Brainstorming Workshop
on
"Soybean for Household Food and Nutrition Security"

Proceedings & Recommendations

National Agricultural Science Centre Complex, New Delhi
21-22 March, 2014

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Progress Through Science

ICAR

Organized by

Trust for Advancement of Agricultural Sciences (TAAS)
Indian Council of Agricultural Research (ICAR)
National Academy of Agricultural Sciences (NAAS)

Trust for Advancement of Agricultural Sciences (TAAS)

GOAL

An accelerated movement for harnessing agricultural science for the welfare of people.

MISSION

To promote growth and advancement of agriculture through scientific interactions and partnerships with stakeholders.

OBJECTIVES

- To act as think tank on key policy issues relating to agricultural research for development (AR4D).
- Organizing seminars and special lectures on emerging issues and new developments in agriculture.
- To institute national awards for the outstanding contributions to Indian agriculture by the scientists of Indian and other origin abroad.
- Facilitating partnerships with non-resident agricultural scientists visiting India for short period.

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Foreword

Soybean (*Glycine max*) a grain legume having 40 per cent good quality protein and 20 per cent oil has gained acceptance and is now cultivated in about 10 million hectare in India with a production of nearly 13.4 million tonnes. Soy protein is the least expensive and quality wise at par with animal protein and contains high quality nutrition, nutraceuticals and therapeutic ingredient that help people to live longer, healthier and happier with enhanced quality of life. In fact, soy fortified diet suits the richest of the rich on health ground and poorest of the poor on economic consideration. Due to its multifarious applicability, soybean is often called as wonder bean or miracle bean or "golden grain".

The ICAR is making concerted efforts for production and utilization of soybean in India through Directorate of Soybean Research (DSR), Indore and Agro-Produce Processing (APP) Division, (earlier SPU), CIAE, Bhopal by providing training to the potential small and cottage level entrepreneurs in production and marketing of soybased food products. However, there is an urgent need to give greater emphasis on processing and utilization of whole soybean as food product and make it available at an affordable cost to the economically under-privileged people of India.

Soy oil with minimum saturated fat, cholesterol free, heart-healthy oil is very well accepted for use as food. However, soy meal containing almost 40 per cent protein is exported at relatively low price thus depriving million of malnourished people in the country. This requires serious considerations to use soybean as nutritious food to combat existing malnutrition. The real challenge before us is to create awareness and make available acceptable and affordable soy food products in the market. This requires a relook at our soymeal export policy keeping in view the economics of export over import of pulses as well as the cost of per unit protein.

Keeping in view the above considerations a two-day brainstorming workshop on "Soybean for Household Food and Nutrition Security" was organized jointly by the Trust for Advancement of Agricultural Sciences (TAAS), Indian Council of Agricultural Research (ICAR) and National Academy of Agricultural Sciences (NAAS) on 21-22 March, 2014 at NASC Complex, New Delhi. The workshop was attended by a select group of policy makers, scientists, representatives of soy industry, extension personnel, farmers, NGO's and small entrepreneurs. Intensive discussions were held on various aspects covering soybean improvement, production, processing and utilization/promotion of soy products.

Sincere efforts made by Dr. Nawab Ali, former DDG (Engg.) to develop a concept paper and the two Rapporteurs Dr. V.R. Sagar and Dr. A. Talukdar for recording the proceedings are very much appreciated. It is our expectation that this publication will immensely be useful to the researchers, policy planners, development agencies, entrepreneurs, students and other stakeholders.

Dr. S. Ayyappan
Secretary, DARE & DG, ICAR
and President
National Academy of Agricultural Sciences

Dr. R.S. Paroda
Chairman, TAAS &
and Chairman
Haryana Kisan Ayog

Acronyms and Abbreviations

AICRP	All India Coordinated Research Project (AICRP)
APP	Agro-produce Processing
ARD	Agricultural Research and Development
ARI	Agharkar Research Institute
ATIC	Agricultural Technology Information Centre
ATMA	Agriculture Technology Management Agency
AVRDC	Asian Vegetable Research and Development Centre
BBF	Broad Bed Furrow
BPL	Below Poverty Line
CFTRI	Central Food and Technology Research Institute
CIAE	Central Institute of Agricultural Engineering
CIPHET	Central Institute of Post-Harvest Engineering and Technology
CSIR	Council of Scientific & Industrial Research
DARE	Department of Agricultural Research and Education
DBT	Department of Biotechnology
DG	Director General
DOC	De Oiled Cake
DSR	Directorate of Soybean Research
FFSF	Full Fat Soyflour
FLD	Front Line Demonstration
FSSAI	Food Safety and Standards Authority of India
GM	Genetically Modified
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICDS	Integrated Child Development Scheme
IITA	International Institute of Tropical Agriculture

INSA	Indian National Science Academy
KTI	Kunitz Tripsin Inhibitor
KVK	Krishi Vigyan Kendra
MAS	Marker Assisted Selection
MP	Madhya Pradesh
MSP	Minimum Support Price
NAAS	National Academy of Agricultural Sciences
NASC	National Agricultural Science Centre
NGO	Non Governmental Organization
NIFTEM	National Institute of Food Technology Entrepreneurship and Management
PCM	Protein Calorie Malnutrition
PDS	Public Distribution System
PHT	Post-Harvest Technology
PPP	Public-Private Partnership
QTL	Quantitative Trait Locus
R&D	Research and Development
R&F	Ridge and Furrow
SAU	State Agricultural University
SFP&WA	Soya Food Promotion and Welfare Association
SLIM	Soybean Literacy India Movement
SLIMN	Soybean Literacy India Movement for Nutrition
SMS	Subject Matter Specialist
SPU	Soybean Processing and Utilization Centre
TAAS	Trust for Advancement of Agricultural Sciences
USAID	United States Agency for International Development
YMV	Yellow Mosaic Virus

Brainstorming Workshop on

"Soybean for Household Food and Nutrition Security in India"

1. BACKGROUND

Having attained food security, major concern in India is household nutritional security, particularly among children; about 40% are currently malnourished. On the contrary, fortunately majority of Indians are vegetarian and depend largely on pulses as protein source. Being short in pulses, India is importing around 2.0 million tonnes of pulses costing almost Rs. 22,500 crores annually. Interestingly the protein from soybean is least expensive and quality-wise better than most pulses and comparable to animal protein. Also, the soy fortified diet is affordable by the poor. Therefore, the need is to ensure use of soybean as a food crop by making its products available at affordable price to economically weaker section of our society.

Soybean is globally known as 'Golden Grain'. Compared to all pulses, it has double the protein content (40%) very good quality containing essential amino-acids, calcium, iron, vitamin B complex and Omega 3 & 6 fatty acids, besides possessing neutraceuticals having therapeutic properties.

In India, besides being relatively a new crop, with cultivation having started in early 1970s, soybean has emerged as number one among oilseed crops covering around 10 m ha area with total production of around 13.4 m tonnes. The average productivity is about 1.3 tonnes/ha which can easily be doubled in near future. Currently, India is at 5th position globally in production. We use 80% of soybean for oil extraction. The de-oiled cake (DOC), a protein-rich by product, is mostly exported as animal feed fetching around US$ 1540 million (2012-13) foreign exchange annually. On the contrary, soy meal could provide protein-rich dietary supplements at low cost to meet the nutritional deficiency prevalent in almost one out of three children. Unfortunately, soybean in India is used mainly as oil crop, whereas, most of the East and South East Asian countries including and China use it as a food crop. As such, soybean not only has the potential of increasing farm production and productivity but also can address effectively the existing concern for household nutritional security.

In view of this background, a two-day brainstorming workshop on "Soybean for Household Food and Nutrition Security" was organized by the Trust for Advancement of Agricultural Sciences (TAAS), Indian Council of Agricultural Research (ICAR) and National Academy of Agricultural Sciences (NAAS) on 21-22 March, 2014 at the National Agricultural Science Center (NASC) Complex, New Delhi.

In all, 78 participants comprising policy makers, scientists, representatives of Soy industry, extension personnel, farmers, NGOs and small entrepreneurs attended the brainstorming session and held intensive discussions on various aspects covering soybean production to utilization. A copy of the Concept note, programme, and the list of the participants are given as Annexure I, II and III, respectively.

2. INAUGURAL SESSION

The session started with the ICAR-song. It was chaired by Dr. R.S. Paroda, Chairman, TAAS, while Dr. S. Ayyappan, Secretary, DARE & DG, ICAR was the Chief Guest. Dr. H.S. Gupta, Director, IARI, welcomed the guests and participants.

In his inaugural address, Dr. Ayyappan highlighted the importance of soybean as household food and for ensuring nutritional security to the large section of the society. He mentioned that large-scale cultivation and regular utilization of soybean as food, feed and fuel can not only promote health and wealth but can bring about wholesome growth of the country. It has potential to alleviate the protein-calorie malnutrition which is widespread in our country. Therefore, there is a need of coordinated efforts by the producer, and the policymakers to enhance production, productivity and domestic consumption of soybean in the country.

In his presidential address, Dr. Paroda mentioned that soybean has shown promise in its short span (about 44 years only) of commercial cultivation in India. However, it has yet to be accepted as a food crop instead of oilseed crop. People are still not aware of its nutritive value and other health related benefits. It is the best source of high quality protein of plant-origin, to the vegetarian people. It can offer solution to so many ailments that are common in women and children. Therefore, policy fatigue is to be eliminated to include soybean in mid-day meal and other government schemes, which will help alleviate protein-calorie malnutrition in our country. Further, market support and irrigation facility development should be given priority to take soybean to non-conventional areas for cultivation. More investment should be made in research and development for genetic improvement of soybean so that it becomes profitable for rice farmers, who wish to replace rice with soybean. Necessary steps should also be taken to support research on GM soybean so as to fight biotic and abiotic challenges. He stressed the need of undertaking flagship projects in mission mode to promote soybean for nutritional security.

The keynote address of the workshop was given by Dr. Nawab Ali, former Deputy Director General (Engg.), ICAR, New Delhi. He emphasized that soybean is a food legume rich in high quality nutrients and health-friendly phytochemicals. The unique chemical composition of soybean seed, which includes about 20% oil and 40% protein, besides a number of nutraceutical compounds, such as, isoflavons, tocopherol and lecithin, has made it one of the most valuable crops of the world. The food derived from soybeans are generally considered to provide, both, specific and general health benefits and being an economical source of high quality protein, the crop has a potential to alleviate large-scale protein-calorie malnutrition, prevailing in the poorer sections of the society in India. Although, India is producing about 13 mt of soybean annually, and earning a huge amount of foreign exchange through the export of soy meal, but it is at the cost of draining out the valuable high quality protein from the country. Currently, the direct utilization of soybean for food uses in India is very small. If the high quality soybean protein is included in the daily diet of Indian masses, it can help in mitigating the widespread energy-protein malnutrition. However, the Government of India, as well as, private sectors have taken initiatives to increase the food use of soybean in the country. As of now, soybean has become the most important oilseed crop of India as it is contributing significantly to the edible oil economy. However, the near stagnant productivity levels are serious challenges to the scientists as well as the farmers.

