Editorial 2

Pivotal Role of Seed Industry in Global Food Security in Current millennium

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Introduction

When we are now feeling pride in living in a global village, global food security is a concern for all. Nutritional security has added a new dimension to food security. Food comes from plants directly and also from animals, which in turn are dependent on feed security based on plant products. Fuel security to meet energy crisis is a recent phenomenon, which also affects food security because a significant proportion of food crops are diverted to growing grains and biomass for bio-fuel production. Land area is not only limited, but is also being eroded by encroachment on agricultural lands for human habitation, setting up various industries and other infrastructure. Population is increasing at an alarming rate and arable land per caput for food security and other needs is inadequate to produce the needed quantum and quality of foods for the immense population that is further increasing day by day.

Agriculture is predominantly rain-fed cultivation in the world and water sources for agriculture all over the globe have become limiting factors for enhancing the area under irrigation. Enhanced yield could not therefore be attempted by increasing the cultivated area under irrigation. Climate change has also begun to be felt on various ecological and meteorological phenomena and may gradually show more adverse impacts in the next fifty years.

How seed industry will drive the 21st century agriculture and food crops in particular and therefore the food security of the world will depend on new innovations in genetics and genetic engineering to alter the potentials of various key crops influencing food and feed production and acceptance of such novel gene insertion technologies by the governments and the public at large. Very challenging times are ahead and new technologies could be innovated by continuous efforts in plant breeding, genetic engineering and other disciplines. Seed is a critical input that can generate newer potentials for agricultural growth and also can generate the possibilities for triggering an ever-green and dynamic revolution with sustainability at new peaks.

Agri-business

Agri-business is a large global industry with a global market of USD 60billion that includes conventional seeds 14b$, GM seeds 7b$ (total seeds 21b$); crop protection 33b$, and non-crop chemicals 5b$. Due to the aggressive emergence of plant protection chemicals in the wake of increase in pests on commercial crops like cotton and food crops like rice and vegetables and consequent international attention, action was initiated on reducing the use of toxic pesticides and reducing environmental pollution resulting in the emergence of new gene technologies

Seeing the high value in seed business, many pesticide giants resorted to seed business in large measure by investing in advanced plant breeding, genetic engineering and seed technology. Thus the seed industry gained prominence due to high yielding varieties, high yielding hybrid varieties of major crops and subsequently the transgenic technologies of making the hybrids and varieties carry their own in-built genes for self-protection and other developments like seed treatments as value addition to growers.

Private Seed Industry & Major Players

There are several multinational corporations and such MNCs included Novartis, Syngenta, Bayer Crop-science, Monsanto, DuPont Pioneer, BASF and Dow-Agro. After mergers, global competitors today are represented by DuPont Pioneer, Monsanto, Syngenta, Dow-Agro Sciences, BASF, Bayer Crop science and Advanta International. Many of them have high stakes in Indian seed business in various food crops especially corn, rice, and sorghum and also oilseed crops.

In India, the private seed industry is a great conglomeration of too many players small, medium and large numbering over 590 or so. The major shares in seed business is held by Nuziveedu Seeds, Rasi Seeds, Mahyco-Monsanto, Vibha Seeds Group, Ankur Seeds, Thulasi Seeds, Krishdhan, Nath bio, Bio-seeds international, Ajit seeds etc. About 40 to 60 per cent of revenue of various Indian seed companies come from the sale of seeds of food crops and rest from cotton.

World-wide seed sales in 2010 were estimated high; such as world's all crop seeds 42billion$. For USA, it was 8.7b$ and USA as percentage of world was 20.7%. Of this 9% were vegetable seeds, 11% oilseeds, 37% grain seeds and 10% miscellaneous seeds. The following based on Yogeshwara Rao, 2010 in a lecture at National Academy of Agricultural Research Management at Hyderabad India gives an idea of the value of domestic markets for seed in certain major countries (Table 1).

