Towards Achieving a 'Second Green Revolution'- The Role of Radiation Technology In Food Processing Management

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INTRODUCTION

Technology is the mainstay of modern industry and trade. The pace of globalization of trade and commerce in today's world is determined by emerging technologies in every area of business. Of these, the eco-friendly technologies are gaining ground as environmental pollution stands as the biggest threat to the survival of mankind. Radiation technology is an emerging technology that comes under the banner 'radiation for peaceful purposes'. It has a wide range of applications in the areas of Health & Hygiene, Medicine, Pharmaceuticals, Agriculture etc. This paper discusses the application of radiation technology to the processing of food so as to improve post-harvest storage facilities & hygiene and pave way for processed-food. This is very important to India as the Indian food processing industry accounts for more than $20billion. Also it is estimated that only 2% of the farm produce in India reaches the processing stage (as compared to 40% in some developing economies and 70-85% in the developed economies) where value addition takes place (Ranganathan 2006). This grave situation has been further aggravated by substantial reduction in the land under cultivation. Since the beginning of the liberalization process started in 1991, there has been no looking back for the Indian economy. The GDP growth has accelerated from 6% in the early nineties to more than 8% in recent years. The contribution to the growth has surprisingly been from the services sector rather than from the industrial or agricultural sectors. Agriculture, that provides employment to 60% of the population, has however posted only a 2.3% growth in the last decade. What then is in store for the people of the world's largest democracy? This question has been repeatedly posed by many policy-makers, technology managers, economists and agriculturalists in key areas of the country's planning process and they all agree that only a 'second green revolution', that will ensure a 4% growth in agriculture, can sustain a 9% GDP growth as envisaged in the 11th Five year-Plan. **It is here that radiation technology has an important role to play.**

NEED FOR THE STUDY

There is a growing concern about the Indian agriculture sector. Starting from lack of proper irrigation facilities and marketing infrastructure to storing of the farm produce to the processing of food, the sector is steeped in a hoard of problems. The areas that require immediate attention are of course

1. The irrigation facilities and
2. The agriculture extension services.

Of the total amount of agricultural land, only about 1/3rd has access to irrigation facilities and this contributes to more than half of our food grain output. The rest of the agricultural land is rain fed and is in the hands of poor farmers. The irrigation projects undertaken in the 9th and 10th five-year plans are yet to be completed.

These projects would cost around Rs.22, 000 million to the exchequer and a fiscal deficit of billions of rupees to the government. While the completed projects are able to generate about 7% of the irrigation facility; about 10 million hectares of the agricultural land is turning into wasteland due to depletion of ground water. Under these circumstances, storing whatever is produced is as imperative as increasing production.

Coming to the question of agricultural extension services, we need to set ourselves two goals. One is to move up in the value chain of food production and create market for horticulture, floriculture and livestock cultivation. The second goal and the one that calls for immediate attention is improvement in the storage facilities for the farm produce. It is estimated that about 20%-40% of the farm output fails to reach the market due to lack of proper storage facilities and market infrastructure. For example, Indian rice production accounts for 14% of the total

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world production. However, 6% of this is lost due to poor storage facilities. India accounts for 8% of the fruit produced in the world and 20% of it is lost due to spoilage at various post-harvest stages. The story is same with the vegetable production where 20-25 percent of the produce is lost due to poor post- harvest practices (Nem Singh 2006). These losses work out to a direct annual loss of about Rs.6000 millions. As only an estimated 2% of farm-produce, compared to 40% in some developing countries and 80% in developed countries, reaches the processing stage where value addition takes place, it is very important to focus on cost effective and environment friendly techniques to store the produce until it reaches the processing stage. Irradiating food with isotopes is one such technology that was developed by Bhabha Atomic Research Center (BARC).

OBJECTIVES

1. To find whether the economic environment is suitable for the application of radiation technology.
2. To find whether the venture into radiation technology is financially viable and commercially feasible.

ECONOMIC APPRAISAL OF RADIATION TECHNOLOGY:

The Government of India has been very keen to improve the agricultural productivity as well as the storage facilities of farm produce so as to eliminate the problem of food security and also to give an impetus to the processing industry. It is in this regard that a national monitoring agency was set up in the year 1986 to oversee the commercial application of radiation processing of food. The Atomic Energy Act was amended in 1991 and in 1994; irradiation of vegetables and spices was approved.

