5th

SOUVENIR

MS SWAMINATHAN AWARD 2013

RETIRED ICAR EMPLOYEES ASSOCIATION

HYDERABAD - 500 038 A.P. INDIA

Edited by

M.V.S. Sastry and V. Jaya Mohan Rao

Correct Citation

Souvenier - 5th M S Swaminathan Award 2013-2014
Current status in Indian Agriculture
RICAREA 2013

Published by

M.V.S. Sastry, Hon President and V. Jaya Mohan Rao , General Secretary on behalf of Retired Indian Council of Agricultural Research Employees Association (Reg. No. 5959 of 1997), 7-1-636/10, Model Colony, Hyderabad-500 038. Ph : 040-23702191, 23350368.
Mobile : 9949041057, 9493250368.

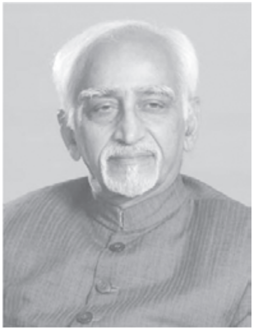
Website

http: //www.ricarea.org

Printed at

Heritage Print Services Pvt. Ltd.
B-11/9, IDA, Uppal, RR Dist. - 500 039
Ph : 27201927

Contents



भारत के उप-राष्ट्रपति के विशेष कार्य अधिकारी

OFFICER ON SPECIAL DUTY
TO THE VICE-PRESIDENT OF INDIA

नई दिल्ली / **NEW DELHI - 110011.**

TEL : 23016344 / 23016422 FAX : 23012645

MESSAGE

Hon'ble Vice President of India is happy to know that the Retired ICAR Employees Association (RICAREA) is organizing the 5th M.S. Swaminathan Award Function in the month of December, 2013.

The Vice President of India extends his greetings and good wishes to the organizers, participants and the awardees and wishes the event all success.

(NAGESH SINGH)

शरद पवार
SHARAD PAWAR

कृषि एवं खाद्य प्रसंस्करण उद्योग मंत्री
भारत सरकार

Minister of Agriculture &
Food Processing Industries
Government of India

MESSAGE

It is a pleasure to know that Retired ICAR Employees Association, Hyderabad is organizing a function to confer 5th M.S. Swaminathan Award in December, 2013.

I convey my heartiest congratulations to the awardees and wish the function a grand success.

Officer on Special Duty (PR)

PROF M S SWAMINATHAN
Founder Chairman and Chief Mentor

UNESCO Chair in Eco technology
M S Swaminathan Research Foundation
Third Cross Street,
Taramani Institutional Area,
Chennai - 600 113
Tel : +91 44 2254 2790
2254 1229
2254 1698
Fax : +91 44 2254 1319
Email : founder@mssrf.res.in

MESSAGE

The Retired ICAR's Employees Association is rendering very valuable service in building our National Agricultural Research System (NARS) through generating pride in our performance. In this connection, I wish to narrate briefly my views on building the capacities of NARS.

In April, 1985, when I joined as Director General of IARI, I did a gap analysis to identify which of the rice-growing countries did not have infrastructure for rice research, because my Indian experience had shown that only a strong national research system could take advantage of advances in international research. For example, when Borlaug sent material, we had the infrastructure, and could use it, but Pakistan, though it had the same material, couldn't do much with it. So the national research system is very important. We must collaborate, not surrender.

In fact, I was asked by many countries, 'Will you open an IRRI in our country?' I said 'No, but I will help you start one of your own'. The first one was the China National Rice Research Institute at Hangchow, there is still a small plaque put up in Chinese, which thanks me for setting up this institution. In China, I helped develop four rice institutes-the second was for hybrid rice at Changsha; a third for azola, useful for biological nitrogen fixing, because when you get high yields, you need also to feed the plant appropriately. The fourth was the China National Gene Bank. Next was the whole of Indo-China - Lao, Cambodia, Vietnam- they are all rice-eating people, but there were no rice research institutes in the Mekong delta, they used primitive methods and got very low yields.

In Vietnam, as I have already mentioned, India helped develop the infrastructure following the end of the war. I only supplemented this by training a large number of Vietnamese at IRRI. Cambodia was the last one – in fact, the contact was established through Mina. She had gone to Cambodia as part of her work with UNESCO. I had sent a letter through her to the Agriculture

Minister, and they responded positively and sent me an invitation when she returned. When I visited in 1987, it was in a bad condition. Due to Vietnamese presence, the Americans had asked all the Allies not to give money to Cambodia. The only country I could get money from was Australia. Bob Hawke, the then Prime Minister, had come to Philippines to meet Cory Aquino when she became the President. I got ten minutes with him to explain the programme. He agreed, but said it should be called the Indo-China programme. He gave one million dollars very quickly. In fact there is a beautiful book on the entire Cambodian programme written by an Australian, Don Puckridge. The Cambodian government was so grateful for my support in building their national agricultural research system that they gave me their Sahametrei award in 2006 - the highest civilian honour for a foreigner.

I also developed a blue print for the Philippine Rice Research Institute (Phil Rice) –the Rice Institute in the Philippines. She asked what the problem was in developing Phil Rice. I said we didn't have the money. They immediately provided it with help from Japan and the Institute was set up. The first Director was a good man, who came from the same province as Marcos; yet when I recommended him as a suitable Director, she immediately approved his appointment. Conferring the Golden Heart Presidential Award on me on 10 November 1987, she cited my 'untiring efforts in pursuing the establishment of a national rice research institute in the Philippines' as one of the reasons for the award. To sum up, if we wish developing countries to progress in agriculture, we must help them to build strong National Agricultural Research Systems. The stronger the NARS, the greater is the benefit of the International Agricultural Research Centres. Human resource development should receive high priority. These days there is greater worship of "bricks" rather than brains. In my view, IARCs should not set up their own institutes in developing countries. Instead, they should help in the establishment of strong, multi-disciplinary National Research Institutes, as I did in the case of China, Myanmar, Vietnam, Cambodia, the Philippines, and also Egypt, Madagascar, and Tanzania. This will confer long-term benefits and also help strengthen the morale and capability of national scientists, working on national salaries.

Building a strong NARS can be an important contribution of RICAREA.

M.S.Swaminathan

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

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद्
कृषि मंत्रालय, कृषि भवन, नई दिल्ली 110 001
GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
MINISTRY OF AGRICULTURE, KRISHI BHAVAN, NEW DELHI 110 001
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, Hyderabad is organizing the 5th M.S. Swaminathan Award function in February, 2014.

It is heartening to see that M/S Nuziveedu Seeds Pvt. Ltd., Hyderabad, a private sector seed company is also associated with award. I congratulate the Awardees for the year 2013 and wish the function and future endeavors of Retired ICAR Employees Association, all success.

(S. Ayyappan)

Dated the 30th December, 2013
New Delhi

M S Swaminathan Award - A Foreword

The Retired Indian Council of Agricultural Research Employees Association (RICAREA) was formed in 1997 to promote and further 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. At present the Association has a membership of 326 members.

As part of the activities RICAREA in association with Nuziveedu Seeds Ltd., Hyderabad, Andhra Pradesh has instituted a prestigious National award in the name of the living legend Prof M.S. Swaminathan. This award carries a Cash prize of Rs. 2.0 lakhs, Medal and a 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 specific age groups, discipline, team work etc and carry less prize money. We may say here that this is the highest recognition to an agricultural scientist for his life time achievements and contributions to Indian agriculture and the prize amount is also the highest at present.

The first M.S. Swaminathan award for the biennium 2004-2005 was presented to leading Poultry Scientist Dr Genda Lal Jain on 27th October 2005. The second M.S. Swaminathan award for the biennium 2006-2007 was presented to Dr B S Prakash NDRI Scientist on 3rd November 2007 The third M.S. Swaminathan award for the biennium 2008-2009 was presented to Dr S. Nagarajan, wheat pathologist, Former Director, Indian Agricultural Research Institute, New Delhi and currently Chairperson, Protection of Plant Varieties and Farmers' Rights Authority, New Delhi on 14th November 2009.

The fourth M.S. Swaminathanaward for the biennium 2010-2011 was presented to Dr S R Sai Kumar, Project Director, Maize, New Delhi and Dr N Shobha Rani Principal Scientist and Head Crop Improvement DRR, Hyderabad. On 19th May 2012 in all the four occasions Souvenirs with articles from leading scientists of different crops, disciplines were released.

In response to our letters we have received 26 nominations from eminent scientists from all over the country covering agricultural sciences (22), animal sciences (2), for the 5th M.S. Swaminathan award for the biennium 2012-2013.

The Selection Committee under the Chairmanship of Dr B.S. Dhillon unanimously selected Dr. Surendra Lal Goswami. This Souvenir fifth in series is brought out to mark the occasion of the Fifth MS Swaminathan award presentation. This Souvenir is a collection of invited articles apart the article of the awardee Dr. Surendra Lal Goswami with the theme "Current Scenario in Indian Agriculture "

The Association convey their gratitude and sincere thanks to Dr. Hamid Ansari , Hon'ble Vice President of India; Shri Sharad Pawar, Hon'ble Minister for Agriculture Govt. of India and Prof M.S. Swaminathan Founder Chairman and Chief Mentor , MS Swaminathan Foundation, Chennai and Dr. S. Aiyappan, Director General Indian Council of Agricultural Research and Secretary DARE for their Messages and blessings.

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

I hope that the Souvenir with articles from specialists belonging to major crops would serve as a reference guide.

Editors

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 November 22, 1997).

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 recognize and felicitate outstanding scientists for their lifetime achievements. At present the Association has a membership of 331.

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 "SASYAPADHAM", 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.
- 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 11 lectures by leading specialists were arranged on health matters in collaboration with corporate hospitals.
- As part of the activities the Retired ICAR Employees Association (RICAREA) has instituted a prestigious National award in the name of Doyen of Indian Agriculture Prof. M.S. Swaminathan in 2005. So far 4 awards in the years 2005, 2007, 2009, 2011 were presented to leading Scientists in animal and Agricultural Sciences.

Annual Day

Annual Day is organized since 1998 and members participate with their families. A custom was started from 2001 onwards to invariably inviting eminent person from public life as Chief Guest for the function. The list of luminaries who graced the annual days was 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 P. Krishnaiah (2011), Dr S .L. Goswami (2012) and Dr. A. Padma Raju (2013).

Members who have completed 75 years are being felicitated on the annual day. So far 92 members were felicitated.

M.V.S. Sastry, K. Madhusudhana Rao and V. Jaya Mohan Rao.
ricarea@gmail.com

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 : Drs. B. Venkateswarlu, P.V. Ramana Murthy, K.V.P. Rao, M. J. Balakrishna Rao, T.P. Sriharan, N.S.Rao K. Vidyasagara Rao, A.P.K. Reddy 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 : Dr. M.V.S. Sastry , Prof K. Madhusudhana Rao. Dr. V. Jaya Mohan Rao, Dr. S Indira. Drs. E.A.Siddiq, M .V. Rao, N.G.P.Rao, M.V. Gupta, M.V.R.Prasad, K. Krishnaiah, N.P.Sarma, U.Prasada Rao, P.S.V.V. Vidysagar, V.V.S. Murthy, Sri.,V.V. Ramana Rao, G. Narayanappa, J. Rama Krishna Rao, Drs. G. Nagaraj, M. Naga Raju, S.S. Narayanan and M. Umamaheswara Rao.

The Executive Body of the Association is able to function efficiently due to the whole hearted support and help received from all its RICAREA members.

Executive Committee of RICAREA

M.V.S. Sastry
Hon. President

K. Madhusudhana Rao
President

Dr. M.V.R. Prasad
Vice President

V. Jaya Mohan Rao
General Secretary

S. Indira
Treasurer

A.G.K. Murthy
Secretary

V.V. Ramana Rao
Regional Secretary
Rajahmudry Centre

G. Narayanappa
Regional Secretary
Visakhapatnam Centre

Committee Members

S. Bala Ravi

D. Gandhi

K. Jangiah

N. Kondiah

K. Krishnaiah

G. Naga Raj

U. Prasada Rao

J.R.K. Rao

G.G.S.N. RAO

N.P. Sarma

K. Satyananda Rao

P.R. Vanamayya

PATRONS

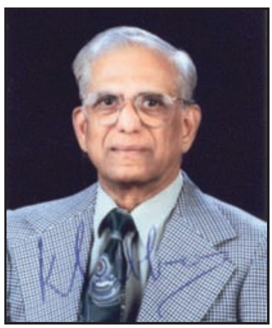
Prof. M.S.Swaminathan
CHIEF PATRON

Genda lal Jain

B.S. Prakash

V.L. Chopra

G Raghuram



Kakarla Subba Rao

Palle Rama Rao

A.V. Guruva Reddy

A. Panduranga Rao

Y L Nene

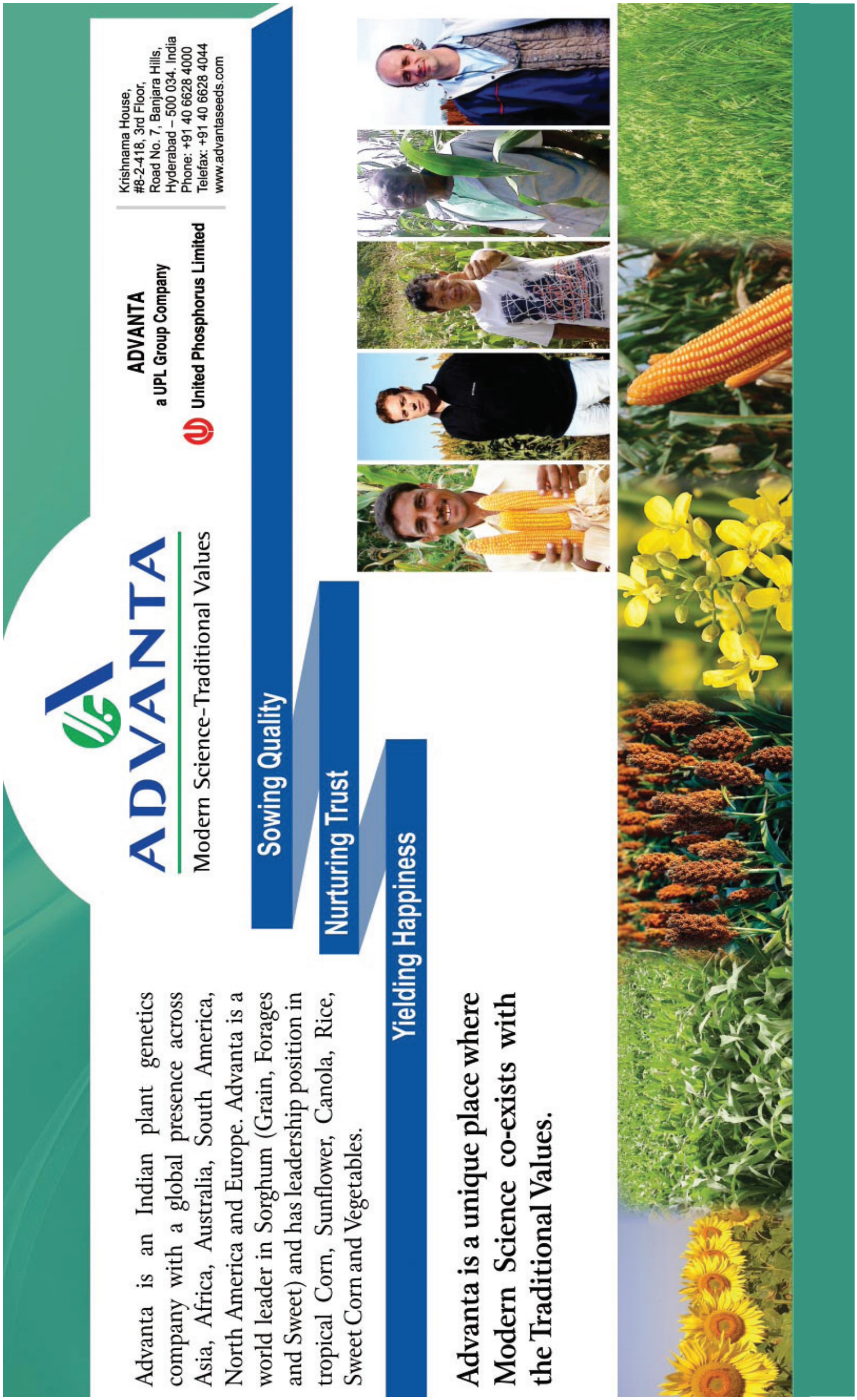
Release of 4th MS Swaminathan award Souvenir

Presentation of 4th MS Swaminathan award to R Saikumar

Presentation of 4th MS Swaminathan award to Dr N Shobha Rani

5th MS Swaminathan award Selection Committee meeting on 25-10-2013

5th MS Swaminathan award Chairman, members of Selection committee with RICAREA Members and ANGRAU Officers


ADVANTA
Modern Science-Traditional Values
ADVANTA
a UPL Group Company
United Phosphorus Limited
Krishnama House,
#8-2-418, 3rd Floor,
Road No. 7, Banjara Hills,
Hyderabad – 500 034. India
Phone: +91 40 6628 4000
Telefax: +91 40 6628 4044
www.advantaseeds.com
Sowing Quality
Nurturing Trust
Yielding Happiness
Advanta is an Indian plant genetics company with a global presence across Asia, Africa, Australia, South America, North America and Europe. Advanta is a world leader in Sorghum (Grain, Forages and Sweet) and has leadership position in tropical Corn, Sunflower, Canola, Rice, Sweet Corn and Vegetables.
Advanta is a unique place where Modern Science co-exists with the Traditional Values.


with best compliments from...
Magic of Prosperity
Through
Miracles of Science
Ganga Kaveri
BRAND
SEEDS
Ganga Kaveri Seeds Pvt. Ltd.
1406, BABUKHAN ESTATE, BASHEERBAGH, HYDERABAD- 500 001. A.P.
Phone : 23233518, 55667222, Fax: 23233418


Quality
Performance
Service
kaveri seeds
Hybrid Maize
kaveri 50
kaveri 244
kaveri 235
kaveri 225
kaveri 2288
kaveri 25K55
kaveri 25K60
kaveri Super 244
kaveri 10W10
Hybrid Wheat
kaveri KW11
kaveri KW51
kaveri KW111
Hybrid Tomato
kaveri 055
Hybrid Cotton
kaveri Jaadoo 14K59 BG II
kaveri Jackpot 15K39 BG II
kaveri Bullet 707 BG II
kaveri Encounter 135 BG II
Hybrid Sunflower
kaveri 618
kaveri Leader 678
kaveri Sunkranthi
kaveri Champ
Hybrid Jowar
kaveri 950
kaveri 6363
Hybrid Bhendi
kaveri 712
Paddy
kaveri 412
kaveri AK56
kaveri 888
kaveri 9090
kaveri Chintu
kaveri KV21
kaveri Sona
kaveri Super Sona
kaveri Supreme Sona
kaveri Sampoorna
Hybrid Bajra
kaveri Boss 65
kaveri Super Boss
kaveri 456
Hybrid Watermelon
Crimson Heart
kaveri seeds®
Produced & Marketed by
kaveri seed company limited
513-B, 5th Floor, Minerva Complex, S.D. Road, Secunderabad - 500 003. Andhra Pradesh, India.
Tel : +91-40-2784 2398, 2784 2405 Fax : +91-40-2781 1237
e-mail : info@kaveriseeds.in web : www.kaveriseeds.in

NUZIVEEDU SEEDS LIMITED - AN UPDATE

NSL completes four decades of service to farmers in 2013. While maintaining the leadership position in the industry NSL has taken steps to overcome the obstacles for future growth. While the core business is still cotton centric, the growth in the field crops has been astonishing particularly in rice and corn. Growth in field crops calls for additional investments in infrastructure in terms of seed conditioning and processing. NSL has always been proactive in this area and established required infrastructure and marketing network. This has resulted in exceeding the targets set for these crops. It is estimated company sells 24000 MT of quality seeds to about 7 million farmers all over India.

