

**POLICY  
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37**

**EMPLOYMENT OPPORTUNITIES IN  
FARM AND NON-FARM SECTORS THROUGH  
TECHNOLOGICAL INTERVENTIONS WITH  
EMPHASIS ON PRIMARY VALUE ADDITION**



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## EMPLOYMENT OPPORTUNITIES IN FARM AND NON-FARM SECTORS THROUGH TECHNOLOGICAL INTERVENTIONS WITH EMPHASIS ON PRIMARY VALUE ADDITION

### PREAMBLE

Generation of adequate work opportunities for the growing labour force has been a central objective of development planning since independence. Productive employment, apart from being a means to poverty reduction and economic well-being, is an end itself because it is a basic source of human dignity and self respect. Although India was able to keep, on the whole, open unemployment quite low, the trends in recent years, call for renewed efforts for creating additional employment opportunities, particularly in the rural areas.

- (i) Despite acceleration in the growth of the economy during the nineties, the pace of creation of jobs has remained low. This has happened mainly due to deceleration in the employment elasticity in the agricultural sector. Employment to GDP elasticity for agricultural sector during 1993-94 to 1999-00 was as low as 0.01. In the base year (2001-02) for Tenth Five Year Plan projections, there were 35 million unemployed, besides several underemployed.
- (ii) Nearly 56.7 percent of the total workforce is engaged in agriculture, 12.1 percent in manufacturing, and 31.2 percent in the service sector. The change in the sector-wise employment during the nineties shows that the number of people employed in manufacturing and service sectors increased, whereas there was no change in those employed in agriculture. Out of 20.91 million additional jobs created between 1993-94 and 1999-00, 51 percent was in THR (trade, hotels and restaurants) sector, 28 percent in manufacturing sector, 19 percent in construction sector and 18 percent in TSC (transport, storage and communication) sector. In the CSPS (community, social and personal services) sector, there was a decline of 20 percent (4.14 million jobs).
- (iii) There are 115.6 million farm holdings, out of which 62 percent (71.2 million) operate on less than one hectare of land, with an average of 0.40 hectare each. The income of tiny landholders is lower than that of landless families. Most of these are poor and food insecure. Technology for primary value addition can be a boon for these families.
- (iv) According to NSSO survey (1999-00), there are 25 million non-agricultural informal sector enterprises in the rural areas (apart from 19 million in urban areas). Nearly 94 percent (23.6 million) of rural enterprises are 'own account' enterprises, which

operate with family labour. Nearly 40 million persons are engaged in these enterprises. Out of 25 million rural non-farm enterprises, 9.6 million are doing some kind of manufacturing, 8.6 million are doing trade and repairs work, and 2.0 million are engaged in transport, storage and communication. Technological support can substantially help rural families dependent on these enterprises. While looking at the technological options for these families, one other fact which needs to be kept in view is that 45 percent (11.2 million) of these enterprises are located within household premises, 32 percent (8 million) outside households but with fixed location and 23 percent (5.8 million) operate as street vendors, mobile shops or work at changing construction sites.

- (v) On the other hand, the agricultural production sector has shown remarkable growth and the linkages of the farm production sector with the rest of the economy have increased manifold both in terms of increase in the use of purchased farm inputs and volume of farm surpluses available for marketing and processing. During the past fifty years, the use of purchased inputs by the farmers has multiplied 283 times from Rs 245 crores in 1950-51 to Rs. 69390 crores in 2000-01. Purchased inputs mostly supplied by the non-farm sector, now account for 72 percent of total inputs (other than land and labour) as against 20 percent in 1950-51.
- (vi) Apart from the increase in demand for inputs, there has been considerable increase in marketed surplus of agricultural commodities, generating demand for handling, transportation, storage, grading, packaging, processing and retailing services. This happened on account of both increase in output as well as increase in the marketed surplus output ratios of all the farm products. The latter is estimated to have gone up from 33.4 percent in 1950-51 to 64.1 percent in 1999-00 and further to around 70 percent currently. The quantities marketed have multiplied to the tune of 10 times that of cereals, 4.6 times of oilseeds, 5.3 times of milk, 15.4 times of poultry products and 7.4 times of fish. In terms of value, the marketed surplus of farm products in 2000-01 was 103.4 times of that in 1950-51, valued at Rs. 4037 billion (Rs. 403740 crores). Handling of such huge surpluses emerging from 115.6 million farm holdings provides tremendous opportunities for employment in the rural non-farm as well as the farm sector. The value addition in agricultural commodities in India is considerably lower than that in several developing countries.

The gross marketing margin in agricultural commodities is estimated as Rs. 1009 billion, consisting of Rs 151 billion as statutory charges, Rs. 207 billion as net margins and Rs 651 billion as marketing cost. About 77 percent of the marketing costs, amounting to Rs. 500 billion are estimated as avoidable losses during handling, transport and storage. Investment in primary value addition activities can save these losses and generate employment in the rural non-farm sector.

A Special Group, constituted by the Planning Commission, has, in its report submitted in 2002, identified several areas for creation of additional 50 million jobs by the end of the year 2006-07. These potential areas are:

- ◆ Agriculture including diversification from cereals to oilseeds and pulses; watershed development for rainfed areas; horticulture; own-farm water management; agro-clinics and seed production; farm machinery; greening India Programme (wasteland development, joint forest management and agro-forestry); development of medicinal plants and energy plantations (9.5 million)
- ◆ Special Employment Generation Programmes like Sampoorna Gramin Rozgar Yojana (SGRY); Swarn Jayanti Gram Swarozgar Yojana (SGSY); Pradhan Mantri Gram Sadak Yojana (PMGSY); and Prime Minister's Rozgar Yojana (PMRY) in SSI and KVIC related areas (7.1 million)
- ◆ Manufacturing sector including small-scale industries like coir; handlooms; power looms; handicrafts; and sericulture and wool (7.1 million); and large scale manufacturing (6.3 million)
- ◆ Services including construction activities (6.3 million); trade, hotels and restaurants (11.2 million); transport, storage and communications (5.5 million); financial sector (1.9 million); and community services (0.5 million) with a total of 25.4 million.