Dr. Ali further stated that *Soybean is considered to be a functional food* as it contains significant levels of biologically active compounds that impart health benefits besides basic nutrition. It is the least expensive source of high quality protein which is rich in essential amino acids, such as, arginine and lysine, needed for growing children. Its oil has an ideal balance of omega 6 and 3 fatty acids. It also contains good amount of minerals, particularly iron, calcium, phosphorus alongwith vitamins, fibres and phytochemicals like, isoflavons and other compounds beneficial for health. However, direct food uses of soybean in the country are 5-10% only. Currently, almost 100% of oil extracted from soybean is consumed in the country, while about 70% of the de-oiled cake is exported for animal and poultry feed. The remaining 30% of the cake is utilized in the country mainly for animal and poultry feed, and to some extent as edible defatted soyflour and texturised soyprotein *(Soy-nuggets)*. Despite its rich nutritional profile and varied uses, exploitation of soybean in food, has been limited because of its beany flavour and presence of anti nutritional factors like trypsin inhibitor. Fortunately, these limitations have been overcome by appropriate processing. Breeding for quality characters and development of food grade varieties suiting to Indian people should be an important objective. Therefore, the focus should remain on developing technologies that can lead to increased utilization of soybean as a food in the

country and to make it a driving force for promoting vegetable soya, soy-based dairy analogs, full fat soy-flour, snack foods, sprouted bean, tempeh, miso, natto, sauce, soy candy and so on.

Soybean is the world's most important grain legume and contributes about 20% to the global edible oil and 65% to the world's protein concentrate for livestock feeding, including poultry and fish. Although, India has about 10% of the total world's soybean area but its contribution to soybean production is only 4%, indicating its relatively lower levels of productivity (1100 kg/ha) as compared to the world average of 2200 kg/ha. It is a major cause of concern for soybean R & D and technology diffusion. Soybean followed by wheat/chickpea cropping system has better profitability per unit land area and it has helped in improving the socio-economic conditions of a large number of small and marginal farmers. As of now total oilseed production in India has reached about 28 million tonnes and the contribution of soybean is about 35% in the total oilseed production and 25% in edible oil. It may reach 40% by 2025.

Soybean has remained a key foreign exchange earner for India on account of soymeal export. It was Rs. 1320 million in 1986-87 which increased to Rs. 75000 million by 2008-09 and it was Rs. 2,50,000 million in 2012-13. The total expenditure on import of edible oil is offset to the tune of 60% by the export-earning of soybean meal. In fact, besides others, the high market price had been one of the main factors for such a spectacular success of soybean venture in India. Since beginning of the commercial cultivation, the soybean economy has mainly been governed/ dependent on the export of soymeal.

The market price of soybean had always been much higher than the minimum support price (MSP) declared by the government due to better price fetched by Indian soymeal in the international markets. However, as of now, soymeal price in the international market is fluctuating a great deal and the total dependence of soybean venture in India on export of soymeal is a major cause of concern. However, in the recent past, there has been an increasing trend in domestic consumption of soymeal for food & feed in India. Soybean being an international commodity and USA, Brazil & Argentina being big players, dependence of soybean on soymeal export can threaten its cultivation in India. Therefore, there is an urgent need to increase domestic consumption of soybean and its derivatives so as to minimize dependence on international markets.

Majority of Indian population, 60-70% is vegetarian and drives its protein from cereals & legumes. 40% the of Indian population is below poverty line and does not have enough purchasing power to buy pulses, the major source of dietary proteins. Soyprotein is least expensive and qualitywise at par with animal protein and has no negative health effects. In fact, soyfortified diet suits the richest of the rich

on health grounds and the poorest of the poor on economic considerations. The need is to give greater emphasis on processing and utilization of whole soybean as food product and make it available at an affordable cost to the economically under-privileged masses of India.

As of now, India is exporting about 5.5 million tonnes of soymeal @ Rs. 35,000/ tonne, worth Rs. 175,000 million, containing 50% protein i.e. 2.75 mt of high quality edible protein @ Rs. 70/kg of protein and at the same time, India is importing about 2.5 million tonnes of pulses @ Rs. 90,000/tone, which amounts to about Rs. 360/kg of pulses protein. Vegetable protein (pulses) import in India is at about 5 times higher price than the export of a better quality soyprotein. It needs to be checked to enhance domestic utilization of soybean and its derivatives.

The ICAR is making concerted efforts to enhance production and utilization of soybean in India through Directorate of Soybean Research (DSR), Indore and Agro-Produce Processing (APP) Division (earlier SPU), CIAE, Bhopal, since 1985-86. SPU provides training to the potential small & cottage level entrepreneurs in production and marketing of soybased food products. Till August, 2013 SPU has trained about 2235 entrepreneurs from different states of India and out of these, around 400 have started their own enterprises.

Those KVKs and the centres of AICRP on PHT, which are located in the major soybean producing districts/states of India and are having Home Food Scientists, can play a very important role in promotion of soyfoods in their respective districts to combat protein-calorie malnutrition and achieve the most desired goal of house-hold nutritional security for the people of our country, particularly, that of the rural masses. The needed technological backup support for production and processing would be provided by DSR, Indore and CIAE, Bhopal, respectively under the aegis of the ICAR.

Today soybean is the most important oilseed crop with substantial contribution to edible oil pool and foreign exchange earnings for India but now the time is ripe for India to think apart from solely export driven soybean economy to the one that has strong roots in the domestic market. India has, therefore, to prepare a road-map for productivity enhancement and promotion of diversified uses of soybean in the country, benefiting consumers and farmers alike. For this to happen, the continuation and strengthening of DSR, Indore, and SPU, CIAE, Bhopal, is essential.

In conclusion, Dr. Ali said that there was urgent need for creation of awareness among people about the nutritional and economic benefits of using soybean in daily diet and for specialized training of food entrepreneurs in production and marketing of soybean based food products and promotion of such foods through community kitchen, mid-day meal programmes, etc. SMS of KVKs and Scientists of

the Centres of AICRP on PHT should be trained in soy-food production, promotion and marketing at DSR, Indore and SPU, CIAE, Bhopal to enhance production and utilization of soybean and its derivatives for an early achievement of household food & nutritional security in India through soybean.

Dr. V.R. Sagar, Head, Division of Post Harvest Technology, IARI, and Dr. Akshay Talukdar, Principal Scientist, Division of Genetics worked as Rapporteurs for all the sessions.

Vote of thanks was presented by Dr. N.N. Singh, Organizing Secretary of the Workshop.

3. SESSION I: INCREASING PRODUCTION AND PRODUCTIVITY OF SOYBEAN

The session was chaired by Prof. R.B. Singh, former Chairman, National Academy of Agricultural Sciences (NAAS), New Delhi. There were two lead lectures and a panel-discussion by four panelists followed by open-house discussion. The proceedings of the entire workshop was recorded by the two rapporteurs viz., Dr. V.R. Sagar, Head, Division of Post Harvest Technology, and Dr. Akshay Talukdar, Principal Scientist, Division of Genetics, IARI, New Delhi-12.

Lead Paper I : Prospects of Doubling Soybean Production in India by Dr. H.S. Gupta

Soybean, also known as the 'wonder bean', is one of the important field crops. It has traditionally been utilized as a source of edible oil, despite the fact that soybean contains more than 40% protein and 20% oil. With >25% contribution to the edible oil pool of the country, soybean has now attained the distinction of being the largest source of edible oil in India. In addition, India exports protein-rich soymeal worth more than Rs. 10,000 crores annually, although, there is widespread protein malnutrition in the country. India has witnessed phenomenal growth in the area and production of soybean during the last four decades, yet, the average productivity of soybean in the country is about half of the world average of 2.5 t/ha.

Soybean is a short-day, photo-sensitive, C_3 plant that produces reasonable yields of seeds with high contents of oil and protein using lesser quantity of inputs. Genetic base of soybean is known to be narrow; therefore, in order to raise the yield ceiling in soybean, widening of the genetic base, is pre-requisite. Intensive pre-breeding and germplasm enhancement involving all the 3 gene pools of soybean are highly needed. Introgression of 'yield-QTL' from *Glycine soja* has shown promise in this direction. The gene for 'long juvenility' has also been introduced so as to allow for an optimum vegetative period before onset of flowering. Indian soybean varieties are classified as early (< 90 days), medium (90-105 days) and late (>105 days).

Early maturing varieties are desirable, particularly under rainfed conditions for avoiding terminal drought, and to fit in different cropping systems. The varieties with 100-115 days' duration are best suited to irrigated areas for harnessing high yield potentials. Ideally, a determinate or semi-determinate variety with erect plant type, early to medium maturity, photo-insensitivity and long juvenility will give better yield under high fertility conditions. There is an urgent need to break the genetic barriers to enhance the photosynthetic efficiency, reproductive potential, seed viability, seed longevity and germinability, so as to achieve newer yield horizons in soybean. Soybean breeders should also look at developing varieties which are resistant to pod shattering and mechanical damage during harvesting and threshing, and retaining germination of more than 70% even after 8-9 months of ambient storage.

Soybean is mainly cultivated in central and western India with Madhya Pradesh and Maharashtra occupying >80% area. It is cultivated primarily as a sole crop; however, soybean has been found to be a good companion crop with maize, cotton, pigeonpea as well as sugarcane to which it imparts sustainability- the most important issue for the small and marginal farmers. In addition, intercropping of soybean will lead to an increase in its acreage and total production in the country. The acreage of soybean can further be increased by about 3 million hectares through promotion of this crop even to non-traditional areas. Soybean is cultivated mostly in rainfed areas, which restricts its productivity to a great extent. Two pronged strategy can be adopted (i) encourage cultivation of soybean in irrigated regions with full technological support to harness the yield potential so that it can compete with the established crops, which are generally high water demanding ones (ii) efficient rain water management to ensure full potential of the genotype being cultivated/recommended.

Dr. Gupta pointed out that efficient pest management is the key to save the yield losses caused by diseases, insect-pests as well as weeds. Efforts should be made to incorporate genes in soybean varieties for resistance against various pests and diseases. This will not only curtail the cost of cultivation but will also help in environmental conservation. Another important strategy could be deployment of the latest tool of genetic engineering for inducing herbicide resistance, which has been successful in the western world, as the yield loss due to weeds in soybean varies from 35 to 70%. This will, although, adversely affect the export of soymeal, but the benefits are definitely on the higher side. Yield enhancement through hybrids is yet another option that will bring in a quantum jump in soybean productivity. This needs to be attempted, especially when China has already developed and released hybrid soybean-HybSoy 1.

Production of any crop is immensely governed by its demand in the market. Therefore, market support in Northern and Eastern India will help in expansion

of soybean area in these regions. Processing and value addition will ensure higher profitability which will, in turn, create demand to be met by increasing production and productivity of this wonder crop. Introduction of speciality soybean like vegetable soybean and high soymilk yielders, will not only help in meeting the demand for food but will also aptly address the issue of adequate nutrition.