Responding to the business needs the R&D has given extremely good products in all the crops. In hybrid cotton new hybrids like Bhakti, Sona, Malini and Balwan are showing good business potential. The R&D got several hybrids notified by the Government of India in Hybrid rice, corn and other crops. NSL also participates in several government sponsored subsidized seed supply programs besides making seeds available through private network.

NSL has taken-up farmers' education through extension both directly and through Public Private Partnerships with various state governments. The objective of this being to help the farmers to realize full potential benefits from their seed. The experience in the last two years has been exciting with the State Governments of Maharashtra and Uttar Pradesh. The investments in this activity are yielding very good results in terms of "Good Will" both from the farming community and the officials. NSL intends to expand this across all the States with or without Government support.

In appreciation of Company's initiative in extension education it has been honored with national awards like "Agricultural Leadership Award" (Extension) and "Public Private Partnership (PPP) award" for its exemplary work from CDRA.

New Corporate Logo :

NUZIVEEDU SEEDS

NSL has adopted a slightly modified new corporate logo which strongly empathizes with the ethos of the farmer and is modern enough to appeal to all the stakeholders. NSL, while ensuring the retention of farmers' recollection of old logo (twin bulls) has modern its look and version which strengthens the heritage of the company which is empathetic in establishing its expertise and universal appeal.

NSL at a Glance : As on September 2013 :

General :

NSL Seed Group Turnover 2011-12	Rs 1061 Crores
NSL Seed Group Turnover 2012-13	Rs 1174 Crores
Number of Employees	1555

R&D

Total number of Research farms	32 (across India)
Total acreage of Research Farms	879 acres
Number of products notified by GOI	14

SCM :

Number of Farmers Growing Seeds	107200
Total Acreage for Growing Seeds	112000 acres
Total Number of Locations	16
Processing capacity	142 MT/hr
Maize Cob Drying facility	2750 MT/batch
Storage capacity	795000 SFT
Total Capacity of Conditioned storage	18000 Tons
Number of GOT testes conducted per annum	98400
Total acreage planted for GOT	1240 Acres
Number of tests in STL	3.5 Lakhs/annum

SCM :

Number of Farmers Growing Seeds	107200
Number of States Covered	17
Number of Regional Offices	12
Number of Distributors	2157
Number of Dealers and Sub-dealers	59345

Biotechnology Research interventions for Production & Productivity Enhancement in Livestock

S. L. Goswami

Livestock sector is a critically important component of Indian agriculture, providing it growth and sustainability. India ranks first globally with its large and diverse livestock population of about 535 million animals contributing 24.82% to agricultural GDP and 4.36 % to National GDP.It ensures livelihood security by employing 22.45 million people that amounts to about 5.50 % of the total working population. Most notable contribution of livestock sector is women empowerment by way of employing 16.84 million women.

The value of output from the livestock sector is estimated to be Rs. 459,051crores, as per C S O Estimates (2011-12) at constant prices. Value of milk is estimated to be Rs.313, 484 constituting 68% of the value of output from livestock and is higher than the value of output from the three principal crops i.e., wheat, rice and sugar put together. In terms of growth rate the livestock sector grew at 3.2% as against 1.80 % growth rate in agriculture being of which food grain production was only 1.2 %. Different segments of livestock sector recorded impressive growth with milk at 5%, meat group 13%, egg production 5%, poultry production > 10 % and fish production at 28.65%. In spite of the impressive value and growth rate, the productivity of indigenous livestock is very poor and there is a wide potential gap which could be bridged leveraging biotechnological interventions.

Biotechnology initiative in the country:

Biotechnology research in animal sciences was initiated in the country towards late 1980's at several Institutes like IVRI, Izatnagar; NDRI, Karnal; TANUVAS, Chennai; NDDB, Anand; NII, New Delhi and CCMB, Hyderabad. Though main focus of research, during this period, at IVRI, Izatnagar; NDRI, Karnal; NDDB, Anand and NII, New Delhi was to harness biotechnology for reproduction augmentation through embryo related biotechnologies for faster multiplication of superior germplasm, the other areas of research included molecular biology, looking for polymorphisms to identify genetic markers, virology, hybridoma technology with a view to develop cost effective, potent vaccines against endemic and emerging diseases, besides developing the recombinant proteins and diagnostics. Exciting developments in Genomics leading to Human Genome Project followed by whole genome sequencing in various livestock species prompted similar attempts at NDRI, CCMB and NBAGR. Though the focus was on Buffaloes, the approach at these institutions differed considerably. NBAGR followed whole genome sequencing and CCMB followed EST, radiation hybrids based approach and NDRI's focus was on genes impacting reproduction and lactation. Biotechnology research at IVRI, TANUVAS and more recently at CCSHAU and GADVADU has been focusing on health with a view to develop Diagnostics, and vaccines etc.

Biotechnology research urgently needs to be focused to address the areas directly impacting

Director
National Academy of Agricultural Research Management, Hyderabad
surender.goswami@gmail.com

the livestock production, productivity, quality (bio-safety) and value addition to the produce. Current status of the efforts made in these areas and the future needs are outlined below:

Reproduction Augmentation:

Reproduction and production are the two faces of the same coin; particularly in large ruminants were the reproductive process culminates in the productive phase. Though males have enormous reproductive potential which can be fully exploited using frozen semen and AI technology, females have limited reproductive potential. To maximize exploitation of female genetic potential protocols were standardised in country with respect to Embryo Transfer Technology (ETT), IVF etc. as demonstrated by birth of several calves from superior cows, buffaloes and, goats. The success in IVF techniques has paved way for venturing into high end bio-techniques such ovum pick up, cloning,transgenesis and embryonic stem cells in buffaloes as evident from birth of cloned goat kids, buffalo calves and development of several stem cell lines. But unfortunately a prudent strategy to use these technologies in development programs for perceptible genetic improvement through selective multiplication of elite animals has been absent.

The research focus during last five years has been on perfecting IVF techniques in buffaloes to optimize the blastocyst yield so that reasonably large quantities of these could be available for upstream areas of research, like cloning, transgenesis and stem cells. Considerable progress has been made in improving the blastocyst yield by manipulating the media and culture conditions. This also prompted research into genomics of early embryonic development to gain better insight into the process of IVM, IVF at gene level. Several candidate genes like GDF-9, IGFBP-5 and BMP15etc directly impacting the process have been identified and their role delineated. Research into cloning technology using an innovative hand guided procedures resulted in successful production of pashmina goat and buffalo calves using somatic cells from foetal, new born and stem cells as donors. Several well characterised embryonic stem cell lines have been developed in buffaloes and attempts are being made to use these for transgenic animal production.

Though techniques of cloning have yielded live calves on ground, there are several challenges that need to be addressed before the techniques could be fruitfully utilized for large scale production of superior progeny tested bulls and elite cows/buffaloes. The efforts to use cells from adult animals as donors have met with limited success so far, only one female calf born at NDRI, Karnal. The efforts should therefore be focussed on fine tuning the cloning technology to aim at cloning any presented adult animal. Further, the limited success of expressing the reporter genes (Green Florescent Protein) at blastocyst stage also needs to be carried further for production of human proteins of pharmaceutical value by expressing them in buffalo mammary gland for secretion in milk. Research on embryo genomics need to delineate the molecular mechanisms of IVM, IVF and early embryonic development, to be able to manipulate these processes for improving the yields so that embryo techniques could be gainfully utilized for reproduction augmentation, faster multiplication of elite germplasm and production of pharmaceutical proteins.

Livestock Genomics:

Recent technological developments in DNA sequencing and bioinformatics have not only enhanced the pace with which different genomes are being delineated but have also reduced the cost tremendously. Next generation sequencing technologies have made it possible to sequence the whole genome of any organism in a matter of days instead of months and years. A large number of species including livestock have been sequenced all over the world. The research in livestock genomics in the country has been going on since the last decade or so using different approaches. Recently, NBAGR, Karnal and AAU, Anand have published buffalo genome sequence, but keeping in view the vast biodiversity, with unique features, the efforts can only be called meagre. Therefore there is an urgent need for establishment of a **National Genome Sequencing Facility** adequately equipped to meet the sequencing needs of researchers. The unique characteristics of indigenous livestock in terms of heat tolerance, disease resistance and capacity to utilize poor feed resources need to be explored at gene level, so that these could be harnessed in combating the impacts of climate change.

Efforts have been made at different institutes to study the genes impacting different economic traits including lactation, reproduction, and disease resistance in cattle and buffaloes. In addition, various milk protein genes with respect to polymorphism and genes relevant to early embryonic development have been studied. Several hormone and hormone receptor genes affecting growth and reproduction have been characterised in different breeds of buffalo. Using micro satellite markers a large number of breeds of cattle, buffalo, goat, sheep and poultry have been characterised at molecular level.

Though research in this important area has been going on at some institutions, there is need to focus on the genes affecting the survival and economic traits. There is need to reveal the potent genetic markers which could be integrated into selection programs to bring about faster genetic improvement. Research in the functional genomics needs to be expedited on priority to understand gene functions in the animal system.

There is also need capacity building in bioinformatics both in terms of human resource and computation facilities to manage the enormous sequence data, to derive meaningful information.

Fertility Augmentation:

Anoestrous and repeat breeding in large ruminants are two of the most serious reproductive problems affecting 30-40% of the total cattle and buffalo population. On a conservative estimate the country is losing 20-30 million tonnes of milk annually on account of anoestrus and repeat breeding in cattle and buffaloes which translates to a loss of nearly Rs. 40-50000 crores annually. At a micro level, each missed heat is a missed opportunity. For each heat missed the farmer incurs a loss of milk production of 21 days, in addition to bearing the feeding cost for animal maintenance. This is further compounded by the incidence of silent heat in buffaloes that ranges from 10.5% in winter to about 70% during summer months.

This has necessitated research focus on reproductive endocrinology, with the aim of developing models to improve reproductive efficiency. The techniques of ovsynch and heat synch protocols for estrous synchronization followed by fixed time AI for enhancing fertility in buffaloes have resulted in the average success rate for conception being around 50%. Additionally, cyclicity was restored in 30-40 % of anoestrus buffaloes.

Efforts need to be made to reduce the cost of the treatment to bring it within the reach of resource poor farmers. Appropriate shelter management practices also need to be worked out to reduce stress on the animals leading to reduced fecundity and reduced fertility. In view of the huge production and economic losses caused due to poor fertility among Livestock, there would be urgent need to apply the hormonal strategies on farmer's animals in a campaign mode. The availability and the cost of hormonal preparations will be the major hindrances in applying these technologies on large scale. Thus production of these using recombinant DNA technologies, by local pharmaceutical industry would be the need of the hour.

Prokaryotic (microbial) Genomics:

India with its vast diversity in food across the country also has equally vast microbial diversity. Microbes, particularly the lactic acid bacteria and other dairy microbes play a central role in the fermented food products. They impart valuable health promoting attributes to the food products. Efforts were made to characterize dairy cultures in general and lactic acid bacteria in particular at DNA level for the purpose of identification and classification etc. However, the potential of manipulating the bacteria for imparting desirable qualities in terms of flavour, taste and health promoting attributes has not been achieved, primarily because of sporadic attempts without focus on improving these traits. There are opportunities employing metagenomics to study the variability of the microbial populations in fermented milk products across the country and identifying the unique characteristics for their industrial applications. Work has also been carried out to develop DNA based diagnostics for detection of food borne pathogens.

Focus of research during recent past has been on development of DNA based uniplex and duplex real time PCR assays for simultaneous detection of food borne pathogens like *Listeria monocytogenes, E. coli O157:H7* and *Salmonella enteritidis.* Limited efforts have been made for whole genome sequencing of microbial cultures. Work was also carried out on expression of recombinant proteins like Buffalo Chymosin expressed in *Pichiapastoris* for application in the preparation of Mozzarella cheese; Human Lactoferrin expressed in *Saccharomyces cerevisiae* and *Pichiapestoris* for food and pharmaceutical applications.

Whole genome sequencing technologies have made it possible to sequence the entire genome in a short span of time. With better insight into the genetic architecture of the bacterial cultures it would be possible to manipulate them effectively to obtain desired combination of cultures. Depending upon the degree of success in the efforts, it would be possible to develop new formulations and use them for industrial applications. Selected potential molecules could be targeted for their recombinant expression for industrial applications.

Proteomic, Structural Biology and Proteogenomics

With the long term goal for discovery of biomarkers associated with animal productivity and dairy processing, research related to animal proteomics have been initiated recently at Animal Biotechnology Centre, NDRI, Karnal. Efforts have been made to analyse the global and differential expression of mammary gland proteins extensively in both cow and buffaloesto understand their role in lactation persistency and milk yield. Similarly, the changes in the protein pattern in blood as a result of climate stress on farm animals are also being investigated. Work on differential expression of seminal proteins to identify protein biomarkers associated with fertility in cattle and buffalo bulls is also being carried out. Since proteomics operates in dynamic paradigm, functional and structural characterization of various proteins becomes inevitable. Work has also been initiated on buffalo proteo-genomics to generate comprehensive proteome data of buffalo in line with buffalo genome.

Protein–protein interactions of Lactoferrins from different species including cattle, buffalo, goat, sheep and camel have been elucidated. Three dimensional structures of various milk proteins such as Lactoferrins, BRP39 and MGP40 have been determined.

The Research efforts as outlined above will help in enhancing the production and productivity of Livestock and would further contribute to the growth and sustainability of Indian agriculture.

Ending Malnutrition and Preserving our Agricultural Heritage

M S Swaminathan

According to the 2011 census, farm families constitute the majority of India's population. A high proportion of marginal farm families as well as landless labour families suffer from under-nutrition, because of inadequate income. Thus, we have to deal with three kinds of hunger if we are to achieve food and nutrition security for all.

First, we have to help farm families overcome under-nutrition as a result of calorie deprivation. This can be achieved through the National Food Security Bill which is now before Parliament. Secondly, protein hunger is becoming serious due to the inadequate consumption of pulses and milk (in the case of vegetarians) and eggs, fish and meat (in the case of non-vegetarians). Thirdly, there is widespread hidden hunger, caused by the deficiency of micro-nutrients such as iron, iodine, zinc, Vitamin A, Vitamin B12, among others in the diet.

The nutri-farm initiative suggested by me to the finance minister and for which a provision of Rs 200 crore has been provided in the budget of 2013-14, is designed to give concurrent attention to the three major problems mentioned above. About 100 high malnutrition burden districts have been selected for starting this project during kharif, this year. Since neither ICAR nor agricultural universities seem to be involved in this exercise, I suggest that in each of the 100 districts chosen, a technical advisory committee (TAC) may be constituted, consisting of appropriate experts in agronomy, agro-meteorology, farming systems design and nutrition. Nutrition experts from home science colleges will be helpful in identifying major nutritional maladies prevailing in the area.

The TAC may also suggest how to achieve convergence and synergy among ongoing programmes like the National Food Security and Horticulture Missions, Mahila Kisan Sashaktikaran Pariyojana and Rashtriya Krishi Vikas Yojana. Such convergence will be very helpful in maximising the benefits and impact of all these programmes.

For ensuring the success of the nutri-farm programme, a nutritional literacy movement needs to be launched in the chosen districts. For this purpose, it will be useful to request panchayats to nominate one woman and one man to be trained as community hunger fighters who will familiarise the village community with the nutritional maladies prevailing in the area. Thus, they will enable farm families to overcome nutritional maladies through the appropriate introduction of agricultural remedies in the prevailing farming system. Agricultural interventions will include the introduction of naturally occurring biofortified crops and varieties, such as Moringa, sweet potato and maize, as well as genetically developed varieties such as iron-rich bajra and zinc rich jowar. In addition, the cultivation and consumption of pulses will be extremely important to fight protein hunger. The development and spread of a farming system for nutrition (FSN) programme through nutri-farms will help to mainstream nutritional

Founder 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
Email : swami@mssrf.res.in / msswami@vsnl.net

parameters in the design of farming system programmes.

Thus, the following steps are needed to implement the nutri-farm programme effectively: (a) Survey and identify the major nutritional problems in the area; such a survey should be engendered, since women suffer more from iron-deficiency anemia. (b) Study the on-going cropping and farming systems (that is, crop-livestock integration) in the area and identify and introduce agricultural interventions, such as the cultivation of biofortified crops and varieties, which will help to address the nutritional deficiencies prevailing among women, children and men. (c) Develop impact assessment criteria for assessing the role of agricultural remedies in combating the nutritional maladies prevailing in the area. (d) Launch a nutritional literacy programme in the area through gram sabhas and panchayats and create a cadre of community hunger fighters who can help to bring about convergence and synergy among various social protection measures against hunger.