In addition to the on-going special employment generation programmes, some other new initiatives in the recent past for creating employment in rural areas are:

- ◆ National Employment Guarantee Act, now in operation in 200 districts;
- ◆ Scheme for promotion of rural godowns with facilities for cleaning, grading and packaging of products;
- ◆ Scheme for creation of rural infrastructure for handling and processing of high value horticulture and livestock products;
- ◆ Promotional schemes of National Horticulture Mission;
- ◆ Promotional schemes of Ministry of Food Processing Industries;
- ◆ Amendment in State Agricultural Produce Market Acts for promotion of private and cooperative markets;
- ◆ Promotion of contract farming; and
- ◆ Promotion of private sector participation in use of wastelands.

Availability of adoptable and sustainable technologies and dissemination/transfer of these technologies to the entrepreneurs is a critical factor in realizing the potential of projections of employment made by the Planning Commission. The network of

Krishi Vigyan Kendras (KVKs) is expanding and by the end of Tenth Five-Year Plan, all the districts in the country will have a KVK each, which is an important link between research/science institutions and farmers/extension organizations. The science and technology research organizations (ICAR and CSIR institutes) have evolved several technologies, which are adoptable and sustainable. The institutional framework for technology transfer, credit support and training is also available. What is needed is the delineation of these technologies for the rural areas and dovetailing the institutional support system for their widespread adoption.

With a view to identifying the technological interventions with high potential of employment creation in the rural areas, both in the farm and non-farm sectors, the National Academy of Agricultural Sciences organized a Brainstorming Symposium on January 14-15, 2006 at the Central Food Technological Research Institute (CFTRI), Mysore. The Symposium was held under the Convenership of Dr V. Prakash, Director, CFTRI and Prof. Shabd S. Acharya, Honorary Professor, Institute of Development Studies, Jaipur and Fellow of NAAS. The Symposium brought together 35 experts including the scientists of CFTRI and representatives of government and non-government organizations, engaged in technological interventions in the rural areas. After the introductory remarks and presentation of background paper by the Conveners, each participant made presentation on the potential of technological interventions for creating employment opportunities in farm and non-farm sectors. The participants suggested several primary processing and value addition activities through available technologies. The recommendations contained in this document are the outcome of the deliberations in the Symposium and subsequent write-ups received from the participants.

## RECOMMENDATIONS

The recommendations have been grouped into six sections viz. (1) foodgrains, (2) fruits and vegetables, (3) sugarcane, (4) livestock, (5) bio-fuel production, and (6) science and biotechnology applications.

### 1. FOODGRAINS

#### 1.1 Maize

Maize is grown in almost all parts of the country. During the last ten years, the annual production of maize has varied between 11 and 15 million tonnes. Nearly 55 percent of the maize grains are used for food purposes, 14 percent for livestock feed, 18 percent for poultry feed, 12 percent for starch and one percent for seed. The mature maize kernel contains 70 to 75 percent starch, 8 to 10 percent protein and 4 to 5 percent oil. The endosperm is largely composed of starch (about 90 percent) and the germ contains high level of protein and oil. Currently very little of maize is dry milled (about 0.5 million

tonnes) where separation of germ is also carried out. Potential exists to process about 4 to 5 million tonnes of maize by dry milling to obtain about 0.5 million tonnes of maize germ, from both white and yellow coloured maize.

#### *(a) Processing of Maize for Use as Food*

Major portion of maize is converted to flour and semolina in plate grinders. The grain contains 4 to 5 percent oil, most of which is present in its germ. Germ accounts for about 10 percent of the maize kernel and has oil content of 25 to 30 percent. It is like an oilseed having a good potential to produce nearly 1.5 to 2 lakh tonnes of oil to supplement the oil requirements of the country. The deoiled germ cake has a protein content of about 25 percent, which can be used to produce supplementary and health foods. The degermed grits can be further processed to produce high value consumer products, such as maize flakes, extruded snacks and fermented beverages using the low fat, low fibre grits. These grits should be the principal focus of dry milling process. Other maize products (germ, flour and meal) have a variety of food and feed uses. Large-scale processing of maize is mostly confined to wet milling for which about 5 percent of the maize is utilized. Wet-milling aims at producing starch and other products for industrial applications. However, a good part of starch, dextrins and sweeteners find their way into a variety of convenience and snack foods. A product of maize with good potential is the high fructose syrup. There are about 19 units in the organized sector producing about 3.8 lakhs tonnes of starch (worth a market value of Rs.440 crores in 2000-01), and liquid glucose and dextrose, using about 4 to 5 lakh tonnes of maize. Demand for starch is poised to rise substantially. Annual growth rate for starch and other value added food products from maize is expected to be around 5 percent. There is scope for production of food grade starch at the village level in maize producing areas.

#### *(b) Processing of Maize for Use as Feed*

It is estimated that about 42 million tonnes of animal feed and around 14 million tonnes of poultry feed are produced and used in the country. Out of this, around 3 million tonnes of animal feed and 4 million tonnes of poultry feed is produced by organized feed manufacturers. Maize being an important component of feed formulations, the manufacturers need good quality maize grits for making compound feeds.

Mostly dry milling process is used to obtain grits. In dry milling system, maize grains (with less than 17 percent moisture) are subjected to milling to produce grits, meal, flour and germ. Grits are subsequently reduced to the desired size. There is another tempering-degerming process (also called TD process or partially wet degerming process), in which water is added to maize to increase the moisture content to 20 to 23 percent. It is then tempered and milled to produce grits, meal, flour, bran and germ.