Lead Paper II : Improving Soybean Productivity in Different Agro-climatic Situation by Dr. S.K. Srivastava

Soybean in India, has shown unparalleled growth from the time it was introduced in late 1960s. The area under the crop in 1970, was merely 30,000 hectares with production of 14, 000 tonnes, which increased to 10.67 million hectares and production of 14.69 million tonnes in 2012. The crop is predominantly grown on Vertisols and associated soils with an average crop season rainfall of about 900 mm, which varies greatly across locations and years. The area under soybean is spread in latitudinal belt of about 15 to 25^0 N, comprising the states of Madhya Pradesh, Maharashtra, Rajasthan, Chhattisgarh, Andhra Pradesh and Karnataka. In recent years soybean has shown a rapid increase in area in the southern parts of the country, particularly, in the states of Maharashtra, Andhra Pradesh and Karnataka. The crop can be grown in most parts of India and states like north eastern states, Punjab, Himachal Pradesh and Jharkhand have good potential of growing soybean.

Simulation studies carried out across India have revealed that the normal climatic potential of the crop is 3000 to 3500 kg/ha while rainfed potential is 2000 to 2500 kg/ha as against national average of 1200 kg/ha. The average rainfed potential of 2000 kg/ha has also been demonstrated in large number of on-farm trials conducted over years across India. Several abiotic, biotic and socio economic factors, responsible for poor productivity of soybean, in India, have been identified. However, the major cause of large yield gaps between rainfed yield potential and actual yields harvested by farmers is attributed to non-adoption of improved production technology by the farmers.

Dr. Srivastava emphasized that in order to improve productivity of soybean under different agro-climatic conditions, zone wise production technologies have to be developed. The technologies include identification of optimum planting time, plant population, integrated nutrient and water management, integrated pest and disease management for different agro-climatic conditions. He informed that steps have already been taken in this regard. More than 105 soybean varieties, suited to different agro-climatic conditions, have been developed and released for cultivation. Yellow mosaic virus (YMV) is a major problem in the northern zone for which resistant varieties such as SL 295, SL 525, PS 1029, DS9814, etc have been released. Soybean cultivation is concentrated to central zone where early maturing and high yielding varieties such as JS 95-60, JS 93-05 and NRC 7 etc which can fit

into the cropping system have been developed. In southern zone rust is becoming a major threat to soybean cultivation. For this region, suitable rust management practices have been developed and continuous efforts are being made to develop rust tolerant varieties.

Dr. Srivastava further stressed that appropriate cropping systems have to be developed for different situations. He indicated that profitable and efficient cropping systems for different agro-climatic conditions such as soybean-wheat and soybean-mustard for areas where irrigation facilities for *rabi* crops are available and soybean-chickpea for rainfed situations have been recommended. Similarly, profitable intercropping systems for different agro-ecological zones such as soybean + pigeonpea, soybean + maize, Soybean + sorghum for central zone, soybean + cotton, Soybean + finger millet, soybean + sugarcane etc for southern zone have been recommended.

Weeds are the major factor which reduce soybean yield in all the agro-climatic zones. Integrated weed management practices through mechanical and chemical means, including the need based use of post-emergence herbicides, have been developed and recommended to farmers. Continuous soybean cultivation and changing climate scenario has resulted in increased pressure of insects, pests and diseases in soybean. The major diseases such as YMV and charcoal rot in northern and central zone rust in southern zone, major insects, such as, *Spodoptera litura, Chrysodeixis acuta* etc in central and southern zones are the major concerns. For these biotic stresses, suitable management practices encompassing, biological and chemical control measures have been developed and recommended to the farmers.

As the crop is mainly grown under rainfed conditions, *in-situ* moisture conservation technologies have been developed which could help in improving the productivity of soybean based cropping system under all the agro-climatic conditions. These technologies include, planting of soybean on improved land configuration such as on broad bed furrows (BBF) and ridge and furrows (FIRBS, R & F). The related mechanization for simultaneous creation of ridges and furrows or Broad bed furrows and planting of soybean have been developed and recommended to the farmers. Also, the occurrence of drought is very common in most of the agro-climatic conditions but the frequency of its occurrence is very high at terminal phase, particularly in the central zone. Therefore, providing irrigation at late seed fill stage, has been recommended to obtain higher yields in soybean. Adoption of these technologies could help in significant improvement in soybean productivity in different agro-climatic conditions.

Dr. Srivastava further stressed on the need of popularizing soybean as functional food. To promote such uses, soybean genotypes with null Kunitz trypsin inhihitor (KTI), low lipoxygenase and vegetable types have been developed. The increased food use of soybean will help in providing food and nutritional security and further stability to soybean cultivation in India.

Views of Panelists

After the lead papers, four panelists presented their views on the subject, details of which are presented below:

Dr. K.D. Kokate, Deputy Director General (Extension), ICAR, New Delhi, briefly mentioned about the urgent need of extension activities for popularizing soybean as house-hold food. He mentioned that front-line demonstration (FLD), farmers training and providing quality soybean seed is the need of the hour. He highlighted the success of soybean intercropping with finger-millet and pigeon pea. More emphasis is needed to popularize it through KVKs, ATMA, SAUs, etc. Also, the entrepreneurs who produce soy-based food products should be supported for commercialization of their products so as to make their venture profitable and attractive.

Dr. Vineet Kumar, Senior Scientist, Directorate of Soybean Research (DSR), Indore highlighted the progress made in the development of soybean research as functional food. He informed that substantial progress has been made in developing soybean line free from Kunitz trypsin inhibitor. Three institutes viz., Indian Agricultural Research Institute (IARI), New Delhi, DSR, Indore and Agharkar Research Institute (ARI), Pune with support from Department of Biotechnology (DBT), Govt. of India has developed lines with null KTI line through marker-assisted selection (MAS) approach. He also emphasized the need of vegetable and beany-flavor-less soybean for household use.

Dr. Akshay Talukdar, Principal Scientist, IARI, New Delhi indicated that the Indian soybean genotypes are poorly diverse and hence there is an urgent need to widen the genetic base through wider use of wild type germplasm (*Glycine soja*) in pre-breeding programs. He stressed that useful genes and quantitative trait loci (QTL) including yield-QTL should be introgressed into the cultivated soybean to make it more stresse-tolerant and climate-resilient. He also emphasized the need of substituting hexane in extraction of soybean oil so that the de-oiled cake (DOC) becomes fit for human consumption.

Dr. A.K. Vyas, Head, Division of Agronomy, IARI, New Delhi indicated that soybean production in India can be increased through appropriate intervention in supply of quality inputs, agronomic management, marketing and procurement prices. Efficient management of rainwater and supply of 1 or 2 critical irrigations can increase productivity substantially. He emphasized the need of system-based approach and adoption of organic soybean cultivation for sustainable production and profitability.

General Discussion and Chairman's Remarks

In the open-house discussion, participants opined that financial support is needed to develop irrigation infrastructure for enhancing profitability of soybean cultivation.

Similarly, policy needs to be put in place to raise minimum support price (MSP) of soybean to make it more attractive and competitive.

Chairman of the session Prof. R.B. Singh summarized the views of the speakers and the panelists. Highlights of his presentation are as follows:

- Productivity of soybean needs to be increased. The yield gap in soybean, which is still alarming, needs to be addressed through system-based approach and policy support for irrigation infrastructure development. In-depth research should be taken up to understand the microbial activities in soybean plants.
- Genetic narrowness needs to be taken care of as it may lead to vulnerability to insect pests and diseases. Pre-breeding activities need to be enhanced involving diverse germplasm, including wild type genotype.
- Molecular breeding and program for hybrid soybean need to be strengthened so as to raise productivity of soybean to global average.
- Finally, Prof. Singh stressed the need of policy support to expand soybean areas to east and north-west India through development of irrigation infrastructure, soy-based industry and market.

4. SESSION II: FOOD PROCESSING TECHNOLOGY AND SOY-BASED FOOD PRODUCTS

The session was chaired by Dr. V. Prakash, former Director, Central Food Technology Research Institute, Mysore, and co-chaired by Dr. Pitam Chandra, Director, Central Institute of Agricultural Engineering, Bhopal. In this session, two lead papers were presented which were followed by a panel and open-house discussion.

Lead Paper I : Processing Technology for Direct Food Uses by Dr. S.D. Kulkarni

He highlighted that soybean was introduced in India as a low cost but rich source legume to meet protein – energy requirements of over 75 per cent vegetarian population. Moreover, over 26 per cent population living below poverty line spends around 60 per cent of their income on food and yet remains malnourished. Recognition of the tremendous potential of soybean to transform it into a number of conventional type soy-based foods, if explored, is expected to further accelerate the demand. The main points highlighted by him can be summarized under the following heads:

The annual soybean production in India is about 12 million tonnes and the major contributing states are Madhya Pradesh (56%), Maharashtra (30%), Rajasthan (10%), Karnataka (2%) and others (2%). Other states are also cultivating soybean and may serve as a source of raw material for soy based food enterprises, thus reflecting on bright future of food uses of soybean in these and other states.

In India, about 80% of the total soybean production is processed for oil, 10% is used as seeds and only about 10% is used as direct food. However, the processing and oil extraction processes make only a small part available as human food. Soy meal containing over 50% protein is exported at meagre price leaving large mass population protein-hungry. Today, the producer of soybean -the farmer- does not retain soybean for food uses for his own family. Domestic scale processing of soybean for food & feed is, thus, a priority in the rural sector. In the present processing set-up, value addition is not to a desirable level. The urge to develop appropriate soy processing technology which has vast scope and potential for adoption throughout the country needs no emphasis. Soy products like oil and protein foods namely soy-nuggets, soy milk, soy *paneer* (tofu), yogurt, soy-fortified bakery products (biscuits and muffins), soy-sauce, health and speciality foods have been established in the market and the consumers have started accepting them.

The Soybean Processing and Utilization Centre (SPU) was established in 1985 at CIAE, Bhopal, under joint collaboration of the ICAR and USAID to develop and disseminate the processing technologies and equipment for extending to the end users for nutritional improvement of the population. Apart from SPU, some work was also done at few SAUs, etc.

Soybean requires careful processing prior to food uses as it contains some antinutritional factors. Whole soybean or partially/fully de-fatted cake/meal can be used for making various soy based food items. Increasing attention is currently being paid to the potential that soybean offers as a major protein source. It was considered necessary to develop and promote a soy product which can serve as a base material for incorporation in a variety of conventional food products of different regions. The simplest product is as full fat soy flour (FFSF). Soybean can be processed for soy flour (FFSF) at domestic, cottage, small or large scale and thus making it easy for processing by house-wives, farmers, or entrepreneurs by adopting different approaches.

Conventional type food products were identified for soy supplementation to provide good acceptability among the targeted segment of population. Acceptability of the supplemented product was judged on different account and for differently processed soy-flours. The direct use of plain soy milk or flavored as soy beverage, soy-nuts as a ready to eat product is expected to be common. To match the requirement, soy products, processing equipment and related technology has been developed in India for food uses of soybean (Table 1) for soy-food manufacturing and marketing.

Attempts made to popularize dietary utilization of soybean are yet to attain sizable magnitude. However, now more and more people are getting attracted towards soy foods. Although, not as a part of daily diet, soy nuggets is an

established product in the market. Out of various soy foods developed at CIAE, full-fat soy-flour, soy-fortified biscuits, muffins, soy nuts and soy-*paneer* have found good acceptance by the consumers from different states. Introduction of soybean as a protein-rich source for food uses in India is now taking some desired shape, though, it is, in general, yet to get recognition as a protein rich economical food source in the diet. However, soy oil is commonly accepted in food uses. To develop soy foods to match changing food habits and create awareness and make available acceptable soy-food products in the market has been the challenging task ahead.