Grassroot democratic institutions such as panchayats are not being adequately used for developing cooperative action in villages in the areas of soil conservation, water and pest management and land use planning. It is in this context that the example set by the Edaiyapattipanchayat of Tamil Nadu, which has converted itself into a pulses panchayat is worthy of emulation. Pudukottai district, which is one of the driest regions in Tamil Nadu receives an average rainfall of 922.8 mm. Climatic variation resulting in erratic monsoon behaviour has affected agriculture dearly, especially dry land agriculture in the region. As a result, pulse cultivation in the district has shrunk drastically by 30 per cent over the past decade. The decline in the pulse cultivation is affecting adversely the health of particularly of children and women.

To help our nation to become self-reliant in pulse production, the people of Edaiyapattipanchayat have passed a resolution and vowed to put maximum available land (about 200 ha) into pulse production. There are 10 villages in this panchayat consisting of 342 families out of which 133 families are dalits (some of them own small land holding). This pulses panchayat is assisting farmers to improve pulse productivity and profitability through soil and water conservation, participatory variety selection, introduction and demonstration of innovative technologies.

Learning from our agricultural heritage

In all areas of human endeavour, the past, present and future constitute a continuum. The past history of biodiversity conservation teaches us many lessons. First of all, about 10,000 years ago, when men went out hunting for food, women started gathering seeds and cultivating crops. This was the origin of agriculture or settled cultivation. The evolution of agriculture was based on selection from naturally occurring genetic variability. Thus, there is a strong relationship between cultural, culinary and curative diversity and agro-biodiversity.

It has been an act of foresight on the part of the Food and Agriculture Organisation of UN, to initiate a programme for recognising globally important agricultural heritage systems (GIAHS). GIAHS was formally launched at the UN Conference on Sustainable Development held at Johannesburg in 2002. I attended the launching ceremony and pointed out the importance of agro-biodiversity in an era of climate change, a point which I have also made in an editorial in Science (July 31, 2009) in the following words:

"The bicentenary of Charles Darwin's life and work reminds us that the great biodiversity on earth underlies natural selection, selective breeding, and the biotechnology required to provide humanity with food, fibre, fodder and fuels. In particular, biodiversity affords the development of plant varieties with novel genetic combinations, which will be required to meet the challenges arising from adverse alterations in temperature, precipitation, sea level, and the frequency of drought and floods - all of which are anticipated from human-induced climate change. The loss of each gene and species therefore limits our options for the future."

GIAHS have been defined by FAO as "remarkable land use systems and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development". The selection of GIAHS sites is done by a high level panel of scientists headed by Professor Li Wenhua of China. Towards the end of May, an international forum of GIAHS met at the Satoyama and Satoumi area of the Noto peninsula of Japan. This region is the first GIAHS recognised in Japan. The Satoyama Satoumi system is a beautiful example of "agri-culture" which creates wisdom, and life in a sustainable environment and passes on blessings and happiness from the present to future generations. So far, 19 agricultural heritage systems have been recognised in 14 countries. In India, two systems namely the tribal agro-biodiversity based sustainable agricultural system of Koraput in Odisha and the Kuttanad below sea level farming system of Kerala have been recognised.

These two GIAHS sites serve as inspiring examples of human innovation and creativity in the field of agriculture and food security. The tribal women and men of the Koraput GIAHS in India have shown how to develop a climate smart food security system based on mixed cropping and local level gene, seed, grain and water banks. The Koraput GIAHS shows how to apply agricultural remedies to nutritional maladies and thereby achieve the goals of both food and nutrition security.

The Kuttanad below sea level farming system shows the way to prepare for sea level rise caused by global warming. Unlike the system in the Netherlands, the Kuttanad system is based on bio-bunds, which are eco-friendly. The Kuttanad GIAHS serves as a model for developing farming techniques to checkmate the adverse impact of sea level rise. It also helps to prevent the proliferation of climate refugees.

Thus, GIAHS represents not only a celebration of the achievements of our ancestors, but also a guide to achieving sustainable food and nutrition security in an era of climate change. GIAHS helps to make young people aware of the glory of past agricultural innovations and stimulates them to make their own contributions to our agricultural legacy. Above all, it recognises the role of women in the origin and development of crop and animal husbandry, fisheries and forestry. GIAHS serves as the flagship of the evergreen revolution movement designed to enhance crop productivity in perpetuity without associated ecological or social harm.

GIAHS provides an opportunity to integrate traditional ecological prudence with modern technology. In these sites, there is much to learn from farm families and therefore the system promotes "land to lab" system of laboratories learning from the practical experience and wisdom of local farm families. In this context, the Kerala government is to be congratulated for deciding to establish an international centre for research and training in below sea level farming at Moncombu and Kumarakom in Kuttanad. Such a centre will be of great interest to all island states, which are likely to suffer if global warming induced rise in sea level takes place during the next few decades.

There are many other opportunities in our country to identify traditional systems of farming and natural resource management, which have relevance today. For example, the Apatani plateau in Arunachal Pradesh represents a unique farming system developed many centuries ago by local farm families. The importance given today to traditional knowledge, as well as to vanishing crops will be clear from the decision of the UN to designate 2013 as the International Year of Quinoa. The slogan for this year is "A future sown a thousand years ago". Quinoa is a grain used by people of the Andean region in South America for thousands of years. We need this kind of awakening in our country since we also have a large number of nutritious food grains. Fortunately, the food security bill, now under consideration of Parliament, provides an opportunity for widening the food basket.

Status of rice production and its requirement by 2030

The rice is a staple food and continuous supply is to be maintained to the consumers. To ensure regular supply of the food grain proper steps are required to be taken in advance. If supply is not maintained uninterrupted than there are chances of a large number of human population drowning in perpetual hunger. About 1 billion households depend on rice cultivation for employment and their main source of livelihood. As the rice consuming population continues to grow, and the land and water resources needed for rice production diminish, we may face a potential crisis. World rice production has been less than rice consumption since 2000. This insufficiency has been addressed by drawing on rice from buffer stock. In this context, advances in science and technology, as well as rice research, are increasingly critical to enhance rice production and sustainable agricultural development. Ensuring an increase in sustainable rice production will require innovation and cooperation within the scientific community, as well as commitment and shared responsibility among all stakeholders

Paddy rice and wheat could have an equivalent share in global cereals production till 2030. Paddy rice and wheat is estimated to account for 2/3 of the cereals production. Both paddy rice and wheat should be the dominant cereal food in the world before 2030. Per capita cereals production for developed countries, wheat would amount to 1/3 of cereals and paddy rice has a very low proportion, which demonstrates that wheat should be the dominant cereal crop in these countries. Unlike developed countries, paddy rice is expected to be the dominant cereal crop (1/2) and wheat is just 1/2 of paddy rice in developing countries per capita production.

Paddy rice yield would increase by 2030 to 24.7 to 35.5% and reach 5.28 to 5.73 metric tones/ hectare (mt ha-1). Paddy rice production in developing countries is estimated to grow at annual rate of 9, 476, 885 mt, much higher than developed countries (74, 027 mt yr-1). Till 2030 the production in developing countries is expected to significantly raise 30.9 to 41.8% against the probable increase of 7.6 to 21.0% in developed countries. Yield increase in developing countries (25.6 to 36.9%) may also be higher than developed countries (4.0 to 23.1%). With a projected production of 5.9 to 7.7 mt, Asia is forecasted to be still the major region for paddy rice production in the world. By 2030 Asia's paddy rice yield is estimated to increase 11.7 to 23.4% and reach 4.59 to 5.08 mt ha-1. On the other hand, Europe (79.0 to 139.2 kg ha-1 yr-1), Oceania (69.3 to 106.7 kg ha-1 yr-1) and North & Central America (65.8 to 74.0 kg ha-1 yr-1) are estimated to have higher annual rates in paddy rice yield, and the production in these regions is expected to reach 7.6 to 9.7 mt, 8.8 to 12.4 mt and 7.4 to 8.2 mt respectively by 2030.

Per capita cereals production of the world is estimated to probably increase 4.5% (1.3 to 10.2%) and reach 375.3 kg yr-1 by 2030. Per capita production in developed countries (7.9 to 39.5%) may have a much higher level than developing countries (0.2 to 7.7%) and is projected to be three times of the later (899.1 kgyr-1 vs. 273.8 kg yr-1) till 2030. Oceania (955.2 kg yr-1) and North & Central America (833.6 kg yr-1) may have the greatest per capita cereals production, while per capita production in Caribbean (62.1 kg yr-1) and Africa (122.2 kg yr-1) should be lower by 2030. Asia is forecasted to be the largest region in cereals production but per capita production in this region (233.3 kg yr-1) may still be lower.

India is essentially an agricultural country with over three-fourths of the population living in rural areas and dependent on agriculture related occupations. Pre-Independent India was badly hurt by frequent famines and drought. The eminent economist AmartyaSen owes his major works on hunger to the devastations of the great Bengal famine which had made deep impressions on him when he was still a child. If India today is self sufficient in food, it is in no small measure due to indigenous agricultural research. Of course, India still has a long way to go. The population is increasing; the land area under cultivation is decreasing and excessive use of chemical fertilisers, pesticides and insecticides are adversely affecting the environment. Far more needs to be produced than now, and produced in a much safer way. These are enough challenges to keep our agricultural research establishment busy. Modern day rice variety have yield potentials much greater than their traditional predecessors, a characteristics that has greatly increased rice production worldwide.

Rice production increased with time, this might be due to technological advances and more efficient use of inputs coupled with increased area under cultivation. Still there are few downfalls which clearly states that prevailing weather has significant effect on yield of rice. Rice production may change as a result of global warming through the CO2 increase, temperature rise and change in precipitation. Thus, policymakers require reliable projections of the regional impacts on the production in order to consider mitigation and adaptation techniques. Projections of regional climate change and impact on rice production are important in relation to food security for these areas, as stated by the Intergovernmental Panel on Climate Change (IPCC) in its Third Assessment Report.

Contributed by RKMP. DRR on Fri, 2013-07-19 11:03

Source :

Mohammad Shamim, K.K. Singh, B.Gangwar, Sunil Kumar and Vinay Prasad Mandal

Project Directorate for Farming Systems Research, Modipuram - 250110

File Courtesy :

Dr. Mohammad Shamim, Project Directorate for Farming Systems Research, Modipuram-250110

(Compiled by Dr M.V.S. Sastry)

The Salient Saga of Wheat Production and Research Priorities in India

Indu Sharma and Sendhil R

Prologue

Wheat (*Triticum*spp.) is one of the principal cereals consumed by all ages of people. The commodity finds a significant share in food basket since it is one of the cheapest sources of energy and calorie intake. It ensures food and nutrition security to a majority of the Indian population through production and hash less supply particularly in the recent past. Although the crop has been under cultivation for eons after domestication, systematic research began only in 1964-65 after the implementation of the multi-locational co-ordinated research programme. An attempt has been made in this paper to document the salient saga of wheat production after co-ordinated research in India and the present research priorities.

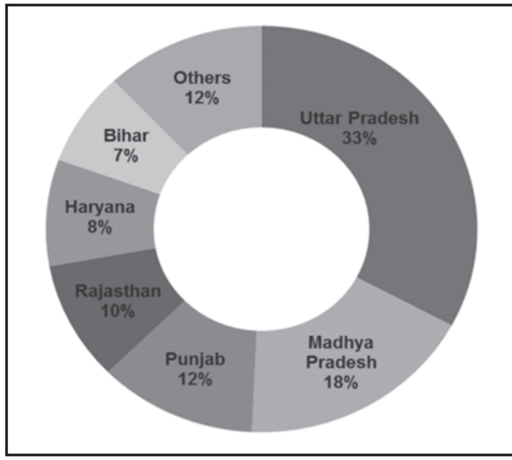
Directorate of Wheat Research - *Modus Operandi*

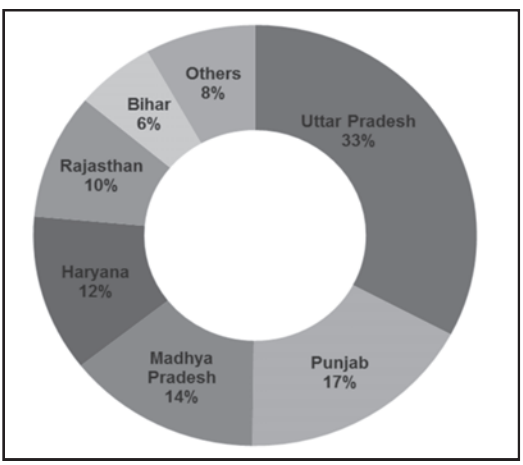
The Directorate has five major units (Crop Improvement, Resource Management, Crop Protection, Quality Improvement and Social Sciences) comprising of about 50 scientists working for wheat development following trans-disciplinary mode of research and ensure food and nutrition security for all population. Crop improvement scientists co-ordinate the trials across six wheat growing zones, works to improve yield potential by harnessing the genetic base, develop genotypes tolerant to biotic and abiotic stress, produce seed based on demand, conserve and categorize germplasm, use molecular markers for wheat improvement, work towards developing hybrid wheat using CMS line and to developing varieties for scarce resources. Resource management group on the other hand devise improved package of practices based on agronomic trials conducted across wheat growing zones, developing technologies that use scarce resources, does experiments on zero tillage, crop diversification, system of wheat intensification, weed floral management, crop residue management and nitrogen profiling. Crop protection scientists does disease and pest screening in multi-location trials, manage wheat diseases through genetic barriers, work on multiple disease resistance and IPM, monitor pests and diseases, use molecular and biochemical markers for crop protection and devise strategies for eco-friendly management of pest and diseases. Quality improvement team prescribes various genotypes available for good product making and other important quality parameters along with the variability in quality traits, adopts molecular marker technology for improving wheat quality, takes new initiative for wheat export (analysis of FCI wheat grain samples), use of anti-oxidants for better human health and strengthen the work on bio-fortification and molecular breeding. Scientists from social sciences works to bridge the yield gap by disseminating improved production technologies across wheat growing zones through Front Line Demonstrations at farmers' field. They also identify different production constraints and come out with specific strategies to tackle those constraints.

Directorate of Wheat Research, Karnal – 132001, Haryana (India)
indu.dwr@icar.org.in

Indian wheat scenario

After the implementation of the All India Co-ordinated Wheat Improvement Project (AICWIP) in 1964-65, production of wheat in India has increased from 12.26 mt to 92.46 mt (2012-13). The production had increased by eight fold with acreage increase by two times and productivity increase by three fold. *Inter alia*, increase in crop productivity is one of the major contributions of the AICWIP. Through the programme, so far 400 genotypes have been released tailored for specific wheat growing zones of the country. These diverse varieties helped to increase the production consistently on a sustainable basis. Registering a record production of 94.88 mt in 2011-12, the country produced 92.46 mt of wheat from 29.65 mha area with a productivity of 3119 kg/ha in 2012-13. About 92 per cent of Indian wheat has been produced from 88 per cent area across Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Haryana and Bihar. The total value of the production was estimated at ‘1248.19 billion at current support price of ‘13500 per tonne (2012-13).





Self-sufficiency status in wheat production and from net importer to net exporter

India was a net importer (imports > exports) for many years and for the first time it emerged as a net exporter (exports > imports) in 1978 reaching its self-sufficiency status. This is one of the finest achievements from increased production that evolved from the efforts of maneuvered co-ordinated research in India. Exports increased from a mere 48 tonnes in 1964-65 to 6.5 mt in 2012-13. Also, the quantity of wheat imported from other countries reduced drastically from 5.62 mt in 1964-65 to as low as 2944 tonnes in 2012-13. Increase in export was mainly due to surplus production and it was a milestone in 2011-12. Further, the country has exported already 6.73 lakh tonnes of wheat worth ‘11806.61 million in April 2013. Recent estimates from the United States Department of Agriculture (USDA) reports that about 7 mt has been exported by July, 2013.

Procurement vis-à-vis stocks

Building stocks out of surplus production and earning foreign currencies due to exporting of huge volume of wheat has been consistent in the recent past. Due to surplus production, stocks held with the central government owing to procurement have been steadily increasing. FCI, the nodal central agency, along with other State agencies procured wheat at the Minimum Support Price (MSP) of ‘13500/tonne in 2012-13. As usual, Punjab, Haryana and Madhya Pradesh contributed more to the central grain pool. In 2012-13 marketing season, the quantum of wheat procured was 38.15 mt. But in the current season, wheat procurement dropped by 49 % and it is estimated at 19.41 mt. The plausible reasons were strong buying by private traders, stockholding by farmers and production drop in major wheat growing states. As on 01.07.2013, stock of wheat in central pool is 42.40 mt (Storage: 42.14 mt and Transit: 0.26 mt) and in FCI, it is 13.76 mt (Storage: 13.50 mt and Transit: 0.26 mt).

What farmers get from wheat production?

Sustainable wheat farming depends on its income generating capacity and cost structure. Economic analysis of Front Line Demonstrations (FLDs) during 2012-13 indicated that wheat cultivation is more profitable in Madhya Pradesh followed by Punjab and Haryana. Estimates of cost of production indicated that the cost incurred in producing a unit quantity of output was less in traditional wheat growing states and zones due to the likelihood of getting more yield. Overall, on an average, an Indian farmer by adopting a new wheat variety or production technology will get ‘ 2.71 per rupee of investment in his/her farm. Further, ‘ 668 have to be spent to produce a quintal of wheat through adoption of a new wheat variety or production technology.

Latest wheat varieties identified for farmers

A list of wheat varieties identified for various production conditions during the All India 52nd Wheat and Barley Research Workers Meet held at CSAUA&T, Kanpur (September 1 - 4, 2013) have been briefed down. Later, the varieties notified by the Central Variety Release Committee will find a place in the seed chain.

1. Northern Hill Zone :
   HS 542 (Rainfed-Early Sown)
2. North Western Plain Zone :
   HD 3086 and DBW 88 (Irrigated-Timely Sown)
   DBW 90 and WH 1124 (Irrigated-Late Sown)
   PBW 660 (Rainfed-Timely Sown)
3. North Eastern Plains Zone :
   NW 5054 and K 1006 (Irrigated-Timely Sown)
4. Peninsular Zone :
   MACS 6478 (Irrigated-Timely Sown)
   HD 3090 (Irrigated-Late Sown)
   DBW 93 (Restricted Irrigation-Timely Sown)
5. Southern Hills Zone :
   HW 1098 (Dicoccum) (Irrigated-Timely Sown)

Harnessing science and technology developments in addressing research priorities.

