4th

SOUVENIR

MS SWAMINATHAN AWARD 2011

RETIRED ICAR EMPLOYEES ASSOCIATION

HYDERABAD - 500 038 A.P. INDIA

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Contents

Messages 4

About RICAREA 8

Nuzuveedu Seeds .....

M S Swaminathan awardees articles

1. Improving the maize productivity in India: Progress, Challenges and Opportunities..... R Sai Kumar .....
2. Basmati Rice Improvement towards enhanced farm income, surge and in sustenance of exports: a success story ..... N Shobha Rani.....

Invited articles

3. Youth for Agricultural Transformation.....Prof M S Swaminathan .....
4. The Seed That Seeded India's Green Revolution .....E.A. Siddiq .....
5. Impact of Climate Change on Fisheries and Consequences for Nutritional Security..... Dr. M. Vijay Gupta .....
6. Food vs Fuel Complimentary or Competitive?..... M.V.R. Prasad .....
7. Ascendancy of Cotton inFarming and Fibre World..... Dr. S. Srinivasan Narayanan .....
8. FOOD SECURITY AND FOOD SAFETY: Converting Gandhiji's Vision of a "Hunger-free India" into Reality..... K. Gopalakrishna Pillai .....
9. Climate Change - trends, Impacts and mitigation strategies..... GGSN Rao and SM Virmani.....
10. Plant Growth Promoting Rhizobacteria as Bio-control Agents .... K.V.B.R.Tilak....
11. Agriculture Biosecurity and Biosafety ..... P.R. Vanamayya.....
12. Policy distortions impede agricultural development.. K. Purna Chandra Rao.....
13. Giant Fresh Water Prawn (Scampy) Hatchery ..... K. Madhusudhana Rao ....

अर्चना दत्ता (मुखोपाध्याय)
राष्ट्रपति के विशेष कार्याधिकारी (जन सम्पर्क)
Archana Datta (Mukhopadhyay)
OSD (PR) to the President

राष्ट्रपति सचिवालय,
राष्ट्रपति भवन,
नई दिल्ली - 110004.
President's Secretariat,
Rastrapati Bhavan,
New Delhi - 110004.

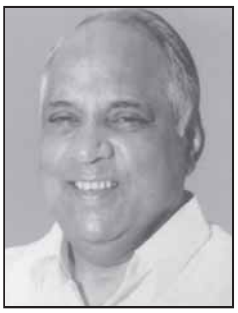
MESSAGE

The President of India, Smt. Pratibha Devisingh Patil, is happy to know that the Retired ICAR Employees Association, Hyderabad is organising the 4th MS Swaminathan Award 2011 in November, 2011.

The President extends her warm greetings and felicitations to the organisers, participants and the awardees and wishes the Award Presentation Cermony every success.

Officer on Special Duty (PR)

शरद पवार
SHARAD PAWAR



सत्यमेव जयते

कृषि एवं खाद्य प्रसंस्करण उद्योग मंत्री
भारत सरकार
MINISTER OFAGRICULTURE &
FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA
14th November, 2011

MESSAGE

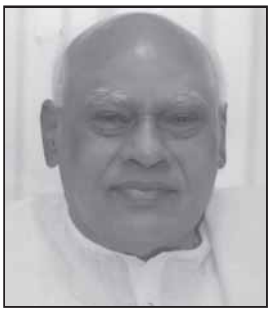
I am glad to note that the Retired ICAR Employees Association (RICAREA) which was founded in 1997 to further the cause of Indian Council of Agricultural Research is organizing the Fourth M.S. Swaminathan Award-2011 function in December 2011. It is heartening to know that 4th M S Swaminathan award is being presented jointly to Dr R Sai Kumar, Project Director (Maize), New Delhi and Dr N. Sobha Rani, Principal Scientist, Directorate of Rice Research, Hyderabad in recognition of their significant contributions to Indian Agriculture. I am glad that the Association is also bringing out a Souvenir on this occasion.

Indian agriculature has registered a phenomenal growth during the last four decades through the dedicated efforts of Agriculatural Scientists.

I wish the Award function a grand success.

(SHARAD PAWAR)

SHAMBHU KALLOLIKAR, I.A.S.
SECRETARY TO GOVERNOR



GOVERNOR'S SECRETARIAT
RAJ BHAVAN
CHENNAI - 600 022
Phone : (044) 22351700
Fax : (044) 22350570
(040) 22301300
E-mail : govsec@tn.nic.in

MESSAGE

His Excellency Dr. K. Rosaiah, Governor of Tamil Nadu is pleased to learn that retired ICAR Employees Association, Hyderabad is organizing the Fourth MS Swaminathan Award 2011 function in November 2011 at Hyderabad.

His Excellency the Governor conveys his warm felicitation to the President, Office Bearers and Members of the Retired ICAR Employees Association and wishes the function all success.

(SHAMBHU KALLOLIKAR)

डा. एस. अय्यप्पन
सचिव एवं महानिदेशक
Dr. S. AYYAPPAN
SECRETARY & DIRECTOR GENERAL

भरत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
बारतीय कृषि भवन, नई दिल्ली 110 114

राष्ट्रपति

GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
MINISTRY OF AGRICULTURE, KRISHI BHAVAN, NEW DELHI 110 114
Tel. : 23382629, 23386711 Fax : 91-11-23384773
E-mail : dg.icar@nic.in

MESSAGE

It is a pleasure to learn that Retired ICAR Employees Association (RICAREA) is organizing the Fourth M.S. Swaminathan Award-2011 in November, 2011 and is also bringing out a Souvenir on this occasion.

I wish the Award function a grand success.

(S. Ayyappan)

Dated the 5th October, 2011
New Delhi

M S Swaminathan Award - A Foreword

The Retired Indian Council of Agricultural Research Employees Association (RICAREA) was established in 1997 to promote and farther the ideals and objectives of the Indian Council of Agricultural Research (ICAR), by providing services to Governmental Agencies, NGOs, Public & Private enterprises, and farming community. The association is also serving as a pool of resource persons for scientific and extension bodies, besides bringing awareness of developments in science and technology among the farming community and general public.

As part of the activities in collaboration of Nuziveedu Seeds Pvt Ltd., Hyderabad, the association with the initiative of Dr B Venkateswarlu , President of RICAREA (2002-2004) Andhra Pradesh has instituted this prestigious National Award in the name of the doyen of agricultural Scientists Prof M.S. Swaminathan. This award carries a Cash prize of Rs.2.lakhs, a medal and Citation. There are several prizes/awards/endowment awards being conferred on agricultural scientists by ICAR and other agencies. But these awards are given on the basis of discipline, team work, etc. and carry less prize money. It may be noted that this is the highest recognition to an agricultural scientist for his life time achievements and contributions to Indian agriculture.

The first M.S. Swaminathan award was presented to leading Poultry Scientist Dr Gendalal Jain on 27th October 2005.The Second M.S.Swaminathan award was presented to Dr B.S.Prakash, Head, DiaryPhysiology, National Diary Technological institute, Karnal on 3rd November 2007.The third M.S. Swaminathan award was presented to Dr S.Nagarajan, an internationally known wheat pathologist, Former Director, Indian Agricultural Research Institute, New Delhi and currently Chairperson, Protection of Plant Varieties and Farmers'Rights Authority, New Delhi.

In response to our letters, e mails, FAX messages 12 nominations were received from scientists from all over the country for the 4th M.S. Swaminathan award for the biennium 2010-2011.

The Selection Committee under the Chairmanship of Dr R.B.Singh unanimously selected Drs R Sai Kumar Project Director Maize, New Delhi and Dr N Shobha Rani Principal Scientist and Head Crop Improvement DRR, Hyderabad were nomiated to receive Fourth MS Swaminathan award jointly

In all the three earlier occasions Souvenirs with articles from leading scientists of different crops, disciplines were released This Souvenir fourth in series is brought out to mark the occasion of the IV MS Swaminathan award presentation. This is a collection of _____ invited articles apart from the articles of the awardees Dr R Saikumar and Dr N Shobha Rani

The Association conveys its gratitude and sincere thanks to …… His Excellency, the Governor of Tamilnadu , Dr. K. Rosaiah, Dr S Ayyappan, Director General ICAR and Secretary DARE Govt of India for their Messages and blessings.

On behalf of the Association we would like to thank Sri M.Prabhakara Rao, MD Nuziveedu Seeds Dr P Sateesh Kumar Director of Research Nuziveedu Seeds and Members of RICAREA and staff of Nuziveedu Seeds. We thank the support and encouragement given by the advertisers which enabled to bring out this Souvenir in record time.

We hope that the Souvenir with articles from specialists belonging to major fields of agriculture would serve as a reference guide.

M.V.S. Sastry J.V. Rao & M. Nagaraju

About RETIRED ICAR EMPLOYEES ASSOCIATION (RICAREA)

- Retired Indian Council of Agricultural Research Employees Association (RICAREA) was formed on 13-09-1997 with 22 members including 5 office bearers with Dr. E A Siddiq as its President. The Association was registered in Hyderabad under the Andhra Pradesh (Telangana areas) Public Registration Act 1350 Fasli (Act I of 1350 F on November 22, 1997 with Registration

The Objectives of the Association are

- To serve as a pool of resource persons for scientific and extension bodies
- To bring about awareness of developments in science and technology among the farming community and general public
- To safeguard the general welfare and to provide a forum for sustaining professional interest of the members
- To recognise and felicitate outstanding scientists for their lifetime achievements

At present the Association has a membership of 302.

Publications

- Keeping in tune with the changing times a website was launched to disseminate information about all activities of RICAREA to members as well as other interested organizations.
- An half Yearly News Letter containing information about current topics on Indian Agriculture , Medical information, Administrative matters and members' views is published twice a year and circulated to members, ICAR Institutes, input agencies and NGO s.
- RICAREA also published a Book" **SASYA PADHAM**", a compilation in Telugu the biographies of 125 Agricultural scientists. Of Andhra Pradesh
- Directory of members with addresses and phone numbers being up dated once in two years.

Welfare Activities

One of the aims of the Association is to take up matters related to healthcare with the concerned authorities. To improve the understanding of the members regarding healthcare 8 lectures by leading specialists were arranged on health matters in collaboration with corporate hospitals.

Annual Day

Annual Day is organized since 1998 and members participate with their families. A custom was started from 2001 onwards to invariably invite an eminent person from public life as Chief Guest for the function. The list of luminaries who graced the annual days were Dr D. Bala Subramaniam (2001), Justice G Raghuram (2002), Gen. K.V. Krishna Rao (2003), Dr Kakarla Subba Rao (2004), Dr Y.L. Nene (2005), Dr A. Appa Rao (2006), Dr A.Panduranga Rao (2007), Dr A.V. Guruva Reddy (2008), Dr Palle Rama Rao (2009), Dr E.A.Siddiq(2010), and Dr P Krishnaiah (2011). Members who have completed 75 years are being felicitated on the annual day. So far 86 members were felicitated. Many members have contributed for the growth of this association. We place on record our fond memories of those departed but left an indelible mark on the growth and development of our Association. Among them are: B. Venkateswarlu, P V Ramana Murthy, K V P Rao, M J Balakrishna Rao, T.P.Sriharan, N S Rao and and R Mallikarjuna Rao. These are the few names which come to our mind when we talk of the Association. The members who are actively associated and still contributing to the overall health of the Association are: M V Rao, N G P Rao, M V Gupta, V.V.Ramana Rao, G Narayanappa, M V R Prasad, K Krishnaiah, N.P.Sarma, U Prasada Rao, V V S Murthy, V Jayamohana Rao, J R K Rao, S.Indira, Vijay Singh, G.Nagaraj, M.Naga Raju, J Venkateswara Rao, S S Narayanan and M.Umamaheswara Rao. The Executive Body of the Association is able to function efficiently because of the whole hearted support and help received from its members.

M V S Sastry and GGSN Rao

3rd MS Swaminathan award function L R M.V.S.Sastry, M. Prabhakarao, Smt. Purandereswari, K. Rosiah, Raghuveera Reddy & MV Rao

Prasada Rao, BRK Murthy Felicitating R B Singh

Dr Rosiah Presenting the award to Dr Nagarajan

Selection commitee members & Executive Committee members

RICAREA Executive committee meeting

Dr Genda lal Jain
First MS Swaminathan awardee

Dr B S Prakash
Second MS Swaminathan awardee

Dr Nagarajan
Third MS Swaminathan awardee

Sri M PrabhakaraRao,
Chairman and Managing Director,
Nuziveedu Seeds Pvt. Ltd. (NSPL)

Executive Committee of RICAREA

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President

K. Madhusudhana Rao
Vice President

M.V.R. Prasad
Vice President

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Ramakrishna Rao J.

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Vijay Singh

Vijaya Mohana Rao

Nuziveedu Seeds Private Limited

Nuziveedu Seeds is the flagship company of NSL Group, a conglomerate with interests in power, textiles, retailing, sugar and infrastructure. It was in 1971 that the world's first cotton hybrids were released in India. Cotton farmers across the country embraced the new technological methods. One of them happened to be Sri Mandava Venkatramaiah, a post graduate in agricultural sciences and an enterprising farmer in Nuziveedu town in Andhra Pradesh. He realised the potential of a business opportunity in production and marketing of hybrid cotton seeds and established Nuziveedu Seeds in 1973. Then the reign was taken over by his son Mr M Prabhakar Rao in 1982 and under his guidance **Nuziveedu Seeds has emerged as the largest seed company in the country**. The cotton seeds supplied by NSPL are planted in 30% of the cotton area and contribute in producing significant portion of best quality cotton in India. NSPL is the recipient of DSIR Award instituted by Ministry of Science & Technology, Government of India, in the year 2002 for the best in-house research achievements. NSPL was recognized as the "Best BIOAGRI COMPANY" in 2008 and 2010 by BIOSPECTRUM for being the largest seller of Bt cotton seed in the country. The NSL group seed companies have achieved a turnover of over Rs 800 crores. Apart from Cotton NSL has also a wide range of products in Paddy, Corn, Sorghum, Pearl Millet, Castor, Sunflower and vegetable crops.

Research & Development-

Nuziveedu Seeds Pvt Limited entered the new Millennium with a clear focus on introducing new hybrids not only in cotton, but also in Corn, Rice and vegetables that bring profits to the farmers through higher yields and superior quality. To achieve the above objective, NSPL has put up a strong accent on research to achieve higher level of excellence in its plant breeding programme to develop superior hybrids in different crops having resistance to pest, diseases, superior quality and wider adaptability. Highly qualified and competent Plant breeders work rigorously utilizing new germplasm and modern technologies. Its R&D units is located at Kompally with well equipped Green House facilities, State-of-art Bio-technology lab, for germplasm banks and fully irrigated research farms of over 670 acres covering all agro-climatic zone of the country. Every year new product evaluation trials involving 70-80 products in 160-170 locations are conducted to select suitable product for each and every agro-climate. NSPL is recognized as an ICAR testing centre for Cotton, Maize, Sorghum, pearl Millet, Sunflower and Rice. NSPL has formed prestigious collaborations with various national and international institutes to accelerate new product development process.

Production, Processing and Marketing -

NSPL is the largest seed producer in private sector with an annual output of about 40,000 Tons of quality seeds are produced in collaboration with about 100,000 seed producing farmers

NSPL has established State-of-art seed conditioning plants in Kompally, Kottur, Nandigam, Kalakal, Tukkulur, Chinakondrupodu, Vijairai in AP; Gadchiroli, Akola and Aurangabad in Maharashtra; Rudrapur in Uttaranchal; Idar in Gujarat and Bargarh in Orissa.

Nuzieedu seeds rigorously enforce quality tests to achieve highest quality standards using the ISTA accredited Seeds Testing Lab, GOT farms and molecular markers.

The ability to deliver the right product of the right quantity to the farmers at the right time is highly dependent on extensive and productive marketing network. The marketing team is made up of highly qualified and experienced professionals in the seed industry. The network consists of 10 Regional offices located at Hyderabad, Delhi, Akola, Ahmadabad, Indore, Lucknow, Guntur Jaipur, Coimbatore and Davangere with corporate office near Hyderabad; 2157 distributors and 59345 dealers and Sub-dealers spread across 17 states in the country.

NSPL at a glance-

As on September 2011

NSL Seed Group Turnover 2010-11	Rs.850 Crore
NSL Group Seed Group Turnover 2011-12 (Latest Estimate)	Rs 1100 Crore
Crops Handled	Cotton, Paddy, Maize, Bajra, Jowar, Sunflower, Mustard, Castor, SSG, Wheat and Vegetables
Number of Employees	1136
Number of Farmers Growing seeds	80,000 farmers
Total Acreage for growing seeds	90,000 acres
Employment created by seed production program of NSPL	**342 lakh man days**

Overview of Marketing, Production, R&D and Quality Maintenance data of NSPL

Corporate & Registered Office	Gundlapochampally, Medchal (Mandal) Near Hyderabad
Number of States Covered	17
Number of Regional Offices	12
Number of farmers using NSPL seeds	>5.5 million
Number of Distributors	2157
Number of Dealers and sub-dealers	59345

Seed conditioning and storage infrastructure

Total number of locations	13
Processing capacity	133 Tons/hr
Maize Cob Drying facility	1000 MT/batch
Storage capacity	**500700 sq ft**
Total Capacity of conditioned storage	18,000 Tons
Total acreage of Research Farms	670 acres (Multi-location)
Number of GOT tests conducted per annum	65,000
Total acreage planted for GOT	800 Acres/annum
Number of tests in STL (ISTA Accredited)	3.2 Lakhs/annum

Nuziveedu Seeds Pvt Ltd are the sponsors of the **M.S. Swaminathan Award'** to be presented to the 'Best Scientiest' in Agriculture' biennially

M.Prabhakara Rao, Chairman and Managing Director

Improving the maize productivity in India: Progress, Challenges and Opportunities

R Sai Kumar

Introduction

Maize (*Zea mays* L.) is grown in more than 166 countries of the world and is the most versatile food crop of global importance. It is being grown widely in tropics, sub-tropics and temperate regions up to 50^0 N and S from the equator to more than 3000m above sea level under irrigated to semi-arid conditions. Present maize consumption pattern in India has changed. In the past it was mainly confined to food in India and many other countries. Now it has become industrial crop. In India, Maize is an important crop which contributes for food (25%), animal feed (12%), and poultry feed (49%), starch (12%), brewery (1%) and seed (1%). Maize has great demand in industries for the development of various products *viz*. pharmaceuticals, textile, paper, film, tyre and biofuel, *etc*. The demand of maize in future will increase continuously. The future demand for maize will be 42 mt by the year 2025, out of which around 21% will be used for human food.

Apart from normal maize it has many other types *viz*. quality protein maize, sweet corn, baby corn, pop corn, waxy corn, high oil, *etc*. It generates employment for many million people in the world. It accounts for 15 to 56% of the total daily calories of people in many of the developing countries. Despite ~80% of 8.26 mha of maize area which is under rainfed condition still maize contribute more than 8% to the national food basket and provide nutritious and risk free green fodder to the livestock.

The demand can be easily met through research efforts in the direction of developing high yielding, insect and pest resistant and abiotic stress tolerant hybrids. With the intervention of biotechnology hybrids can engineered for various traits. Marker assisted selection for quality parameters like Quality Protein Maize (QPM) for improving maize protein quality, and transgenic approach for insect resistant and herbicide tolerance will improve the yield by reducing losses in the field.

Progress in increasing production and productivity of maize in India

Adoption of maize Single Cross Hybrid

In India maize area, production and productivity has increased >2.5, >12 and >4 times touching to 8.26mha, 21.23mt and 2.56t/ha (2010-11) from a mere 3.16mha, 1.73mt and 0.5t/ha (1950-51) since independence respectively. This achievement is remarkable despites ~80% maize area under rainfed and low input condition. The maize area under irrigation has increased marginally from ~11% (1950-51) to only ~20% (2008-09). The low productivity of maize in the past was because of cultivation of land races/OPV in India. The present growth rate of maize (8.94 per cent) production is much more than maize consumption growth rate of 5.0 per cent. In 11^{th} plan, maize has achieved a growth rate of 8.0 per cent (2006-2010). Maize growth rate is highest among all other food crops. Planning commission set 4 per cent growth rate for agriculture and for maize 4.7 per cent but maize achieved 8.0 per cent which is much higher than the target set in 11^{th} plan.