World population

The population in 1950 was 2.5 billion, in 2005-6.5b and expected to reach 8billion in 2030 as per some estimates. The

Table1: Value of Domestic Seed Market (top 10 countries in 2010)	
Country	Domestic market value (USD million)
USA	12000
China	6000
France	2370
Brazil	2000
Germany	1950
India	1500
Japan	1250
Italy	715
Argentina	695
Canada	550
Source: International Seed Federation, 2010; As per the Indian estimates, the Indian Seed Industry is Rs 12000 crores which is likely to touch Rs 15000 by 2015	

projected population by 2050 is 9.0 billion. The number of people fed per hectare in1980 was 2, in 2005:4; and expected to be fed in 2030 to exceed 5 people. This means that enormous increases in productivity have to be achieved in the next few decades to keep control on food needs and food security. The world's food shows falling supply, rising prices, lower stocks to use ratio (24%) etc., and these are concerns today in relation to food security. Food security is coupled with feed security. Food security includes both produce from crops and animals. All these are related to seed security in all food crops and for all agro-climatic regions of the world. Demand drivers include- food; population growth; feed; calorie demand; fuel-oil substitution in the immediate term and the long-term drivers are the increasing population and increasing wealth with 2billion more people by 2030 expecting various requirements for sustainability and satiation of new desires.

The Role of FAO

The FAO was established in 1945. In 1946, the first World Food Survey brought out the food security concerns in the context of changing development perspectives. In 2004, major food production was estimated as cereals: 2266 million tonnes, vegetables and melons: 866m.t, roots & tubers: 715m.t. milk: 619mt. fruits: 503mt; meat: 259mt, oil crops 133mt; fish 130mt; eggs: 63mt; pulses:60mt and vegetable fibres as 30mt; Sugarcane output was1324 m.t, maize:721mt, wheat 627mt, rice 605mt, potatoes:328mt; sugar beet: 249mt; soybean:204mt, oil palms, fruits 162mt, barley 154mt and tomato 120mt; In the last six years, it has increased by about 10-15 per cent in different commodities and some fluctuations have been due to erratic monsoons and other unfavourable conditions in different commodities.

Major Concerns on Food Security Front

These include sustainability; food, energy and water shortages by 2030; and catastrophic constraints; GM / agrochemicals lobby and the recent organic farming lobby and the lobby that such gimmicks cannot feed the world population. The total daily calorie intake is estimated at 2000 to 2500 per person for current and future populations. Nearly one third (1/3) or 33 percent of the global grain is fed to livestock and added to this a little over 20% of USA corn is diverted to bio-fuel production to fuel cars. The existing system in India and certain countries are not sufficient for long term food security. High levels of meat consumption and increasing appetite among the more affluent consumers in developing countries for meat is another concern to food security. Monsanto and others claim that only GM crops can feed the world and this is contested by various groups. Population issue serves agribusiness interests, but does not consider the carrying capacity of our Planet Earth to feed the world and there are views of various approaches.

Countries may face the problems of credit crunch versus food crunch. USA, the most important exporter of food grains has now diverted 20% of its grain output to bio-fuel production. There is a rising demand for animal feeds for intensive meat production in developed and developing countries. Climate change perceptions are adding to the poor harvest expectations. Soil erosion is expected to affect 157million hectares by 2050 as predicted / estimated by world bodies. The options for the future might be to pursue low carbon, organic, more labour (but labour is not available) and intensive food production involving 15-24% population to grow food for all.

Changing Food Habits & Food Markets

Fundamental changes are taking place in food systems all over the world especially in developing countries. Transformation process is happening in which the share of agriculture is declining in favour of other sectors. As a result of changes in demand patterns and technology, changes in food systems are resulting in reorganization of food markets. Agricultural transformation has now become a global phenomenon. There are many driving forces for food system changes. These include rising incomes, diet diversification out of staples, demographic shifts and urbanization. In the state of food security defined in 2004, it was concluded that the Asia Pacific and Latin American countries and Caribbean got high attention in 1990s and not sub-Saharan Africa. Large retails were created in 1980-2001 in EU countries, USA and also UK with supermarkets and increasing retails. These developments have an impact on food security and the same is getting replicated in other countries as well including India.

