a loading opening, a source of constant pressure, a pipeline system in the form of air duct equipped with a pressure regulator, and a pipeline for delivering the preserving agent, provided with an ejector. The air duct is equipped with an air dispersion device. The container for the preserving agent has a tapered bottom part. The ejector is placed in the bottom part of container for the preserving agent. The air dispersion device is located under the ejector. The air duct inner diameter is at least 5 mm, and the

working pressure at the air duct output is 0.15-0.95 bar. Using this technique enables to simplify the design of the dosing supply device of powdered preserving agent, as well as to improve the workflow efficiency<sup>32</sup>.

**Preservation box:** The utility model relates to a repeatedly functioning environmental protection preservation box. The plastic seal bag includes the clamping ring of plastic bag and bottom, the plastic bag is fixed on the clamping ring for ventilated plastic bag, the clamping ring is furnished with the sealing washer with the contact surface of detaining the box connection. The clamping ring outside is the Centro symmetric buckle with the box center of detaining. The utility model does not only seal the fruit vegetables keeping them fresh, and can also carry out the manual regulation through the gas in the preservation box, further promoting its fresh -keeping effect. The plastic bag can be folded, and reducible space does not occupy using this preservation box allowing repetitious usage and to have higher utilization ratio<sup>33</sup>.

**Table 1**

| <b>Sub-topic</b>        | <b>Economic impact due to the problem</b>                                                                                                                                                                                                                                                                                                                                                                                             | <b>Societal impact</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wastage of produce      | Agricultural wastes refers to non-product outputs of production and processing of agricultural products that may hold material that can advantage human beings but their economic value is less than the cost of collection, transportation, and processing for beneficial use.                                                                                                                                                       | <ul style="list-style-type: none"> <li>• Social driver elements potentially related to food loss and waste include household composition in terms of size, education, age, job and sex.</li> <li>• Larger families tend to be more efficient due to a lower waste per capita, while smaller households tend to have a higher waste per capita. However, the relationship between household size and food waste is not a simple one and it not just size of the household that is influencing food waste but also other factors in addition. An additional matter might be packaging and size of portions that are often targeting large families and not to single person households.</li> <li>• A better understanding of the negative externalities of food losses and wastes can lead to the reduction of behaviours that takes to the creation of a higher amount of waste. In this frame, the lack of information and knowledge sharing within households can be considered as a major driver of food losses and waste creation.</li> </ul> |
| Low shelf life          | Increasing urbanization in combination with income growth has hastened the variation of diets. There has been increased consumption of meat, fish, fresh fruit and vegetables and declined consumption of starchy food staples. This shift towards more perishable products and shorter shelf life items - associated also with lack of infrastructure - might lead to increase the possibility of formation of food losses or waste. | There is lack of evidence whether a longer shelf life essentially reduces waste in terms of guaranteeing consumption before reaching the best before date. This vagueness is due to the complexity of food supply chains                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Packaging /Preservation | A package is the face of a product and often is the only product exposure consumers experience prior to purchase. Consequently, distinctive or innovative packaging can boost sales in a competitive environment                                                                                                                                                                                                                      | <p>Packaging provides information to the consumer. For example, package labelling satisfies legal requirements for product identification, nutritional value, ingredient declaration, net weight, and manufacturer information.</p> <p>Additionally, the package conveys important information about the product such as cooking instructions, brand identification, and pricing. All of these enhancements may impact waste disposal.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                           |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Packaging also offers a combination of excellent physical protection and barrier properties, formability and decorative potential, recyclability, and consumer acceptance |
| Price competitive ness | <p>Global agricultural trade has grown much slower than trade in other products. Prior to the 1960s, farm products accounted for more than 30% of all merchandise trade globally, but since the beginning of this century their share has averaged less than 9%.</p> <p>Since agriculture's share of global GDP has also fallen, a more appropriate indicator of the changing extent to which agriculture is globalized is the share of agricultural and food production or consumption that is traded internationally.</p> |                                                                                                                                                                           |

**Table 2**

| Current technology                                                                            | Status-In-practice/evolving/emerging | Applications in    |                |                      |                         |                       |
|-----------------------------------------------------------------------------------------------|--------------------------------------|--------------------|----------------|----------------------|-------------------------|-----------------------|
|                                                                                               |                                      | Wastage of produce | Low shelf life | Cost of distribution | Packaging /Preservation | Price competitiveness |
| Minimal processing                                                                            | In-practice                          |                    | ✓              |                      | ✓                       |                       |
| Fumigation                                                                                    | Evolving                             |                    | ✓              |                      |                         |                       |
| Thermal/non-thermal processing                                                                | In-practice                          |                    | ✓              |                      |                         |                       |
| Biotechnological approach Packaging                                                           | In-practice                          |                    | ✓              |                      | ✓                       |                       |
| Method of Obtaining Fodder Additive or Fertilizer                                             |                                      |                    | ✓              |                      |                         |                       |
| Farm from a Box                                                                               | In-practise                          | ✓                  |                |                      |                         |                       |
| Method for producing fertilizers and feed supplements from agricultural and industrial wastes | Emerging                             | ✓                  |                |                      |                         |                       |
| Process for removal and recovery of nutrients from digested manure or other organic wastes    | Emerging                             | ✓                  |                |                      |                         |                       |
| Radiation processing                                                                          | In-practice                          | ✓                  | ✓              |                      | ✓                       |                       |
| Dosing Supply Device of Powdered Preserving Agent for Feed Preservation                       | Emerging                             | ✓                  | ✓              |                      | ✓                       |                       |
| Reasonable usable environmental protection atmosphere preservation                            | Emerging                             |                    |                |                      | ✓                       |                       |
| Enhancing the minimum support price (MSP)                                                     | In-practice                          |                    |                |                      |                         | ✓                     |

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