### **(c) New Maize Processing Methods**

In India, currently substantial quantity (about 4 to 5 million tonnes) of maize is ground for flour in rural sector and the rest for feed purpose. Virtually no germ is recovered in this process. Due to high content of germ and high oil in it, the resultant products have poor shelf life. However, some quantity (30-40000 T annually) is also processed in India by large scale dry milling methods using specially designed degerming equipments like Beal degermer and Entoleter which are imported units. There are no indigenous dry milling plants operating in the country. However, Central Food Technological Research Institute (CFTRI) has developed following three types of improved maize milling systems:

#### **(i) Mini Grain Mill**

The system of mini grain mill consists of an improved plate grinder in which moisture-conditioned maize is ground, aspirated and then sifted through a deck of sieves to obtain different fractions of the milled grain like bran, coarse semolina, fine semolina and flour. It has a capacity of 50 to 60 kg per hour.

#### **(ii) Maize Mill**

This is a small maize mill, with a capacity of 300 to 400kg/hr. In this system, the maize grain is first moistened, conditioned, passed through modified hullers, aspirated and then ground. This is then sifted to obtain various fractions, viz., bran, meal, grits of different sizes, germ and semolina.

#### **(iii) 1Q-D Type Dry Milling Plant**

It is one tonne per hour capacity maize mill. It is an indigenously developed dry maize milling system incorporating all the concepts that exist in a large capacity modern dry milling system. The operations involved are cleaning, destoning, water conditioning and degerming in stages, size separation and gravity separation of the milled products. Various products and by-products obtained include bran, meal, germ, large grits, medium grits and small grits. The grits can be further ground to semolina and flour, and germ is taken for oil extraction. Value added products for down stream processing of products obtained from the dry milling technology include products like maize flour and semolina, snack foods, noodles, flaked products and *roti* flour. Apart from this, the germ recovered can be used for oil extraction that can contribute to the edible oil pool of the country.

### **(d) Employment Potential**

It is estimated that 750 to 1000 maize mills at 1TPH capacity can be established in the country. The products from these mills viz., big and medium grits, small grits, bran, meal and germ could be used by subsidiary units for further value addition. The low-fat, low

fibre big and medium grits can be used in the manufacture of maize flakes with better shelf life. The small grits can be used in the brewery industry, and can also be extruded with different formulations to give a variety of products. Maize germ is an excellent source of oil for cooking purposes. The deoiled germ and meal from the CFTRI maize mill could be used in the manufacture of cattle feed. Maize bran could also be used as a source of dietary fibre in bakery industries. Each CFTRI maize mill can create employment for at least 10 persons.

For fully exploiting the potential, there is a need for setting up of maize parks, at least one each in the major maize producing states of the country. The maize parks can have an integrated approach wherein good quality maize procured from the farmers could be processed for value addition into products like maize flakes, RTE flakes, extruded maize products, maize *roti* flour, maize germ oil extraction, feed formulations, and bakery products, all under one roof.

Not only is the technology for manufacture of these products available in the country (mainly at CFTRI), but the machinery is also available. The milling machinery developed at CFTRI Mysore could be gainfully utilized for processing of maize to prepare grits, flour, germ separation, and these products would be suitable for various food and added uses. With the diversification of products from maize, it would boost the production of good quality maize in the country directly benefiting the grower. Also, a wide variety of products at competitive prices would be available to the consumer. The technology and machinery used for processing of maize could, with minor modifications, be used for value addition to other grains also. This would ensure working of the mills all round the year.

## 1.2 Sorghum and Millets

India ranks second in the world for sorghum production and first with respect to many regionally important crops like millets and pseudo-cereals. Much of the production of these crops is by the small and marginal landholders living in marginal environments. Sorghum and millets [finger millet (ragi), foxtail millet (navane), kodo millet (varagu), little millet (kutki), barnyard millet (sawan), and proso millet (cheena)] are crucial to the food security of many poor people in the semi-arid tropics. There are other grains, which are not exactly cereals, but are consumed the way cereals are consumed and are classified as 'pseudo-cereals'. Buckwheat, amaranthus and job's tears fall in this category.

It is reported that more than 400 million people in the world depend on millets for sustenance. It may be noted that the dietary patterns, largely dependent on rice and wheat, have led to widespread nutritional deficiency. The prevalence of micro-nutrients deficiency even in the affluent population is a matter of serious concern. In order to alleviate this problem and improve nutritional security, small millets and pseudo-cereals can play a major role. Sorghum and millets have chemical composition similar to or

better than rice and wheat in some respects. In fact, they contain high fibre, non-starchy polysaccharides and starch with some unique characteristics. Protein quality and essential amino acid profile of some of the millets are better than many of the cereals. In recognition of this, these grains are now considered as “Nutritious or Nutri grains”.

Sorghum and millets are grown in diverse soils, varying rainfall regimes and in areas widely differing in thermo and photoperiods. The resilience exhibited by these crops is helpful in adjusting themselves to different kinds of ecological niches. Another important property of most of the millets is that they can be stored without getting infested for years together in the rural areas. These grains hold important place in the grain economy of our country, but utilization of these cereals is limited on account of absence of appropriate processing technologies to produce shelf-stable primary products. Lack of recognition of the potentialities and limited efforts in expanding the market beyond the traditional consumers have also restricted their widespread consumption.