In the liberalized and globalized scenario, new developments like centralization of procurement and squeezing of suppliers lists, shift of spot markets to specialized wholesales to guaran-

tee quantity and quality with new intermediaries and logistics, contract farming-preference of limited transactions, risk of private standards-quality and safety factors, rapid spread of chain model and competition for market share at the chain level have been witnessed. All these have more generalized impacts than on small farmers. The following figures indicate the share of GDP in agriculture (Table 2). Agricultural transformation processes are occurring in various ways such as increasing scales of production, farm size, and productivity reversal, declining competitions of marginal lands and increasing risk of biodiversity loss and environmental sustainability.

Table 2: Share of GDP in agriculture

Share of	Traditional agriculture	Modernizing agriculture	Industrialized agriculture
Agri in GDP	>30%	10-30%	<10%
Agri-labour in GDP	>50%	15-50%	<15%
Meat orientation	subsistence	National	International
Output Mix	Food & staples	Food staples + high value	Highly differentiated
Scale economies	Not important	may be important	Important

FAO & Changes in Global Systems

Such rapid transformations change the balance of concerns between domestic factors and international trade. Food security is a primary objective of development. The concept of food security became prominent and a focal point of global politics after the establishment of the UN-FAO. FAO was established in 1945 with a special purpose and a clear-cut vision and mandate and the constitution was finalized in 1945. The major objectives are to raise the levels of nutrition and living standards, improve the efficiency in production and distribution of food and agricultural production, better the conditions of rural populations, contribute to an expanding world economy and ensure the humanity freedom from hunger. All these needed a big push to development, balanced growth, backward and forward linkages and to solve problems of poverty, undernutrition and food insecurity.

In recent decades, the FAO had witnessed several changes in the global systems such as greater financial uncertainty, end of stability of exchange rates, major increase in oil prices and benefits to OEC and difficulty to OICs etc. In 1972-74, the world food crisis, the fall of cereal production; major cereal purchases on world markets, reduction in grain availability and food price increases caused global concern. In 1974, the world food conference was held and priority concerns were on world food scarcity, higher production to ensure availability in developing countries, greater stability in food supplies and food prices, creation of food reserves at national and regional levels, cost and management of food reserves etc. All these are concerned with the issue of food self-sufficiency. Subsequently also there were problems like soaring debt (petro dollars) and second oil price increase; international recession; higher interest rates; higher debt servicing costs; and fear of crisis of banking system;; privatization and liberalization and the global political and financial instabilities have been of great concern to food security. The expanded concept of food security (availability, stability and access) was evolved and research on new lines and institutional economics were the subject of discussion. In 1996, the World Food Summit was held and in 1975, International Fund for Agricultural development was established. The FAO planned for more equity and employment and less of poverty and food insecurity. The global food security thus faced several dimensions and in this context of high complexity, the role of private seed industry in helping towards global security in food, feed, nutritional standards and seed along with maintenance of biodiversity is discussed.

Private Seed Industry & its Common Philosophy

Public sector seed corporations like the National Seed Corporation established in 1968 followed by 13 state seed corporations in various states have played excellent role in production of quality seeds of public-bred varieties and hybrids and ensured at least 20-35% seed replacement ratios in various crops and were entrusted with mandates that are different from private sector due to need for fulfillment of social responsibilities by the Government agencies to help all classes of framers and at affordable or subsididized prices, besides for each and every crop grown by the farmers. The Seed laws and certification procedures were evolved and the testing and release mechanisms through the state and central seed release committees were evolved and dovetailed with the All India Coordinated Crop Improvement projects and State agricultural Universities.

Private seed industry established since 1960s became stronger in 1980s to 1990s and took a lead over the public sector seed corporations in the subsequent years claiming a major share of over 85 per cent in overall seed production and distribution providing a high replacement ratios in various important crops of profit potential to the seed companies. The private seed companies gained ascendancy over the public sector seed corporations because of their high investment in research and development including biotechnology for development of proprietary hybrids from 1990s and transgenic hybrids since 2002. The national seed association of India represents the majority of the private seed companies and seed industry in general and has evolved mandates, identified a new vision and dedicated mission orientation in respect of their services to agriculture and farming community as discussed below:

- To create sustainable and mutually beneficial public-private

partnerships.