Wheat productivity cannot be increased rapidly to meet the wheat demand by 2050 posed by multiple challenges like population growth, diet preferences, climatic vulnerability, farmland degradation and demand for diverse products. The issue in the recent past is that acreage under wheat is almost stable. Increasing crop acreage is directly beyond the control of research managers, whereas, productivity can be increased by regular technological interventions to meet the production target of 140 mt by 2050 set by the Directorate. This can be done by utilizing the developments in science and technology with prime focus on :

- Promoting novel wheat breeding programmes like adopting doubled haploids to save time and integrating conventional breeding and biotechnological tools.
- Trait focus on wheat productivity, rust resistance, second tier diseases, quality, input use efficiency and abiotic stress tolerance for incremental yield.
- Designing agro-technological packages like site specific nutrient management, Furrow Irrigated Raised Bed System (FIRBS) and need based nitrogen application.
- Special initiatives on integrated pest management, monitoring *Pucciniastriiformis*

virulence across national borders and Pest Risk Analysis (PRA) for developing quality product to consumers.

- Developing hybrid wheat for incremental yield and C4 wheat for resource saving.
- Reducing the yield loss in central zone due to abiotic stresses.
- Technology promotion through extension and market intelligence. Making futures trading on wheat relevant to our Indian farmers.
- Developing varieties for specific Resource Conservation Technologies (RCTs).

Epilogue

Self-sufficiency due to surplus production in wheat, post 1978, enabled the country to meet the domestic demand and reduced the dependency on imports from other countries. The country has achieved several milestones over the past decades in wheat production and exports with drastic reduction in imports. However, tackling the threat posed by population growth coupled with several production constraints in future will be cumbersome for scientists, developmental organisations and policy makers. To meet the set target of 140 mt by 2050, the Directorate aims for a synergy between research, developmental and extension programmes. Success paying strategies like participatory breeding programmes, blending conventional breeding with biotechnological tools for developing genotypes that could withstand biotic and abiotic stresses, and devising strategies for efficient use of scarce resources (doubled haploid production, C4 wheat) has been devised for sustainable production. Extension agents should serve as transformers and facilitate to adopt the successful technologies from lab to farmers' field. Harnessing the developments in science and technology via an integrated mission mode approach will help to sustain our wheat production for future India.

Strategies for enhancing profitability and value addition in Sorghum

J.V Patil and Vilas A. Tonapi

There are many opportunities for enhanced production and profitability of sorghum. Despite a declining *per capita* consumption of sorghum, it still remains the fourth major cereal staple and the cheapest grain accessible to the economically-deprived people especially in rural and remote areas. Resistance to grainmold and introduction of processing technology to facilitate easy cooking and consumption may greatly enhance the food value of kharif grain in addition to the preferred rabi grain. Transgenic approach is being adopted to incorporate superior dough quality in sorghum grain. Mapping populations are being developed to finally implement marker-assisted selection in developing cultivars with resistance to biotic and abiotic stresses and important quality-related traits. Therefore, we are developing strategies for resolving the constraints which inhibit the increased use of improved technologies in a cost-effective manner. The higher scope for industrial utilization, livestock development through quality forage and enhanced utilization of grain by poultry, and potable alcohol industries, and sweet stalk juice by biofuel industry will aid increased income to sorghum cultivators, industries and exporters. Therefore, sorghum can be called as industrial crop rather than poor man's crop.

Kharif sorghum

In recent years, kharif sorghum has been in demand for industrial uses mainly as animal and poultry feed, for ethanol industry (both grain and stocks) and as food item. Kharif sorghum is grown mainly in the states of Maharashtra (4.70 million hectares), Karnataka (1.59), Madhya Pradesh (0.60), Rajasthan (0.60), Andhra Pradesh (0.48), Tamil Nadu (0.48), Uttar Pradesh (0.27) and Gujarat (0.13). Introduction of hybrids basically witnessed a major change in Indian sorghum farming specifically in kharif season, which was traditionally occupied with landraces. Hybrids, CSH 1 to CSH 30, are a standing testimony of success of Indian sorghum breeding not only in terms of yield enhancement, but also in terms of diversification of parental lines and progressive advances in the incorporation of resistance and quality traits against major pests and diseases. Among the kharif hybrids, the role played by CSH 14 and CSH 16 needs special mention, but the recent releases such as CSH 25 and variety CSV 20 are even more promising.

Directorate of Sorghum Research, Rajendranagar, Hyderabad 500 030
dsrhyd-ap@nic.in , jvp@sorghum.res.in, vilastonapi@hotmail.com ; tonapi@sorghum.res.in

Value-addition through diversified utilization

The value-addition through commercialization of the industrial applications of the sorghum grain as well as sweet sorghum technologies are assuming paramount importance in the wake of declining consumption demand and intensifying search for supplementary/ alternate raw material by the various industries. Due to changing scenario of kharif sorghum turning into almost a commercial crop, it has an excellent potential to be used in various industrial uses. It has already established its ground with regard to use as cattle feed, poultry feed and for potable alcohol.

Strategies for improving kharif sorghums

For any crop to become a viable industrial crop, it needs to have two important traits. Besides having high yields (so as to be cost effective), the future kharif hybrids should have qualities which suit specific end-uses. Sorghum is being popularized for many food items like semolina, pops, noodles and vermicelli, which require specific grain (starch) qualities. Grain quality attributes are not only important for food industry, but also for feed and ethanol industry. Ethanol recovery depends on starch quality. The starch and protein digestibility depend on the starch-protein and starch-lipid complexes. Also, phytates which hinder availability of minerals and proteins in food and feed are warranted to be decreased. Grain hardness is one of the important criteria which in turn depend on starch quality of grain, an index for selecting good genotypes for food and feed industry. For brewing industries, malts from sorghum varieties that have high diastatic power, amylase and starch contents are highly desirable and the envisaged research programmes are routed in this direction. Conventional, mutation and molecular breeding approaches are to be used to develop new varieties and hybrids for above mentioned specific end uses. Genes for high ethanol recovery/ ethanol efficiency are to be incorporated from germplasm lines to elite high yielding lines.

Rabi sorghum

Status :

Rabi sorghum is an important dry land crop grown in the Deccan Plateau on ~5.0 m ha area in the states of Maharashtra (3.28 m ha), Karnataka (1.40) and Andhra Pradesh (0.36) with an annual production of >3.73 m tonnes. Because of their higher quality, large grain size and grain luster, rabi sorghum grains fetch higher market price for the farmers. Six hybrids and five varieties were hitherto released by the national programme. In rabi sorghum, the fodder yield is more important than that during kharif sorghum. High levels of resistance against major pest (Shootfly) and disease (charcoal rot), stringent maturity duration requirements are essential in rabi cultivars for better adaptability. Grain quality is also as much important as the grain yield. For food and fodder quality, the benchmark is that of the popular landrace, Maldandi (M35-1). Recently released rabi varieties, CSV 14R and CSV 18 were better received by farmers. Rabi hybrids, CSH 15R and CSH 19R are more productive but farmers have not accepted hybrids under dry land conditions.

Strategies for improving rabi sorghums :

Drought is one of the major production constraints responsible for destabilizing the rabiproductivity. This discourages use of purchased inputs like hybrid seeds and fertilizers. Therefore, research on drought tolerance is now focused on development of early maturing rabi sorghum varieties and identification of QTL for terminal drought tolerance traits. Contrary to kharif hybrids, the heterosis in rabi hybrids is insignificant because the landraces (which are low community performers) are used (mainly to maintain the consumer preferred grain size and lustre) in the development of both parents. It is envisaged that introduction of larger grain size and lustre in the female parents of kharif hybrids by novel methods and hybridizing such female parents with rabi based R lines would increase the yield levels of rabi hybrids to fetch better farm incomes to the farmers.

Forage sorghum

Status :

Introduction of multi-cut sorghum hybrids, single-cut and dual-purpose sorghums which can be grown for quality green forage production in most of the states of India is helping to sustain livestock security. The multi-cut variety, SSG 59-3 (Meethi Sudan) with a potential of four cuts became popular due to its high green foliage, yield potential, regeneration and excellent forage attributes. Recently, the multi-cut hybrids, CSH 20MF and CSH 24MF have been released by All India Coordinated Sorghum Improvement Project (AICSIP). These new multi-cut forage hybrids are more tolerant to leaf diseases besides having higher productivity and dry matter digestibility (DMD). The forage varieties, CSV 21F, Pant Chari 5, Pusa Chari 9, and Haryana Chari 6 are the popular single-cut forage sorghums with resistance to lodging and leaf diseases. These varieties also exhibited higher per-day productivity and improved DMD, and total soluble sugars (TSS) with comparable stalk crude protein content. Few other varieties released at the state-level also provided the base for varietal transformation in forage sorghum.

Still private sector is dominating and marketing few notified hybrids (MFSH 3, Harasona) and many non-notified hybrids as they target at relatively rich farmers and dairies in Western India. Nevertheless, there is a ready and growing market for high-yielding multi-cut forage sorghum hybrids to support the growing dairy business.

Strategies for improving forage sorghums:

DSR has developed dual-purpose lines with brown mid-rib (bmr lines) which have higher digestibility. It is estimated that one percent increase in digestibility increases milk yield by five percent, leading to higher income to farmers. Further, DSR is aiming at developing both female and male parents with brown midrib (brown mid-rib gene is recessive) so as to develop hybrids with high stover digestibility. The forage and sweet sorghum hybrids are based on female parents of grain sorghum. Selecting grain MS lines with same maturity and slightly shorter in height as that of sudan grass pollinator is essential for good seed production. The high yielding grain MS lines with sweetness in stock and having stay-green traits, crossed with sudan grass pollinator will give ideal forage hybrid with high stover digestibility. Utilization of unexploited germplasm especially sudan grass having succulent stems, low HCN content and good tillering and regeneration habit is essential to diversify the genetic base of the hybrids.

Sorghum for dry fodder (stover)

There is enormous demand for dry fodder, particularly during lean winter and summer seasons in the arid and semi-arid regions. Fodder (stover) demand is additionally linked to demand for milk and milk production. Sorghum fodder is the main roughage in the semi-arid regions of Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Gujarat and Rajasthan and in Bundelkhand region of Uttar Pradesh. It is estimated that sorghum fodder constitutes 20-45% of the total dry weight of feed of dairy animals during normal seasons and up to 60% during the lean summer and winter seasons. With increase in milk demand, the production demand for dry fodder is expected to rise. There is already an emphasis on the fodder component of the yield in parts of Tamil Nadu, Karnataka, Andhra Pradesh, Rajasthan, Gujarat and Uttar Pradesh. The extent of trade-off between grain yield and fodder yield acceptable in a cultivar vary among different regions. This demand situation, however, did not receive adequate attention in the national sorghum improvement programme till recently. Earlier kharif HYVs yielded 80% more grain and 30% lesser fodder than the local cultivars. More favourable environment increases the percentage share of grain over fodder, while the reverse is the case under less-favourable environments. The inability of HYVs to give high fodder yield under less-favourable production systems is one of the reasons for their low adoption in such areas. However the recently released dual purpose types in Kharif (CSV 15, CSV 20 and CSV 23) and the improved rabi cultivars released at national and state levels will aid in meeting the dry stover demand in India to usher in fodder security.

Sweet-stalk sorghum

***Status*:**

Demand for renewable energy sources and biofuel which would minimize pollution are expected to rise rapidly in coming years. Sorghum, by virtue of its C_4 photosynthetic system and rapid dry matter accumulation is an excellent bioenergy crop. Therefore, sorghum is expected to gain importance in the coming years in bioenergy farming. Ethanol is a clean burning fuel with high octane rating and it can be blended easily with petrol to the extent of 15-20%. Juice from sweet sorghum stalks can be competitive raw material to molasses for producing ethanol. Few factories have started using this (such as TATA's at Nanded in Maharashtra). This can also be profitable crop during summer with irrigation or during monsoon season. Till date the SSV 84 and CSV 19SS are the only nationally released sweet-stalked sorghum varieties.

There are a few private hybrids in the market such as Madura and Sugargraze. Realizing the importance of high yielding superior sweet sorghum hybrids, the national programme could release the first sweet stalked sorghum hybrid, CSH 22SS which has attracted much attention internationally. Efforts are on for development of sweet stalked sorghums for various specific end-users such as production of alcohol, ethanol, and syrup. We provide consultancy services on commercialization of sweet sorghum for bio-ethanol production to sugarcane- based distilleries, biofuel industries, farmer groups, policy makers, and entrepreneurs.

Strategies for improving sweet sorghums:

At DSR, we are developing cultivars for high stalk yield and sugar content combining tolerance to shoot pests (shootfly, stemborer, etc) and standardizing the crop production practices. Biotechnological tools are being used to develop shootfly and stemborer resistance. Ideal traits for good sweet sorghum genotypes are cane yield, juice extractability, high starch content and sugar content *per se* in the genotype. Photo-insensitive sweet sorghum genotypes with special arrangement of leaves are required to grow them throughout the year. Developing sterile sweet sorghum hybrids on A_3 and A_4 cytoplasm where no translocation of carbohydrates to panicle takes place, and carbohydrates that are retained in the stocks would be highly useful.

Production technology

Sorghum-based cropping systems in kharif

***Status* :**

Sorghum with redgram as an intercrop is found practicable in 2:1 or 3:3 row proportions. Alternatively the sorghum and fodder cowpea as an intercrop in the ratio of 2:2 is also 40% more profitable. Soybean is also becoming other important intercrop with sorghum. In the intercropping systems the yield of grain and fodder from the sorghum crop is similar to its sole crop. Therefore, the gains from the intercrop are additional. In the deep black soils having adequate rainfall, sunflower or bengal-gram can be grown after kharif sorghum. Initially, early duration hybrids, CSH 6 and later CSH 14 became popular hybrids for intercropping.

***Strategies*:**

There is need for *developing* better yielding early duration hybrids. The early hybrids will also be useful for sequence cropping especially when two crops are taken in a year. The traits to be incorporated in high yielding background are earliness and suitable leaf geometry (leaf arrangement) so that the other crop takes advantage of solar light.

Sorghum as health food

***Status* :**

Recent research is *discovering* many new potential health benefits from sorghum, such as high levels of anti-oxidants, improved cholesterol profiles of the consumer, and as a source of safe food for persons with celiac disease. Sorghum grain has high fibre content, moderate digestibility and rich mineral content compared to other cereals such as rice and wheat. Therefore, sorghum foods are recommended for diabetic and jaundice-affected persons and for fighting obesity. Being free from gluten, sorghum is the ideal food for celiac patients also. Sorghum is becoming popular as a part of multi-grain foods, snacks and sweets. Food recipes for breakfast, lunch, snacks and savouries are available. To create greater demand for millets, especially sorghum for foods, we are working through the National Agriculture Innovation Project (NAIP) involving public-private partnership. We have also developed novel-recipe books in several languages to train entrepreneurs.

***Strategies* :**

High tannin sorghums *reduce* the risk of certain types of cancer when compared to other cereal grains. By introducing testa genes B1 and B2, levels of tannins can be increased in white coloured grains also. Some tannins however, are also known to bind with protein and make grain indigestible.

Sorghum wax (with unique health *properties*) has sterols like policosanols which regulate cholesterol absorption and endogenous cholesterol synthesis thus helping in cardiac problems. Sorghum wax also has favourable composition of very long chain fatty acids (VLCFA) that have been shown to have benefits for human health. Genetic variability for sterols can be studied and superior lines to be utilized in breeding programme.

Potential niches

Introduction of sorghum in rice-fallows

Introduction of sorghum in rice-fallows, especially in non-conventional areas when water is insufficient for second crop of rice, appears to be potentially promising with planting in late December to early January ensuring high quality grain for feed industry. It is gaining popularity among farmers in coastal Andhra Pradesh especially in Guntur and adjoining Krishna and Prakasham districts. The area of sorghum in rice-fallows has increased from 1000 ha during 2008-09 to 4000 ha in 2009-10 with an average productivity of 5.7 t/ha, which is the highest in the country. The hybrids like CSH 16 and others gave as high as 8 t/ha grain yield. As the water scarcity is becoming a major problem, there is a great scope for sorghum in rice-fallows.

Summer sorghum cultivation

There is an emerging trend for summer cultivation of sorghum apart from traditional kharif and rabi sorghum as an irrigated crop. It is being taken up with much enthusiasm in Nanded and Pune districts of Maharashtra and Bidar district of Karnataka. Usually kharif hybrids are opted because of their higher yields and the quality of the grain is high. Due to dry weather, grains age highly priced owing to its good quality (unlike during wet kharif, no grain deterioration caused by fungal infection). It has tremendous scope for export purposes. Summer sorghum essentially caters the needs of fodder during peak shortages.

Red sorghum for feed and exports

Specialized red *kharif* sorghum farming for grain export to international market is another emerging opportunity. In order to meet the feed demand in high rainfall regions, red grain sorghum may be targeted as potential raw material for poultry which imparts rich yellowness to yolk of egg. The red grain types have good demand in many countries for feed purposes. Red grain sorghums are relatively more tolerant to grainmolds because of the presence of phenols and red pericarp. At DSR we are screening and developing red grain sorghum cultivars with early maturity combining tolerance to grainmolds as well as resistance to major pests in high yield background.

Sorghum in present scenario of climate change and global warming

Climate changes may affect farming patterns with rinsing temperatures, drought in kharif and heavy rains in rabi, therefore demanding the agriculture sector also to reduce its share of greenhouse gas emissions, at the same time safeguarding the soil through better farm management practices. Sorghum cultivation has better advantage as compared to rice cultivation in the present day scenario of climate change. Sorghum is C_4 plant and utilizes CO_2 efficiently, it does not produce as much greenhouse gases as rice does and also utilizes low inputs as water and fertilizers.