India has great potential to export grain, feed, seed and specialty corn (Baby corn, sweet corn) due to low cost of production and less freight charges. This will help to earn foreign exchange

Director (Maize), Directorate of Maize Research, ICAR, New Delhi-110012
011-25841805 (O), 09868841805 (M), E-mail: pdmaize@gmail.com

and generate employment and engage rural masses. Adoption of SCH technology has contributed significantly in achieving this target and consequently since 2008-09 India became a net exporter with annual exports of maize of 2.5 to 3 million tonnes.

The cultivation of early maturing SCHs has helped in reducing the yield loss on farmers' field in Rajasthan by escaping the effects of drought. In Andhra Pradesh the decline in the ground water table has made rice cultivation less profitable during winter season, therefore the rice area has shifted to maize cultivation as maize requires less water compared to rice. This indicates that maize single cross hybrids are less affected by the vagaries of the above environmental fluctuations. With the cultivation of single cross hybrids, maize has become more remunerative to the farmer and the area under maize cultivation is continuously increasing in many of the states *viz*. Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Jammu & Kashmir, *etc*. The area has increased >2.5 times since independence to present-day 8.26 mha. In eastern India the slight increase in winter temperature has affected some crop but for maize it is favourable as slight increase in temperature will help to take good maize. In India currently it is cultivated in over 8.26 million ha with a production of 21.28 million tonnes having an average productivity of 2560 kg/ha.

The productivity of maize during *Rabi* season in Eastern India is more than double than the *Kharif* season. Some progressive farmers are harvesting up to 9-10t/ha. Therefore increasing maize area during *Rabi* season will not only enhance the production and productivity but is also resource use efficient.

Challenges:

Development of biotic stress resistant and abiotic stress tolerant hybrids

Anticipatory research for change in climate, rise in temperature and scarcity of natural resources requires long term and short term strategies. The short term strategies include development of SCH using the available elite maize inbreds with diverse background. This will facilitate the immediate disposal of hybrids to the target environments. This will counter the immediate problems of scarcity of food and feed. The long term strategies are to target the sustainability of present production and productivity and also ensure food security for the future generation from scarce resources. The long term strategy involves identification and development of germplasm which can withstand stresses like drought, water logging, high and low temperature, salinity, alkalinity and many other biotic stresses.

Application of modern biotechnological tools to strengthen the present breeding programme.

In India maize improvement in the past was mainly achieved through conventional plant breeding approaches. However, recently the application of biotechnological tools in maize improvement has been initiated. In this context India has already released hybrid (Vivek QPM 9) developed through marker assisted back cross breeding. In addition QTL mapping for different biotic and abiotic stresses is going on. In USA and EU transgenic maize has been developed and is being cultivating extensively to address some of the different biotic stresses. In India also both public and private are involved in development of transgenic maize. In future more focus is needed to identify and isolate genes conferring resistance to biotic and abiotic stresses. Further development of drought tolerant and herbicide tolerant transgenic maize will be the priority area of maize biotechnology.

Production and distribution of quality seed

The increase in the area under single cross hybrids will fetch the demand for quality seeds. The availability of quality seeds is one of major constraints for decreasing maize production. The large area under maize is sown with OPVs or the remnant seeds available with the farmers. Just by making available SCH seeds and timely availability of quality seeds are going to take maize production figures to higher level.

The memorandum of understanding (MOU) between the public research and private sector set up will be a viable solution for high seed replacement. Public Private Partnership (PPP) is the strategy for bringing a large area under SCH. More and more seed will be produced by this sector which will create avenues for employment generation and improve the economy of the seed industries which is also a profitable venture for seed industries.

Replacement of existing land races and composites with productive single cross hybrids

In India still >65% of maize area is covered by land races, composites, three way crosses and double crosses, which are not so much productive and uniform as single cross hybrids. This is the biggest challenge which needs to be prioritized. Now we have understood the potential of single cross hybrids which can perform well under various diverse conditions. Single cross hybrids are more responsive for various inputs as compared to the existing land races and other cultivars.

Opportunities

Potential crop for crop diversification

Maize is grown round the year in India. The area in nontraditional states in different season is increasing this indicating that maize is emerging as one of the potential driver for crop diversification. In Andhra Pradesh winter maize is more assured crop with higher productivity potential compared to monsoon season. Therefore, in areas where winter rice crop suffers due to water scarcity, the maize has emerged as potential alternative. Similarly in Karnataka area of cotton and rice and in Maharashtra area of sorghum and cotton has diverted to maize.

Promotion of maize for livelihood security

Specialty corns

With the increase of urbanization, change in food habit and the improved economic status, the specialty corn has gained significant importance in peri-urban areas of the country. To check the migration from rural to urban, to enhancing the profitability and livelihood security of the farmer the suitable hybrids and production technology for baby corn and sweet corn have been developed.

Baby corn – The term baby corn refers to a young finger like unfertilized cob of maize with 2-3cm emerged silk. It can be eaten raw and include in diet in number of ways as salads, *chutney*, *pakoda*, soup, *raita*, vegetables pickles, and *kheer*, *etc*. Peri-urban belt of India is emerging as a one of the potential baby corn producing belt. Because of its low cost of production as compared to many other countries India can become export potential nation in years to come. Because of India's strategic location it will be boon for the export to many Asian, European and Gulf countries. Baby corn has played a significant role in ensuring livelihood security and augmenting income level of farmers in peri-urban areas. Maize single cross hybrid HM 4 possesses all the desirable traits of ideal baby corn.

The cultivation of HM 4 is gaining momentum not only in national capital region but also in peri-urban interface of other states in India. The other advantage associated with this hybrid is the low cost of hybrid seed and wider adaptability. HM 4 has proved boon for the farmers of the "Aterna" village in Sonipat district of Haryana, as its cultivation has improved the socio-economic condition of the villagers significantly. Apart from grain and seed India can become exporter of specialty corns as well mainly the baby corn and sweet corn. One of the baby corn processing industry in India (FreshField) has exported about 267 tons of baby corn worth >$1 million in 2008, and in 2009 it is expecting much more. This will help to earn foreign exchange and generate employment to the rural masses.

The quantum jump in production and the productivity witnessed in recent years across the states, evidently suggests that the research and development in maize in India is in the desired direction and the production will tend to keep pace with the demand trend. The country is poised to give further fillip to the pace of production with new impetus on the expansion of area of maize under single cross hybrids. In future developing maize genotypes which can

escape as many vulnerable growth stages as under rainfed conditions is the priority of the researchers.

Export potential and diverse uses of maize

Maize has great potential for grain, specialty corn (Baby corn, sweet corn), feed etc. In the year 2008-09 India has exported 3mt of grain worth rupees 24,000crores and >12000tonnes seeds of worth rupees 2000crores. Due to low freight charges India has great potential for seed export. Apart from grain India can also exported baby corn. One of the baby corn processing industry in India (FreshField) has exported about 267 tons of baby corn worth >$1 million in 2008, and in 2011 they are expecting export >10$ million. This will help to earn foreign exchange and generate employment and engage rural masses.

Promotion of maize for food and nutrition security

Quality Protein Maize - 86% of the maize produced in the country is directly used as feed (61%) and food (25%). To meet the requirement of food/feed and nutritional security quality protein maize has better say than the normal maize. Therefore in Indian maize programme greater emphasis is given to promote the quality protein maize research.

The development of quality protein maize, their cultivation and availability of QPM grain will provide a nutritious feed to poultry/cattle and for poor people particularly those consuming maize as their staple food. By the virtue of high lysine and tryptophan content in QPM alleviate the protein malnutrition related diseases in underprivileged people who cannot afford milk and egg for dietary supplements. On the other hand, price of the meat and meat products has also gone up in recent years and has become unaffordable to meet their nutrition requirement. Thus, QPM maize is solution to food and nutritional security.

QPM is nutritionally superior with high lysine and tryptophan as compared to normal maize. The biological value of QPM is high (80%) as compared to normal maize (45%), which is near to that of the milk (90%). The biological value of QPM is the highest among all cereals. In India few single cross QPM maize hybrids *viz*. HQPM 1, HQPM 5, HQPM 7, HQPM 4, Vivek QPM 9, Amber shakti, Shaktiman 3 and Shaktiman 4 with different maturity groups have been developed, which suits to different agro-climatic conditions under different cropping systems. Apart from regular QPM food, value added products like QPM Biscuits and Corn chips have got recent momentum as fast moving consumable goods in urban market. New manufacturing companies are flourishing in NCR and Punjab state is highly noticeable.

Strategies to improve further production and productivity of maize

Maize areas under single cross hybrid has been increasing in a quiet satisfactory way especially in Eastern states namely Orissa and West Bengal and North Eastern states like Assam, Sikkim, Meghalaya , Arunachal Pradesh and Manipur. In Jammu and Kashmir state single cross hybrids already had reached the traditional landrace growing areas and SCH received tremendous response across the valley.

Expanding maize area under single cross hybrid during Rabi season

The productivity of maize during *Rabi* season in Eastern India is more than double than the *Kharif* season. Some progressive farmers are harvesting up to 9-10t/ha. Therefore increasing maize area during *Rabi* season will not only enhance the production and productivity but is also resource use efficient.

Timely supply of single cross hybrid seed and demonstration of hybrid seed production technology

To implement the above two strategies successfully there is need to take comprehensive action regarding the timely supply of hybrid seed to the farmers. Therefore there is need to strengthen the national and state hybrid seed corporations.

Summary:

With the introduction of SCH the area,

production and productivity of maize is continuously increasing thus it has become remunerative to farmers. Maize is addressing many issues like lowering water table in rice belt and rising temperature areas in wheat belt and climate change. Quality Protein Maize is nutritionally superior provide solution to food and nutrition security, especially to poor masses and tribal people. Maize cultivation for baby corn, green ear cob and sweet corn by the peri-urban farmer provides livelihood security thus check the migration of rural masses to cities and reduce pressure on urban population. Because of low cost of production and export potential for maize and maize based products generates employment for millions of skilled and unskilled masses.

The Project Director (Maize) and President of Indian Maize Development Association with the help of private sector under public private partnership mode are aggressively moving across the country and supplying single cross hybrid seeds of both public and private sectors, which will result in enhancement of production and productivity of maize; participatory in Jammu and Kashmir, North Eastern states, Bihar, Eastern UP and Rajasthan *etc*.

The country is poised to give further fillip to the pace of production with new impetus on the expansion of area of maize under single cross hybrids. Even today India can double the maize production and productivity by covering 100% area under single cross hybrids. In future developing maize genotypes which can escape as many vulnerable growth stages as under rainfed conditions is the priority of the researchers. Thus, considering the above facts the future prospects of maize in India are bright.

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Basmati Rice Improvement towards enhanced farm income, surge and in sustenance of exports: a success story

N. Shobha Rani

India is a natural repository for multitude of long and short grained aromatic rices, nurtured and conserved by the farmers of northwestern sub Himalayan regions for centuries. Among these Basmati rices endowed with distinctive quality features – pleasant aroma, long slender grains with delicate curvature, remarkable linear elongation which is more than double its original length combined with excellent flaky soft texture on cooking made it exclusive, a gourmet delight, with no celebration in India complete without some cuisine of basmati - *Biryani* or *Pulao* taking pride of place on the table. Being a homeland for basmati, India *has a monopoly over it's trade. It begets the unique fragrance, taste and texture as nurtured by the waters flowing down from the snow peaked Himalayas with the entire ambiance of the region conserving these qualities. Basmati is inter woven into the cultural ethos of the country like no other agricultural product and the farming community has a sovereign right over this wonderful bio resource, the nature given gift to Indian sub continent. Aromatic rices of yore were described in ancient texts and travelogues (Nene 1998).*

On account of the pleasant natural fragrance and flavour, these rices were patronized by kings and zealously guarded by them since times immemorial. Basmati has originated from *Vasumati* which means earth recognized by its fragrance; while the full exposition of the word is from Hindi *Bas* originating from Prakrit *Vas* which has a sanskrit root – *Vasay*_connoting aroma; and *mati* from *mayup* meaning ingrained from the origin. Common usage has changed *Vas* to *Bas* while joining *bas* and *mayup* the latter changed to *mati*. Thus, the word Basmati originated. While, long grain basmati varieties, which have specific geographic demarcation for their cultivation in northwestern India, numerous indigenous aromatic short grain cultivars are grown in localized pockets distributed in several states of the country (Shobha Rani and Singh, 2003).

Basmati as an item of commerce

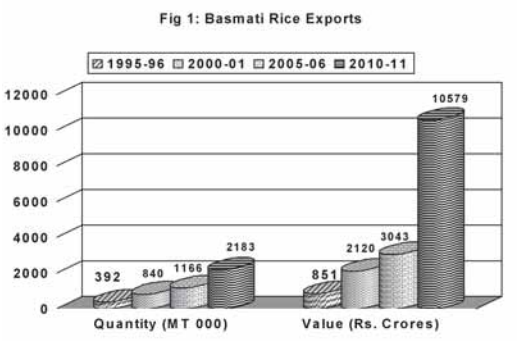
Based on quality preferences that exist in a particular region, country and among ethnic groups six types of rice have demand in world markets. Among these the aromatic rice market constituted mainly of basmati rice, favoured for its aroma and special culinary qualities is dominated by India and Pakistan. Basmati rice fetches three times higher returns (US $ 800-1200 per metric tonne) as against non basmati (US $ 200-400 per metric tonne) in international markets and also in domestic markets with Pakistan being the only other recognized competitor in this segment. India began export of insignificant quantity of around 67,000 tonnes of basmati rice in 1978-79 and earned a modest foreign exchange of Rs.32 crores. During the mid-eighties all the rice that was exported from India was only Basmati rice. The increasing trend in exports flourished with the quantum of basmati raising from 4, 70,000 tonnes in 1996-97 to 7,70,764 tonnes in 2003-04 and the value from Rs.1,200 crores to a maximum of Rs.1990 crores. Highest quantum of basmati rice was exported in 2010-11 (2.18 million tonnes) earning tremendous foreign exchange to the tune of Rs.10,578 crores (Table 1, Fig 1)

Principal Scientist & Head, CIS, Directorate of Rice Research, Rajendranagar, Hyderabad
Email: n_shobha@yahoo.com

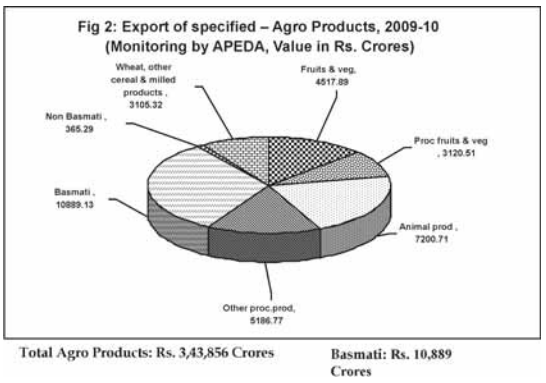
Table 1: Basmati rice exports from India from 1980-81 to 2010-11

Year	Basmati Qty(MT)	Value (Rs. crores)
1980-1981	136543	75.54
1985-1986	235213	173.23
1990-1991	241674	287.31
1995-1996	392000	851.15
2000-2001	840000	2120.00
2005-2006	1166563	3043.10
2010-2011	2183507	10578.67

Note: Quantity in metric tonnes; Value in crores; Source: APEDA & DGCIS.



(www.apeda.gov.in). Of the several agro products exported from India, basmati rice alone constituted **31.66%** of foreign exchange during 2009-10 (Fig 2).



About 50-60% of the basmati produced in the country is exported mainly to Saudi Arabia, United Arab Emirates, Kuwait and the rest to United Kingdom, United States of America and France among the 90 other countries which import Indian basmati rice. More than half the quantity of basmati exported from the country is *sela* (parboiled) basmati mainly to the Gulf countries. Therefore, it is extremely important to develop short statured, non-lodging, high yielding basmati varieties, insulated with pest and disease resistance combining the exceptional quality features not only to make basmati cultivation remunerative to farming community but also to enhance the overall production and productivity of basmati growing states, in order to find exportable surplus to sustain and enhance India's hegemony on basmati rice exports in the international markets.

Major constraints for improvement of Basmati rice

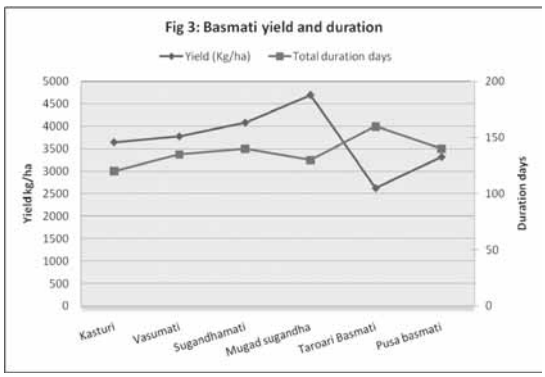
Ever since the introduction of high yielding varieties, there has been several research efforts to combine basmati quality into the high yielding prototype but the attempts were not altogether successful. The traditional basmati varieties are tall, low yielding types. They are photo and thermo sensitive and lodge under high doses of nitrogenous fertilizer. They are susceptible to most of the major pests and diseases. Further, there is a mysticism attached to basmati quality as soil/ climate and temperature interaction plays a major role in it's retention and that only when grown in particular sub-Himalayas tracts it recites the unique quality. Although several aromatic rices are grown and consumed as basmati, it is only few like Basmati 370 (Punjab Basmati), Type 3 (Dehradun Basmati), HBC 19 (Taroari Basmati) were recognized by farmers and the trade as possessing the required quality features for export and it has taken considerable time and effort to convince the farmers that the dwarf high yielding archetypes have similar quality as the traditional tall land races. In order to protect the monopoly of Indian basmati exports, which continue to offer profitable foreign exchange and also help to step up the overall rice production in the country by developing high yielding basmati varieties, research efforts were initiated more than three decades ago. Despite serious attempts by breeders

at several research stations within India through pure line selection, use of mutagenesis and hybridization, success in developing the plant type based high yielding basmati varieties was limited due to the genotype - environmental influence on quality which is not yet properly delineated even till today; inter group sterility barriers (Shobha Rani 1992) and complicated polygenic mode of inheritance and complex breeding behavior of quality parameters (IARI 1980). Even the understanding of basmati traits was a limitation due to lack of infrastructure for grain quality evaluation and no well-defined selection criteria are some of the critical constraints for grain quality and aroma improvement. Screening large segregating populations for the entire constellation of 16 quality components every season before undertaking the selection process in the field has become the biggest bottleneck in achieving success in basmati improvement programmes. As most of the traditional basmati varieties are poor combiners, breeding/selection methodologies especially convergent and back cross strategies were adopted to break the undesirable genetic blocks and to increase the frequency of favorable recombinants.

1A. Development of High Yielding Varieties of Basmati Quality at DRR

As a first step towards varietal development, the rich diversity of **1153 accessions** of aromatic long and short grain rices were studied for exploitable genetic variability at DRR for agronomic, biotic stress resistance and important quality traits. This unique collection included 200 native basmati land races, another 252 short grain aromatic varieties and quality rices of indigenous and exotic origin. They were systematically evaluated for 22 yield & morphological descriptors; for 16 key quality characters and were also screened for major insect pests and diseases which led to the identification of typical donors for utilization in breeding programmes. This valuable collection was also conserved as base collection in NBPGR, New Delhi.

Concerted efforts made by the DRR team under ICAR research network programmes and in the coordinated basmati testing, the convergent breeding approach was followed, to break the jinx of undesirable genetic blocks between yield and quality and the objective of developing semi dwarf, high yielding basmati plant type without foregoing the excellent gamut of quality traits has been accomplished by our team at DRR, Hyderabad. The new basmati varieties recorded progressive yield enhancement from **38.8%** to **78.9%** over Taraori Basmati; **9.8%** to **41.5%** over yield check Pusa Basmati 1, while the days to maturity has also been considerably reduced by clear two to four weeks which is a commendable achievement (Fig 3).