The soy based food products have a very high potential of meeting nutritional requirements. A study conducted on school children using conventional type soyfoods on regular consumption basis revealed improvement in the nutritional status from malnourishment category III to II, and II to I in a span of six months. On this pattern traditional type products of targeted region can be selected for supplementation with soybean for nutritional benefits.

The Soybean Processing and Utilization Centre (SPU), CIAE started in 1995 a training program for upcoming entrepreneurs to facilitate establishment of soy food enterprises, has, so far, trained 2350 potential entrepreneurs in soymilk and soy*paneer*, and soyflour, soy snacks preparation and over 425 of them have established the soy food enterprises in different parts of the country, like Punjab, Haryana, Maharashtra, Rajasthan, Madhya Pradesh, Chattisgarh, etc. Manufacturers of cottage to small-scale soy milk plants and other soy processing machinery extend the machinery support. Roasted/fried soybean as snack food is also being manufactured and marketed by cottage/small-scale food industry and they are increasing in number, every year. Eight limited scale pilot plants developed at CIAE facilitate, upcoming entrepreneurs, training and production of soyfoods for trial marketing before taking final decision to go for establishment of soy-food production plant.

Majority of our population needs protein at low cost for its growth. This situation is likely to worsen with increasing population and food demand. Should we concentrate on export of highly nutritious and economical raw food material – the defatted soymeal for earning foreign exchange- is a question. Aspect related to soymeal export therefore, needs to be reviewed for a policy, keeping in view the economics of profitability of export over import of pulses and loss of human health. The challenges therefore, are:

- To enhance direct food uses of soybean among farmer families and general population. Related issues may be development and popularization of technologies and approaches for primary processing of soybean in production catchment to match conventional product range and food habits.

- To enhance indigenous use of defatted soymeal in the form of defatted soyflour and soy-based products to meet nutritional requirements of our population at low cost. Value addition of soybean/meal for preparation of innovative products for export.

Dr. Kulkarni also gave an account of 41 soy food technologies and 22 equipments produced at CIAE, Bhopal. He also revealed that CIAE has developed 8 different pilot production facilities for soy-based foods and food-products.

Lead Paper II : Soy Food Business Opportunities in India on Small, Medium and Large Scale by Dr. Rattan K Sharma

He mentioned that Soy products have been around in India for almost 30 years but the consumption of these products never took off well in the market till recently. Soybean is a rich source of good quality protein and the cost quite low. Soy products can easily meet the protein requirements of a vegetarian diet. Soybean has been perceived more as a poultry and cattle feed rather than a good source of protein for human consumption. Also the misconception that soybeans are only used in feeding programs conducted by the government for malnourished children has been prevalent. Besides nutritional benefits soybeans provide several therapeutic benefits too.

Soybean is one of the very few plants that provides high quality protein with minimum saturated fat. Soybean helps people feel better and live longer with an enhanced quality of life. Soybean contains all the three macronutrients required for good nutrition, as well as fiber, vitamins, minerals. Soybean protein provides all the essential amino acids in the amounts needed for human health. The protein in just 250 grams of soybean is equivalent to protein in 3 liters of milk or 1 kg of mutton or 24 eggs. The quality of soy protein is virtually equivalent in quality to that of milk and egg protein. Unlike many other good sources of protein, soybean not only has higher percentage of oil but also quality fatty acid profile. It has low saturated fat content with high amount of essential fatty acids. Soybean oil is also rich in omega-3 and 6 fatty acids similar to those found in fish oils and cholesterol-free. Soybean is an excellent source of dietary fiber with both soluble and insoluble fiber. Soluble fiber may help lower serum cholesterol and control blood sugar. Insoluble fiber increases stool bulk, may prevent colon cancer and can help relieve symptoms of some digestive disorders. Soybean has more than two times the amount of most of the minerals, especially, calcium, iron, phosphorus and zinc, than any other legume and very low sodium content. Soybean has all the important vitamins and is a very good source for B complex vitamins and Vitamin E.

In addition to containing important nutrients, soybean has other beneficial compounds such as, phytosterols, lecithin, etc. Soy protein has a number of health benefits such as, cancer prevention, cholesterol reduction, combating osteoporosis

and menopause regulation. Human studies suggest that as little as one serving of soy foods each day may be protective against many types of cancers. For the past 30 years, investigators have shown that consumption of soy protein selectively decreases total and LDL (bad) cholesterol and maintains HDL (good) cholesterol in individuals with elevated blood cholesterol levels. Based on the various research findings, United States Food and Drug Administration has issued a health claim for soy protein in October 1999. The health claim states "consumption of 25 gms of soy protein per day with a diet, low in saturated fat, may lower the risk of heart diseases". Another important aspect of soy protein is combating osteoporosis and relieving menopause symptoms. One factor in bone health is limiting the amount of calcium lost from the body. Although protein, especially animal protein contributes to calcium loss, soy protein exhibits less calcium leaching effects. The isoflavones found in soybeans may also directly stop bone deterioration. Recent research has shown that soy foods can relieve most menopausal symptoms, thus reducing risks of cardiovascular disease and osteoporosis. Soybean is considered as a natural alternate for hormone replacement therapy for treating women who are in menopause.

Dr. Sharma highlighted the scope for the entrepreneurs to take up soybean as a viable business venture. He described various items which can be used as commercial products.

Soymilk is extracted from soybeans using modern technology and can be made to taste great while retaining all the nutrition of soybean. Although it does not taste like dairy milk it is tasty in its own right. Soymilk can be handled and used in much the same way as dairy milk. Besides being rich in protein, vitamins and minerals, soymilk is lactose free, cholesterol free and low in saturated fat. Soymilk can be made into hot and cold beverages like coffee, tea, fruit shakes, yogurt, ice cream, or can be used as such.

Tofu is the most popular among all the soymilk products. It is made by coagulating hot soymilk and removing the whey. Tofu is a versatile food and can be converted into a variety of value added products. Tofu easily takes the flavour of the product with which it is cooked. Tofu is a highly perishable product just like dairy products. It should be kept immersed in water under proper refrigeration, and water should be changed often.

This is nothing but addition of 10% defatted soy flour to wheat flour (add 1 kg defatted soy flour to 10 kg wheat flour) to make rotis, chapattis, puris etc. Addition of 10% soy flour to wheat flour increases protein in wheat flour from 11 to 16%. Several brands of wheat soy flour mix are already available in the market.

Add 20 % de-fatted soy flour to besan and use it to make products such as pakora, chilla, kadhi etc. The products made of this mix absorb 10% less oil than the products made out of just besan. Protein content and quality, of course, is enhanced. Besan is cheaper than soy flour in general.

Nuggets and granules are made of 100% defatted soy flour which has more than 50% protein and less than one percent fat. Nuggets and granules are healthy alternate to meat and can be used easily in Indian cuisine.

Soy nuts are whole soybeans that have been soaked in water and then baked until browned. Most conventional nuts are incredibly high in fat but soy nuts have less fat and more protein compared to conventional nuts. Soy nuts are similar in texture and flavor to peanuts and far less expensive than peanuts. Soy nuts have 50% more protein and 50% less fat than peanuts. Regular consumption of soy products such as soy nuts reduce incidence of various chronic diseases especially heart diseases and cancer.

Noodles and vermicelli are a form of pasta which is becoming extremely popular in India, even as continental and Italian delicacy. This is prepared by means of an extrusion machine which is basically made of stainless steel. The basic raw material for noodles is, refined wheat flour, which has inferior nutritional quality. Incorporating soy flour will not only improve the nutritional quality it will also give some functional benefits to the final product. Addition of 10–12% defatted soy flour to wheat flour gives a product with increased moisture retention in case of wet noodles, whereas, in the case of fried noodles it will save oil during frying. Soy fortified noodles not only increases the noodles strength but also increases the product yield without any effect on colour and taste. Just addition of 10% soy flour almost reduces 60% usage of eggs in case of egg noodles.

Dal analogue is a partially cook-extruded food based on edible grade Defatted soya flour, Whole-Wheat Flour and turmeric powder. The product can be fortified with micronutrients as per the requirements.

It is a high protein proprietary product" specially developed in the form of pellets resembles TUR/ARHAR DAL in appearance. It provides high protein, takes less time to cook than natural dal, have all the functional cooking properties and palatable taste. Besides the general use as dal it has huge potential in various feeding programs. It is made by using twin screw extruder which can also be used for making different kinds of TSP, snacks and value added extruded products.

In different bakery products i.e. biscuits, breads, muffins etc soy can be fortified with wheat flour, both for functional and nutritional reasons. In general replaced soy flour can be added up to 3% without changing formulation except water. In bakery products, three types of soy flour can be used based on the product. Currently a number of bakers are using enzyme active soy flour up to 1% as a bread improver. This enzyme active soy flour can be either full fat or defatted. Lecithinated soy flour is used as an alternate to whole eggs in cakes and dough nuts. By using lecithinated soy flour as an alternate to egg, the raw material cost can be reduced up to almost 25%.

Papad is another potential fortification opportunity for soybean in Indian traditional food products. Soy flour can be blended up to 30-40 per cent with black gram (urad dal) for manufacture of soy-fortified papad. Fortification of urad flour with soy flour at 30% will increase protein from 21% to 30%.

Soybean oil is a natural extract from whole soybeans. Odor-less and flavor-less, this clear oil is excellent for stir-frying as it brings out the flavor of foods. Due to its versatility, soybean oil is used in a variety of processed foods such as margarine, spreads, mayonnaise and salad oil. Soybean oil has a high smoking point, facilitating the cooking process.

Soybean oil is considered heart-healthy as it is cholesterol-free and low in saturated fatty acids – it contains 61% poly-unsaturated fatty acids. Two fat components essential for health and well being, linoleic and linolenic acids, are also found in the right proportions in soybean oil. It is also a good source of vitamin E. Like fish oils, soybean oil contains omega-3, fatty acid known to be protective against heart disease and cancer.

All the above products are being manufactured by various entrepreneurs on small, medium and large-scale all over the country. Excess capacities are also available. You can buy these products in bulk and could pack in your brand name.

Dr. Sharma mentioned that India is highly malnourished country and soy is the only cheapest and best source of protein to overcome the malnutrition problem of the country up to a great extent. Therefore, he emphasized that Govt. should take initiative to use soybean in feeding programs all over the country. This will not only improve the nutritional status of the country but also create employment opportunities on a regional basis.

View of Panelists

After presentation of the two lead papers, four panelists presented their views on various aspects related to soybean and its food uses.

Dr. Lalitha R Gowda, CFTRI, Mysore, introduced various soy-products developed at their centre. She indicated the use of urease index as biomarker for evaluating suitability of soy-products. She also informed that the centre had developed a 'biomarker kit' for day-to-day use so that fitness of the soy-products could be detected easily.