- Increase investments in R&D and indigenously develop new technologies;
- Importing new generation technologies–future generation needs;
- Free flow of germplasm between public sector and private sector and especially the public-private;
- Smoother import of germplasm and planting material for R&D, contract multiplication and commercialization;
- A regulatory framework that is flexible, responsive, transparent and predictable;
- Greater consumer education, consumer protection, free flow of science-based information to farmers and a level playing field.

Its major goal is integration of all seed associations to be truly representative of the entire seed industry to speak with one unified voice, create R&D hubs, have global technology and financial partners; spending 15-18% of turnover in R&D, growing R&D budgets of medium sized companies at 20% per annum.

The approaches should be dynamic, innovative, internationally, compatible, research-based industry producing high quality seeds and planting materials; benefit farmers and significantly contribute to sustainable growth of Indian and global agriculture. It should help in the investment in state of the Art R&D to bring Indian farmers superior genetics and new technologies, which are high performing and adaptable to wide range of conditions of agro-climates and aim at global competition.

Food Security concerns are influenced by rising population, increasing cost of cultivation and low productivity, global and WTO regimen, more demand for limited water, inadequate support and infrastructure, ecological degradation, coastal zones (fish and other marine products for food), demand for more animal feed from agricultural products for feeding meat consuming populations, the extreme weather and other natural and man-made factors. Rain-fed agriculture is a major challenge. Role of seeds in modern context also includes revolution in biotech-led agriculture step change: traits, seed treatments and MAS for precision and rapid breeding etc.

Global agricultural production should increase from 4.1billion tonnes today to 6.0billion tones in 2020 to be achieved through productivity levels opportunity, cost competitiveness and new opportunities. Quality food, bio-fuels, animal feed etc., are major concerns. Industry challenges are identified as climate-change, water, heat and salt; new pests: nematodes, whiteflies, mealy bugs, wilts and virus mosaic etc., environment concerns and sustainability levels. For example, in corn, 70%+ goes for animal feed and 23% for bio-fuel production. Similarly in soybean, 60% goes for animal feeds and in wheat 80% goes for human consumption and in rice 90% is used for human consumption.

Free market economy, no state control of seed pricing, low interest and high credit to seed sector, encouraging more private plant breeding and biotech innovations; and exploring hitherto unfathomed areas will all help in promoting an excellent seed industry to work towards global food and feed security.

Crop Priorities for Global Food Security

Seed companies in the private sector operate on the basis of profit margins and had preferred low volume-high value seeds in most cases to earn sizable returns on investments. Now a days, hybrid and transgenic technologies that were giving huge margins of profit are also affected by heavy competitions between various players, labour shortages, finding sufficient seed production area problems, and undue escalation in cost of labour wages and lack of adequate irrigated areas for assured seed production

Immense Scope for Seed Research

Research has immense scope for crop improvement for achieving higher yields, quality of produce, nutritive value enhancement, novel attributes of new market value and consumer attraction, defect elimination in certain crops and also cost-effective outputs to satisfy the consumers in industry and public. However these are dictated by potential yields, theoretical maximum potentials vis-a vis realizable potentials of C3 and C4 crops, response to best management practices and varied input situations, restricted irrigated and stress situations. There are also limitations of genotype developed for one country and one situation to another country or ecology, but nevertheless there is scope for contract seed production, germplasm exchange and other cooperative endeavour for special efforts in transgenic and breeding researches.

Food security crops are many. Food (human consumption) and feed crops (for livestock feeding, which in turn serve as human food either as milk or meat) including those crops, whose grains are diverted by some advanced countries for bio-fuel production and vegetable crops which provide nutrition to under-nourished as well as those with balanced diets are numerous. Fruit crops have been excluded from the purview of the conventional seed industry as they attract different type of agri-business. There are crops like banana a vegetable-cum fruit crop, sugarcane, sugar beet, grapes, potato, tapioca, sweet potato, yam, colacasia and a host of others like coconut, palmyra, oilpams are under a different planting material regime, being either clonally propagated, tissue culture and other propagation technologies. Many minor grain crops like finger millet, other minor millets and minor pulses, amaranths grain etc., are still predominantly outside the purview of the private seed industry.