★ First breakthrough in basmati rice breeding at DRR in 1989 was with the release of semi dwarf basmati variety with more than 1.0 tonne yield advantage over traditional checks: Basmati 370 & Taroari Basmati

Kasturi, IET 8580: First aromatic, semi-dwarf, high yielding basmati variety with 38.8% yield superiority over traditional Basmati 370 and Taroari Basmati, short duration of 125 days from seed to seed, long slender (LS) grains, excellent milling desirable cooking quality, photo-insensitive, resistant (R) to leaf blast (LBl) and moderately resistant (MR) to stem borer (SB); **CVRC release in 1989 for basmati growing areas of Punjab, Western Uttar Pradesh and Haryana; also SVRC release in Himachal Pradesh (Shobha Rani 1992).**

★ **Basmati varieties with higher yield advantage over semi dwarf check: Pusa Basmati 1**

Vasumati, IET 15391: 14% yield superiority over Pusa Basmati 1 (PB 1) & 44% over Taroari Basmati, LS grains, aromatic, 135 days duration, desirable quality, R to LBl, brown spot (BS), WBPH, Gall midge (GM) 1 & 4. **CVRC release 2001 for basmati growing areas of Haryana, Punjab, Uttarakhand, Western Uttar Pradesh, Himachal Pradesh and Jammu & Kashmir (Shobha Rani *et al* 2006).**

Sugandhamati, IET 16775: 23.4% yield superiority and comparable in quality with PB 1 & 55.5% over Taroari Basmati; R to LBl and BS; LS grains, aromatic with good cooking quality, 140 days duration, **CVRC release in 2004 for basmati growing areas for Punjab, Haryana, Delhi and Jammu & Kashmir.**

Mugad Sugandha (RPST-328, IET 13549): Semi dwarf, consistent yield superiority of 1.0 t/ha over PB 1 (41.5% over Pusa Basmati 1 & 78.9% over Taroari Basmati); 130 days duration, LS grains, aromatic; MR to LBl, SB and Bacterial Leaf Blight (BLB); **This culture developed at DRR, Hyderabad was tested at Mugad and was included in state trials.** Superior to Pusa Basmati 1 by 30% and Kagisali by 12%; suitable for parboiled (*sela*) basmati; **SVRC release in 2001 for Karnataka.**

Bhogavati: Aromatic, LS grains. **This line developed at DRR, Hyderabad was tested at Radhanagari and was included in state trials.** On par with Indrayani in yield, superior in quality compared to Indrayani and Pawana (checks). **SVRC release in 2004 for Western Maharashtra.**

Unique germplasm registered with NBPGR

IET 15833, RP 3135-97-1-11-5: Aromatic, LS grains, elite line with desirable quality features esp., intermediate alkali spreading value (ASV) and amylose content (AC) with high elongation on cooking. Registered as unique basmati elite line (**IC No.296643)** by NBPGR.

Elite basmati lines identified - BLB pyramiding

About 25 semi-dwarf to semi-tall lines with BLB resistant genes (xa13, Xa21) through MAS have been developed in the background of the recurrent parents **Basmati 386, Taroari Basmati and Vasumati** with similar quality and are being tested in station trials. The promising pre breeding lines would be registered with NBPGR as unique genetic stocks. Developed other elite basmati cultures IET Nos: 13548, 14131, 15392, 16776, 17025 and 17278. In addition to quality and high yield potential, they have resistance/ tolerance to LBl, Leaf folder (LF), SB and WBPH.

1B. Impact of the contribution:

Breeder seed of 287.01 quintals of the above mentioned new basmati varietal technology was supplied to indented government agencies for converting to foundation and certified seed while 31,239 kg of truthfully labelled **(TFL)** seed was distributed to farmers which contributed to steady increase in area in the traditional basmati growing states especially in Himachal Pradesh. Western Uttar Pradesh to a limited extent and Uttarakhand for export markets Karnataka, Maharashtra & Andhra Pradesh were identified for domestic consumption purpose. While there is a good demand for **Vasumati, Sugandhamati** in Andhra Pradesh; 25,000 ha area is under **Bhogavati** in Kolhapur, Satara, parts of Nasik, Dhule and Pune districts of Maharashtra while 3,000 ha is under **Mugad Sugandha** in Belgaum and Dharwad districts of Karnataka. The farmers in the non-traditional basmati growing areas have also benefited by cultivating the new basmati varieties and achieved high economic returns. Reports indicate that **Mugad Sugandha** is performing well under organic cultivation and there is a good demand for the organically grown rice.

2A. Facilitating the identification and release of basmati varieties through AICRIP as Principal Investigator

Extensive multilocation testing led to the identification and release of basmati varieties *viz.*, **Pusa Basmati 1 (high yielding basmati variety), Haryana Basmati 1, Pusa Sugandh 2, Pusa Sugandh 3, Pusa Basmati 1121** (highest elongation), **Improved Pusa Basmati 1** (first MAS product with BLB resistance), **Pusa Sugandh 5, Pusa RH 10** (first aromatic hybrid), **Pusa Basmati 6 all of the aforementioned varieties contributed**

by IARI, New Delhi (Siddiq *et al* 2009) which combined basmati quality, higher yield potential with significant reduction in total duration by two to six weeks; **Basmati CSR 30** (first salt tolerant variety) from CSSRI, Karnal; **Pant Sugandh Dhan 15, Pant Sugandh Dhan 17 from GBPUAT, Pantnagar and Punjab Mehak from PAU, Ludhiana and others (Shobha Rani *et al* 2009).**

2B. Impact of the contribution:

Approximately 1050 quintals of breeder seed of the above mentioned varieties was produced for further seed increase by government agencies and 30,740 kg of TFL seed was given to farmers which resulted in an increase in area in basmati growing states. In addition, **DRR efforts in the development of basmati varieties forging close linkages with basmati rice breeders; the strong testing programme of National Basmati Trials under AICRIP and it's success in identifying suitable varieties/ hybrids/ NILs and other interactions with trade and policy makers on various issues related to basmati production, export and policy in the last two decades has helped in adoption of the evolved basmati varieties of high yield potential with biotic and abiotic stress tolerance.**

Though during the period 1995-2000, Pusa Basmati 1 contributed to nearly 60% of total basmati rice exports since the last two to three years Pusa Basmati 1121, (The basmati variety of exceptionally high elongation on cooking) is cultivated in about 50% of the traditional basmati growing areas fetching higher returns of Rs. 2,500-3,000 per quintal during peak season benefiting the farmers. In the international markets also on account of it's superior grains and cooking quality, Pusa 1121 captured additional US$ 200 per metric tonne (Siddiq *et al* 2009).

As a consequence of the adoption of the HYV Basmati varieties released in the country since 1990 the area under basmati has doubled to 1.9 m ha from the initial 8 to 9 lakh hectares and production reached 3.5 mt. The export quantum of basmati rice has gone up by 9 times since 1990-91 (2,41,674 metric tonnes) to 21,83,507 metric tonnes in 2010-2011; the value enormously risen from Rs. 287 crores in 1990-91 to Rs. 10,578 crores in 2010-11. This is the testimony to the efforts made by the breeders, farmers, rice industry and **above all the objective research and breeding combined with the well laid out testing procedures under coordinated testing programme of the Indian Council of Agricultural Research (ICAR) which is organized by DRR (Shobha Rani *et al* 2009).**

We at DRR have also made outstanding contribution in challenging and winning the US patent 5 663 484 on basmati lines and grains granted to Rice Tec Inc, Texas, USA. Enormous technical information (34 reports, documents, declarations) DRR generated was instrumental in filing the reexamination case, resulting in India winning the case and protecting our basmati from the clutches of unauthorized IPR issues and safeguarding our sovereign rights and trade interests over basmati (Shobha Rani N 2004).

Deployment of molecular tools: an exemplar for Basmati breeding efforts

Incorporation of 16 physico-chemical characteristics that comprise rice grain quality in quality breeding programmes is a complex proposition. In addition to genetic, environmental and post harvest practices also influence the quality traits. Further, quality preferences vary among consumers and developing varieties catering to all such requirements is a challenge. Classical and molecular genetic studies have clearly demonstrated polygenic nature of the grain quality traits. The process of determining major grain and cooking quality traits in various segregating generations is not only laborious and time consuming but the results are often available after the selection has already been exercised, as screening is possible only after grain maturity and harvest. Thus, there is a need for identification of molecular markers linked to major quality traits which can help rice breeders in breeding programmes to select progeny with desirable composition of quality at their early stages of development. With the complete sequence of rice genome available in public

domain, exciting opportunities have opened up for genetic and molecular characterization of complex basmati quality components; identification of molecular markers linked to grain shape, elongation ratio, amylose content, aroma etc., along with several resistant genes and gene linked markers available for biotic stresses (Singh *et al* 2011). Till date, most of the work done related to identification of grain quality trait linked markers in *japonica* germplasm. Hence, at DRR studies were carried out with the objectives such as (i) validating of markers reported to be linked to grain quality traits in *indica* germplasm (ii) Identification of more efficient functional markers for the cloned genes associated with grain quality and (iii) identification of major QTL's controlling cooking and eating quality traits in rice. Association study carried out with 13 reported markers in a set of 360 *indica* genotypes showed varied level of association for each trait. We have developed a tightly linked marker namely ARSSR-3 for the trait of fragrance (Madhav *et al* 2010) which serves as alternative to the earlier reported allele specific multiplex marker for regular use in breeding programmes aimed at marker assisted introgression of aroma trait into the genetic background of elite lines. We have also developed another functional marker named BADEX7-5 targeting the 8-bp deletion in the exon-7 of BADH-2 (betain aldehyde dehydrogenase) (BADH2, a candidate gene for aroma), which can clearly differentiate the aromatic and non aromatic genotypes efficiently on a simple agarose gel (Sakthivel *et al* 2009) and validated in a diverse collection of aromatic and non aromatic rices. In addition, we also developed a functional marker named DRR GL-1 targeting an SNP in the major QTL region-GS3, which is associated with kernel length and kernel elongation (KE) and validated through QTL-Marker linkage analysis involving large populations (Ram Kumar *et al* 2010). Major QTLs for gelatinization temperature, grain breadth, grain length, length to breadth ratio and kernel elongation were also reported by DRR (Shobha Rani *et al* 2011). The identification of candidate genes in the QTLs may give some vital clues in understanding the genetic control of key grain quality traits of *indica* genotypes and provide additional markers for immediate use in marker- assisted breeding.

It is a fact few rice breeding programmes have made such great impact as the basmati improvement efforts. Though beset with impediments on account of the complex genetic nature and breeding behaviour of the quality characters, the rendezvous with basmati has been long and arduous. Despite eluding success for a long time, once the traditional tall low yielding plant type has been transformed to the present day improved semi dwarf basmati type through conventional breeding strategies by the rice breeders, the benefits to the farmers, to the traders and to the country through the tremendous surge in the export of basmati has been stupendous.

Today, in addition to the conventional tools, deployment of reliable molecular marker technologies whose potential has already been proved with the development of varieties like *Improved Pusa Basmati 1 and Improved Samba Mahsuri* can assist the breeding efforts in a much more precise manner. We are strongly convinced that marker assisted selection based on molecular markers linked to the genes of interest would complement the conventional breeding efforts by reducing the time and enhance the breeding efficiency in developing designer basmati varieties which can surpass in yield and possess quality attributes of *par excellence,* with in-built resistance to insect pests and diseases in years to come.

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Youth for Agricultural Transformation

Prof M S Swaminathan

While visiting the National Dairy Research Institute, Bangalore, on 27 June, 1927 Mahatma Gandhi wrote in the Visitors' Book "**Farmer**" against the column titled "occupation". He also used to emphasise that **Gram Swaraj** is the pathway to **Poorna Swaraj**. Lal Bahadur Shastri later gave the slogan "Jai Jawan, Jai Kisan" to stress that Jawans and Kisans are the two pillars of our freedom. **The extreme volatility of the price of food grains in the international market emphasizes that the future belongs to nations with grains and not guns**.

For young people to take to agriculture, farming must be both intellectually satisfying and economically rewarding. This will call for a technological and managerial upgradation of farm operations. We have to harness the best in frontier science and marry it with the best in traditional knowledge and ecological prudence. Such a blend leads to the science of ecotechnology. In addition to ecotechnology, our Agricultural Universities should become leaders in biotechnology, space technology, nuclear technology, nanotechnology, renewable energy and management technology. **The University should enable every scholar to become an entrepreneur**.

During his recent visit to India, US President Barack Obama pointed out that India is fortunate to have over half of its total population of 1.2 billion under the age of 30. Out of the 600 million young persons, over 60 per cent live in villages. Most of them are educated. Mahatma Gandhi considered the migration of educated youth from villages to towns and cities as the most serious form of brain drain adversely affecting rural India's development. He, therefore, stressed that we should take steps to end the divorce between intellect and labour in rural professions.

The National Commission on Farmers stressed the need for attracting and retaining educated youth in farming. The National Policy for Farmers, placed in Parliament in November 2007, includes the following goal — "to introduce measures which can help to attract and retain youth in farming and processing of farm products for higher value addition, by making farming intellectually stimulating and economically rewarding". **At present, we are deriving very little demographic dividend in agriculture**. On the other hand, the pressure of population on land is increasing and the average size of a farm holding is going down to below one hectare. Farmers are getting indebted and the temptation to sell prime farmland for non-farm purposes is growing. Over 45 per cent of farmers interviewed by the National Sample Survey Organisation wanted to quit farming. Under these conditions, how are we going to persuade educated youth, including farm graduates, to stay in villages and take to agriculture as a profession? How can youth earn a decent living in villages and help shape the future of our agriculture? This will require a three-pronged strategy.

(a) Improve the productivity and profitability of small holdings through appropriate land use policies, technologies and market linkages; develop for this purpose a "4C approach", i.e., Conservation, Cultivation, Consumption and Commerce.

(b) Enlarge the scope for the growth of agro-processing, agro-industries and agri-business and establish a "Farm to Home" chain in production, processing and marketing.

(c) Promote opportunities for the services sector to expand in a manner that will trigger the

Member of Parliament (Rajya Sabha) and Chairman, M S Swaminathan Research Foundation
Third Cross Street, Taramani Institutional Area, Chennai - 600 113)
Tel: +91 44 2254 2790 / 2254 1229; Fax: +91 44 2254 1319
E-mail: @mssrf.res.in / msswami@vsnl.net

technological and economic upgradation of farm operations.

Some years ago, the Government of India launched a programme to enable farm graduates to start agri-clinics and agri-business centres. This programme is yet to attract the interest of educated youth to the degree originally expected. It is hence time that the programme is restructured based on the lessons learnt. Ideally, a group of four to five farm graduates, who have specialised in agriculture, animal husbandry, fisheries, agri-business and home science, could jointly launch an agri-clinic-cum-agri-business centre in every block of the State. Agri-clinics will provide the services needed during the production phase of farming, while the agri-business centre will cater to the needs of farm families during the post-harvest phase of agriculture.

Thus, farm women and men can be assisted during the entire crop cycle, starting with sowing and extending up to value addition and marketing. The multi-disciplinary expertise available within the group of young entrepreneurs will help them to serve farm families in a holistic manner. The home science graduate can pay particular attention to nutrition and food safety and processing and help a group of farm women to start a food processing park. The group should also assist farm families to achieve economy and power of scale both during the production and post-harvest phases of farming. Such as integrated centre can be named "**Agricultural Transformation Centre**".

Opportunities for young entrepreuners are several. Climate resilient agriculture is another area that needs attention. In dry farming areas, methods of rainwater harvesting and storage, aquifer recharge and watershed management as well as the improvement of soil physics, chemistry and microbiology, need to be spread widely. The cultivation of fertiliser trees which can enrich soil fertility and help to improve soil carbon sequestration and storage, can be promoted under the Green India Mission as well as the Mahatma Gandhi National Rural Employment Guarantee programme. **A few fertiliser trees, a *jal kund* (water harvesting pond) and a biogas plant in every farm will help to improve enormously the productivity and profitability of dryland farming**. In addition, they will contribute to climate change mitigation.

The "yuva kisans" or young farmers can also help women's self-help groups to manufacture and sell the biological software essential for sustainable agriculture. These will include biofertilisers, biopesticides and vermiculture. The Fisheries graduate can promote both inland and marine aquaculture, using low external input sustainable aquaculture (Leisa) techniques. Feed and seed are the important requirements for successful aquaculture and trained youth can promote their production at the local level. They can train rural families in induced breeding of fish and spread quality and food safety literacy.

Similar opportunities exist in the fields of animal husbandary. Improved technologies of small-scale poultry and dairy farming can be introduced. Codex alimentarius standards of food safety can be popularised in the case of perishable commodities. For this purpose, the young farmers should establish Gyan Chaupals or Village Knowledge Centres. Such centres will be based on the integrated use of the internet, FM Radio and mobile telephony.

In the services sector designed to meet the demand driven needs of farming families, an important one is soil and water quality testing. Young farmers can organise mobile soil-cum-water quality testing work and go from village to village in the area of their operation and issue a **Farm Health Passbook** to every family. Farm Health Passbook will contain information on soil health, water quality, and crop and animal diseases, so that the farm family has access to integrated information on all aspects of Farm Health. Very effective and reliable soil and water quality testing kits are now available. This will help rural families to utilise in an effective manner the nutrient based subsidy introduced by the government from April 1, 2010. Similarly young educated youth could help rural communities to organise gene-seed-grain-water banks, thereby linking conservation, cultivation, consumption and commerce in a mutually reinforcing manner.

Young farmers can also operate climate risk management centres, which will help farmers to maximise the benefits of a good monsoon and minimise the adverse impact of unfavourable weather. Educated youth can help to introduce the benefits of information, space, nuclear, bio- and eco-technologies. Ecotechnology involves the blend of traditional wisdom and frontier technology. This is the pathway to sustainable agriculture and food security, as well as agrarian prosperity. **If educated youth choose to live in villages and launch the new agriculture movement, based on the integrated**

application of science and social wisdom, our untapped demographic dividend will become our greatest strength.

Mahila Kisans (Women Famers) and Yuva Kisans (Young Farmers) will determine the future of our agrarian and rural economy. In the central budget of 2010-11, a *Mahila Kisan Shasaktikaran Pariojana* was introduced by the Finance Minister on my suggestion. The Home Science graduates participating in the Agricultural Transformation Centre movement should also organise a "Feeding Minds – First 1000 Days" programme to ensure that there is no maternal and foetal undernutrition and that every new born child has an opportunity for realising its innate genetic potential for mental and physical development. Babies with low birth weight, as a result of foetal undernutrition suffer from hadicaps in brain development and cognitive ability. **Our desire to become a Knowledge and Innovation Super-power can be realised only by paying attention to nutrition and education on a life cycle basis, i.e., from conception to cremation**.

Addressing the World Climate Conference held in Geneva in 1989 on the theme, "Climate Change and Agriculture", I pointed out the serious implications of a rise of 1 to 2 deg C in mean temperature on crop productivity in South Asia and Sub-saharan Africa. An Expert Team constituted by FAO in its report submitted in September 2009, also concluded that for each 1 deg. C rise in mean temperature, wheat yield losses in India are likely to be around 6 million tonnes per year, or around $ 1.5 billion at current prices. There will be similar losses in other crops and our impoverished farmers could lose the equivalent of over US $ 20 billion in income each year. Rural women will suffer more since they look after animals, fodder, feed and water.

We are now in the midst of a steep rise in the price of essential food items like pulses, vegetables and milk. The gap between demand and supply is high in pulses, oilseeds, sugar and several vegetable crops including onion, tomato and potato. Production and market intelligence as well as a demand – supply balance based an integrated import and export policy are lacking. The absence of a farmer-centric market system aggravates both food inflation and rural poverty. FAO estimates that a primary cause for the increase in the number of hungry persons, now exceeding over a billion, is the high cost of basic staples. **India has unfortunately the unenviable reputation of being the home for the largest number of undernourished children, women and men in the world**. The task of ensuring food security will be quite formidable in an era of increasing climate risks and diminishing farm productivity.

China has already built strong defences against the adverse impact of climate change. During 2010, China produced over 500 million tonnes of food grains in a cultivated area similar to that of India. Chinese farm land is however mostly irrigated unlike us where 60% of the area still remains rainfed. Food and drinking water are the first among our hierarchical needs. Hence while assessing the common and differentiated impact of a 2 deg. rise in temperature, priority should go to agriculture and rural livelihoods.