Mr. Manoj Agarwal, Soy-entrepreneur shared his experience on soybean business. He mentioned that the profit made out of soy-business is not up to the mark and needs boosting through market development. He also mentioned about the need of sensitizing the consumers about the benefits of soy-products for their popularization. For this purpose, mass awareness campaign through public media including TV, newspaper, etc. should be taken up early.

Mr. Raj Kapoor representing SFP&WA, New Delhi, described the issues related the to poor health-status index of Indian people, and the role soybean can play for its improvement. He indicated the need of making available quality soy-products for the benefit of the poor and nutrition-starving people of the country. The entrepreneurship development as well as industry-academic institution collaboration is the need of the hour to popularize soy-based food products. He also emphasized the need of awareness development of soy-food and its benefits among the masses.

Mrs. Manju Deshmukh, Soy Entrepreneur from Mumbai introduced the innovations made on extraction of soy oil and soy protein processings at CIAE, Bhopal. She described the importance of soy products for human health particularly women, and the necessity of promoting it in Indian market for the benefit of all. She informed that with awareness acceptance of soy-products has increased in the Mumbai market.

Mr. Bachchattar Singh, Soy Entrepreneur, shared his success story of soy-business which he started in 2002 after taking training at CIAE, Bhopal. He informed that the training helped him a lot and wished that such training be given to many more people so that many young unemployed youth can take it up as livelihood enterprise.

Mr. Daksh Gupta from Delhi shared his experience in business of soy-products, *tofu* in particular. He suggested that the entrepreneurs should be trained about the new norms of food safety and security.

General Discussion and Chairman's Remarks

A General Discussion was held after the presentations by the panelists wherein the participants expressed their experiences in soybean marketing and entrepreneurship development.

Co-chairman of the session Dr. Pitam Chandra highlighted the contributions made by the CIAE, Bhopal, in making soy-based small-scale industries popular among the youth. He mentioned about the training imparted to the entrepreneurs from across the country and their successes. He emphasized the need of proper counseling and financial support to the young entrepreneurs and market-support for launching small-scale soybean enterprises in the country.

In his concluding remark, Dr. V. Prakash mentioned that small-scale soybean industry requires a lot of guidance about the regulatory rules on Food Safety. He also mentioned about need of a National Soybean Literacy India Movement for Nutrition (SLIMN) with five generic products, namely, full fat soya flour, defatted soya flour, soya protein concentrate, fresh soya bean as a vegetable, and other minor soya bean products. The products should be labeled properly for their contents of trypsin inhibitor and other phytonutrients. Dr. Prakash emphasized the need for adoption of GM soybean in India for larger benefit of the Indian farmers and the consumers.

5. SESSION III: SOYBEAN FOR NUTRITIONAL SECURITY: POLICY OPTIONS

The session was chaired by Dr. R.S. Paroda, Chairman, TAAS. There were two lead papers in the session which highlighted the necessity of policy reorientation to make soybean a household food for fighting malnutrition.

Lead Paper I : Policy Reorientation for Soybean Production and Marketing by Dr. Ramesh Chand

Dr. Chand mentioned that from 1985/86 to 98/99, India witnessed highest growth of soybean production and productivity, which, he designated as the 'golden period' of soybean in India. It was, however, followed by a period of decline during 1999/2000 to 2002/03. The crop, again started to recover its growth during 2003/04 to 2012/13, which, he mentioned as 'period of renewed growth'. It is having such a high growth, which is only next to cotton. He predicted that in the next 30-40 years, it will surpass cotton to have the highest growth rate in India.

Dr. Chand pointed out some lacunae in the agricultural policy of the country, which have negative impact on growth of soybean. He mentioned that the minimum support price (MSP) of soybean is far below the market price and hence irrelevant. Therefore, it needs to be increased to make it attractive to the grower. The oil price in India, on the other hand is higher than other oils. Transportation cost further inflates it. Because of higher price, there is higher import of soybean oil in India. So, import duty is an important factor that may influence area of soybean in India. Therefore, a healthy import and marketing policy needs to be put in place.

Dr. Chand mentioned that India cultivates soybean, mostly as a rainfed crop. Therefore, area under irrigation, which, currently, is about 0.5% only, has to be increased so that production can be raised. Vegetable soybean and soy-products meeting Indian tastes are needed to make it popular. However, trade off will decide future of soybean as food or oilseed crop.

Dr. Chand finally recommended that trade policy needs to be revised to increase the tariff on import of crude soybean oil. MSP should be raised to make it relevant to the current market price. Similarly, risk insurance, tax incentives and enterprise development policies are to be implemented so that soybean cultivation becomes an attractive enterprise. He also mentioned about the need of introducing GM soybean in our country so as to increase production at lower costs of cultivation. Necessity of including soybean in mid-day meal and similar other programs may help alleviating protein-calorie malnutrition from our country.

Lead Paper II : Role of Soy Food in Malnutirtion Eradication by Mr. Girish Matlani

He indicated that about 30% households in India consume <70% of energy needed. Therefore, protein and calorie malnutrition is rampant in our country. To alleviate it, highly proteinaceous food like soybean should be a part of daily food. Mr. Matlani emphasized that low-cost energy food should be made available to the general population through various health schemes. Secondly, soyfoods should be pushed through various Govt. schemes viz., mid-day meal, ICDS, etc. Similarly, soyfood should be a part in the food of military, para-military, police jail invitees Govt. hospitals, etc, so that its benefit can reach the target group easily. Soybean should also be made part of the national food security mission so that food and nutritional security can be ensured simultaneously.

Mr. Matlani was of the view that the non-GM soy's productivity is not less than that of the GM soy. The reason for low productivity is poor seed replacement as in Madhya Pradesh.

Views of Panelists

There were three panelists in the session viz., Dr. Mahtab S. Bamji, INSA Honorary Scientist, Dr. N.K. Singh, National Professor, NRCPB, New Delhi, and Dr. Anwar Alam, former Dy. Dir. General (Engg.), ICAR, New Delhi.

Dr. Bamji mentioned that soybean is a treasure trove of nutrients, being rich in essential amino acids (good quality protein), calcium, iron, B- complex vitamins, health- promoting phytochemicals (isoflavones etc) and omega-3 fatty acid – linolenic acid. Therefore, consumption of soybean should be promoted to replace other diets and oils which are heavily tilted towards omega-6 fatty acid –linoleic acid.

Dr. Bamji also indicated that in order to benefit resource –poor population, particularly infants, children, adolescents and pregnant & lactating mothers, suffering from protein-calorie malnutrition and micronutrient deficiencies, soybean should form part of their diet. For this, fat-free soy cake can be used to enrich wheat flour which can be used in feeding programmes as chapati, or to make cereal-legume Ready to Use complementary foods for ICDS feeding programmes. Soya dal can be used as any other dal, if it is easy to cook, easily digested and affordable.

Dr. Bamji emphasized that bioavailability of micronutrients from soy-based diet needs to be examined, since, soybean like many other legumes is rich in fiber. Processed soya-based foods with low fibre content can be beamed at infant and child feeding, while that with high fibre and health-promoting phytochemicals should be used for prevention of age-associated degenerative diseases.

Mr. Bhaskarcharyya stressed upon the need to give wide publicity about soybean and its health benefits so as to popularize soy-foods among the consumers.

Dr. N.K. Singh, National Professor, highlighted necessity of GM soybean in India. He mentioned that there is limitless misunderstanding about GM crops, which needs to be addressed without further delay. For this matter, a 24-hr Agriculture Channel should be started in the National Doordarshan Program for wider publicity of the agricultural programs and their achievements. It can be used to popularize soybean food among the consumers. He also mentioned that research on GM soybean should be continued for the benefit of science and humanity.

Dr. Anwar Alam, discussed the importance of soybean and soy-food in the development of health and wealth of the consumers and the growers. He also emphasized the need of mechanization of soybean cultivation and harvesting so as to reduce the loss and cost of production. He mentioned about the implements developed by the CIAE for commercial cultivation of soybean in India.

General Discussion and Chairman's Remark

During general discussion, several participants, including the soybean entrepreneurs, shared their views and opinions.

Dr. M.M. Krishna, CFS (IFT) suggested that to help healthy growth and development of soy food processing industries in the country, and to promote and popularize soybean consumption, Government of India may set up a Soy Food Processing and Promotion Board (Soy Board). He also mentioned that every year India exports about 4 mt of high-protein soymeal to other countries while importing pulses at much higher prices. Therefore, initiatives need to be taken to retain the soymeal in the country and make it available to the protein-malnourished population in appropriate food forms at affordable price. This will not only help alleviating protein-calorie malnutrition from the country but also would minimize import of pulses.

Dr. Krishna also mentioned that it is necessary to include soybean in the national food security basket alongwith other cereals and millets. Soy-fortified wheat flour may be considered to be provided to the BPL card holders. The soy-based foods like defatted and full fat soy flour, soy fortified wheat and besan, soy dal analogue and textured soy chunks and granules need to be included as essential ingredients in the national nutrition intervention programmes like midday meals, ICDS, etc. to provide low-cost and high quality protein to the beneficiaries. He also suggested that all soy food products and soy fortified food products need to be considered on par with other staple foods like cereals and pulses and exempted from levy of all central and state level taxes and duties, to be able to provide these high nutritious foods at affordable price to the poor people. A separate Food Product Category may be created by the FSSAI for Soy food products including the food forms intended for inclusion in the food and nutritional security programme and other nutrition intervention/feeding programs run by the government.

Dr. R.T. Patil, mentioned that soybean is nutritious for animals too. It can enhance productivity of the farm animals through its consumption. However, awareness is still lacking among the animal growers and hence mass campaigning is needed to be created through mass-media.

Dr. Abul Hassan, CIFRI, Barrackpore, highlighted the use of soymeal as fish food. He mentioned that consumption of soymeal enhances the productivity and quality of the fish products. This can be an alternate route of supplying soy-protein to the non-vegetarian consumers. He further emphasized the need of organizing a workshop on use of soybean as food to the animal, birds and aquatic animals.

In the Chairman's remarks, Dr. Paroda mentioned that soybean in India should be promoted more as food crop, than oilseed crop. Appropriate agronomic practices should be worked out to include it in proper cropping sequences for higher benefit and sustainable agriculture in the country. For higher production and productivity, more areas need to be brought under irrigation and for this matter govt. policy is needed to support irrigation infrastructure development. ICAR, New Delhi, should encourage more research and development activities on soybean so that more number of widely adapted higher yielding varieties can be developed.

Dr. Paroda indicated that the KVKs need to be involved in popularization of the soybased food products developed by the soybean entrepreneurs in the country. He also mentioned about the need of developing a Centre of Excellence for Soybean in India. More soybean germplasm needs to be collected from other soybean growing country so as to widen the genetic base in our country.

Dr. Paroda emphasized that policy fatigue has to be eliminated to enhance MSP of soybean and make quality seed available at affordable price. There should also be a buy-back policy in non-traditionally soybean cultivated areas so that soybean cultivation gets popularized with increased productivity.

6. PLENARY SESSION AND RECOMMENDATIONS

The plenary session was chaired by Dr. S. Ayyappan, Secretary, DARE & Director General, ICAR, New Delhi. Dr. R. Chidambaran, Chairman, Scientific Advisory Committee to the Cabinet was the Chief Guest. Dr. R.S. Paroda, Chairman, TAAS presented the future Road Map, whereas Dr. Akshay Talukdar presented an account of major recommendations emanating from the workshop.