Strategies for breeding for potential niches

Till now the *available* sorghum cultivars have been tried for different niches. The sorghum growers in rice fallows are not interested in fodder as they feel that their cattle prefer rice straw. There is tremendous scope to make feed blocks and sell them to peri-urban dairies. The grain of sorghum is sold to Pune market, where the grain is mixed with rabi sorghum. The phenotype of cultivars suitable for this niche area is high grain yielding, medium in height and with bold and lustrous grain. Summer sorghums need to be photo-insensitive, early and bold grain and should require less irrigation. In mold-prone kharif areas, red sorghums can be encouraged for feed as they have grainmold tolerance due to less phytates in their bold grains with high fat content, hence they can compete with maize in poultry industry. The climate change may cause unpredictable drought and heat stress. So, it is *necessary* to have drought resistance (at various stages of growth) for kharif genotypes. Understanding the resistance mechanisms at various growth stages and utilizing it in breeding will be beneficial. Sorghum has capability to withstand drought at vegetative stage and it revives after it rains. Genotypes which efficiently utilize CO_2 and withstand high temperatures will be useful in climate change scenario. Developing highly digestible sorghum stover and grain will help in reducing green house gas production from animals. Hybrids having good root system (roots to get established in unprepared soils) and performing superiorly in zero tillage will be the requirement in future.

Maize Scenario in India

R Sai Kumar and Chikkappa Karjagi

Maize contributes maximum among the food cereal crops i.e. 40 % annually (> 800 mt) in the global food production. Among the world's maize growing countries; USA is the largest maize producer and exporter and contributes nearly 35% of the total maize produced followed by China with more than 20% production with same acreage of USA. USA has the highest productivity ($\geq$ 10 t ha^{-1}) which is double than the global (5.3 t ha^{-1}). However, in India it is the third most important cereal after rice and wheat for human food by contributing almost 9% to India's food basket, it is mainly grown during *Kharif* season which covered 80% of the total area.. The consumption pattern of maize (feed-64%, food-16%, industry-19%, seed and other miscellaneous 1%) in India largely matches with the global pattern (feed-61%, food-17% and industry-22%). The production has increased more than 12 times from a mere 1.73 million tons 1950-51 to 21.73 million tons in 2010-11 (ASG, 2011) and presently it occupies 8.55 million hectare area with the mean yield of 2.54 tons/hectare. The demand of maize has been estimated that it will continue to increase. The main driving forces for increased maize demand are increasing demand in poultry and livestock sectors in the country and growing non-vegetarian population and changing food habits.

Maize utilization scenario and future projection:

In India as maize production and consumption has been rising consistently, the consumption pattern also has been changed over the years. In the past it was mainly confined to food in India but now it is being used largely for the feed purpose (64%) mainly due to significant shift in its usage in last five to six years. Its use in food & food processing products 16%, sizable maize is also used in industry i.e. 19% for the manufacturing of starch, beverage and other value added products (Fig. 1). The total demand of maize for different sector is met from the country production and India has stopped import and has become exporter since 2007-08. USA is the largest producer of maize in the world, a significant amount of maize is used for ethanol, and bio-fuel production, in the world maize is used 61% as a feed 22% for the industrial purposes and only 17% is used for direct food (Fig. 1). Almost the trend of maize utilization in India is similar to the world. In future, it was estimated that the use of maize as feed is projected to increase by 10% annually. Further, the continued growth in the poultry and starch industry will support the higher consumption of maize in India. In addition, maize has been considered as industrial crop as it is being used as raw material in many important industries *viz*. starch, oil, alcoholic beverages, food sweeteners, pharmaceuticals', cosmetics, textile, paper, film, tyre, food processing, packing and bio-fuel *etc* for developing hundreds of industrial products. Apart from all above several types of maize are being grown to address different issues *viz*. quality protein maize (QPM) to meet the nutritional requirement of under privileged, sweet corn (SC), baby corn (BC) for ensuring livelihood and green fodder security in *peri-urban* areas, pop corn (PC) as a nutritional alternative snack, *etc.* Recently it was reported that the popcorn carries more antioxidants than many fruits and vegetables (TOI, 2012).

Former Director & Scientist, Directorate of Maize Research, New Delhi
r_saikumar123@rediffmail.com

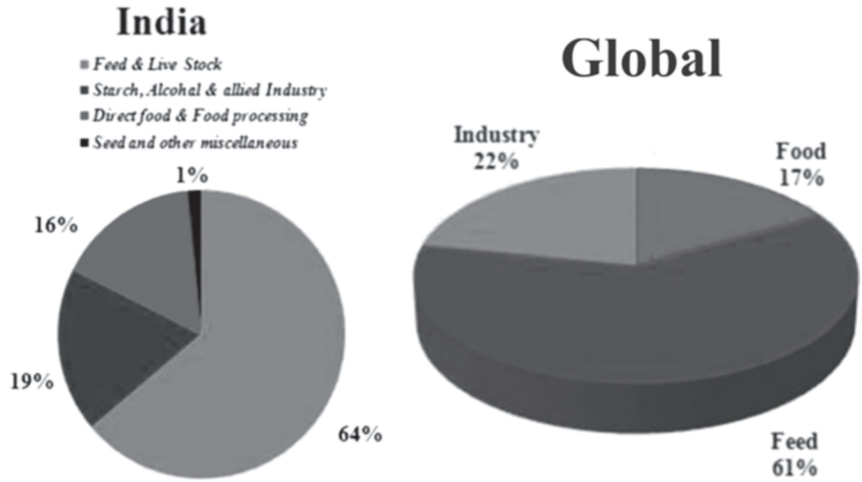


Figure 1. Current maize utilization pattern in India and World

Projected demand of maize :

Owing to burgeoning growth rate of poultry, livestock, fish, and wet and dry milling industries, maize demand is expected to increase from current level of 16.72 to 45 million tons by 2030 (Fig.2)and its production is growing at a faster pace of about 6% against consumption growth rate of 4.7%. The projected requirement of maize can only be met by focused research on high yielding single cross hybrids, and its integration with novel molecular tools and techniques like

introgression of superior alleles (genes) into best available single cross hybrids.

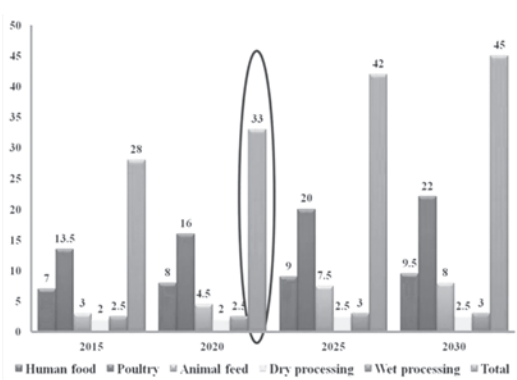


Figure 2. Projected demand of maize in India (*source* : DMR vision 2030)

Maize production and productivity scenario :

The systematic hybrid maize breeding in India had been started with the inception of All India Coordinated Maize Improvement Project (AICMIP) in 1957. The project has led to the release of double cross hybrids (DCHs) and double top cross hybrids in 1961. Since the technology could not exploit full potential of hybrid performance with these hybrids, the emphasis has shifted to single cross hybrids (SCHs). Therefore, the renewed interest in the breeding of single cross maize hybrids to suit particular cropping patterns has started very aggressively in the latter part of the previous decade. The SCH technology has lead to increase in area, production and productivity across several states of India. This is very much evident by the fact that India's maize area, production and productivity has increased >2.5, >12 and >4 times touching to estimated 8.55 mha, 21.8 mt and 2.5 t/ha (2012-13) from a mere 3.16 mha, 1.73 mt and 0.5 t/ha (1950-51) since independence respectively (Fig. 3a). 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 ~25% (2010-11). The increase in maize production in last five years (2006-2012) was remarkable (15 mt to 21.8 mt). However despite all these facts, the maize productivity in India was dismal low (2.5 t/ha) as compared to world average productivity (~5 t/ha). Since 1950 the maize breeding strategy in India has undergone several phases (Table 1) in fact the trend in maize area, production and productivity of India has closely followed the trend in the type of cultivars being developed and released for commercial cultivation by research institutes.

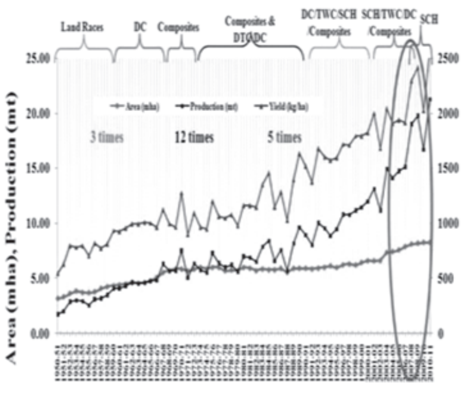


Fig:3a. India Maize cultivar development & its impact on productivity

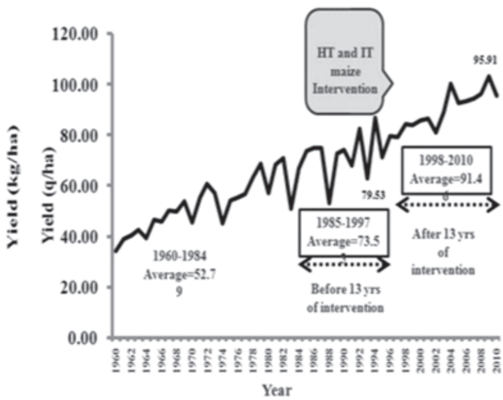


Fig:3b. USA Maize cultivar development & its impact on productivity

India's productivity increased from >500 kg to remained >1.0 ton/ha in 32 years from 1951-89. This was the era of predominantly OPV cultivation in India with the establishment of 1st All India Coordinated Research Project in Maize. During this period 33 composite were released and this is 75% share of the total released variety of the country. The productivity increased from 1951-89 was <20 kg/annum. In 1989 hybrid project was launched in the country. In another 16 years (1989-2005) the period remained predominantly composite breeding. During this period as many as 45 composite were released, however 20 single cross hybrids and 11 double crosses were also released (Fig. 4). With the cultivation of double cross hybrid the productivity increased slightly > 1 ton to nearly 2 tons during this period the productivity increased per annum (1989-2006) was 42 kg. ICAR focus the research on Single cross hybrid since 2006-07 with the result as many as 52 single cross hybrids in public sector and 47 in private sector were released and their cultivation on farmer field made a significant impact in increasing the maize yield in India (DMR 2011). The productivity has increased from 1886 to 2540 kg per ha with the rate of 131 kg/annum.

Table 1. Phases of Maize Research, cultivar development and productivity in India

Period	Strategy	Productivity (kg/ha)	Growth
1950-57	Land races	724	<20 Kg/annum
1957-67	Land Races/DC/Composite	937	
1967-77	DC/DTC/Composite	1053	
1977-89	Comp./DTC/DC	1186	
1989-90	Hybrid project	Launched	41 Kg/annum
1989-99	DC/TWC/Comp.	1619	
1999-06	DC/Comp./SCH	1886	
2007-11	Focus on Single Cross Hybrid	2372	131 Kg/annum
2011-12	Current productivity	2540	

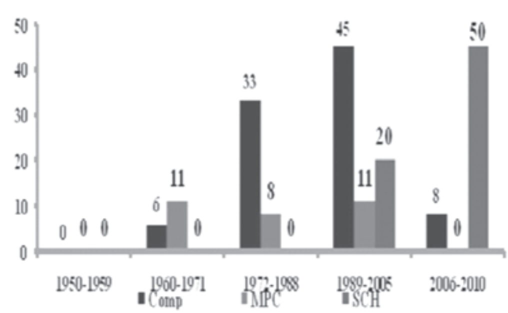


Figure 4. Maize cultivar development in India

Maize grain Export :

USA is the largest maize producer and exporter in the world. India has also been importing maize to meet its requirement for the continuous running of the feed and starch industry till 2006. With the cultivation of single cross hybrid since 2007 India has turn importer to exporter. Now India is exporting 2.5 – >4.0 million tonnes since 2007-08 to the neighboring country (US Grain Council), of the total maize produce in India, about 14-15% is exported and more than 80% is utilized by the various sectors. Due to low cost of cultivation, near to road and sea to the bordering country there is low freight charges and Indian maize is competitive to these bordering countries like Nepal, Pakistan, Bangladesh, Sri Lanka the maize available to them is low priced due to very low freight charges. Earlier these countries were importing from USA. Now the USA maze is very costly as compare to India because of very high freight charges.

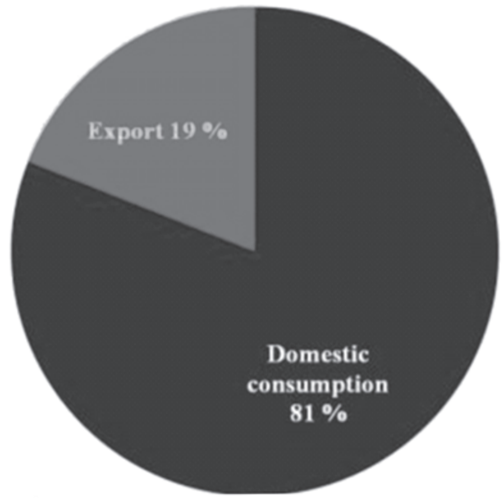


Fig. Maize consumption and export

Enhancing Oilseeds Production in India : Strategies

K.S. Varaprasad

Indian vegetable oil scenario is very sensitive, complex and greatly influenced by the market forces and vagaries of weather as these crops are largely grown in rain-fed areas mostly by small and marginal farmers. The availability of the diverse agro-ecological situations and crop diversity for oil that include annual edible (soybean, rapeseed mustard, groundnut, sesame, sunflower, safflower), non-edible (castor, linseed and niger) oilseed crops, non-traditional sources (cotton seed and rice bran), perennial sources (coconut and oilpalm) and minor edible (maize, tobacco, sal, mahua, phulware, simarouba, etc.), fuel (jatropha, pongamia) and minor perennial non-edible (neem, jojoba, mango kernel, etc.) sources is the major strength of Indian vegetable oil scenario. However, major oilseeds that currently contribute to Indian edible oil economy are soybean, mustard, groundnut, sesame and oilpalm. The area and production of sunflower and safflower significantly reduced in the last decade. Castor continues to be an important cash crop in the non-edible and industrial oil sector. It is a matter of concern that indigenous productions of oilseeds meet only about 50% of the requirement. Edible oil import is valued at Rs 56,000 crores, while oil meals, oilseeds and oil export together valued at Rs 24,342 crores for the year 2012-13. In this context, research, development and price linked policy strategies needed to enhance oilseeds production are briefly discussed.

In order to increase the domestic production of oilseeds and reducing the import bill and to make the country self-reliant as early as possible in vegetable oils , the Technology Mission on Oilseeds was initiated by the late Prime Minister, Shri Rajiv Gandhi in May, 1986 with very ambitious objectives of (a) self-reliance in edible oils by 1990, (b) reduce imports by 1990 almost to zero and (c) raise oilseed production to 18.0 million tonnes by 1989-90 and 26.0 million tonnes and 8.0 million tonnes of vegetable oil by 2000 AD. Thrust was given on the main oilseed crops in selected 180 districts in 17 states which contribute maximum quantity of oilseeds to the nation. When the Technology Mission on Oilseeds started, all the research, developmental, policy making bodies, industry and farmers got fully integrated and worked in unison to make India self-sufficient for oils. The Mini Missions dealing with (1) Crop Technology, (2) Post-Harvest and Processing Technology, (3) Farmer Support System and (4) Price Support, Processing, Storage and Marketing considered all the aspects of oilseed economy and through the overall guidance of the Standing Committee, Empowered Committee, Technical Advisory Committee and through cooperation of 17 concerned Agencies and through the facilitating and coordination role of the Mission Director laid the foundation for the Yellow Revolution (Rao, 2000). With the result, another big jump in production was seen during 1988-89 which raised production from below 13 million tonnes till 1987-88 to 18 million tonnes. The country has achieved the stupendous task of becoming self-reliant in oilseeds production through Yellow Revolution in early 90's which is clearly reflected through the spectacular improvement in the availability of vegetable oils in the domestic front and the associated changes such

Project Director, Directorate of Oilseeds Research, Rajendranagar, Hyderabad-500 030.
(E-mail: prasadksv@gmail.com)

as spurt in foreign exchange earnings, decline in imports and stabilization of prices, etc.

The gain from the self-sufficiency in oilseeds sector remained for short period and started fading and the situation began changing significantly from 1996-97. There is a sharp increase in edible oil consumption in India (5 to 6% per annum) which is fueled by the spurt in *per capita* income of the order of 8%. The demand for edible oils has outstripped the supply and there is a steady rise of edible oil import to bridge the gap. At present, India is the world's largest consumer of edible oils, surpassing China.

The increase in population @ 1.3%/annum and the rise in consumption due to increased economy have resulted in higher demand for vegetable oils in India. As per the recent projection by DAC-Rabo bank, the *per capita* consumption of vegetable oils is likely to rise to 14.57 and 16.38 kg/year by 2015 and 2020, respectively. An emerging dimension of vegetable oil requirement towards non-industrial uses is estimated to grow by 15% in 2020, 20% in 2030 and 25% post 2040 which requires 3.57, 6.34, 9.69 and 10.61 million tonnes, respectively in 2020, 2030, 2040 and 2050. The Indian trade industry predicts that this industry is poised for greater expansion. The total vegetable oil requirement is thus estimated at 25.26, 29.47, 34.27 and 35.90 million tonnes during 2020, 2030, 2040 and 2050, respectively which is a gigantic task for the country for increasing its domestic production. The contribution of vegetable oils from secondary sources including tree species (20%) is estimated at 5.05, 5.89, 6.85 and 7.18 million tonnes by 2020, 2030, 2040 and 2050, respectively.

The estimated *per capita* consumption is placed at 16.43, 17.52, 18.62 and 19.16 kg/annum for the years 2020, 2030, 2040 and 2050, respectively. The *per capita* consumption is pegged at 50, 60, 70 and 74% above the optimum requirement of 30g/day considering the health of the nation. The total domestic vegetable oilseeds requirement from nine annual oilseed crops is placed at 67.37, 71.45, 80.65 and 82.06 million tonnes by 2020, 2030, 2040 and 2050, respectively. Given the current oilseeds output of about 31 m. tonnes, the country needs to almost double the oilseeds production in the next 10 years requiring annual growth of nearly 6% which would indeed be a tall order, requiring efforts much beyond what is being pursued until now.