Primary processing converts the grains into products for their direct utilization for food purposes or make them available in the ready-to-eat form. Value addition during primary processing, as it stands now, is not very high, but the potential is large. With increasing consumer awareness, the potentialities of value addition could be realized, which provides considerable employment possibilities. Opportunities in the processing of sorghum and millets include cleaned jowar and millets; pearled grains and products; refined flours suitable for special foods/ bakery; shelf stable flours for conventional and composite flour based foods; rollable *roti* flours; ready to flake materials; jowar and millet *rotis*, flakes, RTE flakes; malt for food and brewing; and popped RTE foods. Some of the new small scale processing technologies pertaining to sorghum and millets are as below:

**(i) Mini Grain Mill**

It is a grain processing unit that comprises mainly the plate mill commonly used to pulverize the cereals for preparation of flour for conventional foods. It has about 100 Kg per hour capacity and enables to produce semolina of desired size and flour, nearly free from the coarse seed coat matter. It is a versatile mill suitable for preparation of milling fraction from wheat, maize, sorghum and millets.

**(ii) Finger Millet Malt**

Finger millet or *ragi* is unique among tropical cereals for its suitability to prepare malt for food as well as for brewing. Malting methodology standardized at CFTRI, Mysore could be practiced conveniently to prepare the malt-flour suitable for weaning food, milk based beverage and some other special foods. The malt flour also finds extensive usage as amylase rich food.

### (iii) Popped RTE Products

Popping of cereal grains to prepare ready-to-eat products would be very useful to diversify their utilization in the value added foods, especially in supplementary feeding programmes. Popped grains can be used as snack food also. Popped products are stable for longer period compared to many other products from these germs. Popping, being a simple dry treat processing technique, can be adopted at the house hold to industrial level conveniently.

### 1.3 Wheat

Wheat, which is widely grown in five continents, is the most important cereal grain produced, consumed and traded in the world today. It is highly versatile food product, as it can be stored safely for long periods of time and transported in bulk over long distances. Utilization of wheat includes food, feed, seed and other industrial uses. Use of wheat as food accounts for 67 percent of total consumption. Wheat is consumed as food in numerous forms, all of which involve some degree of processing.

Wheat produced in India belongs to three species viz. *Triticum aestivum* (95%), *Triticum durum* (4%) and *Triticum dicoccum* (1%). Varieties of *Triticum aestivum* are used for bakery products, *Triticum durum* for pasta products and *Triticum dicoccum* for traditional products. Wheats are also classified as hard, medium-hard and soft based on their protein content and suitability for different purposes. Soft wheats are suited for cake, biscuit and pastry, medium hard wheats for unleavened breads and noodles, and hard wheats for bread. Extra hard durum wheats are suitable for pasta products. Most Indian wheat is soft or medium hard, best suited for making *chapati*, *nan*, *parontta* and *roti*. Consumers usually take their wheat to small flourmills where it is milled into whole meal flour called *atta* for making traditional products. In India, more than 50 million tonnes of wheat is being processed every year into whole-wheat flour (*atta*) in the unorganized sector. The *chakkies* or disc mills are spread all over the country in the urban, semi-urban and rural regions.

The wheat milling process aims to break open the wheat grain, remove the outer bran layer and the wheat germ, and then grind the endosperm to the fineness of semolina (*suji*) and flour. The different types of flours that can be produced are patent flour, baker's flour, first clear flour, and second clear flour. Flour numbers indicate their suitability for the production of bread, biscuits, crackers and cakes. In India the milling industry is producing wheat flour (*maida*), semolina, resultant *atta* and bran.

The roller flour milling industry in India comprises of more than 820 mills and most of them are having a grinding capacity in the range of 80 to 200 tonnes per day. The installed capacity of the total milling industry in the country is more than 15 million tonnes, but the actual grinding is about 8 million tonnes which shows a capacity utilization of only 50

percent. Some flour mills produce whole wheat flour and market it in both bulk as well as unit packs.

There is a vast potential for the production of whole wheat *atta* at the village level, as the demand for the *atta* exists in all the households of semi-urban and urban regions. This will help in generation of employment in the rural areas. Since the *atta* is shelf stable for 3 months, production, storage and transportation will not cause any problem. The total cost of machinery and equipments necessary for primary processing of wheat into whole-*atta* is approximately Rs. 2.7 lakhs and the estimated electricity consumption for processing of wheat into whole wheat flour is about 100 units per tonne. The number of personnel required is seven. The production capacity of the unit is about 2.5 tonnes per 8 hour shift.

#### 1.4 Pulses

India is the largest producer of pulses (around 14.5 million tonnes annually) in the world. Nearly 11 million tonnes of pulses are converted to *dal* (dehusked and split pulse); of the remaining 3.5 million tonnes, a large proportion is utilized as whole grain for cooking and rest is used for seed purposes. Conversion of pulse grains into *dal* is one of the important food processing industries, as pulses in India are consumed mostly as *dal*.

Although a large quantity of pulses are processed by medium and small scale industries, about 1.5 million tonnes of pulses are still processed in the rural sector without proper machinery, which not only affects the availability of *dal* in rural sector due to loss of *dal* (*dal* yield - 65-68%), but also results in the yield of inferior quality product (removal of husk - 93-95%). This inferior quality *dal* fetches 20% less value in the market than the average quality *dal* and hence it is generally sold in the rural market only, denying good quality *dal* to rural consumers.

CFTRI has developed a mini *dal* mill which can process major pulses (*Tur*, *Chana*) into *dal* at a lower processing cost ( Rs. 20 to 24 per quintal as against Rs 70 to 75 in large scale mill). The capacity of the mill is 100 kg per hour and it requires only 1.5 HP power. The mill gives a *dal* yield of 75 percent with almost 99 percent removal of husk and minimum breakage (2 to 3 percent). It can also be adopted at farm level in the rural sector and can give self employment to the rural men or women. A team of two/ three workers can operate the mini *dal* mill (self employed) and there is scope for engaging another two persons for allied works like pre-milling treatment of pulses. The mill can provide better facilities for milling of pulses at the rural level and also value addition to the by-products (husk, broken and powder) through separation and utilization of edible material from the byproducts. Woman entrepreneurs and organizations, self help groups, and pulse growing farmers can be the beneficiaries of installation of mini *dal* mill.