The crops which presently attract the attention of the private seed industry are as follows:

- Rice, wheat, grain maize, bajra, jowar, sweet Sudan grass (SSG), baby corns, pop corns in direct food crops or grains;
- Sunflower, mustard, castor, sesame, safflower, etc in oilseeds;
- Pigeon pea, green gram, black gram, Bengal gram under

major pulses

- Vegetables group: hot pepper, tomato, eggplant, okra, gourds like bottle gourd, bitter gourd, ridge gourd, sponge gourd, snake gourd etc), melons (water melon, musk melon and several other types); cucumbers (slicing cucumber, pickling cucumber etc), sweet corn, pumpkin, ash gourd, cole crops (cabbage, cauliflower, knoll kohl, beet root, sweet pepper Capsicums, chowchow (*Schium edule*), drumstick, gherkins, beans, peas, cluster beans, coccinias, etc, besides onion, garlic, cowpea, carrot, coriander, leafy vegetables (several kinds including *Sesbania grandiflora (agathi), Fenugreek (Methi) etc)*. In addition, there are local variations of several other crops. All grasses and fodder from grain and legume crops are useful for animal feed and in addition cotton seed cake besides other oilseed crop cakes are preferred animal foods. Thus as far as food security is concerned, a large number of crops and animal foods can contribute to enhancement of food out-puts.

The problem here is only about 30 crop plants have attracted the attention of the private seed industry, a few more are tackled by public sector R&D and seed corporations and many others are local farmer to farmer or local seed men to local farmer transactions. With suitable incentives and more research and non-discrimination of varieties over hybrids and farmers' support, more crops could be covered by the private seed industry. However, it is also the joint responsibility of private and public sector seed research and distribution system to improve all crops and work towards attaining global food security.

Role of Animals in Food Security through Agri-Outputs

Animal breeding is a specialized area and not covered directly under private seed industry. But there are areas like animal genetics and breeding for high milk yields, egg yields and meat yields and various feeds also play an important role in animal nutrition to enhance the output of animal based products. Fishes and prawns also constitute valuable food for human beings and only relatively less connected to their yield levels in marine fisheries and highly connected with inland fisheries which require food from plant products. In future animals may be developed by non-sexual means via stem cells and raising such animals may require gregarious quantities of foods like for such goats, cattle, buffaloes, camels, pigs, other animals etc. There are countries and locations where other insects and certain live creatures serve as food, but they themselves eat away lot of plant produce and products in the production, processing and storage stages accounted under crop losses due to biotic stresses.

Food Destroying Animals & Abiotic Causes

Rats, jackals, wild boars, porcupine, elephants etc., take a heavy toll on agricultural productions both in the field and storage and a sizable food production are lost in spite of all-out efforts to increase food production for food security. Parrots and several other birds also cause losses of food grains in standing crops like maize etc. Other animals like jackals, boars and grazing cattle and sheep and goat also damage a significant part of the expected crop outputs. The losses caused by insects and diseases and also locust storms are manifold and even after R&D on biotic stress management by all out efforts, incurred losses are considerable.

Abiotic stress takes annually heavy toll on food production due to droughts, scarce and scanty rains, low replenishment of underground water discharge, cold, heat, storms and fires etc., the yield levels expected based on research are not realized in many countries. Weather abnormalities due to climate change have become recent phenomena and may increase in the next fifty years or so as predicted by various agencies and scientists.

The systems of storage of food for food security represents one major factor for loss of much of the produced foods, whether it is grain, oilseeds or vegetables or fruits both in terms of quality and quantity.

Research Thrust, Innovations & Constraints Management

How seed industry will drive the 21st century agriculture and food crops in particular and therefore the food security of the world will depend on new innovations in genetics and genetic engineering to alter the potentials of various key crops influencing food and feed production and acceptance of such novel gene insertion technologies by the governments and the public at large. Very challenging times are ahead and new technologies would indeed trigger a new era in various spheres of agricultural production and food processing through basic and applied research-based advancements in genomics and biotechnology.