Dr. Ayyappan welcomed the Chief Guest and other dignitaries. In his Chairman's comments, he mentioned that soybean is the crop that holds potential to alleviate protein-calorie malnutrition, provided appropriate policy supports are given to increase its cultivation and popularization of its products. He also emphasized the need to change to import and marketing policy so as to make soybean a popular and affordable food.

The Plenary Session adopted the following main recommendations:

General Recommendations

1. Soybean is a treasure trove of nutrients. Therefore, use of soybean as human food needs to be promoted through appropriate policy interventions and public awareness initiatives. A Mission Mode project in this regard is fully justified at the national level.
2. Soybean is a crop of considerable importance to India. Its production has to be increased to ensure household nutritional security. Fortunately, India can double its soybean production in next decade, provided area is increased under assured irrigation both in the north and north-eastern region. What is needed is varietal diversification and good agricultural practices, including higher seed replacement rate, effective weed management, on-farm mechanization, ridge furrow planting, supplemental irrigation (1-2) and intercropping.
3. Use of full-fat-soy-flour in Indian diets at 10% level is already an accepted policy. Hence, fortified flour and other soy-products need to be promoted further under food product category by the Food Safety and Standards Authority of India (FSSAI). Further, these soy-products be considered as essential food items and be kept out of taxation network as a national policy.
4. Protein-rich soymeal be also promoted for local consumption as feed for fish and livestock in order to increase their productivity and increased income of resource poor farmers, especially in arid area. A brainstorming session in this regard could, hence, be organized involving all stakeholders to decide future road map.
5. Public-Private Partnership (PPP) has to be strengthened to promote small scale entrepreneurship, contract farming, licensing of new innovations and soy product development etc.
6. Krishi Vigyan Kendra (KVK) of ICAR, Home Science Colleges under SAUs, and some research institutions under CSIR, ICAR etc. are engaged in promoting use of various soy-products as human food. These initiatives need to be strengthened under the proposed Mission on Soybean.

Researchable Recommendations

1. Urgent initiative is needed to widen the genetic base of soybean, which is currently quite narrow. We need to exploit the untapped genetic potential, especially the wild and perennial gene pool, for higher productivity. Concerted efforts are, therefore, needed to introduce germplasm from China, South East Asian countries, USA, Brazil, Argentina as well as from IITA, AVRDC, University of Illinois etc.

2. Research efforts need to be concentrated to develop soybean hybrids with wide adaptability and enhanced productivity. Similarly, research efforts need to be intensified in the field of genomics, Marker Assisted Selection (MAS) and also GM soybean, especially for ensuring effective weed management, abiotic and biotic stresses as well as to attain higher yields.
3. Development and dissemination of rural based, low cost soybean processing technologies need to be promoted and popularized.
4. To intensify research in soybean, a Centre of Excellence must be created immediately by the ICAR at CIAE, especially to develop the new products and to provide training for small scale entrepreneur.

Policy Recommendations

1. For ensuring required coordination and addressing the problems of soybean growers, processors and consumers, a single window system through establishment of a establishment of a regulatory board namely, "Soybean Development Board" be ensured on priority by the Government.
2. Invariably, the existing trade and pricing policies are not favourable to soybean producers in India. Hence, there is a strong case to raise tariff on import of crude soybean oil from present 2.5 to around 10.0 per cent. Similarly, minimum support price (MSP) of soybean be raised to a level that is comparable to the market price and its procurement be ensured especially in new areas as northern and eastern India. Also while introducing soybean in rice-wheat production system, linkage with processing industry be established.
3. Tax incentives as well as tax holiday be given to soy-based industries, especially for establishing and expanding its use in non-conventional soybean growing areas. At the same time, a separate food product category by the Food Safety and Standard Authority of India (FSSAI) for all soy-based products be established. Also soybean must be exempted from all central and state level taxes and duties, in order to make it abundantly available to the consumers to combat existing protein malnutrition in India.
4. Though soybean is currently a rainfed (90%) crop in India, it offers good opportunities for doubling the production through productivity enhancement provided one or two supplemental irrigations are ensured. Hence, the rainfed tag on soybean has to be removed and it be popularized also in the irrigated areas, especially, for the diversification of rice-wheat production system in the Indo-gangetic plains. Soybean can fovourably compete with rice if its productivity can be ensured around 2.5-3.0 t/ha, which is technically feasible.
5. Soybean and processed soy-products (full-fat, defatted soy-flour, dal analogue, textured soy chunks etc.) need to be included in the nutrition intervention

programmes of the Central and State Governments such as mid-day meals, ICDS, military, para military, jails, Govt. hospitals etc. so as to provide low cost, high quality protein to the resource poor consumers. Also the soy-fortified wheat flour be made available through PDS and open markets to promote its use for household nutrition security.

6. India is exporting currently around 5.5 mt of protein-rich high quality soymeal annually @ Rs. 70/kg protein while importing pulses @ Rs. 360/kg protein. Therefore, to fight protein-calorie-malnutrition, which is predominantly high in India, the export of soymeal be rationalized to maintain a balance between internal demand and existing export potential, for which though there is good scope as soymeal from India is all non-GMO.
7. A compensation package, such as, nutrient subsidy equivalent for its high protein content and the nitrogen fixation in the soil be made available to the soybean growers. This alongwith high MSP, linked with procurement, both by Government and Private Sector, would accelerate higher growth of soybean production in India, for which there exists good scope.
8. More investment for soybean R&D (atleast three times) is needed urgently to harness full benefits by soybean growers as well as consumers. Also higher investments on human resource development, involving all stakeholders, would go a long way, in addressing household nutritional security through use of soybean as a food crop in India.

Dr. Paroda, stated that all these recommendations do reflect our future Road Map for making soybean a household food for nutritional security. He emphasized the need to make soybean now as a food-crop in India in order to fight the protein-calorie malnutrition. For this, he stressed on the need to use soymeal more within the country to combat protein malnutrition. He also emphasized the importance of continuing research in GM soybean so that higher production can be obtained while reducing cost on inputs.

Dr. R. Chidambaran, Chairman, Scientific Advisory Committee to the Cabinet, Govt. of India congratulated the ICAR and TAAS for this "excellent initiative" of popularizing soybean as a house-hold food. He mentioned that soybean holds considerable promise for food and nutrition security in the country. He emphasized on the need for developing soybean that meets the taste of Indian consumers. Marketing is an important issue which needs to be taken care of by concerned authorities and through needed policy support. He assured to address the issues relating to irrigation infrastructure development, inclusion of soy-food in mid-day meal, tax-holiday for soybean industries established in newer areas as well as popularization of soybean and soy-food through mass media. According to him, all these issues must receive best possible attention for nutritional security of our future generation.

Dr. N.K. Singh, Secretary, National Academy of Agricultural Sciences offered a vote of thanks to all the participants.

7. VISIT TO THE EXHIBITION

A small exhibition was organized, on this occasion, to show case different soy products and technologies adopted to produce soy products by organizations, like Durg, Ujjain, Hoshangabad, Durgapur, Sangroor (Punjab); BPD Unit, IARI; CIAE, Bhopal; M/s Vaishnavi Food, Warda; Anmol Soy Foods, Patiala and Sohan Soy Products.

The participants and visitors appreciated very much the exhibits displayed at the exhibition.

Annexure I

Brainstorming Workshop on "Soybean for Household Food and Nutrition Security"

Concept Note

Human beings have a strong desire to live longer and are always in search of an appropriate diet and medicine that can help them to live healthier, happier and longer. In this context, soyfortified diet is one of the best options and least expensive. Soybean is a grain legume and provides high quality nutrition, nutraceuticals and therapeutic ingredients that help people to live with an enhanced quality of life. Direct food uses of soybean are that it is more nutritious, healthy and economical.

Majority of Indian population, 60-70%, is vegetarian and derives its protein from cereals &legumes. 40% of Indian population is below poverty line and does not have enough purchasing power to buy pulses, the major source of dietary proteins. Soyprotein is least expensive and quality wise at par with animal protein and has no negative health effects. In fact, soyfortified diet suits the richest of the rich on health grounds and the poorest of the poor on economic considerations. The need is to give greater emphasis on processing and utilization of whole soybean as food product and make it available at an affordable cost to the economically under-privileged masses of India.

As of now, India is exporting about 5.5 million tonnes of soymeal @ Rs. 30,000/ tonne, worth Rs. 165,000 million, containing 50% protein i.e. 2.75 mt of high quality edible protein @ Rs. 60/kg of protein and at the same time, India is importing about 2 million tonnes of pulses @ Rs. 75,000/tonne which amounts to about Rs. 300/ kg of pulse protein. Vegetable protein (pulses) import in India is at about 5 times higher than the export of a better quality soyprotein.

The ICAR is making concerted efforts for production and utilization of soybean in India through Directorate of Soybean Research (DSR), Indore and Agro-Produce Processing (APP) Division (earlier SPU), CIAE, Bhopal, since 1985-86. SPU provides training to the potential small & cottage level entrepreneurs in production and marketing of soybased food products and till August, 2013 SPU has trained about 2235 entrepreneurs from different states of India and out of these, around 400 have started their enterprises.

Those KVKs which are located in the major soybean producing districts/states of India and are having Home Scientists can play a very import role in promotion of soyfoods in their respective districts to combat protein-calorie malnutrition and achieve the most desired goal of house-hold nutritional security for the people of the country, particularly that of the rural inhabitants. The needed technological backup support for production and processing would be provided by DSR, Indore and CIAE, Bhopal, respectively under the aegis of the ICAR.

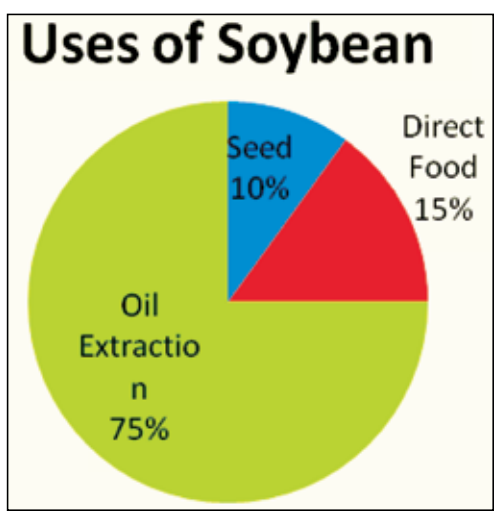
1. BACKGROUND

Human beings 7 billion or so, on the planet earth, rural or urban; male or female, have a strong desire to live longer and are always in search of an appropriate diet and medicine that can help them to live healthier, happier and longer. In this respect, soyfortified diet is one of the best possible and least expensive options. Soybean is a grain legume and provides high quality nutrition; nutraceuticals and therapeutic ingredients that help people live longer with an enhanced quality of life. Soybean has tremendous potential to be transformed into a number of healthy foods and pharmaceuticals suiting to each individual not only in India but across the globe. Soyprotein is one of the best proteins and least expensive.