There are 11 pulse growing states in the country, but most of the pulse processing centres are away from the main pulse productive areas. There is, therefore, a scope for setting up around 8000 mini *dal* mills in the rural areas of the country, providing direct job opportunities for 30,000 rural men/women, while another 10,000 persons can be indirectly benefited because of upliftment of pulse processing activity in the rural sector. At least 5000 small *dal* mills could be set up in major pulse growing states during the 11<sup>th</sup> Five Year plan. Indirect benefit of better milling facility will be available to 15,000 villages. The availability of *dal* will increase by 50,000 tonnes in the rural sector alone because of less breakage and improved dehusking.

Another area of employment potential is, value addition to about 2.5 million tonnes byproducts obtained annually from *dal* mills in India. At present these by-products are sold as cattle feed. Analysis of commercial samples of by-products has revealed that around 35 percent of cotyledon material can be recovered using appropriate machinery for de-stoning, size separation and air classification. The recovered cotyledon material can be used in traditional products like *papad*, *vada*, *chakli*, *sev*, and *halwa*. This can enhance the availability of pulses in the country. By-product recovery units can be set up near a major pulse processing center where a cluster of *dal* mills exist [like Indore (MP), Gulberga (Karnataka), Akola (Maharashtra) Virudunagar (Tamil nadu) etc.].

There is a scope for setting up 5000 such by-product recovery units in semi-urban sector which can give an income of about Rs. 2 lakhs per year per unit and an employment generation to about 25,000 persons. The net value addition to the total by-products of *dal* milling sector in the country can be of the order of Rs. 100 crores.

## 2. FRUITS AND VEGETABLES

India ranks second in production of fruits and vegetables in the world. It produces a wide range of fruits, of which mango, banana, citrus, guava and apple account for 75 percent of the total fruit production in the country. In recent years, papaya, amla, ber, fig, date palm, watermelon, pomegranate and custard apple have also shown marked improvement in output, availability and market demand. India produces about 70 different varieties of leafy, fruity and starchy tuber varieties of vegetables. Potatoes, onions, tomatoes and brinjals account for bulk of the vegetable produced in the country.

Obviously, production of such a wide spectrum of fruits and vegetables provides immense scope for their proper harvesting, storage, transportation and marketing, every stage involving deployment of manpower. Establishing primary processing centre in the producing areas of selected fruit and vegetable can serve to protect the crop from perishability, reduction in bulk, easy transportation, storage and trade, including value addition.

The potential of employment generation through primary processing of fruits and vegetables is presented under four broad groups viz., (i) basic processing; (ii) minimal processing; (iii) processing of under-utilized fruits; and (iv) other products.

## 2.1 Basic Processing

### (a) Dehydration

Dehydration represents the simplest technology of value addition and extension of storage life of fruits or vegetables, by removal of water content to a residual moisture of around 5 percent. This requires the installation of mechanical driers at the rural centres. Owing to the problem of availability of electricity, solar driers can be used to remove moisture levels of fresh commodities. But solar driers can not fine-tune the residual moisture to the range of 5 to 8 percent. Another dimension of dehydration is osmo-dehydration, which encounters the use of sugar/salt solution depending on the desired fruit or vegetable. Use of mechanical driers after osmotic removal of water ensures fine quality product and microbiological safety. Osmo-dried fruit products maintain excellent texture and flavour with added sugar. Dehydration has many advantages of reducing the bulk, reducing the freight charges and enhancing the storage life. Dehydrated products could be reconstituted in water at the room temperature or with mild heat, to fresh-like fruit or vegetable, assuring easy consumption. This is applicable in the case of a number of fruits (like mango, pineapple and jack fruit), vegetables and mushrooms.

The fresh commodities (either fruits or vegetables) require washing, grading, and sizing followed by some pre-treatment before subjecting them to the choice of dehydration. This can contribute to the development of quality product for domestic as well as export market. Further, the processed produce requires hygienic handling, packaging, sealing and storage till consumption. All of these post harvest operations are labour intensive and help in linking the producers with processing centres, and delivering the items of preferred consumption to the urban masses. Dehydrated lime and mango pickles are classic examples. The commodities available in the harvest season are brine soaked and dried, followed by spicing to form packs, which can be reconstituted overnight to fresh pickles. Such dry pickles offer the advantages of lightness, reduction in volume and freight charges, extended storage life and quality after reconstitution, akin to the fresh pickle. Dehydrated mushroom is another illustrated example. Here, ninety per cent of water content of the fresh mushroom is reduced to a residue of about 5 percent, using mechanical hot air driers with pre-treatment to prevent discoloration. The dry mushroom can also find useful application as a flavouring agent in a number of dishes like soups, drinks, *chutneys*, *pulavs*, and fried products. In case of mushrooms too, both production and processing require manual assistance, particularly in cleaning, washing, grading, sizing, drying, packing, sealing and storing under defined conditions. In fact, in mushroom industry both in production and processing, manpower cost is more than 20 percent of

the net project cost, and hence is a lucrative business. It is well known that the international trade of specific major varieties of mushrooms is in dehydrated form.

### **(b) Canning and Aseptic Packaging**

Canning unit serves the purpose of holding the primary processed product under sterile conditions till it is transported to and used in the secondary processing centres. As canning ensures sterility of the product, it is very convenient for exporters. Classic examples of use of canning are canned slices of mango, pineapple and mushrooms, mango pulp and green peas. The canning units are labour intensive and have great potential of employment creation.