2010 was the International Year of Biodiversity. We can classify our crops into those which are climate resilient and those which are climate sensitive. For example, wheat is a climate sensitive crop, while rice shows a wide range of adaptation in terms of growing conditions. We will have problems with reference to crops like potato since a higher temperature will render raising disease free seed potatoes in the plains of North-west India difficult. We will have to shift from planting tubers to cultivating potato from true sexual seed. The relative importance of different diseases and pests will get altered. The wheat crop may suffer more from stem rust which normally remains important only in Peninsular India. A search for new genes conferring climate resilience is therefore urgent. **We have to build gene banks for a warming India**.

Anticipatory analysis and action hold the key to climate risk management. The major components of an Action Plan for achieving a Climate Resilient National Food Security System will be the following:

Establish in each of the 127 Agro-climatic Sub-zones, identified by the Indian Council of Agricultural Research based on cropping systems and weather patterns of the country, a **Climate Risk Management Research and Extension Centre**.

- Organise a Content Consortium for each centre consisting of experts in different fields to provide guidance on alternative cropping patterns, contingency plans and compensatory production programmes, when the area witnesses natural calamities like drought, flood, higher temperature and in case of coastal areas, a rise in sea-level.
- Establish with the help of the Indian Space Research Organisation (ISRO) a Village Resource

Centre (VRC) with satellite connection at each of the 127 locations.

- Link the 127 Agro-climate Centres with the National Monsoon Mission, in order to ensure better climate, crop and market intelligence.
- Establish with the help of the Ministry of Earth Sciences and the India Meteorological Department an Agro-Meteorological Station at each Research and Extension Centre to initiate a "Weather Information for All" programme.
- Organise Seed and Grain Banks based on Computer Simulation Models of different weather probabilities and their impact on the normal crops and crop seasons of the area.
- Develop Drought and Flood Codes indicating the anticipatory steps necessary to adapt to the impact of global warming.
- Strengthen the coastal defences against rise in sea level as well as the more frequent occurrence of storms and tsunamis through the establishment of bio-shields of mangroves and non-mangrove species. Also, develop sea water farming and below sea level farming techniques. Establish major Research Centres for Sea- Water Farming and Below Sea-Level Farming. Agri-aqua farms will have to be promoted along the coast. 2010 marked the 80thanniversary of Gandhiji's salt satyagraha. Gandhiji emphasized that sea water, which forms 97% of the global water resources, is a social resource. We should have a large programme to convert sea water into fresh water through halophytes.
- Train one woman and one male member of every Panchayat to become **Climate Risk Managers**. They should become well versed in the art and science of Climate Risk Management and should help to blend traditional wisdom with modern science. The Climate Risk Managers should be supported with an internet connected Village Knowledge Centre.

A Climate Literacy Movement as well as anticipatory action to safeguard the lives and livelihoods of all living in coastal areas and islands will have to be initiated. Integrated coastal zone management procedures involving concurrent attention to both the landward and seaward site of the ocean and to coastal forestry and agro-forestry as well as capture and culture fisheries are urgently needed. A Genetic Garden for Halophytes is being established at Vedaranyam in Tamil Nadu. Biodiversity is the feedstock for a climate resilient agriculture and food security system.

Gandhiji pointed out long ago that the future of rural enterprises will depend upon our ability to marry intellect will labour. The Mahatma Gandhi National Rural Employment Guarantee Programme, which accords priority to water harvesting, aquifer recharge and watershed management, provides a unique opportunity for integrating brain and brawn. MGNREGA workers should feel that they are working for the important cause of water security. Government should institute on **"Water Security Saviour Award"** to recognise and reward the best MGNREGA Team in the areas of water harvesting and Watershed Management.

The challenging economic, environmental and social problems facing our country can be solved only with the help of science and technology. Technology is the prime movers of change, as will be evident from the impact of mobile telephony in our day-to-day life. Jawaharlal Nehru with his characteristic vision, said over 60 years ago, "the future belong to science and to those who make friendship with science". I therefore wish to cite for the benefit of young scientists a few examples from the work of the M S Swaminathan Research Foundation, Chennai, on the translation of vision to impact.

From Vision to Impact

During the last 21 years, the scientists and scholars of MSSRF have been working on the design and implementation of projects which could have a large extrapolation domain in respect of imparting a pro-nature, pro-poor, pro-women and pro-sustainable livelihood orientation to technology development and dissemination. I would like to talk about a few of the MSSRF initiatives, which have now become State, national and global programmes.

Mahila Kisan Sashaktikaran Pariyojana: Strengthening the role of women in agriculture

MSSRF initiated the Mahila Kisan Sashaktikaran Pariyojana in the Vidarbha region of Maharashtra in 2007 for empowering women farmers, including the widows of farmers who had committed suicide, in areas related to enhancing the productivity, profitability and sustainability of small-scale rain-fed farming. The empowerment measures incorporated access to technology, credit, inputs and

market. Separately, an education programme was introduced for the children who had lost their fathers due to the agrarian crisis. Encouraged by the results of this small programme, Finance Minister Shri Pranab Mukherji included funds in the Union Budget for 2010-11 for initiating a national Mahila Kisan Sashaktikaran Pariyojana.. The Ministry of Rural Development, Government of India, which is in charge of administering this programme, has made it an integral part of its Rural Livelihood Mission. Recently, MSSRF was invited to undertake the Mahila Kisan programme in the Wardha and Yavatmal districts of Vidarbha from 2011 to 2014. This will include both technological and organisational empowerment. It is anticipated that by 2014, a well-organised Mahila Kisan Federation with a membership of over 3000 women farmers will emerge. There is a growing feminisation of agriculture in India, and it is hoped that the Wardha-Yavatmal Mahila Kisan Federation will be a forerunner to others at State and national level, capable of securing women farmers their entitlements. In addition to technology, inputs and market, women farmers also need services like crèches and day care centres. The gender-specific needs of mahila kisans, both as women and as farmers, will have to be met, if women are to play their rightful role in India's agricultural progress.

In addition to action at the grass-roots, MSSRF organised several consultations to prepare a draft Women Farmers' Entitlements Bill to be introduced in Parliament as a Private Member's Bill. The draft Bill is ready and is currently under circulation among women parliamentarians and gender specialists for their scrutiny and advice. It is hoped that this two pronged action - one at the village level, and the other, at the national policy level - will help the over 350 million women engaged in farming to contribute more effectively to agrarian prosperity and sustainable food security.

Pulses Villages: Bridging the demand-supply gap

To illustrate how the gap between demand and supply in pulses, which is one of the contributory factors to food inflation in the country, can be speedily bridged, MSSRF organised Pulses Villages in the Pudukottai and Ramanathapuram districts of Tamil Nadu over 15 years ago. In these Pulses Villages located in low rainfall areas, farmers undertook to harvest rainwater in farm ponds and cultivate pulses with appropriate varieties and soil fertility and agronomic management. Based on the success of this approach to accelerating progress in the production of pulses, a national programme for the establishment of Pulses Villages was recommended to the Union Finance Minister, who announced financial provision for starting 60,000 Pulses Villages in the country. A sum of Rs. 300 crore has been provided in the Union Budget for 2011-12 for organising 60,000 Pulses Villages. Already, the impact of this integrated and concentrated approach is becoming evident from the increase observed in pulses production from 14.66 million tonnes in 2009-10 to 16.51 million tonnes in 2010-11. Under the umbrella of the Pulses Village programme, special *Arhar* Villages (pigeon pea;*Cajanus cajan*) are being developed based on hybrid *arhar* strains. High-yielding *arhar* hybrids have been developed at the International Crops Research Institute for the Semi-arid Tropics (ICRISAT) located in Hyderabad. Women's Self-help Groups will be trained to become hybrid-seed producers and some of the pulses villages will be developed into Pulses Seed Villages for this purpose. This will enable the rapid spread of a yield revolution in pulses.

Nutri-cereals: Role in strengthening food security and climate-resilient farming

Almost from the early years of its establishment, MSSRF started working on underutilised or orphan crops such as a whole range of millets belonging to *Panicum, Pennisetum, Paspalum, Setaria, Eleucine* and other genera. These crops, normally classified as coarse cereals, are very nutritious and are rich both in macro- and micro nutrients. In fact, a combination of millet and *Moringa*(drumstick) provides most of the macro- and micro-nutrients needed by the body. The widespread hidden hunger now prevailing in the country as a result of a deficiency of iron, iodine, zinc, vitamin A, vitamin B_{12} and other needed micronutrients in the diet can be overcome at low cost through the consumption of millets and vegetables.

In 1992, MSSRF initiated in Kolli Hills in Tamil Nadu a programme for the revitalisation of culinary traditions involving a wide range of millets. A four-pronged strategy involving concurrent attention to conservation, cultivation, consumption and commerce was initiated. Commercialisation proved to be a trigger in the area of conservation, since farmers generally prefer to grow crops like rice, wheat or tapioca, for which there is a ready market. Similarly, in the Wayanad district of Kerala, tribal

families were enabled to continue the conservation and consumption of tuber crops like *Dioscorea*. There is now a revival of interest in millets and other underutilised crops, both because of their ability to help in overcoming chronic and hidden hunger and their role in the design of climate-resilient farming systems.

In partnership with Bioversity International the Agricultural Universities of Bangalore and Dharwar, and with financial support from the International Fund for Agricultural Development (IFAD) and the Swiss Agency for Development Cooperation (SDC), MSSRF has succeeded in introducing appropriate milling machines as well as markets for value-added products in a wide range of millets. Through several Policy Makers' Workshops and efforts in nutritional literacy, an understanding of the role of millets, tubers and other underutilised crops in improving rural nutrition and income in an era of climate change was promoted. Finance Minister Shri Pranab Mukherjee thus referred to *jowar (sorghum), bajra (pearl millet), ragi (Eleucine)* and minor millets as "nutri-cereals" and provided an allocation of Rs 300 crore in the Union Budget for 2011-12 for their popularisation.

In its draft National Food Security Bill, The National Advisory Council, headed by Shrimati Sonia Gandhi, has included millets among the staple grains that should be made available to food-insecure families, both in rural and urban India, at a highly concessional price through the public distribution system. If this Bill is approved and implemented, there will be a revival of interest in the cultivation and consumption of these nutrition-rich and climate-resilient crops. Agro-biodiversity hot spots can then become happy spots and will witness the dawn of an era of biohappiness where rural and tribal families are able to convert bioresources into jobs and income in an environmentally-sustainable and socially-equitable basis.

Another significant recent development is the initiation of a project on "Alleviating Poverty and Malnutrition in Agro-biodiversity Hotspots" with financial support from the Canadian International Food Security Research Fund (CIFSRF). The project is administered by the Canadian International Development Agency (CIDA) and the International Development Research Centre of Canada (IDRC) and involves partnerships with MSSRF, the University of Alberta, Canada, Bioversity International, the World Agroforestry Centre (ICRAF) and the World Food Programme (WFP). This five-year project (2011-16) will help to revitalise the *in situ* on-farm conservation traditions of tribal and rural families in the Kolli Hills area of Tamil Nadu, the Wayanad district of Kerala and the Koraput district of Orissa. MSSRF has been working with them for over 15 years. The contributions of the tribal families of Koraput have been recognised through the Equator Initiative Award at the UN Conference on Sustainable Development held at Johannesburg in 2002, and the Genome Savior Award by the Plant Variety Protection and Farmers' Rights Authority of the Government of India in 2011. Thus, two decades of research and education carried out by MSSRF in the area of orphan crops have led to important research investment and public policy initiatives at the national and international level. The expansion of the food basket by increasing the number of crops which go into the daily diet will also impart stability to food security systems.

IDRC through CIFSRF is also supporting another project on strengthening rural food security through the production, processing and value-addition of nutritious millets. This project is being implemented in collaboration with McGill University, Canada and the University of Agricultural Sciences, Dharwad. MSSRF also coordinates the project activities assigned to the Himalayan Environmental Studies and Conservation Orgnisation (HESCO), Dehradun. This project capitalises on the progress earlier made by MSSRF in these crops with support received from the International Fund for Agricultural Development and Bio Diversity International.

Price Volatility and Hunger: Operation 2015

Nearly 70 per cent of the income of the poor goes to buy food. High prices therefore tend to reduce food intake by the poor, thus leading to the persistence of hunger. The extent of price volatility in recent year with reference to rice, wheat and oil (petroleum products)

The Agriculture Ministers of the G-20 Nations who met in Paris on 22-23 June 2011 have emphasised that "small scale agricultural producers represent the majority of the food insecure in developing countries. Increasing their production and income would directly improve access to food among the most vulnerable and improve supply for local and domestic markets." The Ministers also decided to establish an Agricultural Market

Information System, to start with in wheat, rice, maize and soybean, in order to improve agricultural market outlook and forecasts at the national and global levels.

MSSRF's work in this area has three major dimensions. The first is the development of village-level food security systems based on community Gene, Seed, Grain and Water Banks, which will help to store and distribute local nutritious grains like millets and pulses; the second encompasses the training of a cadre of "Community Hunger Fighters" who will be well versed in the science and art of overcoming both chronic and hidden hunger. The third dimension of MSSRF's work in the management of price volatility is a dynamic and location-specific market information system through Gyan Chaupals or Village Knowledge Centres. Many of these centres, now operating for over 15 years, provide timely information on the monsoon and the market. The behaviour of the monsoon and the market determines farmers' well-being. Hence, the Gyan Chaupals operated by local women and men give priority to empowering farm women and men with timely information on weather and market behaviour. Also, they provide information on food quality and safety, as well as on the entitlements of farm households to various government schemes.

The tribal areas where MSSRF is working in Tamil Nadu, Kerala and Odisha, as well as the Vidharba region of Maharashtra, are yet to achieve the progress necessary in the reduction of hunger and poverty to reach by 2015 the target set under the first among the UN Millennium Development Goals. Therefore, MSSRF in association with other partners has launched a programme titled "Operation 2015" to help these areas achieve UNMDG 1 by 2015. The programme consists of the following features:

Adoption of a lifecycle approach in nutrition support programmes

- Promotion of a "deliver as one" method with reference to nutrition, clean drinking water, sanitation, environmental hygiene, and primary health care
- Payment of concurrent attention to small farm productivity improvement and producer-oriented marketing
- Encouragement of a food-cum-fortification approach (especially fortification of salt with iron and iodine) in respect of fighting chronic calorie deprivation and micronutrient deficiencies
- Establishment of a cadre (at least one woman and one man in every village) trained as Climate Risk Managers and Community Hunger Fighters

Thus, MSSRF hopes that the challenge of price volatility can be fought at the local community level as well as at national and global levels.

Seawater Farming

From 1990 onwards, MSSRF has been working on integrated coastal zone management, involving concurrent attention to the seaward and landward sides of the shoreline. The aim has been to strengthen both the ecological security of coastal areas and the livelihood security of coastal communities. A Coastal Systems Research (CSR) methodology was thus developed. The research activities included the conservation and restoration of mangrove wetlands, development of a Participatory Mangrove Forest Management System, generation of awareness of the importance of mangrove and non-mangrove bioshields in reducing the fury of coastal storms and tsunamis, and the breeding of salinity-tolerant rice, pulses and other crops of importance to coastal agriculture by transferring genes for salinity tolerance from mangrove species through marker-assisted selection of recombinant DNA technology. Eighteen years of sustained research in this field led to international patents being granted for the novel genetic combinations produced by MSSRF scientists for tolerance to abiotic stresses like salinity and drought. These include:

- US patent for the Dehydrin gene from *Avicennia marina* responsible for conferring salt tolerance in plants (Dr. Ajay Parida, Dr.Preeti Mehta and Dr. Gayatri Venkataraman)
- US patent for the Glutathione-S-transferase gene from *Prosopis juliflora* conferring drought tolerance in plants (Dr. Ajay Parida and Dr. Suja George) Three more patents - for Phytosulfokine-α precursor sequence from *Avicienna marina* conferring stress tolerance, Antiporter gene from *Porteresia coarctata* conferring stress tolerance and Superoxidase dismutase gene for conferring abiotic stress tolerance in plants - have been filed and are in the process of being granted.

Marker-assisted breeding has resulted in developing location-specific transgenic lines in popular*indica* varieties (IR64, IR20, Ponni and ADT 43) showing 99.5 percent purity and enhanced salinity tolerance of 400mm of NaCl.

MSSRF's work led to the rehabilitation and replanting of 2400 ha of mangroves in Tamil Nadu, Andhra Pradesh and Odisha. The 2011 Coastal Regulation Zone Notification (6 January 2011) by the Government of India derives its scientific basis from MSSRF's research during the past 20 years and from two reports submitted by committees chaired by me.

On the basis of the projects proposed by MSSRF, both the Ministry of Environment and Forests (MoEF) and the Department of Science and Technology (DST) of the Government of India sanctioned funds for making effective use of seawater not only to raise bioshields, but also to initiate seawater farming projects involving integrated agro-forestry and mariculture techniques. The support from MoEF is through the Society of Integrated Coastal Management (SICOM). Seawater constitutes nearly 97 per cent of global water resources and Mahatma Gandhi rightly emphasised that it is a very important social resource. In 1930, Gandhiji's salt march was to manufacture salt in the Dandi beach in violation of the then prevailing government regulations. In the same year, C Rajagopalachari and Sardar Vedaratnam Pillai organised a salt satyagraha at Vedaranyam in Tamil Nadu. MSSRF organised a workshop at Vedaranyam on 26 December 2010 to highlight the need for undertaking the conversion of seawater into fresh water through halophytes possessing food and other economic value. The seawater farming project was included by DST under its WAR for Water Mission (Winning, Augmentation and Renovation). Steps have been initiated for establishing a genetic garden of halophytes in Vedaranyam, both to conserve the genetic resources of halophytes and to spread economically-attractive and environmentally-sustainable seawater farming methods. Under conditions of a potential rise in sea level, halophytes will become crops of the future in coastal areas.

Preserving Agricultural and Biodiversity Heritage Sites

During 2010-11, two important initiatives of MSSRF achieved wider impact. First, the Government of Tamil Nadu established genetic heritage gardens based on the description of ecosystems in the classical Sangam literature. These were set up at:

Kurinji (hill) – Yercaud, Salem District

Mullai (forest) – Sirumalai, Dindigul District

Marudham (wetland) – Maruthanallur, Kumbakonam, Thanjavur District

Neithal (coastal area) – Thirukadaiyur, Nagapattinam District

Palai (arid land) – Achadipirambu, Ramanathapuram District

In such genetic heritage gardens, the flora and fauna characteristic of each ecosystem will be preserved, which will help to spread the understanding of the value of such ecosystems. The garden in the Taramani campus of MSSRF also contains a replica of these five ecosystems described 2000 years ago.

The other important initiative relates to getting recognition for two Globally Important Agricultural Heritage Sites (GIAHS) under FAO's GIAHS programme. The project proposal seeking recognition for the Koraput rice genetic heritage site in Odisha has been prepared and forwarded to FAO. Here, tribal families have conserved a veritable mine of valuable genes in rice for hundreds of years. Recognition under FAO's GIAHS programme will help to give prestige to those conserving vanishing varieties and dying wisdom.

Another globally important agricultural heritage site is the Kuttanad area of Kerala where, for over a century, farmers have been practising farming below sea level. This system developed by farm families through practical experience involves the cultivation of rice during the monsoon season and fish during the non-rainy season. Unlike in the Netherlands, the Kuttanad farmers only put up low-cost temporary dykes. The GIAHS designation for the below sea level farming system developed by the farm families of Kuttanad will help to give recognition to the pioneers of this technology as well as refine it further. This will be particularly useful in the event of a rise in sea level as a result of global warming, as it now seems very likely. It is proposed to establish a Regional Training Centre for Below Sea Level Farming in Kuttanad, for the benefit of countries in this region - like the Maldives, Sri Lanka, Bangladesh and Thailand - which may have to

undertake farming below sea level during this century.