Solar energy capture through photosynthesis is the secret of crop plants' success and support to produce farm products for food and feed security. There are many areas of physiological approaches to conversion (C3 to C4) of at least certain major crop plants to improved photosynthetic capacity and this is an eco-friendly way of agricultural output enhancement. These all require specialization and multiple disciplinary involvements. The outlook for protein engineering in crop improvement is also bright.

Diverse areas of research especially in seed technologies, germplasm, transgenics, non-transgenics and seed treatments, which includes conventional breeding, agronomic traits, quality traits and germplasm pre-breeding; molecular markers and quality, nutracutical traits etc., require special treatment in the hands of seed industry investors as well as policy-makers. In USA, existing product support gets 163b$ and new product research 392b$ and together 555b$ as proportion of expenditure. .In other words, the share is for traits 52%, germplasm 45% and novel processes 3%. As investment by crops, corn and feed grains get 30%, vegetables-30%, Cereal grains-10%, fibre 3%, oil crops 20% and rest for others. Some investment

that is not significant yet goes for organic seed production also. Advances in breeding through MAS, MARS, GAS, forward breeding vs backcrossing; and new trait delivery methods are receiving priority attention.

Meeting customer needs is of great concern to the private seed industry. The growing niche markets with specialized value chain and vertical control; geographic specialization, biotechnology and organics are of recent interest. Meeting demands of farmers and consumers, increasing the yields, increasing the income levels of farmers, cost effectiveness, optimum use of resources, mutagenesis, conventional plant breeding and molecular marker assisted selection and best oil profiles apart from a very strong product portfolio are important for the seed industry to offer the desired cultivars to farmers.

Biotechnology traits, value added crops, value transfer between agrochemicals and seed; new technology like herbicide tolerance, drought tolerance, compliance of IP Protection laws, NUE, healthy plants, high yield, feed-nutrition enhancement; safety to human and animal health and their nutrition, water and soil nutrients are major areas of interest. These are reported to be the technologies for superior product development in the future. These however require satisfying various bio-safety concerns, various lobbies for and against genetically modified crops and government policies also should be such that prior education of the people on new gene technologies proposed and also prior action to intimate the seed industry about the possible implications and other problems the seed industry should be prepared to face. At the same time, on sensitive and most commonly consumed crop commodities, the private seed industry should have universal deliberations and only such genetically modified technologies, which are most likely to be accepted and least harmful should be given priority in next few decades.

Seed prices due to enhanced value and incorporation of multiple traits, enforcement of new IPR laws should be made transparent to avoid protests by various stakeholders and the governments concerned. Contract farming models, industry consolidation; technology vs public reception and stewardship; risk management of farmers, functional value of new traits, tracking and quality control; labour problems and new approaches; new geography are things which will benefit seed industry, if properly implemented. S.E. Asian and some African states have seen recent active involvement of the seed industry. The Indian seed industry would like to continue investment in breeding and gene technology, multinational coverage and positioning of crops by refinement in various ways. Food crops like rice, wheat, mustard, corn, pulses, other oilseeds etc., besides vegetables are key areas of the private seed industry for the future to contribute towards national and global food security. If in place of hybrid technology that is preferred for various reasons by the private seed industry, it resorts to variety development because of other constraints, the seeds should be allowed to be charged premium price from the farmers for its superior performance and demand for consumer requirements.

There are crops like rice, wheat, certain pulses and all vegetables, which offer an immense variety of qualities and consumer tastes and preferences also widely vary. In such crops, hybrid technology and variety technology mix shall continue for more time. Since certain genetically engineered traits may not be acceptable to bulk of the community in respect of these major food crops, it may pose some limitations for the seed industry to work at its free will. Further there are labour shortages and non-availability coupled with demand for high wages on account of certain government policies on employment guarantee schemes in seed production areas and villages in general and on account of this also, hybrid seed production may suffer. The potential of permissible genetic engineering and botanical technologies that may help to modify crops for facilitating easy and economical hybrid seed production could be exploited by the seed industry to continue earning better margins than from varieties.