The radiation process is now a globally accepted processing technology with many international organizations like Food and Agricultural Organizations [FAO], World Health Organization [WHO] and International Atomic Energy Agency [IAEA] advocating its use. After about forty years of detailed scientific research and testing, it has been concluded that irradiation presents no toxicological hazard for food products (Gopal Reddy 2006) because the food does not come into direct contact with the source of irradiation. The process is considered as eco-friendly compared to the conventional methods like fumigation which is now phased out due to its harmful effects on human health and environment. The radiation process is a cold process and preserves the nutritional value and wholesomeness of food when compared to the conventional thermal treatment. The working conditions at the irradiation center can easily be maintained at maximum safety levels.

In India, the Bhabha Atomic Research Center [BARC] and Board of Radiation and Isotope Technology [BRIT] have established irradiation centers at Mumbai and Jodhpur. These organizations provide valuable guidance to the operation of these centers. The Ministry of Food Processing Industry, on the other hand is providing financial assistance and subsidies in order to exploit the commercial opportunities offered by the new process. The Food Production and Processing Industry in India has a tremendous potential to grow. With its past record of successful 'green' and 'white' revolutions, will India be able to repeat history and provide the much- needed impetus to this sector is an unanswered question. Many policy makers in the country feel that this is an uphill task but not an impossible one. The need of the hour is focused investments of resources that can turn around the processing sector.

India produces around 600 million tons of food grain every year. It is a major exporter of rice and wheat and leads the world in milk production. It produces two million tons of spices every year and is the second largest producer of fruits and vegetables. The Confederation of the Indian Industry [CII] has estimated that the food-processing sector can provide 9 million jobs in ten years time and classified it as a 'sunrise industry'. The recent entry of Multinational Companies into the retail food sector is also an added attraction. These companies view India as having a great potential for future growth and they will be only too willing to invest in this sector. It is in this scenario that the radiation technology comes as a shot in the arm for the food processing industry. It is the safest and most eco-friendly technique that has wide applications along the length of the agricultural sector, from field to fork. None of the conventional methods are any match to the list of advantages it provides.

FUNDAMENTALS OF RADIATION PROCESSING OF FOOD

In Radiation Processing, the food substrate is subjected to controlled application of energy of ionizing radiations such as Gamma rays, X-rays and accelerated electrons. The choice of the radiation source depends on the nature,

size and thickness of the material to be irradiated (Sabharwal 2006). The radioisotope, Cobalt-60, is used for the emission of Gamma rays and this source has wide industrial applications. The energy of Gamma rays breaks down the DNA chains in bacteria present in the food thus stopping bacterial reproduction. The reaction with DNA also impairs the ability of potato and onion to sprout. During the process, the temperature does not increase, that is, the process is a cold process and hence the various nutrients do not get destroyed. By this process, the food does not become radioactive and is safe for consumption. In conventional methods like heating and cold storage, the wholesomeness of food gets destroyed and in chemical treatments like fumigation, the food becomes harmful for consumption.

ADVANTAGES OF RADIATION PROCESSING OVER OTHER EMERGING TECHNOLOGIES

There are many emerging technologies that serve to process foods. Some of them are: flash freezing, ultra-high temperature treatment, fumigation and vacuum packing. However none of them has as wide a range of applications as radiation processing. Also **radiation can be applied uniformly over a range of food products. The research work going on at BARC and BRIT is about bringing more and more food products under radiation processing.**

India has a substantially large domestic market where cereals, pulses, spices, fruits and vegetables are produced, stored and distributed. India is a major exporter of rice, spices and onions. These export items should be processed to increase the shelf life, to ensure hygiene and to overcome quarantine barriers. Since the food processing industry is still nascent, it offers opportunities for FDI. It is estimated that the Indian food processing industry accounts for more than $20billion. The globalization of markets has resulted in international convergence of tastes and preferences. This along with the rising income levels of the middle class and a growing number of women workers has created a huge demand for processed foods across the country. Therefore, **economic prospects for radiation technology in India are very encouraging.**

The food items approved for radiation preservation by the Ministry of Health & Family Welfare, Government of India under Prevention of Food Adulteration Rules, 1956 is shown in Table 1.