Land and Water Care: Role of Global Soil Partnership

Since 2000, MSSRF, with financial support from the Tata Trusts and in association with the Punjab Agricultural University, Ludhiana and the Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, has been carrying out detailed studies on rainwater harvesting and efficient use, and watershed development and management. The emphasis in the current phase of this project is on maximising employment and income-generation opportunities for the watershed community through both on-farm and non-farm enterprises. The programme is hence known as "Bio-industrial Watershed" development. Small-scale market-linked enterprises supported by micro credit are promoted. Land-use decisions are also water-use decisions, and hence an integrated approach to land and water care is necessary to achieve an ever-green revolution leading to enhancement in productivity in perpetuity without associated ecological harm. Since land is a shrinking resource for agriculture and since there is a growing tendency to 'grab' prime farmland for non-farm purposes, such as for real estate and biofuel production, I proposed in October 2009, in my capacity as Chairman of the FAO's High Level External Committee (HLEC) on the UN Millennium Development Goals, the establishment of a Global Soil Partnership (GSP) for Food Security and Climate Change Adaptation and Mitigation. Both HLEC and the Director General of FAO have accepted this suggestion The Ministry of Environment and Forests has invited MSSRF to assist in developing strategies for sustainable food and nutrition security within the framework of a green economy. Obviously, a National Soil and Water Care programme involving all stakeholders, particularly farmers' associations, has to be an integral component of India's Rio +20 programme.

Human Resource Development

MSSRF's institution building philosophy has always been to concentrate on brains and not bricks. The sustained growth of MSSRF's Gyan Chaupal movement is a good example of the value of this approach. It is equally important that initiatives like Village Knowledge Centres are based on the principle of dynamic and location- specific information delivered in the local languages, based on a demand-driven approach. Local communities should also have a sense of ownership, as otherwise it will not be sustainable. The Jamsetji Tata National Virtual Academy, which now has nearly 1500 rural women and men as Fellows as well as 35 foreign Fellows, has become a valuable institutional device to build the self-esteem and capability of rural women and men belonging to socially- and economically-underprivileged families. In a recent review of the project, the reviewers concluded that the Academy has helped to convert ordinary people into extraordinary individuals.

Remember Your Humanity

It will be clear from the foregoing that the bottom line of the programmes undertaken by MSSRF during the last twenty years has been the wellbeing of rural and tribal families in an environmentally and socially sustainable manner. Unless we place faces before figures in our programmes dealing with human beings, we will not know whether the steps we have taken are really beneficial to those for whose welfare they are intended. "Remember Your Humanity" is therefore an effective method of monitoring the social impact of research and development programmes.

The Seed That Seeded India's Green Revolution

E.A. Siddiq

Dwarf plant type based varietal technology in rice and wheat and prior to them hybrid technology in millets widely recognized as two landmarks in the breeding history of crop plants, enabled breaching of centuries long yield stagnation at very low levels. In transforming the chronically food deficit India into a self-sufficient and surplus nation popularly referred to as 'Green Revolution', the role played by quality seed is as much as that of the varietal technology. But for the production and supply of quality seed that enabled extensive adoption of the new varietal technology, the country would not have witnessed so early the impact of it. In independent India, among the agriculture related industries that grew along and contributed phenomally to the enviable growth of agriculture sector since the introduction of the high yield varietal technology, 'Seed Industry' edges even the equally important fertilizer and pesticide industries. In the last fifty years, it has grown sizewise, to earn the distinction of being the third largest in the world comprising over 500 seed companies in the private sector and 15 large seed corporations in the public sector. Unlike anywhere in the world, Indian seed industry represents an excellent blend of private and public sector, involvement. Commercial valuewise, Indian seed market with a turnover of about US$ 1.2 billion (Rs.7000 crores) is the fifth largest.

Historically, in the initial decades, it was the public sector National Seed Corporation, State Farm Seed Corporation of India and State Seed Corporations, that wholly shouldered the responsibility of catering to the seed need of the country. Bulk of the seed need then being of self pollinated rice and wheat varieties and open pollinated maize hybrids and composites, production and supply of quality seed was not found difficult by them. Over the years, especially with hybrid technology assuming importance in a variety of field crops including sorghum, pearlmillet, sunflower, cotton etc. private sector seed companies stepped in and started sharing increasingly the responsibility of quality seed production and supply. Their pace of growth since early 1980^s has been quite phenomenal. Today, they account for over 40 percent of quality seed production and marketing, largely of hybrid crops including rice now. Interestingly, not only 100 percent of seed production and marketing of transgenic BT cotton hybrids is by the private sector, but also all the transgenic cotton hybrids now commercially planted in the country are from the same sector. It is very much true as well in rice, wherein over 80 percent of the commercially planted 45 hybrids is from the private sector and nearly 90 percent of hybrid seed produced and marketed of them is by this sector only. Thus the pattern of growth trend of this sector reflects a major change in its role from seed production- marketing of seed to varietal breeding-seed production-marketing. The transformation in its role akin to multinational companies with strong R&D component is a good development at this juncture, when public institutions at national and international levels

Based on the talks delivered in the Indian Seed Congress-2011 and the Annual Meeting of the Andhra Pradesh Seedmen Association - 2011, Hyderabad

Honorary Director, Institute of Biotechnology, Acharya NG Ranga Agricultural University, Rajednaranagar, HYDERABAD-and Distinguished chair , Centre for DNA Fingerprinting and Diagnostics, Nampally, HYDERABAD-500001, E-mail: easiddiq@gmail.com

are gradually losing their competitiveness *visa vis* private sector institutions in providing progressively competitive and value-added varieties/hybrids. It is encouraging that R&D component of as many as 50 Indian companies in the private sector have now been recognized by the Government of India, which should make them soon competent to develop future hybrids/ varieties employing innovative molecular breeding-selection strategies, the new biosciences offer now and remain globally competitive in price and performance of their products.

Growth trend and contributing factors

Begun with a few lakh tonnes decades back, today the industry produces quality seed- certified and truthfully labeled- by many folds enough to meet the increasing requirements of as many as 4000 high yielding varieties/hybrids of field and vegetable crops and to ensure the stipulated seed replacement rate (SRP) of 15% in varieties and 100% in hybrids. In case of rice and rapeseed mustard varieties the SRP is as high as 36 and 76 percent respectively. Sticking to its strategy, the industry produces 10-15% more seed than what is actually required. As against the actual requirement of 21 lakh tonnes, availability of seed in 2009-10 was 25 lakh tonnes, of which private sector largely confined to low volume high value hybrid crops accounting for about 40 percent.

As for the factors that contributed to such an impressive performance of the industry, pace of technological advance, developmental initiatives and favourable policy environment are important. From technological angle, extension of hybrid technology beyond traditional hybrid crops to rice, mustard and vegetable crops, increasing area under value added speciality rices and QPM maize, extensive adoption of transgenic (*Bt*) cotton, while from development angle, strengthening of infrastructure in the seed corporations in the public sector under the National Seed Project (NSP) I, II and III, rapid growth of Indian seed companies and the advent of multinational seed companies, promotion of seed village strategy have been the major factors that contributed to this growth. Among the policy related factors provision in the Seed Act-1996 itself for marketing truthfully labelled seed along with certified seed of formally notified varieties/ hybrids, permission under the New Seed Act-2002 for bulk import of seed of exotic varieties/ hybrids and marketing for two years without complying to the requirement of prior testing under the coordinated programme, provision under the PPV & FR Act, 2002 allowing farmers to sell seed of protected varieties as non-branded and subsidy on seed ranging between 50 and 100 percent for hybrid crops like rice are important.

Demand projections and strategies for achieving:

Keeping in view the need to raise the seed replacement rate of crop plants, where it is still less than the stipulated and projected area increase under hybrid crops, especially rice, and possibly wheat in the near future, Indian mustard, pigeonpea and castor, quality seed requirements by 2015 and 2025 have been estimated to be 36 and 42 lakh tonnes at 15% and 20% growth rates respectively. This could still be more, if seed export prospects increase.

Despite the vastly strengthened infrastructure and institutional base and decades of experience and expertise in seed production and processing, achievement of such high targets would require further research, developmental and policy interventions.

As for research, enhancement of yield advantage and cooking quality of hybrid rice, raising the yield advantage and seed yield in wheat and pigeonpea, diversification of male sterility-fertility restoration system in rice, development of stable cytoplasmic male sterility system in cotton, rapeseed mustard and vegetable crops are some of the researchable issues warranting priority attention. Gaps from development angle include further strengthening of seed villages giving emphasis to production of seed of large seeded crops like groundnut, improvement of quality of farm-saved seed, which still forms the major source of seed, development of additional and state of the art seed storage facilities at national/state levels

and seed banks at village level for seed source for crops lost due to natural calamities and identification and development of new areas favourable to quality seed production during *rabi* as well as *kharif* seasons.

Such research and development efforts in the absence of appropriate policy support may not yield desired results. The following are some of the additional policy interventions needed for continued growth of the Indian seed industry

(i) Clear National Policy on Biotechnology: In the era of genomics, when the country is rightly serious about finding solution to problems that continue to defy conventional breeding/ selection strategies, through development and adoption of genetically modified (GM) crop varieties, amidst loud anti GM voices apprehending biosafety related risks, it is important to have in place with no more delay, a clear National Policy on Biotechnology and stringent and transparent Biotechnology Regulatory System that respects consumer right and has concern for environment safety. Such measures, while helping to ward off of the kind of hassles we have passed through in the adoption of BT cotton, would pave the way for promoting many more GM crop varieties now in the pipeline and potential enough to contribute substantially to the country's economy in general and the Indian seed industry in particular.

Favourable policy guidelines for seed export-import

Given the large and still unexploited seed market in countries of agro-ecologies comparable to ours, especially Africa and availability of relatively less expensive skilled manpower in the country for quality seed production, it is high time that we identify seed as one of the major agricultural commodities for export. While efforts are warrented for extensive survey for identification of prospective export markets, new opportunities for producing very high quality seed at much less cost elsewhere and exporting back the same to our own country, where seed demand is steadily on the increase as well as to other potential seed markets should as well be taken advantage of by our seed industry. Countries in the sub-Saharan Africa having highly favourable seed production environment for a variety of tropical crops with perfect isolation facilities be considered for such a venture. Public sector seed companies like NSC, SFCI strengthened adequately with competent breeders, seed technologists and marketing experts could as well emerge as multinational giants in seed industry, if government of India could come forward with helpful policy support to this effect.

Strengthening of public-private partnership

In the unique seed industry like ours, where both public and private sector organizations are actively involved in research and devolvement activities, if they work in partnership recognizing and sharing each other's strength on areas of common interest, the outcome and its impact would be phenomenal. Though stray instances of such partnership are there, they are not only not formal enough but also not to desired level. There is ample scope for the two streams to come together in the following areas and modes of partnership: (a) opening up breeding nurseries in advanced stages of development periodically by large public research institutions for the private sector companies to select and commercially exploit lines of their interest. When such a system is in practice in the CGIAR institutes, like ICRISAT, IRRI, CIMMYT etc, there is no reason for ICAR and SAUs for not formalizing such arrangement between their commodity institutes/centres and private seed companies, (b) enabling private seed companies to commercialize the finished and notified varieties/hybrids of the public sector organizations. Instances like the Basmati hybrid rice Pusa RH10 now being exploited by several private seed companies through a formal memorandum of understanding with the Indian Agricultural Research Institute, the developer institute should be replicated. The Indian Foundation Seed and Services Association (IFSSA) established under the aegis of Barwale Foundation serves as an interface between public

and private sectors by providing quality Foundation Seeds (c) undertaking joint research programmes for addressing crop improvement related problems. Support being extended under the SIBRI of the Department of Biotechnology and similar opportunities extended by the ICAR, could be taken advantage of to find research solutions to problems of common interest. Understandably, very large number of private-public organizations involved research projects are now receiving substantial support from the DBT and ICAR and (d) Contractual research, wherein private sector companies could approach public sector institutions on cost basis for finding remedy to crop related problems that impede their progress. Increasing instances, wherein public institutions are approached by the private sector companies to find transgenic solution to not easily controllable pests etc. are some of the encouraging trends.

Strengthening of R&D component in private seed companies

Indian seed companies in general and private sector institutions in particular engaged mainly in production and marketing of seed only until 1970^{s} have started breeding research to evolve hybrids/varieties of their own since 1980^{s}. This transformation has become inevitable for private seed companies for sustaining themselves in the fast changing seed scenario. Over the years many of the large seed companies have developed fairly strong R&D component for evolving progressively improved hybrids and varieties of their own. It is all the more satisfying that they are increasingly employing innovative breeding-selection techniques in crop improvement research. Convinced of the power of the genetic engineering research, a Consortium of lead seed companies is now funding an advanced research centre to develop and make available transgenes and transgenics of their interest. Not withstanding such encouraging developments in the private sector, unlike in the multinational companies, the level of R&D component in terms of number and competence of scientific staff is left much to be desired. Unless this deficiency is corrected, Indian seed industry cannot be expected to remain competitive in global seed business.

Resolution of contentious provisions in the New Seed Bill

The Bill awaiting Parliament approval since 2004 has many provisions for further regulating seed commerce. They include regulation of seed pricing, compulsory registration of seed for marketing, seed producer, seed processing unit and seed dealer, compulsory licensing, compensation to the grower in the event of a technology failing to measure up to the claims and penalty for seed related offences. It is important that the final version of the Bill gives due consideration to the concerns of the farming community as well as the seed industry.

Need for merger of small and medium seed companies

In the fast changing globalized market it would be increasingly difficult for small and medium level seed companies to be technologically competitive and financially viable. As is happening at global level, it would be desirable for such companies to merge among themselves into larger ones or merge with already existing large Indian companies.

The Seed that has to sustain the Green Revolution

Good seed is the base for a good variety to express its full potential. It was the quality seed made available in keeping with the growing need of over a large number of improved varieties that helped the country witness major production breakthrough and thereby the socalled Green Revolution. To sustain the revolution, along with progressively improved varieties and expanding area under them quality seed availability is inevitable. To meet so growing seed demands, continued research, developmental and policy interventions are necessary. Substantially increased investment on crop improvement and seed production research, matching human resource and infrastructure development, stringent regulatory system for accelerated development and extensive adoption of products of innovative biosciences and all out measures to sustain the farmer would alone enable the country achieve the envisaged growth in the agriculture sector.

Impact of Climate Change on Fisheries and Consequences for Nutritional Security

Dr. M. Vijay Gupta

Introduction

The world is passing through a critical time in terms of increasing population, food shortages and high inflation in food commodities. Global food prices have increased by 83% between 2003-2008 and predicted to continue with serious implications for food and nutritional security. Increasing food costs and general living costs have led to social and political unrest in about 60 countries. By 2050, global demand for food and fibre will nearly double and at the same time, crops may also be diverted for biofuel and animal feeds. The steadily declining average rate of growth of agriculture yield per year from 4.4% in 1980-1990 to 2.8% in 1991-1998 and 0.6% during 1999-2009, is of grave concern. This will be exacerbated in the coming years by the global warming and climate change that will have a major effect on terrestrial and aquatic resources directly and on the human population indirectly.

Contribution of Fish to Nutrition and Livelihood Security

Fish considered as *"rich food for poor people"* and rich in micronutrients, essential fatty acids and proteins, has been playing an important role in addressing nutritional and livelihood security of poor in developing countries. Over 3 billion people get at least 20% of their animal protein intake from fish and the sector has been providing livelihoods to over 520 million or 8% of population worldwide. The number of fishermen and fish farmers has grown at a faster rate than the world population and faster than employment in traditional agriculture. Fish is the most internationally traded commodity and the value stood at $ 102 billion in 2008. About 40% of global fish production is traded across countries as compared to about 10% for meat.

Projected Demand for Animal Protein and Fish

It is estimated that animal protein requirements globally will increase by 50% by 2020 and an additional 30 million tons of food fish would be needed by 2020 at the present level of consumption, as against present production of 115 million tons.

Fisheries and Climate Change

Responsible management of the resources and ecosystems on which millions of fishers/farmers depend for their livelihood and billions depend for their animal protein requirement is a challenge for world food security. The sector which is already threatened by over-exploitation and external factors such as pollution runoff, land-use transformation and competing aquatic resource uses, will be further compounded by the climate change. The people dependent on fisheries and aquaculture as producers or consumers will be particularly vulnerable to the direct and indirect impacts of predicted climate changes either due to changes in physical environment, ecosystems or aquatic stocks or due to impacts on infrastructure, fishing/farming operations or livelihood options.

It is anticipated that the climate change will result in: increased ocean temperature, ocean acidification, altered aquatic ecosystem, changes in fish distribution, salt water intrusion in to freshwater areas, changes in productivity of marine and freshwater fish species, spread of diseases/ pathogens, etc. The Inter-Governmental Panel on Climate Change (IPCC) indicates that global annual

World Food Prize Laureate
Assistant Director General, WorldFish Center (Retd.)
C502, Aditya Elite, B.S. Maktha, Hyderabad 500016,
Tel/Fax: 91-40-23400229; Mobile: 91-9866508555, E-mail: guptamo2000@yahoo.co.in

seawater temperature and sea level could increase by 0.8-2.5°C and 8-25 cm respectively by 2050. There is evidence that inland waters are also warming, with differential impacts on river run off.

All the above changes are expected to impact on the productivity of marine and inland capture fisheries and the livelihoods of all those who depend on aquatic resources. Being poikilotherms, even 1°C increase in temperature, will affect distribution and life processes of fish. Over the medium term – a few years to a decade, temperature regulated physiological stresses and changes in the timing of life cycles will impact the recruitment success and thereby the abundance of many marine and inland aquatic populations. It is expected that small-sized low-value species of fish with rapid turnover of generations will replace large-sized, high value species which are already showing declining trend due to over-fishing. The impact of ocean acidification will be particularly severe for shell-borne organisms and coral reefs. Further, climate change will result in extreme events such as drought, very high tides, violent winds and storms. Fisheries dependent coastal/inland communities are likely to face increased vulnerability in terms of less stable livelihoods, decreases in availability of fish for food and safety risks due to fishing in harsh weather conditions. If we are to sustain the livelihoods and nutritional security of these coastal communities, we have to address issues that impact on their livelihoods by undertaking mitigating measures and adaptation strategies.

Way Forward

While on one hand increasing demand for fish provides opportunities for fish farmers to increase production, on the other hand declining production from capture fisheries due to over-exploitation of stocks which is further exacerbated by the impacts of climate change, pose challenges for sustaining the production from capture fisheries, let alone increase. In view of this, while adopting mitigation measures for sustaining/increasing production from capture fisheries, aquaculture production also has to be increased to meet the increasing demand. Adaptation and mitigation measures that need to be undertaken include: implementation of an integrated ecosystem approach to managing oceans, coastal zones, fisheries and aquaculture; adoption of environmental friendly and fuel efficient fishing and aquaculture practices; strengthening knowledge of the dynamics of biogeochemical cycles in aquatic ecosystems,

The loss of agriculture productivity as a result of salination from sea level rise and sea water intrusion could have an important impact and lead to aquaculture taking a major climate change adaptive role as an alternative livelihood, compensating for income and some aspects of food supply. In view of this, fisher and famer communities have to adopt themselves taking advantage of aquaculture technologies that are available.

Global public spending on agriculture R&D declined by 58% in real times between 1980 and 2005. For every $100 of agricultural output, developed countries spend $2.36 on public R&D, whereas developing countries spend only $0.53. In view of the increasing gap between supply and demand for food and anticipated further aggravation by climate change, there is urgent need to increase investments in agriculture research and development if we are to improve the food security situation.

It is necessary to bring awareness among policy makers, managers of resources, fishers and farmers and other stakeholders of the impact and vulnerability from climate change and the need for adaptation and mitigation of negative impacts. It is necessary to build institutional and legal frameworks that consider and respond to climate change threats and uncertainties along with other pressures such as overfishing, pollution and changing hydrological conditions and enhance resilience of fishing and aquaculture communities by supporting adaptive livelihood strategies and management institutions.

Food vs Fuel
Complimentary or Competitive?

M.V.R. Prasad

What do you do with a country that is developing, cut off from the global biomass trade by a tyranny of distances, with a carbon emissions problem, a partially wealthy urban population, a stumbling and degrading rural economy, and half-hearted political will to do something about climate change? My saying goes thus: "if life gives you lemons, make lemonade; if life won't even give you lemons, make bio-fuels."

The US Department of Agriculture tells us that US farmers are going to harvest in 2011 more corn for ethanol production than for food or feed. More than 50% European rapeseed production will be used for bio-fuel production. The growing diversion of fertile crop land for fuel production is causing imbalances and scarcities in food production.