In some varieties of citrus, the juice, when heated, turns bitter due to condensation of lactones into limonin. The aseptic packaging is very useful for such juices. The juice can be aseptically filled in packages of 50 kg for storage at optimum low temperature and for long distance transport. In aseptic packaging, manpower requirement is quite high.

## **2.2 Minimal Processing of Fruits and Vegetables**

CFTRI has done considerable work on minimal processing of vegetables. Conditions have been established to minimally process as many as 27 vegetables and store under optimum low temperature conditions. These vegetables include ash gourd, beet root, beans, bitter gourd, carrot, cabbage, cauliflower, cluster beans, coccinia drumsticks, cucumber, field beans, green peas, green chillies, knol khol, okra, onion, plantain, ridge gourd, snake gourd, tomato, turnip and leafy vegetables such as coriander, curry mint, fenugreek and spinach. The technology has been successfully transferred to five industrial entrepreneurs, which in turn serve to link the rural production centres with processing centres.

The basic steps involved in minimal processing include washing of the vegetables harvested at optimum maturity, their grading, peeling, trimming, slicing/dicing/shredding, pre-treatment, surface drying, modified atmosphere packaging, storage at optimum low temperature, and marketing. The method confers several advantages, namely, fresh-like vegetables, free of wastage, in ready-to-cook form, reduction in bulk, extension of storage life, easy transportation and value addition upto 60 percent. Eventually these steps generate lot of employment.

## **2.3 Processing of Under-Utilized Fruits**

Several fruits like *ber*, wood-apple, *jamoona*, *amla*, and custard apple are grown under natural conditions in the forest areas or waste lands without much care by the human beings. These fruits contain useful compounds of biofunctionality such as prominent anti-oxidant activity, anti-platelet aggregation, and peroxidase inhibition. Careful collection of these fruits and utilization in many ayurvedic preparations can fetch

considerable income to the poor families. CFTRI is continuing to do more research on the extension of the storage life in fresh and processed form of such fruits.

Wood-apple is a classic example of under-utilization due to lack of information about standards of maturity, harvesting and ripening indices. It is mostly grown in forest areas, but requires very careful harvesting, since the fruits that fall from tall trees develop hairline cracks that lead to microbiological infection of the pulp inside. This is a fruit, just like coconut, with a hard shell outside. Several products such as juice, jam and jelly have been developed from this fruit. Similarly, *jamoon* can find useful applications in the preparation of several products like juice, concentrate, jam and jelly. The fruit and its products are known for many ayurvedic benefits to the human body. *Amla* is well known for its tannin contents with related antioxidant potential and its use in pickle preparation. The fruit pulp in fresh form finds immense application in preparation of *ayurvedic* products.

Custard apple is another fruit, which is little exploited for processing. The fruit peel and seeds of custard apple are reportedly used for insecticide preparation, and the pulp is thrown as waste for making compost. The pulp is rich in sugar, minerals and anti-oxidant compounds, and can find useful food applications. CFTRI has developed eight products, for which national and international patents have been filed. The products, through alternative methods of processing, are free from bitterness, discolouration and off flavour. Similarly, methods have been developed at CFTRI for preparing products like nectar, ready-to-serve beverages, jam and jelly from palmirah palm.

There is an immense potential of fruits and vegetables from the forests and the uncultivated lands, that can serve to generate employment and income of the forest-dependent poor and tribal populations. The products in fresh/processed form can contribute to the bio-medicinal properties gearing towards improvement of human health. This requires concerted measures to increase their production, quality through varietal multiplication, careful harvest, storing, processing and development of market linkages both in the domestic and foreign markets. Since such fruits are hardier varieties and come out of natural growth with little agronomic care, they deserve special attention as they can generate considerable employment in the difficult areas.

## 2.4 Other Products

### (a) Preparation of Grape Raisin

Fully ripe seedless grapes with high sugar content (about 22° brix) are used for making raisin. The grapes are exposed to sulphur dioxide fumes and dried. The dry raisins are then freed from stalks and pedicles, and kept for moisture equilibrium. These can be packed in polyethylene bags, which can be further placed in cardboard boxes.

### **(b) Osmo-Air Dried Fruits**

It is a novel process for fruit drying wherein the dry fruit is comparable to fresh fruit in colour, flavour and texture. Fruits like apricots, *ber*, pineapple, jackfruit and mango can be used for drying by this method. The process involves operations like selection of fruits, cleaning, washing, peeling, curing and slicing/dicing. The prepared fruit slices are steeped in sugar solution to remove about half of the water by osmosis. The slices are then drained, dried in a hot air drier and packed in flexible pouches.

### **(c) Jam, Jelly and Marmalade**

Jam is prepared by boiling fruit pulp with sugar to a moderate consistency. Commercially prepared product has 45 parts of fruit pulp for every 55 parts of sugar and contains about 68 percent soluble solids. Jelly is prepared by boiling clear fruit extract with sugar and additives to a stage at which a clear gel forms. Marmalade is a fruit jelly wherein the fruit slices or peels are suspended. It is generally prepared from oranges and lemons.

### **(d) Fruit Toffee**

Fruit toffee is more nutritious than sugar boiled confectionery. It is made from fruit pulp and other ingredients. The process involves cooking the fruit pulp to 1/3rd volume. Other ingredients are added and the whole mass is spread as a thin sheet of 0.75 to 1 cm. thickness. The cooled sheet is cut with a toffee cutter and dried. The toffee is wrapped individually with decoratively printed cellophane.

### **(e) Bleached Dry Ginger**

Fresh ginger is cleaned thoroughly to remove the adhering soil and dirt. The outer skin is scrapped off using SS knives or sharp-edged bamboo device. It is washed, partially sun-dried and then soaked in limewater overnight and dried in the sun. The process of dipping and drying is repeated two or three times and finally dried to a moisture level of 10 to 12 percent and packed in polythene-lined gunny bags.