2. PRODUCTION, PROCESSING AND UTILIZATION

Soybean production and utilization are growing globally. The present world production of soybean is about 230 million tones, accounting for nearly 57% of the total global oilseed production. Soybean provides approximately 60% of vegetable protein and 30% of oil to the world.

India produces about 11 mt of soybean annually and the major soybean producing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh and Chattisgarh. The growth in production and processing of soybean for oil in India has been encouraging but the direct food uses of soybean, especially that of the whole-bean, has been rather slow but it is growing each year. Present utilization pattern of soybean in India is, as 10% for seed purposes, 15% for direct food uses and 75% for oil extraction. Soybean oil is used domestically but most of the soymeal is exported.



3. POTENTIAL AND STRATEGIES FOR COMBATING PROTEIN-CALORIE MALNUTRITION

India today exports about 5.5 million tonnes of soymeal @ Rs. 30,000 /t, worth Rs. 165000 Crores, containing about 50% protein i.e. 2.75 mt of high quality edible protein @ Rs. 60/kg of protein and at the same time, India is importing about 2 million tonnes of pulses @ Rs. 75/kg which amounts to about Rs. 300/kg of pulse protein. Vegetable protein (pulses) import in India is at 5 times higher price than the export of a better quality vegetable protein (soyprotein).

The strategy should be to make use of whole-bean into food products through appropriate processing and make them available at an affordable cost to economically under-privileged population (40% or so) of India. Soybean could be processed at domestic level also and, thereby, help in combating protein-calorie malnutrition (PCM) at house-hold level at a very low cost. Promotion of soyfortified diet should become an integral component of programmes to achieve the Millennium Development Goals and other similar initiatives aimed at reducing global hunger and malnutrition.

Direct food uses of soybean in the form of soyfortified cereals/legumes/millets flour or Sattu; roasted/fried/fermented soysnacks; soymilk; soypaneer (Tofu), etc. are more nutritious, healthy and affordable for all.

Nutritionally, soyprotien is one of the best proteins and least expensive. Cost of one kg of soyprotein in the form of flour is Rs. 100-150/kg only whereas it is Rs. 300 from pulses, Rs. 480 from eggs, Rs. 1000 from milk, Rs. 1020 from chicken, Rs. 1080 from fish and Rs. 1800 from mutton (goat meat). There are no side-effects from eating plant proteins whereas considerable risks are associated with livestock products based diets.

The absorption/assimilation of health promoting soybean phytochemicals by humans may be better when taken/eaten as part of the foods prepared from whole-beans than when these phytochemicals are extracted and isolated from soybean and its products and then later used as micro-nutrient/medicine, as & when required. Examples are soybased isoflavones, lecithin, dietary fibre, fatty acids, etc. It, therefore, suggests that direct food uses of soybean is in the interest of humanity, on account of health & economic benefits and need to be encouraged and promoted.

Addition of soybean into wheat enhances the protein content and its quality and also improves the quality of chappaties, puries, parathas prepared from soy-wheat blended flour in comparison to that prepared from wheat flour alone. Economic and Nutritional Benefits of using soy-wheat flour is as under:

Economic and Nutritional Benefits of Soy-Wheat flour		
Cost of 1 kg of wheat flour	:	Rs. 25.00
Cost of 1 kg of fullfat soyflour	:	RS. 60.00
Cost of 1 kg of soy-wheat blends flour (10:90)	:	Rs. 28.50
Increase in cost on account of soy-fortification	:	Rs.3.50/kg

Nutritional benefits due to fortification, 10:90 (Soy:Wheat)			
Additional protein	:	30 g/kg.	Cost of 30 g of protein from pulses = Rs. 9.0 Hence a saving of Rs. 6.5/kg and better quality protein.
Additional calories	:	90 kcal/kg	
Additional fibre	:	2.8 g/kg	
Additional cost	:	Rs. 3.5/kg	
Phytochemicals	:	Reasonable Qty.	

Majority of the Indian population, 60-70%, is vegetarian and derives its protein from pulses and cereals and to some extent from oilseeds like soybean, groundnut and sesame. Proteins from milk, meat, fish & poultry are costly and only select group of rich population has access to it. About 40% of Indian population is below poverty line and does not have enough purchasing power to buy pulses, the major source of dietary proteins. Use of soybean as protein source is the only option for India to augment its protein supply at an affordable price to poorer sections of the population and thereby to ensure household nutritional security for all. One of the simplest ways of using soyprotein in diet is through soyfortified wheat flour.

Public-private partnership could help in creating greater awareness among policy makers and consumers to promote use of soybean as nutritious, cost-effective and healthy food. At the same time, industry & institutions need to work together for nationally/globally competitive and high quality soyproducts. Availability of such products needs to be assured through organized sector and small-scale decentralized soyfood processing entrepreneurs.

4. R&D EFFORTS

The ICAR has made a concerted efforts for production and utilization of soybean in India through DSR (The then NRC for Soybea) at Indore and SPU (Now APPD) CIAE, Bhopal since 1985-86. As of now NRC Soybean through AICRP, soybean has developed a number of soybean varieties giving higher productivity and the SPU, Bhopal has developed processing technology, equipment and pilot plants for 32 soybased food products such as full-fat soyflour, soyfortified bakery products, dairy analogs, roasted/fried/fermented/ extruded soy-snacks, etc, suiting Indian dietary habits. SPU provides training to the potential small and cottage level entrepreneurs in production and marketing of soy-based food products. Since December, 1995 and as of now (August, 2013), there are over 400 soybased food enterprises in different parts/states of India.

5. PROMOTION OF SOYBASED DIETS THROUGH KVKS

There are more than 600 KVKs in India located in each district of the state/ country and these units can serve as a soybean knowledge resource centres and promote soyfortified diet among rural people to combat protein calorie malnutrition (PCM) and help in achieving the much needed nutritional security and better health, at a low cost affordable by one and all. Technological backup support would be provided by SPU (Now APPD), CIAE, Bhopal and the NRC on soybean (Now DSR), Indore. To realize the goal, following approaches are suggested:

- Creation of awareness among people about the nutritional, health and economic benefits of using soybean in daily diet, through print and electronic media.
- Specialized training for food entrepreneurs in production and marketing of soybased food products and promotion of such foods through mid-day-meal programmes of schools, restaurants, military establishments and such other organizations where community kitchen exists.
- Making soyfoods available in the local markets through organized and/or decentralized production of such foods.

KVKs located in the major soybean producing states/districts of the country and having a number of scientists especially the Home Scientists and the Food Processing Engineers can play a very important role in promotion of soyfoods in their respective district to combat protein-calorie malnutrition at low cost and achieve the most desired goals of house-hold nutritional security for the people of the country, particularly that of the rural inhabitants. APPD (SPU), CIAE, Bhopal and the DSR (NRC Soybean), Indore would provide the needed technological backup support. Food values of soybean, its production status in Indian and abroad, and its various products have been depicted in the following Tables and Figures.

Table 1: The approximate food value per 100g of edible soybean

Constituents	Value, g
Protein	40
Carbohydrates	23
Fat	20
Moisture	8
Minerals	5
Fibre	4
Energy	430 kcal

Table 2: Major health benefits from the regular use of soybean in the daily diet

Soybased nutrients	General Health benefits on regular eating
Protein	Lowers blood cholesterol
Carbohydrates	Relaxes constipation, Good for diabetics
Fat	Prevents cardio-vascular diseases
Minerals	Overall health promotion
Vitamins	Overall health promotion
Phytochemicals	Prevent cancer, helpful in menopause and osteoporasis

Table 3: Some of the food uses of soybean and its derivatives

Soybean and its derivatives	Food/Feed/Fuel uses
Whole soybean (Containing all nutrients & Phytochemicals)	Soybean dairy analogs, fullfat soyflour, snack foods, sprouted bean, Tempeh, Miso, Natto and Sauce
Soybean Oil (20% of wholegrain)	Cooking/shortening oil, salad oil, margarine, bread spread, and soylecithin
Soyproteins (About 50% in edible soy meal)	Texturised soyprotein, soyprotein concentrate, hydrolysates & isolates, defatted soyflour, and dietary fibre
Soybean by products (hull & okara)	Single cell protein (SCP), dietary fibre, livestock feed, snacks
Soybean crop residue (leaf, branches & stems)	Animal feed, fuel and manure

Table 4: Protein digestibility corrected amino acids score (PDCAAS) of some of the selected proteins

Protein source	PDCAAS Value
Egg white	1.00
Casein	1.00
Soyprotein	1.00
Meat	0.92
Peaflour	0.69
Lentil	0.52
Wheat	0.40

Table 5: Approximate cost of one kg protein from some of the protein sources

Protein Source	Cost, Rs/ kg	Protein content, %	Cost of one kg protein, Rs	Remarks
Defatted Soyflour	35	50	70	Cost of one kg protein from: - Soybean: Rs. 70-100 - Pulses: Rs. 300 - Livestock: Rs. 480-1800
Fullfat Soyflour	60	40	150	
Split Pulses (dal)	75	25	300	
Egg	85	16	480	
Milk	40	4	1000	
Chicken	170	16	1020	
Fish	180	16	1080	
Meat	300	16	1800	

Table 6: World soybean production during 2010-11

Country	Production, mt	% of total production
USA	94	41.0
Brazil	59	25.7
Argentina	31	13.4
China	16	6.9
India	10	4.4
Paraguay	4	1.7
Others	16	6.9
World total	**230**	**100.0**

Table 7: World production of major oilseeds during 2010-11

Oilseeds	Production, mt	% of total world production
Soybean	230	57.5
Mustard/Rape	48	12.0
Cotton seed	45	11.2
Groundnut	32	8.0
Sunflower	28	7.0
Palm kernel	11	2.8
Coconut	6	1.5
Total	**400**	**100**

Table 8: Production of soybean in India during 1970 to 2010-11

Year	Production, million tones	Remarks
1970-71	0.01	It is a grain legume and contains high quality protein, fat, minerals and phyto-chemicals. Soybean productivity in India is about 1100 kg/ha. During the last few years, soybean annual production has been about 10mt and out of this 10% is used for seed, 15% goes for direct food consumption. The remaining 75% is solvent extracted for edible oil. Most of the soymeal containing about 50% protein is exported for live-stock feed. Soybean leaves and fine branches are used as animal feed.
1980-81	0.44	
1990-91	2.60	
2000-01	5.28	
2001-02	5.96	
2002-03	4.65	
2003-04	7.82	
2004-05	6.87	
2005-06	8.27	
2006-07	8.85	
2007-08	10.97	
2008-09	9.91	
2009-10	10.05	
2010-11	10.55	
2011-12	11.50	

Table 9: Major Soybean producing states of India during 2010-11

State	Productivity, kg/ha	Production, mt	% of total production
Madhya Pradesh	1105	6.42	61.0
Maharashtra	1060	2.75	26.0
Rajasthan	1130	0.76	7.2
Karnataka	1025	0.18	1.7
Andhra Pradesh	1075	0.15	1.4
Chhattishgarh	1050	0.16	1.5
Other States	1020	0.13	1.2
Total, all India	**1090**	**10.55**	**100.00**