According to Prof. M.S. Swaminathan, experts have pointed out that "the Arab Spring" had its genesis in food inflation. Hence, he stresses that "future belongs to nations with grains, and not guns". According to the World Bank the "land rush" is not likely to slow. As a consequence, the land less population will grow, leading to greater unrest in rural areas of developing countries like ours. Under such pressure of human population with declining per capita land availability, what are the priorities? Food or Fuel (for Energy)? There is a strong argument justifiably that the land should be available to food production on priority basis. All the same, food production needs energy. We can't depend continuously on fossil fuels as a source of our energy. The sudden escalation of prices of food grains like rice and wheat witnessed in a couple of years ago in India was largely due to a steep increase in the price of fossil fuels, which has resulted in the scaling-up of input cost. This means we should no longer be at the mercy of "OIL MAFIA"; but we need to look for alternate renewable sources of fuel for energy, which is possible only with bio-fuels.

What kind of bio-fuels? What has been the global experience in bio-fuels? The pioneer in producing the renewable source of energy in the form of bio-fuels is Brazil. As back as 1979, Brazil switched over to bio-alcohol produced from sugarcane as source of energy, particularly for automobiles. Initially it was a happy experience and a matter of national pride. Over the period of years, more and more land was occupied by sugarcane, as a result of which, soybean production, for which Brazil was acclaimed, suffered very badly. Now Brazil has realized that Ethanol from Sugarcane is not a sustainable proposition. In this back drop, have Brazilians abandoned programs of bio-fuels? No, Instead Brazilian Government is diversifying its bio-fuel program with emphasis on dry-land castor. Most of the Brazilian dry land agriculture is confined to the North-eastern States of Bahia, Pernumbuco, Ceara, Pariba, Alagoas and Piaui, where intensive production of food crops is at risk, which may not be sustainable in terms of cost – benefit ratio. Therefore, Brazilian Government have formulated a strategy to stimulating the production of dry-land castor in these vast stretches of lands for bio-fules, in order to meet the nation's growing energy needs, notwithstanding the fact of recent discovery of oil in their costal zones.

We did not seem to learn this lesson from Brazil. India has an important sugarcane industry, with 5 million hectares used for sugarcane, resulting

Project *Director (Retd.), DOR, Hyderabad,* E mail: mvrprasad@yahoo.com

in 6 to 9 million tonnes of molasses per year and 1.2-1.8 million m^3 ethanol per year (most of which for potable use or industrial use). Of great interest is the program that the Indian Government has introduced in order to increase the production of ethanol. This is going to be a costly experiment if we don't retrace our steps very soon.

The Southeast Asian countries viz., Malaysia, Indonesia and Philippines have achieved massive production levels of palm oil. Malaysia is the world leader in production of palm oil. A considerable part of palm oil produced in these countries is being diverted to the production of biodiesel. A comparison of oil palm with other non-edible oil producing perennials is given below. The data presented below are obtained through the best scientific management of the systems indicated from Australia.

	Oil Palm	Jatropha	Pongamia
Rainfall requirement per year	2,000-3,000mm	600-2,000	250-2,500mm
Harvest Method	Manual	Manual	Easily Mechanized
Plantation Carbon Credits Qualified	No	No	Yes
Area managed per plantation worker	10Ha	5Ha	60Ha
Oil Yield / ha in 3yrs (tonnes)	2.75	3	10
Oil Yield / ha in 10yrs (tonnes)	10.5	9.5	18
Oil Yield / ha in 15yrs (tonnes)	11	10	28

The solution to the problem lies in our correct approach with regard to bio-fuels. When we employ food crops like maize etc., for producing bio-fuels, this would automatically result in food and feed shortage. The recent happenings in USA and Africa are the testimonies to this tragedy.

Secondly, if you grow non-food crops with expensive inputs and irrigation, the fertile cropped area will be alienated to food production. This has happened with regard to sugarcane being taken up for bio-fuel production. Also use of edible oil bearing crops viz., rapeseed in Europe and Oil palm in Southeast Asia for bio-fuel is going to open chapters of disaster on the farm front. Moreover, growing bio-fuel plant species under intensive management conditions is not going to be cost-effective.

India possesses enormous diversity in terms of non-edible bearing oil bearing perennial plant / tree species, which offer perceptible advantage in terms of augmenting oil production on marginal lands not fit for regular food crop production. Hence, the appropriate option should be to grow hardy non-edible bearing plant species on marginal lands not conducive for crop production backed up by appropriate production technologies. Tree species such as *Pongamia pinnata* do not need any fertile soil or irrigation or higher quantum of monitory crop inputs. Now the technologies for augmenting the production of *Pongamia backed* up by elite genotypes are becoming available. Australia is going in a big way with the exploitation of "Pongamia production system" for bio-fuel production.

Every farmer including small and marginal ones have some land which is left out without regular crop production, for the reason of it not being suitable for production of regular food and commercial crops. Such lands could be profitably utilized for production of trees like *Pongamia,* which offer immense scope for bio-fuel generation, without any adverse effect on food production.This would not only ensure the production of oil for energy; but also help poor and marginal farmers to augment their income levels substantially. It may be recalled that during the worst droughts that India had suffered in the years 1972, 1974 and 1979 the farmers who had

around 20 to 30 Pongamia trees each on their field bunds and marginal soils, were able to tide over the adverse economic effects of drought.

According to the estimates of the Ministry of Agriculture (1982) and the National Commission on Agriculture (1976), India has over 175 million hectares of poor or waste lands not suitable for regular crop production. This figure has further been revised to 187 million hectares by the National Bureau of Soil Survey and Land use Planning of ICAR in 1994. Therefore, it could be observed that these lands characterized by poor soils forming around 53 to 57 % of the total geographical area of the country could be put to use by growing suitable hardy perennial species like Pongamia that yield oil for energy purposes.

Over 80% of such waste lands are in the states of Rajasthan, Uttar Pradesh, Gujarat, Madhya Pradesh, Chhattisgarh, Orissa, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. Plantations of Bio-diesel / Vegetable Oil yielding perennial plant species could be taken up in the overall ambit of micro-panning for rehabilitation of such lands covering 146 districts in 19 states that include the above, as launched by the Government of India. Self Help Groups for landless people can be profitably involved in this activity in the ambit of Integrated Watershed Management programs. In this context, the National Mission on Bio-fuels too has identified around 13.4 million hectares for the production of plants of bio-fuel value.

Ascendancy of Cotton in Farming and Fibre World

Dr. Srirangam Srinivasan Narayanan

Cotton is a precious natural cellulosic fibre with highest purity and a unique gift of nature to mankind. It is called 'White Gold' because of its pristine chemical purity and high economic importance in farming, trade and textile economy as a money spinner in whichever country democratic civilized agrarian and industrial economy prevails. The total global output of cotton that was 15million tonnes in 1960 has been raised to over 27 million tonnes in 2010-11, though in this period the share of cotton in global textiles has come down from 68 to 36%. Out of 70 million tonnes of all fibres required for a variety of textiles and other uses by human population of 4.1 billion today, only 26-27million tonnes of this natural fibre is produced all over the world in some more than 90 countries. Current global average yield of lint is around 790 to 800kg/ha as against the highest national average of 2300kg lint in Australia and 1100 kg in China, while the average yield of India ranged from 495-500kg lint /ha in the last few years.

The cotton prices ruled so high in the last couple of years that it held its reputation high as the king among fibres and enjoyed a status akin to rising prices of gold in recent years. The trade and textile business faced some shocks and setbacks due to phenomenally high raw cotton prices, but entrepreneurial cotton farmers and seasoned spinners on the whole performed well in the economic scenario of the world and in our nation. High inflationary pressures all over the world and rising costs of inputs have caused the overall escalation in prices of all commodities including cotton and these global phenomena may take a little more time to settle to comfortable levels.

In India, the farmers have felt good amount of relief from the tedious and costly task of saving the cotton crop from the bollworm pests through the hassle free cultivation of bollworm tolerant transgenic Bt-hybrid cottons ensuring better yields from saving of losses caused by the pest in non-Bt cottons and consequent lower costs of production and reduced environmental pollution and hazards. The favourable prices for cotton with high minimum support prices announced by the Central Government coupled with Bollgard BG-II cotton and choice transgenic hybrid genotypes made available by the private seed industry and favourable cotton export policies of the Government of India for cotton and yarn made the farmers enthusiastic to grow cotton in larger scale than ever in Indian history during 2011-12. The area has touched 12million hectares in 2011-12, thereby Indian cotton crop constituted more than 34-35% of the global cotton area of around 35million ha. India's total produc tion in 2010-11 was estimated at 5.53 million tonnes (32.5million bales) with 495kg average yield of lint/ha. However much one may point out the causes of natural hazards, it does not do credit to our country to obtain only 495kg lint/ha with all the support and good seeds supplied to the farmers. Our country should have achieved a production of some 7-8 million tonnes.

Evidently, extension support to farmers is lacking and when enterprising farmers could reap as much as 1000 kg to 1500kg lint /ha from BG-I and BG-II hybrid cottons, the majority of

Director (Officiating) CENTRAL INSTITUTE FOR COTTON RESEARCH **& Advisor,**
Vidya Sagar Foundation, Hyderabad.
Tel: +91-40-27794241, Mobile: 9490119558, Email: narayananss@rediffmail.com

cotton farmers have not probably executed the recommendations for adopting the best management practices for Bt-hybrid cotton cultivation in the different zones.

With reduced pest and diseases problems, the farmers could have harvested more and raised the national average yields far higher, with more guidance to manage the crop by adopting better management practices. Growing of refugea borders has not been properly practiced by a large number of farmers and experimentally proven management techniques to mitigate weather-aberrant situations on which Central Institute for Cotton Research Nagpur and State Agricultural Universities have brought out very valuable recommendations. Neither the private seed suppliers nor the government machinery can undertake massive extension work in a country of vast dimensions with an array of languages and varied levels of literacy among farming community as in India. There should be private practice by extension specialists as in medical and also veterinary professions and even if the farmers pay reasonable charges for consultancy, it should be compensating through higher yields. Contractual consultancy services and contract farming are highly essential in cotton farming with the help and support of the mill industry of the country. It will also open up additional self employment opportunities. With very low margins of profits in seed sales compared to rising costs of production and R7D costs of developing and releasing superior proprietary hybrids, seed cost still remains a miniscule in total cost of cotton production, seed industry may not be able to bear the cost of extension work, apart from remaining to be a catalyst for change to modern technologies. After the strong and successful emergence of transgenic cottons, the cultivation of Asiatic and short staple cottons have gone out significantly and *Gossypium hirsutum* has become the species of choice commanding over 92 per cent area under cotton.

Research is being geared up by MNCs and various major Seed Companies in India in developing superior genotypes with improved yield levels and toned up quality parameters prescribed for various staple categories. CIRCOT, Mumbai has laid down superior norms for the cotton breeders and fibre technologists to help the highly automated textile industry and also educated message dissemination experts, farmers, ginners and traders to handle cotton in the most scientific manner at various processing and handling stages. In view of labour shortages and rising wages, seed production of hybrid cotton transgenics that ushered in a successful cotton revolution is difficult to sustain and the seed rates and demand for seed packets is increasing year after year. The seed rates adopted in India is far lower than other countries and however much we plan to step up the per plant performance for higher boll numbers and yield, it is difficult to match with the yields obtained by countries like USA, Australia, Brazil, Turkey, Uzbekistan etc, which have plant population rates of 60000 to 120000 plants/ha and resort to crop termination at appropriate maturity duration and adopt machine picking. Time is not far off for India to evolve plant phenotypes suitable for opting for the machine harvest technology and reap far higher harvests. This needs higher focus on new research areas relevant to implement the technology. Farmers also need to be consolidated for undertaking this task on a nation-wide scale so as to confer acceptable level of benefits to the farmers and also provide industry with clean cotton. A combination of new gene technologies like the emerging advances in pest management through BG-III, BG-IV and even sucking pest management in future, herbicide resistance like Round-Up Ready for raising cost effective weed free cotton crop management, more effective control and management of serious problems like whitefly, leaf curl virus and mealy bugs, rain-water harvesting and recycling and other newer techniques of moisture management and superior genotypes with appropriate phenotypes for machine harvesting coupled with evolution of suitable machines for Indian conditions should help the cotton yield potential to improve greatly in the coming decades.

The Indian Mill industry has projected a demand for cotton to the extent of 7.7million

tonnes for 2020-21 and traders demand a share of not less than 1.5 to 1.6 million tonnes of quality cotton for exports on regular basis and China has become a dependable buyer of Indian cotton next only to USA. Bayer CropScience AG and Precision BioSciences Inc. have recently invented a DNE-engineered mega nuclease – that is produced by Precision to target the insertion of a transgene near an existing transgene in a plant line; the first known report of a site-specific insertion using an engineered nuclease in cotton. Precision's DNE technology based on production of DNA-cleaving enzymes called engineered mega nucleases enables crop researchers to delete, insert, or otherwise modify genes at user-defined sites within plant genomes. This BSC Innovative technology can streamline product development and reduce the time it takes to get a product ready for the market as reported in Cotton International News (October 2011). Some top MNCs and also advanced laboratories and Seed Companies in India have also intensified genomic research in *Gossypium* and introgression technologies for improving the various technological parameters of cotton. With 9.3 billion people expected to live in our planet by 2050, we have a long way to go in cotton for meeting the demands and expectations for fibre needs. Cotton being a renewable fibre crop and with research gaining momentum, there is scope for increasing its share and quantum in total fibre consumption.

FOOD SECURITY AND FOOD SAFETY: Converting Gandhiji's Vision of a "Hunger-free India" into Reality

K. Gopalakrishna Pillai

1. Introduction:

Food Security refers to the availability of food and one's access to it. A household is considered food secure, when its occupants do not live in hunger or fear of starvation. Worldwide, almost a billion people are chronically hungry due to extreme poverty, while upto two billion lack food security intermittently due to varying degrees of poverty. It is estimated that almost six million children die of hunger every year, which amounts to 17,000 children per day.

India is still home to the largest number of undernourished and malnourished children, women and men in any country, even after sixty five years of Mahatma Gandhiji's famous Noakhali speech in 1946, expressing the importance of making **"access to food a basic human right".** The number of people going to bed partially hungry now is estimated to be more than the entire population of India in 1947. Gandhiji wanted that the pathway to ending human hunger should involve opportunities for everyone to earn their daily bread, since the process of ending hunger should not lead to the erosion of human dignity.

2. U.N. FAO Definitions:

Food security exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for leading an active and healthy life. Food security for a household means access by all members at all times to enough food for leading an active, healthy life.

Food security includes at a minimum

(i) the ready availability of nutritionally adequate and safe foods; and

(ii) an assured ability to acquire acceptable foods in socially acceptable ways, without coping strategies and without erosion of human dignity.

3. Food Security in India:-

Politicians may be able to manipulate the definition of poverty, but they cannot hide its symptoms! The "2010 Global Hunger Index" ranks India at 67 out of 122 developing countries reporting that serious hunger exists in all states.

India is home to 42 percent of the worlds' underweight children according to this index. In 2005, 46 percent of children in India aged under three years were under weight and there is no indication that the Millennium Development Goal (MDG) target of 26.8 percent by the year 2015 could be achieved! Worldwide, the number of undernourished children has reached one billion and the irony is that the number of over-weight children has almost surpassed the number of undernourished children

4. Public Distribution System:

PDS in India is a major safety net, offering BPL families an opportunity to purchase heavily subsidized food and cooking

Ex-Project Director (Rice), Directorate of Rice Research (ICAR), Hyderabad and
Ex-Senior Plant Production Officer (i/c) and Regional Advisor, FAO Regional Office for Asia-Pacific Region, Bangkok. E mail : kgopalakrishnapillai@yahoo.com, kgpillai42@hotmail.com

essentials through a vast network of 489,000 fair price shops. But corruption and fraud, of late, has ravaged the PDS to the extent that 70 percent of its resources may be misdirected.

5. A New National Food Security Bill

The new bill currently under consideration is expected to bring about radical reforms. Recognizing the right to food under International Law, the bill would by pass PDS structure by issuing credits for staple rice and wheat to eligible farmers. "Universal Identification Smart Cards" are expected to fulfill the role of cash at the fair price shops. There is debate as to whether the new right to food should be universal rather than limited to BPL families alone. With food, fuel and fertilizer subsidies already absorbing 12.5 percent of the National Budget, it is no surprise that the Government Departments are more cautions in making the final decision!

At least there is a ray of hope in the draft National Food Security Bill, 2011 as it is designed to make access to food a legal right, rather than remaining a token of political patronage and hopefully it will help erase India's image as the land of the undernourished. The stated aim of the draft Bill is "to provide for food and nutritional security, in human life cycle approach, by ensuring access to adequate quantity of quality food at affordable prices, for people to live a life with dignity". A life cycle approach to food security, as envisaged will imply attention to the nutritional needs of a human being from conception to cremation!

To make food-for-all a legal right, it is necessary to adopt a Universal Public Distribution System with common but differential entitlements with respect to the cost and quantity of food grain. The draft Bill adopts the nomenclature suggested by the National Advisory Council (NAC) and divides the population into "priority" - that is those who need adequate social support and "general" - that is those who can afford to pay a higher price to food grains.

6. Poverty Line:

The affidavit which the Planning Commission recently submitted before the Supreme Court stating that a person is to be considered 'poor' only if his or her monthly spending is below Rs.781/- Rs 26 per day in the rural areas and Rs.965/- (Rs. 32 per day) in the urban areas has exposed how unrealistic are our "poverty line" estimations. Amazingly, however, 460 million Indians subsist below these levels. The outcry against calling these "destitution lines" as 'poverty line is justified, for true poverty lines are much higher than these, and show that 75 percent of all persons in India are poor. This high level of deprivation therefore would provide the rationale for doing away with targeting and revert to a universal distribution system and combining it with an urban employment guarantee scheme.

However, in view of the widespread opposition to these suggestions, the planning commission is now more or less agreeing that there should not be any poverty line cap for social schemes and food entitlement!

7. Nutri-cereals:

The question of widening the food basket by including a range of "nutri- cereals such as bajra, ragi, sorghum and maize (Coarse cereals as they were called earlier), along with rice and wheat is an important feature of the new Food Security Bill. In an era of climate change, these nutria-cereals, (which are essentially "health foods") are relatively more "climate – resilient" and as such these are expected to play an increasingly important role in human nutrition security, as well.

8. "Food Safety" in Food Security and Trade:

As the important links between food and health are increasingly getting recognized, food safety is receiving heightened attention, worldwide. Improving food safety is an essential element of improving food security, which exists when populations have access

to sufficient and healthy nutritious food. At the same time, as food trade expands throughout the world, food safety has become a shared concern among the developed and developing countries. Unsafe food contains hazardous agents or contaminants that can make people sick-either immediately or by increasing their risks of chronic diseases. Such contaminants can enter food at many different points in the food production process, and can occur naturally or as a result of poor or inadequate production and processing practices. Hazardous agents that are receiving attention from policy makers and food technologists include:-

- microbial pathogens;
- zoonotic diseases;
- parasites and mycotoxins;
- antibiotic drug residues; and
- pesticide residues

G.M. goods and their potential to contain allergies or toxins not found in conventional food also has started receiving attention.

9. Food Insecurity:-

Food prices globally rose in 2008 and stayed relatively high until mid 2011; causing food insecurity in many countries. Many factors influence food price volatility:

- agriculture and energy policy;
- commodity prices and market speculation;
- extreme weather events and climate change;
- rising global demand, and;
- falling surplus stocks.

Without considerable increase in world food production and improvement of food distribution, the world will have trouble feeding a growing population. The G20 meet proposed for November 2011 is expected to focus on ways and means to improve food security and lessen price volatility.

It is heartening to note that in India our farmers produced 95 million tones of rice, 86 million tones of wheat 42 million tones of nutria-cereals and 18 million tones of grain legumes during 2010-11. However, as Mahatma Gandhi often used to say, for the 460 million hungry people in India, God continues to appear in the form of bread!