Agricultural production is a function of several factors that include research to develop and release of improved varieties/ hybrids in addition to production and protection technologies aiming to enhance the productivity; development departments hand-in-hand need to take these technologies to farm at farmer level and respective government departments to provide conducive policy environment allowing farmers to choose the efficient technologies for profit. One of the key measures for research contribution to enhanced production is compound growth rate achieved in productivity. Let us examine comparatively, the case of oilseeds as a group. Among the major annual crops, cotton registered compound growth rate (CGR) of almost 10% in productivity during the past decade and this spectacular growth rate was mainly possible due to release and cultivation of Bt cotton. Oilseeds closely followed by maize are next only to cotton with a compound growth rate of 3.13 and 2.93, respectively (Table 1).

Table 1. Compound Growth Rates of annual oilseeds *vis-à-vis* other important/competing crops (2001 to 2012)

Crop	Area	Production	Productivity
Rice	0.003	1.82	1.817
Wheat	1.35	2.65	1.29
Maize	2.79	5.71	2.93
Cotton	3.22	13.22	9.99
Gram	4.16	5.97	1.73
Oilseeds	1.83	4.97	3.13

There are two important observations; firstly as India needs a quantum jump in productivity, we need to find ways on how to harness the power of genetically modified technologies without compromising biological and environmental safety and secondly to focus on ways and means of integrating and achieving complementarities across the research, development and policy departments of governmental, non-governmental and farmer organisations.

Strategies to increase production

Following research, development and policy strategies are the immediate need for increasing both oilseeds production and vegetable oils availability in the country.

I. Research

- Develop short duration, high yielding genotypes for better adaptation to climate change through integration of modern biotechnological tools like MAS and transgenic breeding; supplementary to conventional breeding and develop cultivars with in-built resistance to biotic and abiotic (specially drought and heat) stresses. In this context, greater use of trait specific germplasm through pre-breeding will be highly desirable.

- Marker assisted breeding through development of molecular markers and utilization of genetic engineering tools more particularly for the biotic stresses for which germplasms are not available and for improving quality traits is the need of the hour. The examples are: transgenics with resistance to stem necrosis, *Aspergillus,* Vit A fortification in groundnut; resistance to rust, YMV and reduced beany flavour in soybean; resistance to aphid and *Alternaria* in mustard; resistance to necrosis virus in sunflower; transgenic for *Botrytis* in castor and resistance to *Alternaria*and phyllody in sesame and resistance to bud fly in linseed.

- Development of special varieties suitable for specific situation such as early duration to fit in to the relevant cropping systems, drought resistance, acidity and low temperature tolerance, table purpose types in groundnut; early duration, high oil content, salinity tolerance, high temperature tolerance, late sown, foliar disease resistance in rapeseed-mustard; early maturity, thermo and photo insensitivity, rust and YMV resistance, suitable for *rabi*cultivation in soybean; white seeded, short duration, drought resistance, phyllody resistance, semi-*rabi*condition; high temperature tolerance in sesame; non-spiny with high oil and seed yield in safflower and short duration hybrids for Indo-gangetic plains, high oleic lines, resistance to SND and *Alternaria*in sunflower.

- Develop low cost nutrient management practices for sustenance of soil health and reduce pesticide residues in products. Technologies for enhance input use efficiency and maximize production with optimum utilization of natural resources, conservation agricultural practices to mitigate climatic changes.

- Improve oil quality to increase wider adaptability and uses *viz.*, reduction of ricin in castor, increase oleic acid content and develop confectionery types in sunflower, double zero and low glucosinolate rapeseed- mustard, increase gamma linolenic acid content in safflower and utilization of Omega 3 content of linseed, trypsin inhibitor reduction in soybean, aflatoxin reduction in groundnut for diversified uses.

- Value addition to the raw oil and other parts of the mandate crops such as castor oil for bio-diesel and oleochemials, safflower petals for pharmaceuticals purpose, crop biomass for biofuel and reduction of anti-nutritional properties in the oil meals.

- Develop small farm machinery for different operations specific to each crop so as to ensure timely farm operations and efficient use of costly inputs.
- Increased emphasis needs to be given on post-harvest technology and value addition for diversified uses in order to ensure higher profitability.

II. Development

- Establishing strong linkages for successful operation of 'seed village concept' with producers, technocrats, certifying agencies, concerned State Departments of Agriculture and private seed industry for timely procurement and distribution to ensure higher seed replacement by improved varieties/hybrids and quality seed availability.
- Exploring new avenues for area expansion such as crop intensification in under utilised farming situations like rice fallows (15 m.ha), intercropping in widely spaced crops (45 m.ha), situations of limited water availability, as options under contingency planning (*toria*, sunflower and sesame) and as catch crops, replacement of less-remunerative crops, promotion of oilseed crops in saline (safflower, mustard, sunflower, castor) and acid soils (groundnut),crop diversification in rice-rice and rice-wheat system areas.
- Promote oilseeds cultivation in new and non-traditional areas and seasons for ensuring crop diversification and additional area for expansion. Eastern region offers potential for area expansion especially in paddy fallows. Similarly, soybean and sunflower offers great opportunity for diversification of rice-wheat cropping system in Northern India.
- Adopt location specific efficient dry farming technologies for drought proofing and sustainable oilseeds production. Integrate oilseeds production with watershed programmes for holistic development.
- Increase area under protective irrigation and promote efficient irrigation methods, especially micro-irrigation, for achieving higher production and stability.
- Promote adequate and balanced fertilization with emphasis on use of sulphur and limiting micronutrients through proper soil amendments, based on soil testing.
- Effective transfer of technology with assured input, market and technological backstopping by both public and private sector agencies. Licensing of improved varieties and hybrids for seed production and other bio-intensive production technologies can be of very useful for reaching the products to a large number of farmers.
- Promote intercropping systems involving oilseeds for achieving higher efficiency of resources, profitability and risk minimization.
- Large scale production of promising small farm equipments through involvement of state governments that will help in improving efficiency in farm operations. Also provision of credit and incentives for manufacturing of small farm equipments and machinery by small scale industries and promotion of custom hiring to ensure resilience in farming.
- Greater thrust on use of soybean as food rather than only as oil and feed will help the nation in addressing current major concerns for protein malnourishment, while ensuring nutrition security.
- Exploit additional features of crops like high value safflower petals and linseed fiber for realizing additional profits. Also, there is a need to accelerate area expansion of oil palm plantations and extend assured irrigation, power, local processing facility and competitive prices for realizing higher production of vegetable oil per unit area per unit time.

- Twenty five per cent of foliage of castor can be used for eri-silk production without affecting seed yield.
- Tapping and assessment of potential of non-traditional oil sources such as corn, tobacco and oil bearing tree species.
- Avoid use of rice bran directly as feed in order to promote greater extraction and use of rice bran oil.
- Promote scientific processing of cotton seed for higher oil recovery and to get high protein retention (42%) compared to traditional processing practices (22%).
- Improve efficiency of extraction of oil through solvent extraction for hard seeds (<20% oil) and expeller extraction for soft seeds (35 to 40% oil).

III. Policy

- Regulate import of vegetable oils through adoption of appropriate import policy aiming at increased domestic production. Hence, vegetable oils should be viewed beyond export - import balance with the goal of achieving self sufficiency to a greater extent. The need for achieving self sufficiency in vegetable oils should be seen in the context of improved livelihood, higher profitability of oilseed farmers and for processing industry.
- Ensure market intervention for effective implementation of MSP through needed procurement of oilseeds, being a major national priority.
- Appropriate regulations to amend the Agricultural Produce Marketing Act for making it pro oilseeds producers and enhance proper trading and fair pricing to both producer and consumer.
- Encourage establishment of large scale 'captive plantations' and specialized 'seed gardens' of oil palm by declaring oil palm as a plantation crop and also ensure proper pricing policy for profitability.
- Similar to sugarcane model, oil expeller industry should promote local/regional oilseeds production for assured and adequate supply of raw material as per pre-determined assured prices. The industry should also be involved in supporting technology development and extension activities.
- Greater emphasis and investments on public awareness about rationalization of vegetable oil consumption for proper health becomes our national priority.

Conclusions

In order to achieve self-reliance or to double the oilseeds production to match the country requirement, following three points deserve special attention as emerged from various panel discussions including the latest chaired by Dr R S Paroda, Former Secretary DARE and DG, ICAR:

Establishment of Technology Mission exclusively for oilseeds

In the words of Dr. M.V. Rao, former Special Secretary, DARE & Special Director General, ICAR: "If the Technology Mission has to be succeeded in its objectives and deliver the goods, it should concentrate on oilseeds and oilseed connected problems along (which consists of many crops with diverse problems) and shed the pulses, maize and other crops as it is the position at present. The Mission should be dynamic, inventive, innovative and inspiring to all the involved implementers and agencies. To put a whole range of crops with entirely different problems, approaches and strategies under one mission cannot give the needful thrusts and guidance and will be self-defeating". Commitment and will is needed to revive and establish such an "Oilseed Technology Mission" with specific targets.

Exploring cutting edge technologies including transgenic for suitable varieties/ hybrids

Unlike food crops that are directly consumed, several oilseeds have potential advantage to develop bio-environmentally safe transgenic varieties/ hybrids as oil that is extracted from seed, free from protein (toxic) is consumed. Potential of developing such varieties or hybrids is demonstrated in several laboratories across the globe including India in major oilseed crops.

Participatory approach

Joint efforts with complimentary roles of government, non-government and farmer organizations in research, development and policy of oilseed sector particularly in the areas of developing variety/hybrid/transgenic technologies, seed production and extension.

Suggested Reading

Hegde, D.M. 2012. Carrying capacity of Indian agriculture: oilseeds. *Current Science*, Vol. 102: 867-873.

Paroda, R.S. 2013. Addressing the Emerging Concerns of Indian Agriculture. Dr. M.V. Rao Lecture delivered on August 24, 2013 organized by Indian Society of Oilseeds Research, Rajendranagar, Hyderabad, India, pp.26.

Rao, M.V. 2000. Can yellow revolution be sustained under globalization. Lecture delivered during the Foundation Day of Directorate of Oilseeds Research, Hyderabad on 1st August, 2000, .17pp.

Varaprasad, K.S. 2011.Enhancing Oilseed Production through Improved Technology in India.*In*: Enhancing Oilseed Production Through Improved Technology in SAARC Countries. NasrinAkter*et al.* (Ed.). SAARC Agriculture Centre, Bangladesh, pp.55-86.

Cotton Scenario 2013-14 - in World & India

Dr. S.S. Narayanan

World Situation

Cotton is a highly volatile commodity in global commerce and trade. Cotton is grown in over 100 countries in about 34-36million hectares annually, China, India, USA, Pakistan, Turkey, Brazil and CIS collectively account for about 90% of the global production. China is the largest producer of cotton (27%), largest spinner (39%) and largest importer of cotton (50%), while India is the second largest producer of cotton (22%), second largest spinner (18%) and second largest exporter of cotton (22%) in the world. As per International Cotton Advisory Committee release in September 2013, world production in 2013-14 is forecast at 25.55 million tons, while consumption is forecast at 23.72 million tons. Other statistics on consumption and import/export are given below :

World Cotton Situation, ICAC September 2013 (Million Tons)			
Year	2011-12	2012-13	2013-14
Production	27.81	26.30	25.55
Consumption	22.74	23.51	23.72
Imports	9.75	9.65	8.80
Exports	9.84	9.79	8.80
Ending Stocks	14.56	17.402	19.22
Cotlook A Index (US Cents/Pound of Lint)	100 (One$)	88 (0.88$)	103 (1.03$)

Better prices prevailed in 2010-11 and 2011-12, but subsequently came down. At the global level, the fight for cropland between food crops like corn, soybean and wheat with cotton also influenced global cotton area and production.

National yields of all major countries growing homozygous (transgenic/non-transgenic) varieties only and predominantly upland cotton are Australia: 2100kg; Israel 1800kg; China 1306kg; USA 897kg; Turkey 850kg, Egypt 780kg, Brazil 1446kg; Mexico 960 kg; Pakistan 620kg, Uzbekistan 760kg as against 770kg for the world average. In spite of growing transgenic and hybrids, India's poor performance in productivity is evident from above and it stands at 481kg lint/ha plus 962kg cottonseeds/ha. Highest yields reported by progressive farmers in AP, MP, MS, PS, TN, GS etc range from 900 to 2100kg lint/ha in irrigated and 420 to 900kg in rain-grown situations; replicating this performance over the entire country calls for imaginative action plan and

Formerly HOD (CI) & Director, CICR Nagpur
narayananss@rediffmail.com

its effective implementation, besides encouraging higher investments and wide-spread modern technology adoption to enhance Indian cotton yields to global average and that of other advanced countries.

Long term trends in fibre / cotton demand analyzed by ICAC indicatedthat end-use consumption of all textile fibers in 2013 is projected to be 5 times the level of 1960, meaning that total fiber consumption increased on average by 1.2 million tons each year. Cotton consumption has lost market share to other fibers, mainly polyester. The loss accelerated during the 1990s, was more subtle during the first half of the 2000s, and it accelerated again after 2008. In 2013, the market share of cotton is projected at 31.7%. The most frequently cited drivers of cotton end-use consumption by fiber analysts are population increases, income per capita, and the relative price of cotton to other fibers. The consumption of synthetic fibers has exceeded consumption of cotton since 1997 (ICAC Cotton - Review of the World Situation by Alejandro Plastina, ICAC, August, 2013 Cotton Statistics & News).

The total of all fibres used in textiles and clothing is currently about 80million tonnes in the world of which cotton is about 26million tonnes. The projected world demand for all fibres by 2050 is about 140-150million tonnes and if 32% share of cotton is maintained, the global production of cotton should be stepped up from 26 million tonnes to 48million tonnes, probably without much addition to area under cotton to more than 35-36million hectares. USA is the only country making special efforts to promote the larger use of cotton in various textiles.

Cotton growers around the world spent an average of 11 cents on planting seed to produce a kilogram of lint in 2012-13, representing 7% of the net cost of production. (Costs excluding land rent and the value of cottonseed). In the 1990s, the cost of planting seed averaged 4 cents per kilogram of lint and rose to 9 cents per kilogram during the 2000s and has now reached 11 cents. More recently, the addition of insect resistance and herbicide tolerance traits introduced through biotechnology and new seed treatments further boosted the value of planting seed and consequently the cost paid by farmers. Additional features in the pipeline, such as nitrogen use efficiency and increased drought tolerance, will be delivered through seed improvements and will further increase the cost of planting seed. According to Dr. RafiqChaudhry, Head, Technical Information Section of the ICAC, improvements in planting seed are becoming the most important platform for the utilization of advanced technology in cotton (ICAC, September 2013 report).

As a result of productivity increases in cotton lint especially based on modern technologies including transgenic cultivars for bollworm resistance and herbicide tolerance, cottonseed output has also increased as it is always double that of lint yields. Cottonseed oil production and consumption have increased substantially and various by-products of cottonseed like linters, de-oiled protein-rich cake, hulls etc., have also resulted in industrial expansion and their export potentials.

Indian Situation

Cotton is an important textile fibre crop as well as high contributor to processed edible oil output and several by-products. Cotton is grown in nearly 11 to 12million hectares in recent years and it represents predominantly the American Upland (*Gossypiumhirsutum* L.) cotton hybrids carrying transgenic BG-II. The cotton production was estimated at 6.35million tonnes in 2011-12 and at 6.05million tonnes in 2012-13. India exported 2.16million tonnes of lint during 2011-12. The current average yield is estimated as 481kglint/ha and 962kg cottonseeds/ha for processing. Gujarat Andhra Pradesh and Maharashtra states are the largest producers of cotton in India.

The large scale cultivation of transgenic cotton hybrids (in over 90% area) has resulted in substantial production advancement at comparatively lowered average costs of production and causing least environmental pollution. The raw cotton prices were also very favorable to cotton farmers with attractive MSP by the Government of India and larger mill use supported by international and internal demand boosted the morale of the farmers resorting to cotton growing. A major percentage of the cotton growers reaped higher net profits from cotton and could build up their farm and family assets. However, greater support is essential by way of extension guidance to marginal and subsistence cotton farmers to adopt modern techniques in a proper way and help in risk management to reap the benefits of modern technology rather than be affected by debts and tragic events in certain pockets.

The season 2013-14 has witnessed good monsoon rains and resulted in sowing already more than 11.10million ha. The area is likely to go up to 12millinha, when rest of the sowings in south zone is completed. Notwithstanding the excessive rainfall in certain areas reported to have caused problems for the standing crops of cotton, India can expect a better harvest than the previous seasons and that may exceed about 38million bales of production of lint (6.50million tonnes) by proper management of the standing crops including harvests and processing in the ginneries.

The mill industry and export trade will be highly benefited by the higher output of cotton in India at comparatively lower costs, especially as the prospects in China, USA and Pakistan are not so bright in this year. The cottonseed output will be about 12-13million tonnes leading to enhanced edible oil outputs and other by-products causing higher industrial and trading activity in the country. India can plan for higher refined edible cottonseed oil output of at least 1.0million tonnes by giving support to the AICOSCA and the oil mills. The government may also provide incentive prices to cotton growers, incentives for cotton and yarn exports besides those by-products like linters, de-oiled cake etc.

Planting cottonseed demand witnessed a significant rise during the season from 350 million to over 400-450 million packets due to favourable monsoon and good rainfall all over the cotton growing areas and adoption of higher planting density per hectare by large number of farmers is witnessed with a keen desire to reap better and assured high harvests. Some of the popular genotypes grown are reported to be Jadu BGII Kaveri Medium staple, ACH-155 BGII Ajeet Medium, MRC-7347 BGII (Dr Brent) Mahyco Medium, Mallika BGII Nuziveedu Long, Bhakthi BGII Nuziveedu Long staple, Brahma BGII Monsanto Long, MRC-7351 BGII (Kanak) Mahyco Medium staple, Ankur Jai BGII Ankur Medium, some superior hybrids of Bio-Seeds, Rasi Seeds and Thulasi Seeds have a significant presence.