A survey of the global regions and various developmental and economic considerations may be analyzed by a representative group of the global seed organizations. This would help to identify new potential areas for seed production and intensification of private seed industry R&D in several countries of Africa especially those highly affected by frequent food shortages and conflicts there from, south American countries and other vulnerable island nations (Srilanka, New Zealand, Indonesia, Maldives etc) and least developed areas of Asia like Afghanistan, Burma, Thailand etc. These are also countries, where animal feed and meat (mutton, chicken, marine fish etc) are important for the people. Hence in future more grain feeds and oilcakes may be needed for feeding animals so that the resulting meat, milk and milk products may be available to satisfy the human food security needs. All these require greater consolidation coupled with meaningful distribution / dispersal, planning of tasks and R&D priorities on region-based major and minor crops.

Another development visualized in future based on what is happening already is the type of change in food habits. There may be greater shift from coarse grain cereals to finer grains. Even coarse grain cereals may be amenable to certain genetic modifications for finer grain quality and nutrition enhancement. There are unutilized and unexploited plants like grain amaranthus and others, which could be exploited for increasing food output and some of these crops, are amenable for cultivation in harsh ecological areas, which is also advantageous in the era of climate change.

Yet another development is the preference or large consumption of manufactured and ready to cook food items. Due to conversion in processing, losses may occur both in quantity and quality. Hence, the incorporation of superior processing qualities in food grains, enhancement of higher keeping quality of vegetables and also superior nutritive attributes will become essential requirements. Food production and distribution patterns shall also undergo immense changes all over the world. Feed requirements for animals also will change greatly and specific

attributes of grains and other by-products may be needed for poultry and other livestock. When we try to protect crops from animals that damage the crops, the animal fauna may also be affected from survival rates. There is also need for manipulating grain to stalk ratios and development of quick growing, high biomass bearing and nutritionally superior grasses and other fodders may be required for livestock feed and that helps to increase animal-based food.

Special Tasks of Indian Seed Industry for Global Food Security

- Taking green revolution to eastern states as the full potential of agricultural crops has not been exploited by the seed industry; Eastern states comprising the sates of Orissa, Chattisgarh, Bihar, Jharkhand, West Bengal and Eastern UP need special attention by the seed companies to gear up R&D and ensure quality seed distribution with 100 per cent annual seed replacement ratio. Dr. M. S. Swaminathan, respected as the father of green revolution in India stated this region has the potential to help ease the food security of the country. Dr. Sharad Pawar, the Union Minister for Agriculture has also emphasized the immense need for special attention to agricultural development by all stakeholders in this region.
- The green revolution areas account for 24% of the area under food grains in the country and contribute to more than 40% of food production; there is scope to enhance it to 60 to 70% based on yield gap analysis and research goals for the future. Evergreen revolution with high sustainability is the target of the policy makers.
- The institutional framework and infrastructure for effective participation of stakeholders such as farmers, researchers, extension agencies, politicians, seed industry, other input industries and agri- outputs buyer agencies etc require further strengthening and networking with effective integration.
- Maintenance of peace and order in various regions especially those mentioned above and others are also highly essential for seed industry to function effectively and help the government for ensuring food security. This is of indirect concern and needs government efforts to bring in more peace and stability.
- Improvement can be achieved by effective and healthy competition by various seed industry players and other stakeholders to achieve more effective delivery of quality seeds. Good quality seed distribution should also be supported by effective distribution of other yield enhancing inputs like fertilizers, recommended pesticides, irrigation water and also improving the cost-competitiveness of farm commodities with least environmental pollution.
- As per the national plan of 2005, seed replacement rate for varieties of self pollinated crops, cross pollinated crops and hybrids/hybrid with transgenics should be 25, 35 and 100 per cent respectively; however the following problems are encountered by the seed industry:
  - Many farmers still obtain seeds from various local sources
  - Use farm saved seeds or exchanged seeds from fellow farmers
  - Use of F2/F3 of seeds of hybrids seeds/ transgenic hybrid seeds
  - Often varietal seeds replacement is in alternate years or once in three years;
  - There is mismatch between farmers' preferences / demands and actual supply situation;
  - Farmers often get a supply of loose seeds from traders for gap filling and the seeds often do not represent the variety sown originally and create mixtures and unstable performance;
  - As against an NSC statement of 254 lakh quintals of quality seed in the country, the actual was only 189.34 lakh quintals showing a wide gap between demand and supply;
  - Farmers do not sow refugea seeds supplied to them often leading to poor performance in most cases in transgenic crops;
  - There is often mismatch in the production of breeder seeds of different genotypes of varieties or parents of certain hybrids leading to setback in forward production linkages;
  - There is no suitable advisory mechanism to identify the potential varieties for different areas based on research studies and due to competition wrong seed enters into a given region affecting the potential production.
  - The public sector has lagged behind in R&D for the development of hybrids and transgenics compared to private seed industry and among players of private seed industry, at least 80% of the nearly 600 seed companies in India do not have an R&D back-up of the expected standard and the biotechnology set up is available only in a few top companies of the industry.