Climate Change - trends, Impacts and mitigation strategies

GGSN Rao and SM Virmani

Introduction

Increasing evidence over the past few decades indicate that significant changes in climate are taking place worldwide as a result of enhanced human activities. The inventions of last few centuries, more so in the last century have altered the concentration of atmospheric constituents that lead to global warming. The major cause to climate change has been ascribed to the increased levels of greenhouse gases like carbon dioxide (CO_2), methane (CH_4), nitrous oxides (NO_2), chlorofluorocarbons (CFCs) beyond their natural levels due to the uncontrolled human activities such as burning of fossil fuels, increased use of refrigerants, and enhanced agricultural activities. The long-term trend of declining CO_2 emissions per unit of energy supplied reversed after 2000. Atmospheric concentrations of CO_2 (379ppm) and CH_4 (1774ppb) in 2005 exceed by far the natural range over the last 650,000 years. The annual emissions of CO_2 grew by about 80% between 1970 and 2004. The CO2 contribution from various sources namely burning of fossil fuels, deforestation etc. accounts for 76.6 percent of the total green house gas emissions over the globe. 44 percent of the entire GHG emissions over the globe are from the Industry and Energy sectors.

The Intergovernmental Panel for Climate Change (IPCC, 2007) reported that eleven of the last thirteen years (1995-2007) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The temperature increase is widespread over the globe and is greater at higher northern latitudes. Land regions have warmed faster than the oceans. These activities accelerated the processes of climate change and increased the mean global temperatures by 0.6°C during the past 100 years .Global average sea level has risen since 1961 at an average rate of 1.8 (1.3 to 2.3) mm/yr and since 1993 at 3.1 (2.4 to 3.8) mm/yr, with contributions from thermal expansion, melting glaciers and ice caps, and polar ice sheets. Satellite data since 1978 show that annual average Arctic sea ice extent has shrunk by 2.7 percent (2.1 to 3.3) per decade, with larger decreases in summer 7.4 percent (5.0 to 9.8) per decade.

Indian Scenario

According to TERI's estimates, India's carbon dioxide emission levels increased by 6 percent per year as a result the total emissions have increased tenfold since 1950. While the CO_2 emissions for India at 1997 level had been 237 million metric tons, it is projected to increase to 775 million metric tons by the end of the century if coal is continued to be used at the current pace.

Temperature trends

Using the all-India mean surface air temperatures during 1901-2000 from network of 31 well-distributed representative stations, the trends in mean annual temperatures over the country indicated warming trends during all the four seasons with higher rate of temperature increase during winter and post-monsoon seasons compared to that of annual. (Table.1)

Table.1: Trends in Mean Surface Air Temperatures over India during 1901-2000

Season	Trends (°C / Decade)
Annual	0.03*
Winter	0.04*
Pre-monsoon	0.02*
Monsoon	0.01
Post-Monsoon	0.05

Retd) Project coordinator(Ag met),CRIDA &(Retd) Principal climatologist, ICRISAT

. The long-term variation of the mean annual temperature of the country for the period 1875 to 2004 is given below. It is observed that the increase in temperature was in the order of 0.03°C per decade while for the period 1971 to 2004; it was around 0.22°C per decade indicating greater warming in the recent decades.

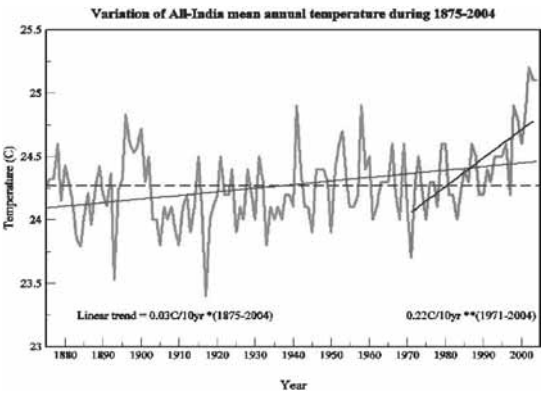

Fig. 1: Variation of All-India mean annual temperature during 1875-2004

Rainfall

In case of rainfall, the observed southwest monsoon seasonal rainfall at all India level does not show any significant trend. Trend analyses has been carried out on monthly basis for all the 36 subdivisions of the country and suggest that contribution of June and August rainfall exhibited significant increasing trends, while contribution of July rainfall exhibited decreasing trends. Interestingly, contribution of August rainfall is increasing in all these subdivisions. Regional level, variations in rainfall patterns have been observed over the country. Analysis of long-term rainfall data for over 1100 stations across India show pockets of deficit rainfall over eastern Madhya Pradesh, Chhattisgarh and Northeast region in Central and Eastern India especially around Jharkhand to Chhattisgarh. In contrast, increasing trends (+ 10 to 12%) in rainfall are observed along the west coast, northern Andhra Pradesh and parts of NW India

Mitigation Strategies and policies for sustainable agricultural production

All the projections indicate that the impacts of climate change would have considerable physical and socio-economic consequences on the country's linked resources and would have a strategic influence on future livelihood prospects of large percentage of the country's population. There is already considerable awareness on these issues and the country, at the highest level had initiated special drive on adaptation and mitigation strategies to face the challenges posed by the climate change. Briefly they are given below;

a. Improve inventories of emission of greenhouse gases using state-of-art emission equipments coupled with simulation models, and GIS for up scaling

b. Evaluate carbon sequestration potential of different land use systems including opportunities offered by conservation agriculture and agro-forestry

c. Critically evaluate the mitigation potential of bio fuels; enhance this by their genetic improvement and use of engineered microbes

d. Identify cost-effective opportunities for reducing methane generation and emission in ruminants by modification of diet, and in rice paddies by water and nutrient management. Renew focus on nitrogen fertilizer use efficiency with added dimension of nitrous oxides mitigation

e. Assess biophysical and socio-economic implications of mitigation of proposed GHG mitigating interventions before developing policy for their implementation

Policies

f. Mainstreaming adaptation in current policy considerations: Climate change impacts and adaptations should be considered in all major development planning activities.

g. Develop new infrastructure, policies and institutions to support the new land use arrangements identified by science and technology.

h. Enhance investment in water harvesting and conservation options; and promote small farm mechanization and efficient water use technologies.

i. Facilitate greater adoption of scientific and economic pricing policies, especially for water, land, energy, and other resources.

j. Explore international partnerships for joint food security.

k. Consider financial incentives and package for improved land management including resource conservation/ enhancement (water, carbon, energy), and fertilizer use efficiency.

l. Establish an inter-ministerial institutional mechanism for strategic follow-up action.

m. Consider incentives for industry and farming community for producing and using slow release fertilizers and Green House Gas inhibitors.

n. Explore CDM benefits for mitigation strategies for farmers and agriculture-based industry.

o. Explore international partnerships for collaborative research on adaptation of climate change r research.

p. Establish 'Green Research Fund for strengthening research on adaptation, mitigation and impact assessment.

India's National Action Plan on Climate Change

On June 30, 2008, Hon'ble Prime Minister Manmohan Singh released India's first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation. The plan identifies eight core "national missions" running through 2017 and directs ministries to submit detailed implementation plans to the Prime Minister's Council on Climate Change by December 2008. The eight national missions are as follows.

National Solar Mission: This mission aims to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar competitive with fossil-based energy options. The plan includes:

- Specific goals for increasing use of solar thermal technologies in urban areas, industry, and commercial establishments;
- A goal of increasing production of photovoltaic to 1000 MW/year; and
- A goal of deploying at least 1000 MW of solar thermal power generation.

Other objectives include the establishment of a solar research center, increased international collaboration on technology development, strengthening of domestic manufacturing capacity, and increased government funding and international support.

National Mission for Enhanced Energy Efficiency: Current initiatives are expected to yield savings of 10,000 MW by 2012. Building on the Energy Conservation Act 2001, the plan recommends:

- Mandating specific energy consumption decreases in large energy-consuming industries, with a system for companies to trade energy-savings certificates;
- Energy incentives, including reduced taxes on energy-efficient appliances; and
- Financing for public-private partnerships to reduce energy consumption through demand-side management programs in the municipal, buildings and agricultural sectors.

National Mission on Sustainable Habitat: To promote energy efficiency as a core component of urban planning, the plan calls for:

- Extending the existing Energy Conservation Building Code;
- A greater emphasis on urban waste management and recycling, including power production from waste;
- Strengthening the enforcement of automotive fuel economy standards and using pricing measures to encourage the purchase of

efficient vehicles; and Incentives for the use of public transportation.

National Water Mission: With water scarcity projected to worsen as a result of climate change, the plan sets a goal of a 20% improvement in water use efficiency through pricing and other measures.

National Mission for Sustaining the Himalayan Ecosystem: The plan aims to conserve biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers that are a major source of India's water supply are projected to recede as a result of global warming

National Mission for a "Green India": Goals include the a forestation of 6 million hectares of degraded forest lands and expanding forest cover from 23% to 33% of India's territory.

National Mission for Sustainable Agriculture: The plan aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, and agricultural practices.

National Mission on Strategic Knowledge for Climate Change: To gain a better understanding of climate science, impacts and challenges, the plan envisions a new Climate Science Research Fund, improved climate modelling, and increased international collaboration. It also encourage private sector initiatives to develop adaptation and mitigation technologies through venture capital funds.

Epilogue

It has been noticed that climate change is a reality due to sharp increase in the concentration of green house gases since the industrial era. This has altered the climatic systems and has influenced the regional climate by way of increased frequency of extreme weather events and change in moisture and thermal regimes. The resultant impacts are expected to influence various sectors, *viz*., water resources, agriculture, forestry, natural ecosystems, fisheries and aquaculture and energy. The impact assessment studies due to projected climatic changes in the next 100 years provide directions and clues to develop adaptation and mitigation strategies in coping up with the expected changes in future.

Plant Growth Promoting Rhizobacteria as Bio-control Agents

K.V.B.R.Tilak

Intensive agriculture requires among many things, a heavy input of chemical fertilizers and pesticides. Although the application of such inputs has no doubt increased the crop production, there is a growing concern among researchers about their adverse affects on environmental quality and soil health. The application of heavy doses of chemical fertilizers often leads to susceptibility towards diseases in plants. In recent years, interest has been generated on alternatives to chemicals for controlling plant diseases. The use of biological control agents is one of the best options to combat the plant diseases in an ecofriendly manner and the efforts are diverted all over the globe to assess its commercial acceptability and applicability.

Biological control should be justified on its own merits without compromising its perceived importance to chemical controls. In this context, the microorganisms that harbour in the root region are the most befitting candidates for use as biocontrol agents since the rhizosphere provides the frontline defense for root against attack by pathogens. Pathogens face a complicated phenomena of antagonism from roots. They also compete with each other for site of colonization on the root surface. The ideal biocontrol agent introduces and /or promotes the antagonists only, whenever required and are most effective in minimizing the wasteful application of inoculum to non-targets.Many genera belonging to bacteria, fungi, actinomycetes and viruses are used as biocontrol agents to combat several important plant diseases. The present communication deals only on the bacterial biocontrol agents active against soil-borne root fungal pathogens.

The usefulness of *Bacillus* as a source of antagonist for many plant pathogens is well known. Several potent strains from different species of Bacillus have been tested on a wide variety of plant species for their ability to control several diseases. Bacilli have ecological advantages because it produces endospores that are tolerant to extreme environmental conditions such as heat and desiccation. They occur in large numbers in soil and produce a broad spectrum of biologically potential metabolites active aginst a range of fungi. The greatest interest is *B. subtilis* A 13, which was isolated from lysed mycelium of *Sclerotium rolfisii* as reported by Broadbent et al. in 1971 .It was found to be antagonistic to several pathogens besides serving as a seed inoculant in improving the yields of crops.

Enterobacter cloacae, a potential root colonizer, was reported as biocontrol agent against *Pythium ultimum*, a prevalent phytopathogen that causes damping-off on many crop plants.

In recent years fluorescent pseudomonads have gained considerable importance in the field of biological control of phyto-pathogenic fungi. This is mainly because of the fact that they readily colonize roots in nature, where they are frequently the most common among bacteria.The simple nutritional requirements and the ability to use many carbon sources that exude from roots and to compete with microflora, may explain their ability to colonize the rhizosphere.

Former Principal Scientist and Head Microbiology , IARI New Delhi
Senior Scientist, Platinum Jubilee Fellow The National Academy of Sciences India, Department of Botany , Osmania University, Hyderabad-

Additionally, pseudomonads are amenable to genetic manipulation. These characteristics make them useful vehicle for the delivery of antimicrobial compounds and phyto hormones to the rhizosphere. There are a number of examples of biocontrol of several devastating fungal plant pathogens of important crops by fluorescent pseudomonads and has been reviewed from time to time.

Interestingly several nitrogen-fixing bacteria like *Azotobacter, Azospirillum, Acetobacter dizotrophicus, Enterobacter,* some species of *Rhizobium* etc. are capable of showing anti-fungal activities. Hence, there is an ample scope to explore potent biocontrol agents.

A more ecologically sound approach for biocontrol involves the use of multiple of microbial strains. Increasing the genetic diversity of the biological control system through the use of mixtures may result in treatments that persists longer in the rhizosphere and express a wider array of biocontrol mechanisms under a broder range of environmental conditions.

Several hypotheses for protection against plant diseases with the use of biocontrol agents such as, production of siderophores, accumulation of antifungal metabolites, nutrient competition and niche exclusion etc. have been proposed . Production of lytic enzymes like chitinases, β-1,3-glucanases by certain bacteria forms the basis of control of phyto-pathogenic fungi in the rhizosphere. Production of hydrogen cyanide and ammonia has been reported by some workers as a mechanism of disease suppression by few bacteria.

During the past two decades, research in the field of plant growth promoting rhizobacteria has provided a lead in biological control of soil-borne phytopathogenic fungi. Investigations at the molecular level using DNA recombinant techniques would enable one to improve the effectiveness of rhizobacteria.

Agriculture Biosecurity and Biosafety

P.R. Vanamayya

During past five decades, agriculture in India has made a great progress in augmenting food production. The liberalization of world trade in agriculture since the establishment of WTO in 1995 has brought in many challenges that have opened up new frontiers in growth and diversification of agriculture. Import of seeds/ planting material/ superior germ-plasm/ biologicals/ livestock and livestock products has led to introduction of a number of new plant and animal diseases and pests of which several have become well established causing severe economic losses every year. Emergence of a new pathogen or incursion of a foreign disease agent is a primary factor that could lead to agricultural crisis.

In India, during last five decades, there had been severe damages/losses to livestock and poultry due to introduction/spread of Exotic/ transboundary animal diseases such as African Horse Sickness (not reported after 1963); Equine Influenza; Equine Infectious anaemia. Swine Fever; Infectious Bovine Rhinotracheitis; Peste des Petits Ruminants(PPR); Blue tongue; Marek's Disease; Avian Encephalomyelitis; Gumboro Disease; Infectious Bronchitis; Reoviral Arthritis; Infectious laryngotracheitis; Egg Drop Syndrome; Inclusion body hepatitis; Chicken Infectious Anaemia;

- African Horse Sickness entered India causing mortality of 33,000 equines in 1961-62 and could successfully be eradicated by timely vaccination developed by IVRI, Mukteswar and granting India the disease free status from OIE.
- Since 2003, H5N1 strain of AIV has been circulating in East Asia and spread to African countries causing more than 200 human deaths in addition to heavy mortalities. The disease was first reported in Feb'2006 in Maharastra (Nandurbar /Jalagoan Dists.) state of India. The disease could be contained due to immediate diagnosis by HSADL and prompts action by DADF, GOI in record time. Still the loss due to this outbreak was estimated around 8000 crores to poultry industry.
- Nipah virus is a high risk group pathogen first reported in Malaysia in 1998-99 with 105 deaths in human and heavy mortality in pigs leading to depopulation of one million pigs. In 2001, the disease entered in Siliguri district of West Bengal affecting 66 people with 74% mortality and again in 2007, death of 3 persons in Nadia district. There are many other diseases reported in neighboring countries.
- African Swine Fever (ASF) a contagious and fatal disease of pigs entered Portugal in 1957 and became enzootic in many parts of Europe, now (since June 2007) causing severe outbreaks in Georgia and Armenia.
- Rift Valley Fever (RVF), a viral zoonotic disease was primarily limited to African continent and in Sep, 2000, the disease was first reported outside the African continent causing human deaths and major livestock losses (in millions) in Saudi Arabia & Yemen.

Former Principal Scientist & Station Incharge, IVRI, Muktheswar
vanamayya47@gmail.com

- In aquatic animal field, collapse of the Shrimp farming industries of Taiwan in 1987, China in 1992 in India in 1995 was due to infectious viral diseases causing billions dollars loss of revenue for the industry. The main causative agents were viral diseases such as penaeid viruses, WSSV (white spot), TSV (Taura syndrome) and YHV (Yellow Head).

The devastating effects resulting from diseases and pests introduced along with International movement of planting material agricultural produce and products in India were many and well documented. Ug99, a virulent race of stem rust pathogen was first reported in Uganda in 1999 and subsequently spread to Kenya(1999) and Ethiopia(2003);Yemen and Sudan(2003); and up to Iran during 2007. This fungal infection cautions a threat and preparedness to wheat farming in India.

The recombinant gene products derived from the use of recent biotechnological tools and their animal experimentations have also become a global concern on various **biosafety issues.**

Biosafety, or to be more accurate **laboratory biosafety**, describes a set of comprehensive principles, technologies, and practices implemented to prevent the unintentional exposure of facility workers to pathogens and toxins and also to reduce the possibility that an accident with these materials might result in their release outside of the laboratory. To put it simply, **biosafety** is about how to work safely and properly with pathogens and toxins that can be harmful to people, animals, and plants. As concern has grown about the possibility of infectious diseases spreading across national boundaries, disease control and surveillance have become a prominent part of an expanded concept of biosafety. Biosafety laboratories are designed on the containment needs of the work being performed from basic Biosafety Level -I, to maximum containment, Biosafety Level-IV. Biosafety level designations are based on a composite of design features, construction, containment facilities, equipment, practices and operational procedures required for working with agents from four corresponding 1 to 4 risk groups. Four levels of risk groups have been defined (WHO, 2004) as follows:

Risk Group 1 (low individual and community risk): Any biological agent that is unlikely to cause disease in healthy workers or animals.

Risk Group 2 (moderate individual risk, low community risk): Any pathogen that can cause human disease but under normal circumstances, is unlikely to be a serious hazard to laboratory workers, the community, livestock or the environment. Laboratory exposures rarely cause infection leading to serious disease; effective treatment and preventive measures are available, and the risk of spread is limited.

Risk Group 3 (high individual risk, low community risk) : Any pathogen that usually causes serious human disease or can result in serious economic consequences but does not ordinarily spread by casual contact from one individual to another, or that causes diseases treatable by antimicrobial or antiparasitic agents.

Risk Group 4 (high individual risk, high community risk) : Any pathogen that usually produces very serious human disease, often untreatable, and may be readily transmitted from one individual to another, or from animal to human or vice-versa, directly or indirectly, or by casual contact.

Biosecurity has a broader scope of meaning and is interpreted by various individuals with different professional and cultural backgrounds. As per FAO "***Biosecurity*** encompasses all policy and regulatory frameworks (including instruments and activities) to manage risks associated with food and agriculture (including relevant environmental risks). ***Biosecurity*** is composed of three sectors, namely food safety, plant life and health, and animal life and health. These sectors include food production in relation to food safety, the introduction of plant pests, animal pests and diseases, and zoonoses, the introduction and release of genetically modified organisms (GMOs) and their products, and the introduction and safe management of invasive alien species and genotypes. ***Biosecurity,*** thus, has direct relevance to food safety, the conservation

of the environment (including biodiversity), and sustainability of agriculture." The term "**biosecurity**" has been used in different contexts and acquired different meanings (Veterinary Health, ecology, agriculture, food supply, arms control & public health) for people with different back grounds. Presently, WHO in collaboration with FAO & OIE, defined the term and restricted the use of" **biosecurity**" to laboratory environments. "**Laboratory *Biosecurity***" refers to institutional and personal security measures, control and accountability of valuable biological materials (VBM) in order to prevent the loss, theft, misuse, diversion or intentional release of pathogens or toxins. Laboratory biosecurity involves a program of accountability for pathogens and toxins. **Effective biosafety practices are the very foundation of laboratory *biosecurity* practices.**

Primary component to a **biosecurity** plan must be a detailed **risk assessment**. The biosecurity risk assessment should review and list the relevant assets, define the threats, outline the vulnerabilities, and determine the countermeasures or mitigation strategies specific for each facility. The biosecurity plan should then address the following factors: **physical protection; personnel suitability/reliability; pathogen accountability; and related incident and emergency response.**

Laboratory biosafety and biosecurity mitigate different risks, but they share a common goal**:** keeping the valuable biological material (VBM) safely and securely inside the areas where they are used and stored. The biocontainment facilities that help to control outbreaks of the disease have the potential to cause if organisms are accidentally released into environment. The recent outbreak of FMD in UK (2007) at two farms near Pirbright, Surrey, UK points to release of the strain that has been used at IAH and the Merial Laboratories.