Table 1: Food Items Approved For Radiation Preservation by Government of India Under Prevention of Food Adulteration Rules, 1956

Name of the food	Purpose	Minimum dose [kilo Grays]	Maximum dose[kilo Grays]
Onion	Sprout inhibition	0.03	0.09
Potato	Sprout inhibition	0.06	0.15
Ginger	Sprout inhibition	0.03	0.15
Garlic	Sprout inhibition	0.03	0.15
Shallots	Sprout inhibition	0.03	0.05
Mango	Disinfestation [Quarantine]	0.25	0.75
Rice	Insect disinfestation	0.25	1.00
Sooji/Rawa, Wheat atta and Maida	Insect disinfestation	0.25	1.00
Pulses	Insect disinfestation	0.25	1.00
Raisins, Figs and dried dates	Shelf-life extension	0.75	0.25
Spices	Microbial Decontamination	6	14

Source: Sharma, Arun. 2006. Radiation preservation of agricultural and allied products. pages 1-4 in National symposium on radiation processing of foods, food products and feeds-Sept 8th & 9th, 2006, Hyderabad.

Financial Viability of Radiation Technology:

As the economic prospects are encouraging, it is worthwhile to find whether radiation processing is a profitable venture. This can be analyzed by calculating the cost of setting up an irradiation center, by estimating the operating costs and determining the revenue flow. The revenue flow, like in any other industry, will depend on the capacity utilization of the plant or the volume of food processed.

Cost of Project:

As per the estimation given by Iyengar and Kohli (2006), a radiation processing plant that uses 500kci (kilo curie)

of Co-60 source will cost about Rs.70 million. The processing capacity of such a plant is estimated to be 5000 tons of spices for hygenization per year. The processing cost works out to be Rs.4/-per kg of spices. The processing costs, it is believed, would come down substantially if the same plant runs with 1000kCi source. Once all the costs are known, capital budgeting can be done to evaluate the profitability of the venture. The break up of costs for major components is shown below.

1. Land cost and development	= Rs. 2.0 million.
2. Irradiation cell, storage facilities, utilities area etc	= Rs.12.5 million
3. Product handling system	= Rs.10.0 million
4. Radiation source	= Rs.25.0 million
5. Radiation source handling system and controls and instrumentation	= Rs.7.5 million
6. DM plant, fire-fighting and DG set	= Rs.2.5 million
7. Laboratory and health Physics equipment	= Rs.2.5 million
8. Working capital	= Rs.2.5 million
9. Know-how, pre-operative expenses	= Rs.4.0 million
10. Trial runs and marketing development	= Rs.1.5 million
Total	= **Rs.71.5 million**

OPERATING COSTS:

Co-60 replenishment cost	= Rs.3.1 million
Staff salaries	= Rs.4.0 million
Cost of utilities	= Rs.4.0 million
Maintenance costs	= Rs.1.4 million
Amortization of capital	= Rs.2.0 million
Interest on capital and miscellaneous expenses	= Rs.5.5 million
Total per year	= **Rs.20.0 million**

Many Indian corporate houses like Birlas, Tatas and Reliance and a host of MNCs are vying for a share in the profitable Indian retail food business. They are keen about investing in the agricultural extension services. Investing in new technologies that will ensure the smooth movement of food from farm to market, through vertical integration, will save on costs and yield great profits in the long run. Improving shelf life of different foods will therefore be one of their priority areas. Since BARC is operating a commercial irradiator (Krushak) for treatment of onions, pulses, rawa and turmeric at Lasalgaon, Nasik district of Maharashtra and the Ministry of Food Processing Industry is offering subsidies to encourage private participation, there is no need for any concern to set up a radiation processing unit. The cost of the plant will work out to be around Rs 70million. These costs can be offset by low operating costs. It is estimated that the project costs can be recovered within 3-5 years. **Normally,**

Table 2: The Status of Private Sector Radiation Processing Plants in India.