Matters Requiring Additional Attention

- There is no realistic listing and identification of players in seed distribution for various crops and regions;
- A large number of superior varieties identified by the public sector agencies as well as seed companies do not penetrate into cultivation for various reasons and defeats the very purpose of research;
- If public sector genotypes are superior and they cannot handle the seed production, quality control and seed delivery effectively, such genotypes could be transferred to private sector seed companies on MOU basis so that the companies can handle the system efficiently and better;
- Breeding programmes have not advanced in certain food crops and for specific areas as a result of which time-honoured old varieties are only continued without replacement.

International Efforts

The discovery and cultivation of high yielding varieties of rice

and wheat and the resultant green revolution and optimism shown in technology transfer and adoption have contributed greatly in the latter half of the last century to improve food grain supplies. Today nearly 55% of the Indian population is below poverty line. In African, some South American and certain Asian countries also poverty is very high or much higher than in India. In 1946, the first world food survey was conducted and the importance of food security in the context of changing development perspectives was brought out. In 1975 the International food for agricultural development was formulated (IFAD). They desired to ensure more equity and employment and less of poverty and food insecurity. Attention to small farmers by World Bank, integrated rural development, labour intensive technologies and criticism of urban bias were also discussed. In 1977, the global information and early warning systems were launched. In 1979, the plan of action for world food security was drawn up. In the same year 1979, WCARRD that is World conference for Agrarian Reforms and Rural Development was mooted. Policies in rich countries (more market and less state) and international financial organizations-IMF and World Bank played an important role. In 1985 the world food security compact was developed, but it failed. Dr. Amartya Sen, Dr. M. S. Swaminathan, Bharat Ratna Dr. C. Subramaniam, Mr. Jagajivan Ram, Mrs. Indira Gandhi and others contributed valuable ideas to food production and food security concept in India in the last four decades of the 20th century. Privatization and liberalization were realized to be not ends, but the means towards a sustainable, equitable and democratic development. The need for building up world partnership for development was proposed.

The following are considered as major food security objectives: Policies should be socially acceptable, efficiently implementable and internally consistent. Poverty, inequality, unemployment, hunger and food insecurity were to be tackled by political will and democratization. India constitutes 2.4% of land area and accounts for 7 to 8% of the global biodiversity and offers enormous opportunities for R&D and development. India has a large network of collaborative modules under the nation-wide ICAR and SAU systems. IPR laws are in place to promote invention and investments. The ICAR system is expected to support sharing of biological resources for both R&D and commercial exploitation. The public and private sector should tackle all important crops necessary for global food security in India and mutually beneficial programs should be identified and acted upon.

The private seed industry expects interest subvention of 5% on funds for development of seed industry, besides opportunities for setting up shops in India and registered under the Company's Act. The Seed industry wants to work towards global millennium goals regarding hunger and poverty alleviation. Global food security would provide the backdrop to the discussion on seed technologies. Foreign seed companies and Indian counterparts should work closer and discussions on technology transfer and developments be made in a transparent and right manner. Commercial seed market in the globe is $36.5billion and India's share in world seed trade is less than one percent. With a 1.5billion seed market, India is at joint fifth position with Japan and Germany. In availability of arable land, trained manpower especially excellent breeders and research and biotechnology inputs, varied agro-climatic zones etc., India provides huge opportunities for growth in the country and extending support to other developing countries. Contract research, contract seed production and export potential also hold promise in crops associated with food and feed security.

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