WHO (2006) defined ***Valuable biological material*** (VBM) as "biological materials that require (according to their owners, users, custodians, caretakers or regulators) administrative oversight, control, accountability, and specific protective and monitoring measures in laboratories to protect economic, historical (archival) value, and/or the population from their potential to cause harm. VBM may include pathogens & toxins as well as non-pathogenic organisms, vaccine strains, foods; genetically modified organisms (GMOs) cell components, genetic elements and extraterrestrial samples

Biological terrorism is described as the use of microorganisms or toxins derived from living organisms to induce death or disease in human beings, animals, or plants. The basic events of Sep, 2001 and the subsequent dissemination of *Bacillus anthracis* through US postal system underscored the dangers of national and international security posed by terrorist attacks especially involving pathogenic microorganisms & toxins. Compared to nuclear and chemical weapons, biological weapons not only are cheaper, they are easier to acquire because of the availability of dual-use equipment and materials on open market. Many strategies are being applied to combat the proliferation and the use of biological weapons (BW). The Federation of American Scientists identified the following ***as potential* biological threats*:*** Anthrax; Botulinum Toxin; Brucellosis; Cholera; *Clostridium Perfringens* Toxins; Crimean-Congo Hemorrhagic Fever; Ebola Hemorrhagic Fever; Smallpox; Melioidosis; Plague; QFever; Ricin; Rift Valley Fever; Saxitoxin; Staphylococcal Enterotoxin B; *Trichothecene Mycotoxin;* Tularemia; Venezuelan Equine Encephalitis

Biosecurity aims to stop proliferation before it starts by protecting dangerous pathogens and toxins – the basic building blocks of a biological weapon (BW) – against theft or malicious diversion from bioscience institutions. By preventing potential bioterrorists or proliferant states from acquiring certain dangerous biological materials, biosecurity provides the first line of defense against both state-based BW proliferation and bioterrorism.

Biosecurity Challenges in the "Livestock Revolution":

Population growth, urbanization and income-growth in developing countries are fuelling a massive global increase in demand for food of animal origin. This demand comes from changes in the diets of billions of people. From the 1970s to the 1990s, meat consumption in developing countries increased by more than three times, while milk consumption more than doubled. Meat consumption is expected to double between 1993 and 2020 and, by 2020, global livestock production will be the most important agricultural sector in terms of added value. The combination of higher demand, more people and less space is leading rapidly to a global transformation of the livestock sector. The next 20 years are likely to see a true "Livestock Revolution", which will stretch the capacity of existing production and distribution systems, and exacerbate environmental and public health problems, but which will also provide income growth-opportunities for many rural poor, and improve health in developing countries. At the same time, a whole series of new *Biosecurity* questions will need to be addressed. The concentrations of animals close to urban areas means a rapid increase in the incidence of zoonotic diseases. Intensification of livestock production is in many parts of the world leading to a build-up of pesticides and antibiotics in the food chain and, as the scale of output increases, food safety risks from microbial contamination are becoming more prevalent, especially in the tropics.

Biosecurity Infrastructure in India

Animal quarantine: The regulation of import and export of livestock and livestock products, diagnosis & control of exotic animal diseases and certification as per OIE regulations is done through Animal Quarantine & Certification Service (AQ&CS) under Department of Animal Husbandry & Dairying (DAH&D) that are located at New-Delhi, Mumbai, Kolkata and Chennai. The functions of AQ&CS include quarantine/testing of livestock/livestock products as per the requirement of the importing country and as per the protocols of Terrestrial Animal Health Code of OIE and also implementation of various provisions of Livestock Importation (Amendment)Act, 2001.India has a strong disease investigation network at each district/state level. There is one central and five Regional Disease Diagnostic Laboratories (RDDLS) funded by DAHD&F, Ministry of Agriculture. CADRAD at IVRI, Izanagar; Project Directorate on FMD, Mukteswar &ADMAS, and Bangalore and disease diagnostic laboratory of NDDB are specialized laboratories providing animal disease diagnosis. A few private hatcheries are also well-equipped with poultry disease diagnosis.

In addition, ICAR built High Security Animal Disease Laboratory (**HSADL**) at Bhopal with **biosafety level-IV facility** to monitor ingress of exotic/foreign animal diseases into the country. The laboratory has become functional since 1998 and also has high containment facilities to carry large animal experiments with high risk pathogens/recombinant organisms. Presently, HSADL can only handle the rinderpest virus and keep its repository under high containment as India got the status of "Freedom from Rinderpest Infection" from OIE in 2006.

Plant Quarantine: The Directorate of plant protection, quarantine and storage (DPPQS) of Ministry Agriculture is the nodal agency in India for implementing plant quarantine regulations, which have been revised and known as **plant quarantine** (Regulation for import into India) Order 2003. It presently has a national network of 35 plant quarantine stations at different airports, seaports and land frontiers dealing with the commercial import of consignments of grains for consumption and sowing/planting. National Bureau of plant genetic resources (NBPGR) undertakes the quarantine processing of all germplasm and transgenic planting material under exchange for research purposes. NBPGR also deals with testing for absence of terminator technology which is mandatory as per national legislation. Over the years, during quarantine processing, a large number of pests have been intercepted in imported bulk consignments and

in germ-plasm and research material. These interceptions, especially of pests and their variability not yet reported from India, signifies the importance of quarantine in preventing the entry of devastating exotic pests which might have caused havoc with the plant diversity and agriculture.

Chairman, National commission on Farmers, in a leader page article in "The Hindu" (31st March, 2006) strongly felt the need to set up a National Agricultural Biosecurity Council, a National Centre for Agricultural *Biosecurity*, and a National Agricultural *Biosecurity* Network. This will help **to strengthen considerably our ability to prevent the outbreak of disease pandemics and to initiate timely and effective control measures, when needed.** The proposed Agricultural *Biosecurity* Network could include also neighboring countries, thereby forming strategic partnerships to prevent potential pandemics. Above all, a National Agricultural *Biosecurity* Fund will help to strengthen our infrastructure, introduce new molecular techniques of identification and verification, derive benefits from our animal genetic resources, and provide needed and timely help to the affected families. Presently, The Agricultural Biosecurity Bill, 2011 is listed for introduction before parliament, and precisely, the bill seeks to provide for prevention, control, eradication and management of plant pests and diseases, animal diseases and unwanted organisms for ensuring agricultural biosecurity.

Policy distortions impede agricultural development

K. Purna Chandra Rao

Both the agricultural producers as well as the agricultural consumers in India are suffering. Farmers are facing increasing costs and are not able to realize remunerative prices, while the consumers are facing high prices due to shortages and manipulation of the markets by the middlemen. The Union Government does not have any idea as to how the problems of shortages and high food inflation have to be tackled except hoping that the prices will fall once the kharif produce comes to the market. It refuses to recognize that there are supply side constraints and that the farmers are unable to increase production due to several constraints. In stead, it believes that the food prices are increasing due to excessive purchasing power in the market and is trying to curb it through higher and higher interest rates.

Independence to Liberalization era

In fact, The Union Government failed to deal with the issues related to agriculture right from the days of liberalization. Prior to the much touted economic liberalization in 1991, the excessive protection given to industry ensured that the rate of return in industry was always much higher than that in agriculture. Consequently, investible resources flowed from rural to urban areas and from agriculture to non-agriculture sectors in search of a better return. The restrictions on the movement of agricultural products between states, and, sometimes even from one district to another within a state, depressed the prices of agricultural products. Export restrictions and over-valued exchange rate of rupee discouraged agricultural exports and limited the incomes of the farmers. Minimum support prices were not ensured in the absence of effective procurement support, particularly in the case of coarse cereals. By restricting the procurement only to rice and wheat and only subsidizing their consumption through public distribution, the Governments drove away the nutritious coarse cereals from the cropping patterns. The rural sectors were impoverished and industrialists increased their assets at a fast pace, not so much because of any production efficiency but due to protection offered by the Government policies. The total factor productivity in agriculture sector was always positive between 1947 and 1991, often growing at more than one per cent per year. In contrast, the total factor productivity of the manufacturing sector was always negative. Yet, the rich class that invested in industry and business could manipulate the law makers to milk profits at the cost of agricultural sector.

Liberalization Phase

The people dependent on agriculture hoped that the liberalization would improve their lot *vis-à-vis* those dependent on non-agricultural sectors. Although the devaluation of rupee and its consequent free float initially helped the agricultural exports and the farmers producing them, the gains to agricultural sector were limited due to delayed liberalization of the sector. The investments in agricultural sector dried up and the capital formation slowed down both in the public as well as in the private sector. The so-called sons of the farmers that took to politics

Former Principal Scientist, NAARM and ICRISAT, Hyderabad
kpcr_48@rediffmail.com

found their investment opportunities in the urban and non-agricultural sectors. They depended less and less on farm incomes and are paying only a lip service to agriculture. Their patronage is limited to only some subsidies here and there. Limited subsidies are no substitute to widespread investments needed in the agricultural sector. Later, the politicians found a convenient scapegoat in World Trade Organization (WTO). They tried to shift the blame to WTO for lack of investments, reduction of subsidies and absence of capital formation in Indian agriculture. The impoverishment of agriculture continued even at a faster pace after the liberalization. There is a limit beyond which the docile cow can not be milked.

Signs of Wear and Tear

For more than a decade, the signs of wear and tear are already visible in the agricultural sector. A technology fatigue has already set in. The fruits of green revolution are already harvested to the brink. The total factor productivity estimates in the last decade showed that it is tending from low positive to negative. It implies that any further growth in agricultural output can only come from the increased use of agricultural inputs. The political masters have been ordering for a second green revolution! The new research fields like biotechnology have been promising miracles for the last three to four decades. But nothing is on the horizon beyond Bt cotton! Further applications of Bt in food crops are being vehemently opposed by the environmentalists and social activists. A sense of disappointment with the agricultural research system for not delivering a second miracle is already clouding its efficiency. But the question is whether the agricultural sector is fertile enough to yield productivity increases on a continuous and sustainable basis? Can it produce more even if there are path-breaking technological innovations? The agricultural production increased by only at a rate of 1.2 per cent per year during the years, 1996 to 2008. It is even below the growth rate in population! Yet, the food stocks are comfortable and there are some net exports of food grains. One wonders whether every thing is right with the statistical system! Is it because we are underestimating production? Or is it that the poor do not have purchasing power? Otherwise why the food stocks are bursting when production growth is falling below the population growth?

Possible explanations

Some believe that the food grain requirements of people are diminishing. With the trends of mechanization and sedentary life of people, the calorie requirements are themselves falling. May be that the average calorie requirements are falling from 2400 calories per day to 2000 calories per day or even lower! An alternate explanation comes from the substitution theory. People have become more prosperous and are graduating to quality foods and, hence, less food grains are needed! So, there is no scarcity of food grains but there is a scarcity of fruits, vegetables, fish, meat, dairy products and edible oils. The implication of this view is that there is an urgent need to shift attention to their production by freeing up some resources from food grains. The market signals are clear and farmers are running in that direction. Yet, the populists have an interest in arguing that the poor do not have purchasing power and the food grains should be further subsidized to ensure food security. The power-hungry politicians jump at such suggestions to reduce the price of food grains from three rupees per kg to two rupees, one rupee and even to nothing! What a wonderful opportunity to brand themselves as champions of the poor and to cover up all their policy failures!

Over-dose of Populism

The country is already saddled with an over-dose of populism. In the quest for a pro-poor image, politicians have already ruined the productive forces. Two of the measures implemented in the last five years have adversely affected agriculture. One is the debt relief scheme through which about 60,000 crores of rupees were written off! It is seemingly pro- farmer and has already harvested votes in a couple of elections. No doubt, it helped some farmers who had dues. But those farmers who repaid their

debts amidst droughts and other calamities were felt aggrieved. The governments should have credited the accounts of those farmers with as much money as they have repaid. Although it is more burdensome in the short run, it would have preserved the faith of poor but law-abiding and morally upright farmers. But, as a result of this policy of benefiting only the defaulters, the moral fabric is torn and credit ethics are eroded. The farmers do hesitate to repay now any loan taken for the fear of losing out in the event of another power- hungry politician opting for another debt relief to drum their pro- poor image and win an election. Any inducement in the name of interest subvention is failing to make the farmers repay the loans taken. Of course, this gives another opportunity to the politicians to move in the direction of interest- free loans to start with. The logical end to this seems to be in declaring principal- free loans! May be another politician would jump on this bandwagon!

Another populist and seemingly pro-poor scheme is the Mahatma Gandhi National Rural Employment Guarantee Act. Under this, poor households seeking work will be offered employment for at least 100 days in a year at an assured wage of Rs. 120 per day. There have been many employment schemes since the last four decades and they aimed at providing off-season employment opportunities to the needy workers. The present one makes employment a right and is taken up even in the cropping season if drought conditions are prevailing. One can not deny its role in providing employment in the off-season. But the production gains from such employment depend on the ability of the implementing agencies to create community assets or infrastructure needed by the villagers by utilizing the work force. There are many complaints that the huge funds meant for this program are often misused by the corrupt officials and local politicians. Even when the money is reaching the intended beneficiaries, not many productive assets or infrastructure works are created. They are found not to be having any lasting effect on the rural services or utilities. Very little work turnout is noted, if any. An unintended consequence of this scheme is non-availability of labor to the farmers. The wage rates are bid up but the working hours are reduced. The labor costs for different operations have gone up phenomenally, thereby adding to the cost of cultivation significantly. The farmers feel that the labor discipline is vitiated and they are not sure of completing even the critical operations needed for successful crop husbandry.

Land alienation

Special Economic Zones have come up all over the place for setting up industries and service facilities. The Governments have taken position of land from the farmers and handed them over to the entrepreneurs. At many places, this land acquisition was forceful and many farmers were dispossessed of their land. Many entrepreneurs turned out to be real estate companies that profited from the resale of land after some development. Farmers associations and Non-Government Organizations have organized massive protests against such land alienation which forced the Government of India to come out with a new land acquisition policy for protecting the interests of the farmers. Considerable amount of fertile land near the cities, towns and highways was alienated in favor of land sharks during the last decade. For real estate and recreation purposes, agricultural land was diverted in a brazen manner. Mining companies and polluting power plants have also acquired huge chunks of land. Political power was misused to usurp the lands and to amass huge wealth. Land is converted as a storehouse of wealth and a commodity for the rich to profit in the recent years as against a source of employment to the poor. Land reforms have proceeded in the reverse gear transferring it from poor to the rich.

Suicides of farmers

Over the last three decades, thousands of farmers committed suicides due to crop failures, indebtedness and non-viability of farming in several parts of the country. Till 1980s, it was common to notice starvation deaths in the famine-prone areas. But in the recent decades, it is not the poor consumers who are dying out of hunger but the poor farmers who are forcibly killing themselves. The net cultivated area is shrinking due to competing demands for land. The organic matter content has dropped to less than 0.3 per cent and the nutrient deficiencies are limiting productivity due to excessive dependence on fertilizers and reduced use of organic manures. Water tables are touching lower and lower depths. The prices of fertilizers are sky rocketing. The Government policies have destroyed both credit and labor discipline. Labor scarcity is forcing the farmers to invest in farm machinery and drawing them deeper in to debt. The cost of production of crops is shooting up while the prices received are not remunerative enough. While there is some increase in incomes, it pales into insignificance when compared with the incomes of people dependent on the non-agricultural sectors in the urban areas. The rural-urban income gulf is only widening over the years. Farmers are in agriculture by compulsion and not by choice. Nearly seventy years of Independence have degraded K*heti* from *Uttam* to *Neech* profession! The probability of a young farmer finding a bride even from the rural areas is diminishing. At the time of Independence, many land owners were in the list of affluent persons in a given area. Now, hardly any farmer (solely depending on agriculture) makes to any of such lists. It is the Policy and the Governments who are the villains in the piece. All this happened while every political party in the country swears by the farmers! If only God takes away the Governments and Policies from the lives of the farmers, they will benefit. What is the use of thousands of pages written in agricultural policy and reports of the countless commissions? There is only one basic law in Japan which says that "the Government will positively discriminate in favor of agriculture as long as the average income of the farmers is less than that of blue collared workers". This one sentence was enough to safeguard the interests of the farmers to a great interest. What Indian agriculture suffers from is a diarrhea of policies and constipation in implementation!

Unless the governments recognize the need to encourage production with both price and non- price incentives, the supply of quality foods will continue to fall short of demand and the food inflation would remain a double digit phenomenon. Any amount of demand curbing by raising interest rates would be futile! Populist policies have played *havoc* with agriculture and they are bound to give diminishing and even negative returns to the politicians if the basic problems of agriculture are not addressed with the seriousness they deserve. Welfare of the farmers should form the central concern of the policy makers and not the concern for supply of agricultural commodities. Farmers deserve to win back their dignified place in the society. Happy farmers would have all the ingenuity and determination to nurture and feed the many more mouths to come!

GIANT FRESH WATER PRAWN (SCAMPY) HATCHERY

K MadhusudhanaRao

Macrobrachiumrosenbergii, also known as the **giant river prawn**, **giant freshwater prawn**, **Malaysian prawn**, **freshwater scampi**(especially in India), or **cherabin**, is a species of freshwater shrimp (not a prawn or scampo in terms of phylogeny, although colloquially "prawn" can refer to freshwater shrimp or true prawns) native to the Indo-Pacific region, northern Australia and Southeast Asia. This species (as well as other *Macrobrachium*) is commercially important for its value as a food source

Giant River Prawns have been farmed using traditional methods in south-east Asia for a long time. First experiments with artificial breeding cultures of *M. rosenbergii* were done in the early 1960s in Malaysia, where it was discovered that the larvae needed brackish water for survival. Industrial-scale rearing processes were perfected in the early 1970s in Hawaii, and spread then first to Taiwan and Thailand and then to other countries.

The techniques of larval rearing and cultured practices have been and developed by Fisheries Research Institutes , Agricultural Universities and some State Fisheries Departments.

Therefore , it is necessary to develop simple hatcheries for giant prawn breeding and their larval rearing.

HATCHERY MANAGEMENT

Each cycle of operations in a freshwater prawn hatchery takes up to 40 days, including the time necessary to prepare for the next cycle. Careful attention to all aspects of hatchery management is essential to achieve success (the production of the maximum number of healthy postlarvae at the cheapest cost). The hatchery consists of brood stock maintenance , mating, spawning .larval rearing and live feed culture tanks , aeration system, water storage and mixing tanks and filtration system

Brood Stock

The commercial success of a giant freshwater prawn (*Macrobrachiumrosenbergii*) hatcherydepends upon the uninterrupted supply of the desired quantity and quality of broodstock. The brooders are collected by operating the dol et (Bhokshi net) operating against the tidal water currents in the creek and by cast netting and angling methods in the culture tanks.

Hatching

200 litres conical jars are used for the hatching purpose. The jars are filled with 5 ppt filtered brackish water and arranged aeration. In each jar berried females having roughly same age group of rood are kept for hatching.

Larval rearing

6′ diameter and 2 ½ height conical tanks are used for larval rearing The requirements for Hatchery production are

Live feeds: Moina and Brachionus species

Artificial feeds : Egg yeast suspension in the initial stages.

The larvae are fed initially 4 times a day of which two times live feed and 2 ties artificial feed. Post

Retired Principal Scientist, Central Institute of fisheries Education ,
Mumbai and Vice President, RICAREA

larvaeare fed with formulated feed prepared with Acetessp, rice , groundnut oil cake , maize, wheat flour and vitamin mineral mix

Water quality : The water quality is maintained by changing one/third water from the tank bottom evert alternate day.

The other requirements for larval rearing are

1. Dissolved oxygen—The dissolved oxygen level is maintained between 7 and 9ml/litre
2. Temperature: 27^{c} to29 ^{c}during rearing period
3. pH pH 7.5 to 8.5 changed by changing major volume of water

commercial importance

The Giant Fresh water Prawn is an important export commodity with great demand in the International Seafood market. This species also has great potential for Aquaculture in India and can be farmed in inland areas also with good fresh water resources