One World, One Health, One Medicine

Dr P.R. Vanamayya

Human medicine and veterinary medicine are inextricably interlinked and great advancements took place in both the medicines during last century. However, there remains huge divide between the two disciplines with overspecializations and a very little sharing of knowledge. In 19th century, Rudolf Virchow, a German physician and the father of cellular pathology formally recognized the connection between human and animal health and stated that ***"between animal and human medicine there is no dividing line nor there should be. The objective is different but the experience obtained constitutes the basis of all medicine"***(Brown, 2006). This original "one medicine" concept is presently expanded as "one health" since last decade to encompass the broader perspective.

Virchow also coined the term "zoonoses" to describe diseases caused by infectious agents from animals (both domestic and wild) to human either directly or indirectly through a vector. About two-thirds (60.3%) emerging infectious diseases (EID) result from zoonoses; majority of these diseases has their origin from wildlife (71.8%) and with a steady increase of zoonotic problems during last three decades. The top story began with human immunodeficiency virus (HIV) moving from African primate to human that resulted into most critical new infectious problem facing human health.

In 2002-03, SARS corona virus descended from bats to civet cats to human and then caused havoc through human to human transmission in china and Hong Kong; then spread rapidly to other continents. The severity and the rate of spread of SARS virus alarmed WHO to declare a "global alert.'' In 1999, West Nile virus from Israeli geese crossed continents to cause equine and human mortalities in North America. Since 2001, Nipahvirus infections were occurring in West Bengal and bordering Bangladesh rural areas in winter season causing human causalities. The spread of virus is through fruit bats contaminating date palm sap that is consumed in the region.

Prions in beef (Bovine Spongiform Encephalopathy or mad cow disease affected cattle) found their way to neurons in human teenagers in UK in1989. In humans, it is known as a new variant, nvCJD and by 2009, it had killed 166 people in the United Kingdom and 44 elsewhere.

Highly pathogenic avian influenza (HPAI H5N1) has become the "zoonosis" of Influenza A/H5N1 has infected humans following contact with poultry. Fortunately, human-to-human transmission is rare, preventing pandemic spread of this potentially devastating disease. Influenza A/H5N1, first isolated in 1996 from a goose in Guangdong Province in China, caused severe poultry losses and occasional human infections in Hong Kong in 1997. The main human public health response that controlled this outbreak was by mass culling of poultry. However, from 2003 the virus has moved throughout southeast and eastern Asia, to Russia, central Asia and the Middle East (in 2005), Europe (2005), Africa (2006) and the

Ex.SIC& Principal Scientist, IVRI, Mukteswar, NainitalDt.., UttaraKhand
vanamayya47@gmail.com

Indian subcontinent (2006), making it the largest recorded epizoonosis in poultry (both commercial and backyard). The pandemic (H1N1) 2009 influenza virus infection first occurred in the southwestern United States and Mexico in April 2009 and then spread worldwide. This virus was identified to have animal origins, with re-assortment of influenza gene segments from North American and Eurasian swine, avian and human viruses. (Dwyer and Kirkland)

"One world, one health" approach is a new vision that brings a connectivity to the health of humans, animals and their environment. This vision had origin from discussions of health experts in a symposium of Wildlife Conservation Society at Rockefeller University (2004) and the recommendations are known as "Manhattan Principles". (www.oneworldone health.org). Participants in the December 2007 New-Delhi

International Ministerial Conference on Avian and Pandemic Influenza recommended that the International community draw on experiences with HPAI and develop a medium-term strategy to address EID. It was agreed that a better understanding of drivers and causes around emergence and spread of infectious diseases is needed under the broad perspective of "One World, One Health (OWOH) principles. In response to these recommendations, in 2008, three major International organizations associated with human and animal health- the FAO, the OIE and the WHO-collaborated with the UNICEF, the UN system of Influenza coordinator (UNSIC) and the World Bank to develop joint strategic framework in response to the risk of emerging and re-emerging infectious diseases. The document communicating to this framework, ***Contributing to One World, One Health- A strategic Framework for Reducing the Risks of Infectious Diseases at Animal-Human-Ecosystem Interface,*** set out specific interlinked objectives for countries to consider in their a*pproach to infectious disease control at animal-human-ecosystem interface* (Atlas *et al.*2010). American Medical Association (AMA) and American Veterinary Medical Association (AVMA) have both adopted endorsing the resolutions leading to the creation of "One World Initiative." It is a movement to forge co-equal, all inclusive collaborations between physicians, osteopaths, veterinarians, dentists, nurses and other scientific-health and environmentally related disciplines. More than 700 prominent scientists, physicians and veterinarians worldwide have endorsed the initiative. (www.onehealthiniative.com)

Jacqueline Fletcher, a plant pathologist joined "one health" concept by highlighting strong view points, justifications for incorporation of "**plant health.**" A complete, balanced one health initiative must be tripartite that comprises all the essential components of healthy plants, healthy animals and healthy humans. Plant – pathogen interactions have more direct consequences when microbes are human pathogens such *Escherichia. Coli* 0157:H7 or *Salmonella* spp. which can contaminate fresh produce or by consumption of toxic metabolites such as mycotoxins that are produced in fungal contaminated food stuffs. The role of certain plant pathogens in causation of human diseases was mentioned. For example, *Burkholderiacepacia, Pseudomonas aeruginosa* that can cause diseases in onions, are also responsible for cystic fibrosis, infections in humans (Fletcher *et al*, 2009).

Global eradication of smallpox (1980) is an illustrious achievement on One Health movement during last century. Similarly, Global eradication of **rinderpest in cattle** (2010) is also a glorious success story of "one health" in action that involved various International organizations, agencies, countries and worked together with commitment to stamp out the disease for safe food security and for trade.

Major breakthroughs were accomplished based on fundamental research by physicians and veterinarians working together in diseases like yellow fever, anthrax, brucellosis, tuberculosis and Ebola hemorrhagic fever etc. (Kaplan and

Echols, 2009). One health has also accelerated biomedical research discoveries and expanded the knowledge in clinical care in the fields of cancer, orthopedic biomedical prosthetics, diabetes, heart valve advances and vaccine development.

In1996, a veterinarian, Peter C.Doherty and a physician, Rolf Zenkernagel won "the Nobel Prize" in medicine for their discovery of how the human (and animal) body's immune system distinguishes normal cells from virus-infected cells. In 2007, Centers for Disease Control & prevention (CDC), USA established a new National Center for zoonotic, vector-borne and enteric diseases (ZVED) to function "with a multidisciplinary strategy, to prevent, control, and, where possible eliminate infections within a large ecological context that includes humans, animals and plants interacting in a complex, ever-changing natural environment."

The International Organizations such as WHO, FAO, OIE and CDC are continuing to meet with public health and infectious disease specialists to move forward with a global One Health agenda.By bringing divergent fields together under "One Health" concept, many difficult problems of the developing world can be addressed.

References :

American Medical Veterinary Association and World Veterinary Congress (2008). One world one health, one medicine. President's Message. *Can. vet. J.*, **49** : 1063-64.

Atlas, R; Rubin,C; Maloy,S; Daszak; Colwell, R and Hyde, B (2010). One Health-Attaining Optimal Health for People, Animals and the Environment. *Microbe*,**5** (9) : 383-88.

Brown, C (2006). Avian Influenza. Virchow's Reminder. *Am. J. Pathol.*, **168** (1) **:** 6-8.

Dwyer, DE and Kirkland, PD (2011). Influenza. One Health in action. *NSW Public Health Bulletin*, **22** (5-6) : 123-26.

Fletcher, J; Franz, D and Le Clerc. (2009). Healthy Plants : necessary for a balanced "One Health" concept. *VeterinariaItaliana*, **45** (1) : 79-95.

Kaplan, B and Echols, M (2009). "One Health"-The Rosetta stone for 21st Century Health and Health Providers. *One Health Initiative Website*, http://www.worldhealth initiative.com

Recent Developments in Agricultural Engineering

Pitam Chandra

Introduction

Indian agriculture at present is at another point of inflection for greater technological inputs to achieve a quantum jump in profitability. Under the changing agricultural scenario, the agriculture technologies needs to shift from production oriented to profit oriented sustainable farming. Intensive agriculture with higher input use efficiency coupled with better management practices and value addition of products in production catchments holds the key to success. This requires farm machines to ensure timeliness of operation, precise and judicious application of inputs, protected cultivation, handling, storage, and value addition to farm produce in production catchments. Technologies for effective utilization of crop residues and processing by-products is essential for environmental sustainability, employment generation and additional rural income. Thus, primary and secondary agriculture continuum has the potential to rid the shortcomings of Indian agriculture today.

Farm Mechanization

India is one of the largest producers of small 4-wheel tractors in the world with wide range of matching implements and machines. There are about five million tractors in India at present and about 600, 000 units are being added every year in view of the depleting farm labour availability. However, spread of farm mechanization is not uniform throughout the country. It is more visible in the Green Revolution areas. It has not adequately penetrated in East and North-East India, hills and mountain regions, tribal areas particularly amongst marginal and small farms in general. Farm power availability now ranges between 0.5 - 5.0 kW/ha for different states. The average farm power availability today is 1.7 kW/ha. For current level of crop intensification an average farm power availability of about 3 kW/ha is considered desirable. Shortage of farm power leads to untimeliness in field operations leading to low productivity, dependence on low capacity farm equipment restricting cropping intensity. Therefore, judicious efforts need to be made for increasing the farm power availability in India.

Indigenous R&D on farm implements and machines has resulted into development and adaptation of vertical conveyor reapers (walking type, riding type, power tiller & tractor mounted), improved serrated sickles, power threshers (crop specific and multi-cropped), winnowers, rice transplanters, weeding and interculture equipment, power weeders, grain combines, laser land levellers, scrapers and graders, zero-till drill, raised-bed planter, vegetable trans-planters and diggers for some of the vegetable crops. Today farm mechanization industry has annual sales of about Rs. 50,000 crore. Indigenous manufacturers, numbering more than 20,000, meet most of the needs of farm machinery. Still the availability of suitable farm machinery of the requisite quality and cost is a serious bottleneck in promoting farm mechanization. Development of micro-irrigation systems together with fertilizer application systems has made horticultural and other commercial crop productions more profitable.

Agricultural Produce Processing :

After production, agricultural crops and commodities undergo a series of post-harvest operation such as collection, clearing, sorting/grading, decortications, drying, packaging, transportation, storage, value addition before reaching the consumer. Post-harvest losses

Director Central Institute of Agricultural Engineering, Nabibagh, Berasia Road, Bhopal - 462038
pc1952@gmail.com

occur between 6-18% for most of the agricultural commodities. Majority of the food processing entrepreneurs (42%) are small and unorganized, with 33% small scale and only about 25% organized. Share of food processing in total manufacturing is about 9% but growing rapidly. India has 820 large flour mills, 3 lakh small flour mills, 1.4 lakh rice mills, 43000 modern rice mills, and about 10000 pulse milling plants, 5263 F&V processing units, 568 food processing units, 482 cold stores, 656 sweetened and aerated water units, 171 meat processing units, 266 milk product units, 429 sugar mills.

As a result of last few decades of efforts post-harvest losses have reduced but are still too high amounting to about Rs. 60,000 crores/annum. In the present context it is a strong proposition to look at Indian farmer as not only producer of raw material but producer-cum-primary processorto augment the income through value addition and make high quality raw material for food processing industry.

Agricultural Energy

There is close high correlation between degree of agricultural mechanization, energy use and agricultural production and productivity. Making agriculture sustainable is possible only through production systems that make the most efficient use of environmental goods and services without damaging these assets. Energy intensity of mechanization needs to be reduced on one hand and renewable energy sources need to be used more and more on the other hand. Several solar thermal and solar photovoltaic technologies are now available to meet process heat requirements on farm and in agro-processing industries. Indian agriculture produces about 450 million tonnes of crop residue per annum. Aconsiderableportion of these residues is burnt in the field after harvest creating environmental problems and loss of soil organic matter. Some technologies such as biomass gasification for decentralized power generation are close to widespread promotion; other technologies need greater science and engineering inputs before making them available to potential users.

Ergonomics and Safety in Agriculture

For sustainable agricultural modernization, man-machine-environment continuum needs to be made congenial. Anthropometric data for Indian farm workers have been collected through painstaking surveys and field studies to facilitate design of worker friendly implements and machines. This information and ergonomic principles have been utilized to develop women friendly tools and implements. Tractor operators' comfort and safety are being addressed through design of roll over protection systems (ROPS) and tractor work-place design. Protocols and practices for safe operation of machines such as threshers, chaff cutter, sprayers, and coconut tree climbers have been developed.

Protected Cultivation :

India has a significant cut flower export only due to the adoption of greenhouse technology. Appropriate greenhouse structures suitable for Indian conditions have been developed and demonstrated leading to wide spread adoption. Similarly, structures and practices for row covers and plastics mulching have been developed. Machines for practicing plastics mulching and row cover technologies over large areas are being developed. Energy conservation in greenhouses and use of renewable sources for Indian agriculture are being attempted for greater profitability. Hydroponics, aeroponics, and vertical farming are the technologies for which indigenous efforts would facilitate their wide-spread promotion in the country.

Concluding Remarks :

The issues of labor shortages, timeliness, drudgery, rising input costs, climate resilience, seasonality of certain crops, soil and water management, post-harvest losses, diminishing farm size, need for additional income for farm holders, and value addition to surplus biomass have all contributed to increasing engineering inputs to Indian agriculture. This trend is going to continue in the near future. Greater resources, financial and human, are needed for realizing the inclusive benefits of engineering interventions in Indian agriculture.

Recent Developments in Soil Science

A. SubbaRao and BrijLal Lakaria

Food security is one of the great global challenges of the 21st century. Soils and their continuing ability to support the sustainable intensification of agriculture, will have to play a central and critical role in delivering food security. But, most of our important soil based production systems are showing the signs of fatigue. As a result, the partial factor productivity of fertilizers has declined in intensive cropping systems. The current status of nutrient use efficiency is quite low in case of N (30-50%), P (15-20%), S (8-12%), Zn (2-5%), Fe (1-2%) and Cu (1-2%) brought about by the deterioration in physical, chemical and biological health of soils. The major reasons for soil health deterioration are: wide gap between nutrient demand and supply leading to low and imbalanced fertilizer use; emerging deficiencies of secondary and micronutrients in soil, soil acidity, impeded drainage, soil salinization and sodification, etc. Fortunately, rapid scientific advancements and availability of new tools, techniques, and approaches promise technological breakthroughs to accomplish these difficult missions. As far as developments in Soil Science are concerned, it has progressed to a large extent since inception as a fundamental subject. It has achieved significant success in the areas of integrated nutrient management, impact on soil under long-term cropping, technology for preparation of enriched composts, soil test based nutrient prescriptions, generation of district-wise GIS based soil fertility maps, organic farming practices, carbon sequestration in soils, sink capacity of soils for heavy metal pollutants, recycling of wastes, soil microbial diversity and biofertilizers, quality standards for municipal solid waste composts etc.

Online Fertilization Recommendation System

User friendly software's have been developed that are able to provide fertilizer recommendations based on the targeted yields of various crops while using actual soil test values at the farmers' fields. These aid the farmer in improving the efficiency (appropriate dose) of fertilizer use to achieve a specific crop yield. The system works as a ready reckonner to give prescription in the form of fertilizers (*e.g*. Urea, SSP, MOP etc.). The soil fertility data on N, P, and K index values at district level for different states are also available through GIS and GPS based soil fertility maps prepared based on primary information. The farmers can assessing soil fertility status of their fields as well as are able to get fertilizers recommendations for different crops of their interest.

Software for Evaluating Municipal Solid Waste (MSW) Compost :

Municipal Solid Wastes have considerable potential to contaminate the environment but recycling of this waste material through composting can generate valuable resources for augmenting crop productivity. This new method that enables the grading of MSW compost based on its quality and with this grading can be done on the basis of four point scale for Marketing or on a three point scale for

Director, Indian Institute of Soil Science, Berasia Road, Bhopal- 462 038
asrao_iiss@yahoo.co.in' pmecelliiss@gmail.com

Restricted Use class based on the *Fertilizing Index* and *Clean Index* of the MSW compost.

Nano-Technology in Agriculture

Nano-technology is emerging a new are of research especially in agriculture. Attempts are on to utilize this field in increasing the nutrient use efficiency. For instance, Rock phosphate (RP) is the only economic source of phosphorus (P) for production of phosphate fertilizers. Nano-technological interventions are on the way to explore the possibility of utilizing vast deposit of commercially non-viable Indian rock phosphates as a source of P in crop production. Preliminary results from a pot study clearly demonstrated that crop utilization of P from Nano-rock phosphate (less than 100 nm) was better than that of the normal rock phosphate. The % P utilized from the nano RPs was 22.6% (Sagar RP), 19.2% (log grade Udaipur RP) and 39.4% (high grade Udaipur RP) as against 47.6 % in case of single superphosphate (SSP), a traditional fertilizer of P.

A protocol has been developed to coat urea with pine oleoresin and the coated urea contained 3.8-4.4% pine oleoresin and 44.1-44.3% N. The crude resin is composed of Levopimaric, Palustric, l-Abietic and Neoabietic acids in different proportion. All these acids are having antibacterial and antifungal properties. It acts as physical barrier around the urea granules thereby reduces the release of N from coated urea; inhibits urease activity through antibacterial properties; and being acidic in nature, it inhibits volatilization loss by reducing alkaline microsites. The time required for hydrolysis of 90% of the applied urea was markedly increased from 88.6 to 328.9 h in presence of pine oleoresin. The volatilization loss of pine oleoresin coated urea from a Vertisol decreased from 16.9% to 10.1% after 240 hours. Thus, pine oleoresin coated urea can be better substitute of neem coated urea for enhancing the nutrient use efficiency. Similarly protocol has been developed to fortify the Urea granules with a consortium of nano-particles of Zn, Cu, Fe, Si using oleoresin. The nano-particles coated urea, thus produced contains 43.8% N, 2.2 mg Zn/g urea, 1.1 mg Fe/ g urea, 0.7 mg Cu/ g urea and 1.1 mg Si/g urea. Urea thus fortified becomes less hygroscopic than the normal urea.

In order to supply the requisite amount of Zn to the plants through seed coating, a protocol has also been developed to coat the seeds of many crops maize, soybean, pigeon pea and okra with microns scale (<30μm) and nano scale (<100nm) ZnO powder. Seed coating with nanoZnO doesn't exert any osmotic potential at the time of germination of the seed, hence, the total Zn requirement of the crop can be loaded with the seed.