### **(f) Spice Powders**

It is a process for making ready spice/curry powders for *sambher*, *rasam*, *pulao* and other preparations. The dried clean spices are powdered to 40 to 50 mesh size. The powder is cooled to room temperature and sifted. The spice powder is placed in airtight container and fumigated. The powder is packed in flexible pouches for marketing. For curry powder preparation, the cleaned dry spices are given a mild roasting (optional step), mixed as per recipe and ground to 40 to 50 mesh, cooled to room temperature, sifted, fumigated and packed.

### 3. SUGARCANE - JAGGERY

Jaggery or unrefined sugar (*GUR*), which is the concentrated form of sugar cane juice, is one of the important traditional food components of Indian culinary. Jaggery is nutritionally superior to refined sugar in terms of minerals and nutraceuticals. In India, nearly 35 percent of about 250 million tonnes of sugar cane produce is crushed for jaggery preparation. Current annual production of jaggery in the country is around 15 million tonnes. In many of the Indian food preparations, jaggery is preferred to sugar because of its specific sensory and textural characteristics.

Although there is considerable technological advancements with respect to production of sugar from sugar cane, preparation of jaggery has still remained at the cottage industrial level as a traditional practice. Normally, preparation of jaggery from sugar cane involves crushing of canes in iron or steel rolls and simmering the expelled juice in open pan for evaporation of water. During boiling of sugar cane juice, the floating impurities are separated using perforated ladle. Some of the dissolved impurities are made to coagulate and float over the surface of the juice by addition of external source of coagulants. Traditionally, natural coagulant such as ladies finger root extract was being used but nowadays, most of the jaggery manufacturers have shifted to chemical additives. Although, addition of chemicals improves the texture and appearance, it invariably affects the taste and keeping quality of the product. There are reports of jaggery samples containing 1000 ppm of  $\text{SO}_2$ . High proportion of  $\text{SO}_2$  in jaggery affects its quality in terms of imparting acidic taste to the product, triggers formation of invert sugar during storage because of absorption of water, leading to increased microbial growth and overall spoilage of the product.

There is considerable demand for good quality jaggery in the country and also outside India. Hence, production of good quality jaggery by following good manufacturing practices can enhance its consumption and provide employment to the people. A considerable portion of refined sugars is mixed with molasses and sold as brown coloured sugar in many of the developed countries. Instead of this, good quality jaggery itself can be supplied to the consumers. There is lot of scope for value addition in terms of preparation of jaggery with diversified forms. Liquid jaggery is very popular in parts of coastal India and north-eastern states. This is extensively used in the preparation of several sweetmeats in West Bengal and surrounding areas. Some of the value added products that could be prepared of jaggery are:

#### (i) Tonic Jaggery

The sugarcane extract, concentrated to about 80° brix, is a very good source of digestible carbohydrates to serve as a carrier for several micro-nutrients. The consistency of the product permits incorporation of vitamins, minerals and other additions with induced taste and flavour of the product. Such a product will be specially liked by the school going children and may also be useful as a bread spread. Considerable part of jaggery can be diverted for this kind of value added product.

#### (ii) Spiced Jaggery

In several parts of the country, the farmers prepare small quantity of jaggery spiced with ginger, *elaichi* and such other desirable spices, especially for home or local consumption. Since some of these spices and condiments have nutraceutical value, such a product will be a value-added food and may have very high market in India as well as abroad.

#### (iii) Powdered Jaggery

Most of the jaggery produced in the country is in the form of cubes and buckets. However, when the jaggery is to be utilized at the household level, it is always crushed into small grits. Hence, production of jaggery in the powder form for ready utilization may be very useful. Such a product can find application in large quantities in the government sponsored nutrition programmes such as energy food. As on date, the difficulty for preparation of such a product is non-availability of granulators at the jaggery production sites and a suitable technology for its packaging and transportation. These difficulties could be overcome easily.

#### (iv) Jaggery Cubes

Sugar cubes, which disintegrate and disperse when mixed with warm liquids, are very commonly used in star hotels both in developed and developing countries. However, similar kinds of products from jaggery are not being produced so far. Jaggery cubes can replace sugar cubes because of the special taste, aroma and health benefits of jaggery.

The sugarcane crushing and preparation of jaggery are totally done manually. The element of mechanization is mostly at the crushing stage. Because of this, if the production of jaggery is increased, there will be proportional increase in the rural employment. Indirectly, it may result in increased cultivation of sugarcane which will also increase rural employment and incomes. The by-products of sugar and jaggery production units such as bagasse, the ash and also the muddy particles containing molasses are also not being efficiently used for much of value addition. The bagasse being a very good source of cellulose can find utilization in paper and cardboard industry. The molasses containing muddy particles may be used for production of biogas along with the ingredients used for gobar gas.

## 4. LIVESTOCK

### 4.1 Use of Wastes

There is considerable production and consumption of meat, poultry and fish products in India. But the proper use of wastes of these livestock products is generally wanting. The wastes created in processing of livestock products include the following:

- Mutton, beef, pork - Fur, viscera
- Poultry - Feather, viscera
- Fish, prawn, shrimp, lobster - Scales, exoskeleton, viscera

Fur and feather, composed of kerato-proteins, can become a good source of sulphur containing amino acids. By application of enzyme based biotechnologies, high value amino acids can be obtained for use in food and pharmaceutical industries. The exoskeleton of shrimp and prawns are made of chitin, from which chitosan production by deacetylation process can be undertaken. Chitin can be depolymerized to yield N-acetyl glucosamine, which is an important pharmaceutical ingredient. The animal and fish viscera can be processed as sources of protein for food, feed and pharmaceutical purposes. The protein hydrolysates can also be designed as excellent media for microbial fermentation processes. The technologies of small, medium and large-scale industrial processes for production of enzymes and use of enzymes have a big potential for employment generation.