SL NO	Name of the entrepreneur	Purpose	Date of signing MOU	Status/comments
1	M/S AGROSURG Irradiators, Mumbai.	Food, Packaging& Medical products	23-02-01	Plant commissioned in March 2008.
2	M/SVARDAAN Agrotech, Sonepat	Food & Medical products	20-04-01	Commissioned in 2005.
3	M/S ORGANIC GREEN FOODS LTD, Kolkata.	Food, Pack & Medical Products	24-01-02	Commissioned in 2004, commercial operation started.
4	M/S GAMMA AGRO MEDICAL PROCESSING, Hyderabad.	Agro& Medical Products	29-01-03	Will be commissioned shortly.
5	M/S AV PROCESSORS PVT LTD, Mumbai.	Food & Medical-Surgical Products	17-10-03	In operation since 2005.
6	M/S UNIVERSAL MEDICAP LTD, Baroda.	Food and Medical Products	14-02-04	In operation since 2005.
7	M/S MICROTROL, Mumbai.	Food & Medical Products.	08-05-04	In operation since DEC 2006.

different foods need different doses of radiations, say, low dose, medium-dose or high-dose. So entrepreneurs would prefer to have a plant that can provide all types of dose requirements so that products are available for processing throughout the year. This will ensure full capacity utilization and maximum value creation. The investors will therefore look for

a) Nearness of the radiation unit to the production center as well as demand center,

b) Availability of products for processing throughout the year and

c) Adequate profit margins.

The fact that BRIT has signed more than a dozen MoUs with industry and entrepreneurs for setting up radiation processing units shows the emerging trend in investing new cost effective and environment-friendly technologies in the food processing industry. Some of these units are in the advanced stage of construction. As per BRIT sources, the status of Radiation Processing Plants set up by private entrepreneurs in India is shown in Table 2.

Apart from the above plants, many MoUs have been recently signed up by private businesses. To speed up the process, BRIT has set up a full-fledged Customer Support Service Cell at its Mumbai Office. This Cell has been catering to the wide needs of customers. It has created awareness about Radiation Technology and has been successfully marketing radioisotopes and radiation equipment. BRIT operates a website, **www.britatom.gov.in,** to disseminate latest product and market information to customers in India and abroad. The outstations of BRIT at Bangalore, Kolkata, Dibrugarh and Delhi are also evolving into focal centers for Customer Relationship Management. The efforts put in by BRIT to take Radiation Technology to the street show the unflinching commitment with which it has set about this daunting task.

CONCLUSION:

In this age of globalization, technologies have a great role to play in almost every area of business as they stand to reduce the time gap between the idea generation stage and product launch stage significantly. There is an urgent need for developing economies like India to utilize the technological advances made by BRIT to revamp the food-processing sector. Starting from deregulation of the sector to investing in R&D facilities, to providing post-harvest storage facilities and marketing infrastructure, to linking economic policies to investments in agricultural extension services, a lot of ground has been cleared for the successful implementation of radiation technology. So what is needed is a concerted effort by the policy-makers, financial institutions and corporate houses to coordinate the above activities towards achieving a second green revolution.

BIBLIOGRAPHY

1. Iyengar, R. D., and A. K. Kohli. Gamma radiation processing plants: engineering and economic aspects. pages 32-38 in National symposium on radiation processing of foods, food products and feeds-Sept 8th & 9th, 2006, Hyderabad

2. Radiation Processing of Food-A Technical Document, Government of India, DAE.

3. Ranganathan, S. 2006. Bio-safety of radiation processing of foods, food products and feeds. Pages 47-52 in National symposium on radiation processing of foods, food products and feeds- Sept 8th & 9th, 2006, Hyderabad.

4. Reddy, Gopal. 2006. Irradiation of food for protection from microorganisms. Pages21-30 in National symposium on radiation processing of foods, food products and feeds- Sept 8th & 9th, 2006, Hyderabad.

5. Sabharwal, Sunil. 2006. Radiation processing in India: Exploring new horizons. Pages 39-46 in National symposium on radiation processing of foods, food products and feeds-Sept 8th & 9th, 2006, Hyderabad.

6. Sharma, Arun. 2006. Radiation preservation of agricultural and allied products. pages 1-4 in National symposium on radiation processing of foods, food products and feeds-Sept 8th & 9th, 2006, Hyderabad.

7. Singh Nem. 2006. Market opportunities for irradiated food in India and abroad. Pages 91-98 in National symposium on radiation processing of foods, food products and feeds- Sept 8th & 9th, 2006, Hyderabad.