Table 10: List of Soy-food Technologies Developed at SPU (Now APPD), CIAE, Bhopal (upto July 2013)

Soyproducts and Technology (34)	
Soydal (instant)	Soypaneer (tofu)
Soyflakes	Soy-yogurt
Soyflour-Full fat by blanching	Soy-ice cream
Soyflour-Full fat by sprouting	Tempeh
Soyfortified biscuits (sweet and salty)	Soy-sattu
Soy fortified kodo/kutki biscuits	Okara based burfi & Gulabjamun
Soyfortified bread	Soy-sauce
Soyfortified muffins/cup cake	Soy-shrikhand
Soyfortified bun	Soy-suji
Soy nuts (roasted/fried/fried)	Soybased sweet analog
Soy amrakhand	Soy sev
Soy based Rasogulla	Soy dosa
Soy dhokla	Soy idli
Soy fortified kodo/kutki based extruded products	Soy chakli
Soy Papad	Soy butter
SoyBati	Multigrain Biscuits
Soymilk	
Soybean Processing Equipment (23)	
Cleaner-Grader	Thermic fluid based deep fat frier
Manual dehuller	Plate type wet grinder
Power operated dehuller	Modified oil expeller
Blancher	Low-cost steam generator
Natural convection tray dryer	Soybean cake grinder
Forced convection tray dryer	Dough mixture
Multipurpose LSU type dryer	Lever-type paneer pressing device
Three-roller flaking machine	Screw-type paneer pressing device
Two-stage roller mill for soyflake	Cottage level soy paneer plant
Integral extrusion – expelling unit	Low-cost single screw forming extruder
Biscuit cutter	Dough mixer (lab scale)
Surface oil removing unit for soynuts	

Limited Scale Pilot Production Facilities for eight products	
Fullfat soyflour	Soypaneer
Partially defatted soyflour	Soyfortified bakery products
Soymilk	Soy ice cream
Soynuts (enrobed, fried and roasted)	Soy protein isolate and concentrate

SOYBEAN – The Golden Grain of the Globe

- Soybean is a food legume and excellent source of nutrition and health promoting phytochemicals.
- Regular use of soybean in daily diet enhances and protects human health at reduced cost.
- Direct food uses of soybean is in the interest of mankind and need to be promoted

Table 11: Training Imparted by SPU (Now APPD), CIAE, Bhopal to upcoming entrepreneurs for establishment of soy based enterprises in different states of India

(As on August, 2013)

State	Total No. of trainees	No. of Enterprises established
Andhra Pradesh	67	18
Assam	5	0
Bihar	31	0
Chhattisgarh	48	5
Delhi	80	20
Gujarat	67	15
Haryana	140	38
Himachal Pradesh	22	5
J & K	3	2
Jharkhand	21	3
Karnataka	17	4
Madhya Pradesh	577	31
Maharashtra	459	46
Meghalaya	7	1
Orissa	11	3
Pondicherry	3	1
Punjab	241	127
Rajasthan	136	25
Sikkim	2	1
Tamil Nadu	10	5
Uttar Pradesh	200	28
Uttrakhand	64	10
West Bengal	18	2
Kerala	1	0
Nagaland	5	0
Total	**2235**	**400**

Soy-fortified Baked Products



Soy-based Snack Foods



Soy-Dairy Analogs



Program

DAY I : FRIDAY, 21 MARCH, 2014

10.00-10.30	**OPENING SESSION**
	Chief Guest : **Dr. S. Ayyappan**, Secretary, DARE & DG, ICAR
	Chairman : **Dr. R.S. Paroda**, Chairman, TAAS
	Welcome Address : **Dr. H.S. Gupta**, Director, IARI
	Inaugural Address : **Dr. S. Ayyappan**, Secretary, DARE & DG, ICAR
	Chairman's Remark : **Dr. R.S. Paroda**, Chairman, TAAS
	Vote of Thanks : **Dr. N.N. Singh**, Secretary, TAAS
10.30-11.00	*Keynote Address* : **Dr. Nawab Ali**, Former DDG (Engg.), ICAR
11.00-11.30	**Tea Break and Group Photograph**
11.30-13.30	**Session I: Increasing Production and Productivity of Soybean**
	Chairman : **Prof. R.B. Singh**, Former President, NAAS
11.30-12.00	Lead Paper I : Prospects of Doubling Soybean Production in India **Dr. H.S. Gupta**, Director, IARI
12.00-12.30	Lead Paper II : Improving Soybean Productivity in Different Agro-climatic Situation **Dr. S.K. Srivastava**, Director, DSR
12.30-13.10	*Panelists* : (10 Minutes each) **Dr. K.D. Kokate**, DDG (Agri. Extn.), ICAR **Dr. Vineet Kumar**, Senior Scientist, DSR **Dr. A. Talukdar**, Principal Scientist, Genetics Division, IARI **Dr. A.K. Vyas**, Head, Agronomy Division, IARI
13.10-13.30	**General Discussion**
13.30-14.30	**Lunch**

14:30-16:00	**Session II: Food Processing Technology Soy-based Food Products**
	Chairman : **Dr. V. Prakash**, Ex-Director, CFTRI
	Co-Chairman : **Dr Pitam Chandra**, Director, CIAE
15.00-15.30	Lead Paper I : Processing Technology for Direct Food Uses **Dr. SD Kulkarni**, Principal Scientist, CIAE (Former PD-SPU, CIAE)
15.30-16.00	Lead Paper II : Soy Food Business Opportunities in India on Small, Medium and Large Scale **Dr. Rattan K Sharma**, Tech Director, Soy Foods U.S. Soybean Export Council
16.00-17.30	*Panelists* : (10 Minutes each) **Dr. Lalitha R. Gowda**, Chief Scientist, CFTRI **Mr. Manoj Agarwal**, Soy Entrepreneur **Mr. Raj Kapoor**, Chief Executive, SFP&WA **Mrs. Manju Deshmukh**, Soy Entrepreneur **Mr. Bachchattar Singh**, Soy Entrepreneur **Mr. Daksha Gupta**, Soy Entrepreneur
17.30-18.00	**General Discussion**
18.00-19.00	Exhibition Visit
19.00	Reception Dinner

DAY II : SATURDAY, 22 MARCH, 2014

10.00-13.00	**Session III: Soybean for Nutrition Security: Policy Options**
	Chairman : **Dr. R.S. Paroda**, Chairman, TAAS
10.00-10.30	Lead Paper I : Policy Reorientation for Soybean Production and Marketing **Dr. Ramesh Chand**, Director, NCAP
10.30-11.00	Lead Paper II : Role of Soya Food in Malnutrition Eradication **Mr. Girish Matlani**, Sonic Biochem
11:00-11:30	**Tea Break**

11.30-12.30	*Panelists* : (10 Minutes each)
	Dr. Mahtab S. Bamji, INSA Honorary Scientist
	Dr. N.K. Singh, Secretary, NAAS
	Dr. Anwar Alam, Former DDG (Engg), ICAR
12.30-13.00	General Discussion
13.00-14.00	**Lunch**
14.00-15.00	**Plenary Session**
	Chief Guest : **Dr. R. Chidambaram**, Chairman, Scientific Advisory Committee to the Cabinet
	Chairman : **Dr. S. Ayyappan**, Secretary, DARE & DG, ICAR
	Welcome & Chairman's Remark : **Dr. S. Ayyappan**, Secretary, DARE & DG, ICAR
	Recommendations of the Workshop : Session Rapporteurs
	Future Road Map : **Dr. R.S. Paroda**, Chairman, TAAS
	Address by Chief Guest : **Dr. R. Chidambaram**, Chairman, Scientific Advisory Committee to the Cabinet
	Vote of Thanks : **Dr. N.K. Singh**, Secretary, NAAS
	Rapporteurs for all Sessions
	Dr. V.R. Sagar, Head, PHT Division, IARI
	Dr. Akshay Talukdar, Principal Scientist, Genetics Division, IARI

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Recent TAAS Publications

- Brainstorming Workshop on "Emerging Challenges before Indian Agriculture - The Way Forward", March 6, 2009 - Proceedings & Recommendations.
- Brainstorming Workshop on 'Strategy for Conservation of Farm Animal Genetic Resources' 10th – 12th April, 2009 – Ranchi Declaration.
- Brainstorming Workshop on "Climate Change, Soil Quality and Food Security", August 11, 2009 – Proceedings & Recommendations.
- Millions Fed: Proven Successes in Agricultural Development, January 19, 2010 (Translation in Hindi jointly published by IFPRI, APAARI and TAAS)
- National Seminar on "Quality Seed for Food Security through Public-Private Partnership", April 13-14, 2010 – Proceedings & Recommendations
- TAAS Foundation Day Lecture on "Climate Change and Food Security: From Science to Sustainable Agriculture" by Dr. Mahendra M. Shah, May 7, 2010
- NSAI Foundation Day Lecture on "Revitalizing Indian Seed Sector for Accelerated Agricultural Growth", October 30, 2010
- Brainstorming Session on Prospects of Producing 100 million tons of Wheat by 2015 and presentation of Fifth Dr. M.S. Swaminathan Award for leadership in Agriculture - Proceeding & Highlights December 18, 2010
- National Dialogue on Building Leadership in Agricultural Research Management, Hyderabad, August 27 - 28, 2010 - Proceedings & Recommendations
- Stakeholders' Interface on GM Food Crops, May 19, 2011 - Recommendations
- TAAS Foundation Day Lecture on "Harnessing Knowledge for India's Agricultural Development" by Dr. Uma Lele, August 12, 2011
- Strategy Paper on "Implementing the International Treaty to Address Current Concerns about Managing our Plant Genetic Resources" by Dr. R.S. Paroda. January 23, 2012
- The Sixth Dr. M.S. Swaminathan Award Lecture on "Challenges and Opportunities for Food Legume Research and Development" by Dr. M.C. Saxena, January 25, 2012
- Proceedings and Recommendations of Farmers' Led-Innovation. December 23-24, Hisar, Haryana, 2011
- Proceedings and Recommendations of Global Conference on Women in Agriculture. 13-15 March, 2012 New Delhi; India.
- The Seventh Foundation Day Lecture on "Ensuring Food and Nutrition Security in Asia: The Role of Agricultural Innovation" by Dr. Shenggen Fan, DG, IFPRI. January 11, 2013
- Proceedings & Recommendations of "Foresight and Future Pathways of Agricultural Research Through Youth" March 1-2, 2013
- Strategy Paper on "Managing Our Water Resource for Increased Efficiency" by Dr. R.S. Paroda. May 28, 2013
- A Brief Report on Seventh Dr. M.S. Swaminathan Award presented to Dr. William D. Dar, DG, ICRISAT, Hyderabad. June 24, 2013
- Proceedings and Recommendations of "Brainstorming on Achieving Inclusive Growth by linking Farmers to Markets", June 24, 2013
- Strategy Paper on "The Indian Oilseed Scenario: Challenges and Opportunities" by Dr. R.S. Paroda. August 24, 2013.
- Proceedings and Recommendations of "National Workshop on Outscaling Farm Innovation", September 3-5, 2013.
- Recommendations of Brainstorming Workshop on "Soybean for Household Food and Nutrition Security", March 21-22, 2014.