#### 4.2 Poultry Dressing

The process of poultry dressing involves ante-mortem inspection, slaughtering, scalding, defeathering, singeing, evisceration and postmortem inspection. The edible internal organs are separated, washed and packed separately. The carcasses are washed, packed and chilled in crushed ice for further storage. The marketing of dressed chicken is done in fresh, chilled or frozen form. It is also feasible to market the product in cut up portions like half chicken, drumstick, thigh, back breast and wing.

### 5. BIO-FUEL PRODUCTION ON WASTE LANDS

India has considerable wastelands which can be used for cultivation of non-conventional oil bearing crops or trees. Also, on the cultivated lands, particularly which are rainfed, there is tremendous scope for growing such oil bearing short-duration and/or hardy crops like castor and jatropha. The borders of the existing crop lands can be used to grow oil bearing crops without impairing the food security of the country. This can generate tremendous rural wealth and employment in rural areas. The employment potential is very high in post-harvest operations like decortication, oil-expelling, transporting of oil to a central bio-fuel facility, and transportation of oil-cake to the markets. These operations can be done by entrepreneurs employing semi-skilled and unskilled labour both in rural and semi-urban areas.

### 6. SCIENCE AND BIOTECHNOLOGY APPLICATIONS

There are several areas where educated rural youth can be trained in science and biotechnology applications, and employed in agricultural support services as

entrepreneurs, which in turn can provide employment to others. Some of the potential areas have been identified here.

### **6.1 Improvement of Culture Products: Utilization of Microbial Cultures in Agriculture**

Popularization of such technologies as organic farming, organic fertilizers, growth regulators and biopesticides which are eco-friendly, can be done by training the agripreneurs who could, in turn, develop enterprises for such technological interventions and applications. In the non-farm sector, units can be set up for development and production of cultures, inoculum, and adoption of microbial biotechnology and scale-up methods. Industrial production of microbial cultures can be taken up by small scale industrial enterprises.

### **6.2 Production of High Yielding Planting Material**

Adoption of tissue culture method for micropropagation, like banana and potato propagation, is another potential avenue that needs to be encouraged. This would require training in tissue culture for adopting simple and efficient technology with less dependence on electricity. It could also be an entrepreneurial activity to cater to the requirements of elite propagules essential for the region for large scale cultivation. Industrial production of uniform propagules for providing high yielding and assured varieties for enhancement of yields will create opportunities for setting up of SSI units based on the requirement of the crops in a particular region.

### **6.3 Floriculture**

There is a need for identification of the local varieties which are cultivable in a geographical region and their multiplication using modern farming methodologies. This provides opportunities for rural women in cultivation and in cut flowers business with a potential to cater to the urban markets. Interface of packaging technology for extension of shelf life would be useful. This venture provides opportunities for plant tissue culture based industrial activity, which can make India as a global leader in meeting the world requirement of selected flowering plants and foliages.

### **6.4 High Quality Banana Planting Material by Tissue Culture**

Banana varieties such as Cavendish, 'Rasabale' and others can be mass multiplied by tissue culture technology. The method involves establishment of plant tissue culture, large-scale production of plantlets, growing tissue culture-plants in poly-house and field cultivation. The steps involved are selection of high yielding mother clones, disinfection of explants, removal of bud/meristem, establishment of shoot cultures on nutrient medium

with suitable hormone in recommended containers and incubation at specified conditions, multiplication of shoots in nutrient medium with specific hormones, transfer of selected shoots for shoot multiplication or rooting, hardening of tissue-culture plants in poly houses and transportation for field cultivation.

### 6.5 Biocontrol of Microbial Pathogens and Arthropod Pests at Farm and Post Harvest Levels

Environment management employing blends of useful microorganisms for pollution control, deodorization and sewage treatment is gaining increased attention. These concepts could be extended to the agricultural practices as well as food processing as a means of preservation and enhancement of nutritive value and acceptability. Biotechnological processes using genetically modified and proven friendly consortia of microorganisms can be employed. The industrial scale production of such microorganisms and creation of their blends for commercial purposes also provide good potential for employment of skilled rural youth.

### SUMMING UP

Clearly, there is immense potential of employment generation through technological interventions for primary value addition to the agricultural products like foodgrains, fruits, vegetables, sugarcane and livestock products/by-products. The employment potential is also very high in production of bio-fuels and application of science and biotechnologies in agricultural activities. In addition to the areas identified in the paper, there are several other agricultural crops like barley, potato, coconut and medicinal plants which provide considerable potential of employment creation in primary value addition activities. As simple as cleaning, washing, sorting and packaging of fruits, vegetables and other farm products at the farm or village level can provide tremendous employment and also save huge physical losses of the product that occur during storage, handling and transportation to the market. Obviously, the employment opportunities exist for unskilled, semi-skilled as well as educated youths. However, there are two pre-conditions for full utilization of these opportunities. First, the technological interventions will need to be dovetailed with institutional support system including technology transfer, credit delivery and training of entrepreneurs in the form of specific government programmes and schemes. And second, there will be a need for new enterprises (individuals, self help groups or cooperatives) to procure the products from individual farmers and add value to them. While some such primary processing enterprises may be established in small villages, a majority will necessary become viable in large villages, towns or semi-urban areas. Complementary policies to encourage such enterprises will be quite critical for their viability and success.

## NAAS Documents on Policy Issues\*

1. Agricultural Scientist's Perceptions on National Water Policy - 1995
2. Fertilizer Policy Issues (2000-2025) - 1997
3. Harnessing and Management of Water Resources for Enhancing Agricultural Production in the Eastern Region - 1998
4. Conservation, Management and use of Agro-biodiversity - 1998
5. Sustainable Agricultural Export - 1999
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