Opportunity to Promote Conservation Agriculture

Conservation agriculture is based on the principle of providing continuous soil cover (crop residues, cover crops), minimum soil disturbance, and crop rotations and has a high potential to increase productivity while protecting natural resources and environment. It is practiced on more than 75 million ha worldwide in more than 50 countries. It is estimated that over the past few years adoption of zero-tillage has expanded to cover about 2 m ha in India. The potential of C sequestration in C depleted soils of India is high with adoption of conservation tillage. It is also estimated that most parts of the country will receive higher rainfall in 2020, 2050 and 2080 than the current value, so this changing scenario can be converted to suitable opportunities in conserving and sequestering C in Indian soils bringing with it attendant benefits of improved soil structure, improved soil and water quality and reduced soil erosion.

Climate Mitigation Through Microbial Processes

On account of the future climatic scenario with elevated global temperature, higher precipitation, and increased area of wetter land, there is need to understand the complex interaction of soil microbes and soil redox species. Experiment was conducted to define greenhouse gas CH_4 oxidation and CH_4 driven redox metabolism during sequential reduction in a flooded soil ecosystem. CH_4 oxidation is stimulated by 29-32% during NO_3^- and Fe^{3+} reduction while inhibited during SO_4^{2-} reduction and methanogenic period. Reduced inorganic electron donors like NH_4^+, Fe^{2+} enhanced CH_4 oxidation by stimulating CH_4 oxidizers. Preliminary results have confirmed a novel complex interaction between methane oxidizing microbial groups and redox species during sequential reduction processes of flooded soil ecosystem.

Organic Farming

The Indian organic farming industry is estimated at about 900 million rupees (US$ 20 million) and is almost entirely export oriented (www.eximbankindia.com). According to Agricultural and Processed Food Products Export Development Authority (APEDA), a nodal agency involved in promoting Indian organic agriculture, about 6,792 tonnes of organic produces worth 712 million rupees are being exported from India (www.apeda.com). Ascertaining the scope of organic farming in the country in the context of geographical advantages and export potential of crops, with special reference to annual crops. This market of organic products is expected to grow globally in the coming years and high growth rates over the medium term (from 10-15 to 25-30 %) are expected. Organic farming is being advocated in certain areas and selected crops having export potential. Opportunities exist to devise organic produce protocols and package of practices for different agro-ecoregions. It is also a viable option with resourceful farmers to minimize the use of chemical/synthetic inputs in agriculture. It offers the promise of better soil quality and soil health. DGGE (Denaturing Gradient Gel Electrophoresis) analysis of soil DNA showed highest OTU's (Operational Taxonomic Unit) in organic maize and wheat in UAS, Dharwad. The microbial community structure of inorganic soil remain more evenly distributed. India has 15% of the world's livestock population and a great opportunity lies ahead for organic farming in the regions where the livestock density is higher.

Biofertilizer and Mixed Biofertilizers

The role of biofertilizers has been crucial for increasing the crop productivity. These preparations having living organisms are useful for promoting plant growth through a variety of mechanisms like biological nitrogen fixation, solubilization of insoluble phosphates, oxidation of sulphur, production of growth hormones, and also help plants to fight against diseases. The recent improvements in the biofertilizers include *Mixed Consortium Biofertilizers* (BIOMIX) containing a consortium of N fixers, P solubilizers and Plant Growth Promoting Rhizhobacteria (PGPR) to promote crop growth of cereals, legumes and oilseeds, Enhancement of biofertilizer efficacy by mixingbioinoculants (*Azospirillum*, *Azotobacter*, PSB) mixed with well decomposed FYM/Vermicompost, and Liquid Biofertilizer Formulations. In the present scenario a number of mixed biofertilizers are being produced commercially. The quality of such mixed biofertilizers can only be evaluated with confidence on a medium, if it allows the growth of any one or all the constituent organisms and is also discriminative enough to allow a differential count. Studies have been conducted on mixed cultures of *Bacillus megaterium* (phosphate solubilizing bacteria), *Pseudomonas fluorescens*, *Azospirillum*sp., *Azotobacter*sp., and *Rhizobium* sp. It was concluded that King's B agar, CRYEMA and N-free malic acid medium can be used to enumerate *Pseudomonas*, *Rhizobium* and *Azospirillum* respectively from consortia. Jensen's agar can be used when the consortium contains not more than one nitrogen fixer. However, none of the media proved to be useful for differentially counting all the members of a given consortium. DAPG (DiacetylPhloroglucinol) producing fluorescent pseudomonads hold promise to suppressive to soil-borne fungal pathogens, *S. rolfsii* and *A. niger* in soils causing stem- and collar- rot, respectively. Seedling mortality of groundnut, cultivar GG20 have been found from 70% in pathogen control to 35-42% in DAPG- treatments. They enhance the pod yield of crops over uninoculated control. Similarly there are other results such as application of enriched compost (@10t/ha) gave fresh yield of hot chilli (*Bhutjolokia)* of 21.3t/ha in Assam compared to control yield of 9.9t/ha at AAU, Jorhat; inoculation of *Gluconacetobacter diazotrophicus* and *Azotobacter* in sweet sorghum in farmer's field trials increased green biomass yield (11%), grain yield (8%) and quality of the juice at MAU, Parbhani; application of liquid biofertilizers of *Azospirillum* and PSB (300ml/ acre) along with 200 kgs of FYM gave best response on maize in Alfisols in Amaravathi, A.P. *Rhizobium* and PSB liquid biofertilizer along with organic manure also gave good response on Pigeonpea. Wilt incidence reduced (40-50%) wherever biofertilizers were applied in pigeonpea.

Future Research Focus

1. Providing food and nutritional security by improving nutrient and water use efficiencies
2. Harnessing biodiversity and genomics for efficient agriculture and maintaining ecological balance
3. Self sufficiency in plant nutrient supply through utilization of indigenous mineral resources
4. Clean and safe soil environment through waste recycling
5. Soil quality/health management for sustainable agriculture
6. Developing strategies for energy efficient and climate resilient agriculture

Developments in Indian Seed Industry

M. Prabhakar Rao

Indian Seed Industry is one of the most mature and vibrant in the world. The Industry made rapid stride and grew to become more professional. In order to further strengthen the industry, in 2007 four fractured associations decided to merge to form National Seed Association of India (NSAI). Since then the association has taken several initiatives to help the growth and recognition of the Seed Industry in India. NSAI is the bridge between the Government and the Industry. The "Indian Seed Congress", an annual event organized by NSAI, is one of the developments that have led to the recognition the Industry deserved from the Government and general public.

The world market size for seeds is estimated to be $45 Billion for the year 2012-13. Global seed industry has evolved into a multibillion dollar industry due to pioneering research in biotechnology and genetics. Major contribution to this is from US (27%) followed by China (20%) and then France (8%). The genetically modified crops have contributed significantly to the industry's growth.

India has a share of 6% in the global domestic seed market ($ 34b) which accounts for $ 2000 million. India's contribution to International global trade is less than 1% with export of Field crop Seed worth $ 30 million and vegetable seeds worth $ 29 million, totalling to meagre $59 million. The annual growth rate of Indian seed industry has been healthy i.e. 15-20% in the past decade which is double than the world's average growth rate. However, with the uncertainty in the govt. policies on GM crops and lack of required investments in agriculture, the projected market size of Rs 16000 crores by 2014 seems unrealistic. I am sure this is only a temporary setback and the Industry will regain the momentum soon due to the following positive developments that are taking place in the sector as narrated hereunder:

Growing Markets

Seed markets of all crops particularly of hybrid maize, hybrid rice and hybrid vegetable crops are growing between 10 to 15% annually. Due to adoption of high density planting in Bt hybrid cotton the market size shall increase by about 20% in next 3 to 4 years.

Improvement in seed replacement rate:

During the last decade, there has been a jump in the adoption of hybrids and improved varieties which favoured enhancement of the Seed Replacement Rate. It is visible from the SRR of paddy which has grown at a Compound Annual Growth Rate (CAGR) of 5% at national level. In the year 2001 SRR for Varietal paddy is 19% and now it is about 40%. The same scenario is observed in many other varietal crops like Maize, Wheat so on.

GM Seeds :

The ongoing dialogue among the scientific community, the government and submissions before the judiciary will hopefully result in a fool proof system for evaluation and release of new GM crops.

President, National Seed Association of India
mprmd@nslindia.com

Quality Assurance :

Healthy competition in the Industry has made the seed producers more quality conscious. The companies have invested in training their technical personnel and are using tools like molecular markers and high quality testing equipment apart from investing in modern seed conditioning machinery. Also the Seed Testing laboratories of many companies have got accreditation from International Seed Testing Association. The result is evident from the recent remarks of Hon'ble Minister for Agriculture, Government of AP Sri. Kanna Lakshmi Narayana that he did not receive a single complaint on seed quality from farmers in the state after he shared his personal phone numbers with the farmers to receive any sort of complaints.

PPV&FR Act :

The enactment of the PPV&FR Act, 2001 encouraged private research to breed for better OPVs in crops like wheat, Soybean, pulses etc. Apart from this it also helps in facilitating the growth of seed industry through domestic and foreign investments. Till December 2012, out of 4267 applications received, 1796 were from private sector.

Public Private Partnership (PPP) :

All the stake holders in agriculture like farmers, Input companies and the Government bodies have realized that Public Private Partnership in agriculture is the need of the hour. The following are the developments in this area

Extension:

Government of India has recognised the importance of public private partnership for integrated agri development and has released a document " Framework for Supporting Public Private Partnership for Integrated Agricultural Development under Rashtriya Krishi Vikas Yojana (RKVY)" to encourage the State Governments to undertake more and more projects for extension education under PPP. Many states like Punjab, Gujarat, Maharashtra, and Uttar Pradesh have taken up the initiative and implemented the same successfully in various crops recording improved yields.

Research :

Industry has sponsored research on biotech and genetics with various public research institutes and universities.

The synergy between depth of expertise in public system and the strong marketing abilities and network of private sector has yielded many solutions to our farmers. The best example is of rice, in which about a dozen hybrids have been licensed to a number of private seed companies. In fact the success of licensing PRH-10 by IARI to 18 seed companies paved way to several replications of the PPP model. Similarly products developed by the Agricultural Universities are being offered to Private sector under MoU.

The dialogue between seed industry and the ICAR on sharing of gerplasm is in progress and suitable policy will be announced soon.

It is to be noted that the announcement from Syngenta to offer vegetable hybrids and breeding lines to public sector researchers is indeed a welcome initiative in fostering mutual trust for building partnerships.

Agricultural Engineering :

One of the main challenges of Indian Agriculture is labour shortage and the high cost associated with it. For example, while the value of total cotton produced in the country is about Rs 80000 Crores, the amount spent by the farmers for just picking the cotton is estimated at Rs 17000 Crores (>20%). The only answer is mechanisation. PPPs in developing suitable machines for Indian conditions are being studied and hopefully will be implemented soon. Breeding by the Seed Industry to develop right plant types for mechanisation shall further add value to the Industry.

Infrastructure :

For further developments in this sector, Industry has been looking forward to Public

Private Partnership for investments in infrastructure like Ambient and Conditioned Storages, Agriculture Information Centres etc.

These activities will benefit both the farming community and the seed industry as this would build trust among farmers on the improved varieties and with the extension activities, the SRR can be increased, paving the way for increase of market size for the industry.

Export opportunities :

Currently seed exports from India are very minute at around Rs 1billion accounting for just 1% of global exports. The Indian seed sector today is well established with tremendous potential to grow beyond boundaries of domestic market

The initiative, taken by NSAI and Ministry of Agriculture to make India a member of OECD (Organisation for Economic and Co-operation Development - Paris) in 2008 for Seed Schemes, is opening the world market to Indian Seed Industry. Out of 7 Seed Schemes, India has opted for relevant 5 categories which will help India to introduce hybrids into similar agro-climatic regions like SAARC and South East Asian countries and the African continent. Till now the MOA has identified 61 public and 40 Private varieties/hybrids for OECD Registration.

With the above developments triggering growth of both domestic and international seed trade, India should aim to enhance her contribution to $ 3500 million (Rs 21000 Crores) to the world seed trade in next 5 to 6 years.

Infrastructure and Welfare Schemes in Fisheries Sector

K Madhusudhana Rao*

The total annual production of fish, shell fish and other aquatic organisms is around 100 million mt; while the estimated requirement of fish and shell by 2025 will be around 260 million mt. The gap between demand and supply, which is gradually widening, can be bridged to some extent by exploring resources, especially aquaculture.

The contribution by India to World fish production increased from 3.2 per cent to4.2 per cent during the past decade. This sector provides a livelihood to 3,838,000 full and part time fishermen but excluding2, 121,000 occasional fishermen. The fishing fleet includes 190,000 traditional craft, 35,000 motorized traditional craft, 47,000 mechanized boats and 170 deep sea vessels. The growth of marine fisheries is low compared to the inland sector. Aquaculture is a popular rural enterprise, and it is anticipated that when the resources are fully exploited, it will contribute 75 per cent of total inland fisheries production.

At present 71 per cent of fish are used for direct consumption and 1.6 per centfor animal feed.The present export value of fish and fishery products is Rs 46.20 million. In addition to shrimp, exports include frozen squid, cuttle fish and other varieties of fish and fisheries products.

At the same time, due to improper planning, unregulated growth,overcrowding of farms, the shrimp farming sector experienced a rising trend in the incidence of disease. This resulted in heavy economic losses. In addition, mono – species culture and lack of proper guarantee and quality control methods have been identified as other setbacks. The haphazard growth of the sector has invited various environmental and social problems in certain areas.

The infrastructure facilities required are :viz

i. Establishment of mini- fishing harbours, fish landing centres, fish disease diagnostic laboratories etc

ii. To encourage the fishermen , farmers and entrepreneurs by providing subsidies. The subsidies are proposed as per the norms of the centrally sponsored schemes/ schemes being implemented by the Marine products Export development Authority (MPEDA)

iii. Establishment of common facility centres with all basic facilities like office room, storage of nets, cyclone shelter , space for drying fish etc

iv. Supply of FRP mototorized fishing crafts under NCD assisted schemes

v. Ex – gratia payment under the Group Accident Insurance Scheme for fishermen has been enhanced from Rs 35,000 to Rs 50,000 in case of death / total disability and Rs 17,500 to Rs 25,000 in case of partial disability (Govt. of A.P.)

vi. Relief cum savings scheme:under the revised pattern, the marine fishermen have to

* Retired Professor & Head CIFE.
Mumbai and President,RICAREA,Hyderabad

save Rs 600/- (Rs 75x 8 months) and the assistance provided is Rs 600 – shared by State and Central Governments. The assistance provided is Rs 450/- in case of inland fishermen,which is equal to the amount saved by him (Rs 50x9 months). Now the scheme is extended to marine and in land fishermen (Govt. of A.P.)

vii. Housing for fishermen GOI: GOAP share in subsidy 50:50.

viii. Dissemination of satellite technology for identification of potential fishing zones.

ix. Establishment of modern fishing market complexes.

x. Establishmentof ice plants and cold storages in private sector— providing subsidies.

xi. Utilization of shrimp hatcheries to produce Juveniles ofScampi.

xii. Encouraging the farmers to take up ornamental fish culture and fresh water pearl culture.

xiii. Integrated coastal aquaculture to take up alternate species like scampi, fattening of mud crab, Lates etc.

xiv. Organization of Aqua clubs for adopting collective approach in shrimp farming for effective control of diseases.

xv. Establishment of stationary, mobile disease diagnostic and microbiological laboratories with the assistance from FAO

xvi. Establishment of effluent treatment plants for farms of 5 ha. and above providing subsidies.

xvii. Establishment of Artemia processing plant for healthy growth of shrimp from hatchery stage to farm stage.

xviii. Village access Roads covering 508 marine fishing villages all along the coastal line of 974 kms and it is essential to have village access roads.

xix. Supply of tri – wheelers and Mopeds to fishermen with ice-boxes are very useful for the small fishermen for quick transport.

xx. Exemption ofcentral excise duty on SD oil being used bythe mechanised fishing boats.

Some considerations on Tea breeding

M.V.R. Prasad

Tea (*Camellia sinensis*) breeding started around a century ago and the early breeding work concentrated on development of sufficient planting materials by mass selection and mass multiplication from random crosses from natural populations. These approaches consequently lead to less emphasis on productivity and quality parameters.

In the recent past, however, the breeding strategies were well defined and breeding projects were well directed with a focus on enhancing productivity and quality involving parental materials confirmed for needed specific genetic attributes. This became possible with the development of improved techniques of germplasm evaluation, characterization and conservation.

Tea germplasm being the most valuable basic foundation for tea breeding and biotechnology, efforts must be intensified to widen and diversify the genetic base of germplasm at the same time enhancing the efficiency of technological procedures to characterise the genetic resources.

With the advances being made in cell genetics and DNA sequencing, it should be possible to achieve development of varieties with specific DNA markers that will play ever important role in tea commerce.

Tea breeding has taken a big semi circular cycle in India starting from the extensive use of seed propagated progenies and ending up currently with preponderance of clonal selections. Continuous emphasis on clonal selections has created lack of adequate levels of genetic diversity within breeding populations leading to low genetic advance in the selected varieties.

In the above backdrop, there appears to be a need to revamp the breeding approaches as indicated below.

❑ Identify and characterise genetically diverse clonal clusters. Genetically diverse clonal populations are available in diverse geographical locations. In these cases the geographical isolation has resulted in erecting isolation barriers among these clonal populations, resulting in different gene pools for economic attributes. Data on Coefficient of Parentage (COP) may be useful in measuring genetic diversity among the selected geographic types.

Ref : (*Ariyarthna&Gunasekare 2007.Genetic basis of tea cultivars in Sri Lanka as revealed by pedigree analysis. J.ApplGenet. 2007: 125-128*). Evaluate these diverse clusters for productivity and quality and hybridize these clonal clusters SELECTED carefully for the specific and / or

Former Project Director, DOR, Hyderabad
mvrprasad@yahoo.com, manohar.maddiptla@gmail.com,
dr.mvr.prasad@vayugrid.com

combination of needed attributes. This approach will provide significant genetic variance in the progenies warranting effective selection.

❑ The promising approaches in the above context could be as follows: (1) Plant the selected promising clones possessing adequate levels of genetic diversity among them in an isolated orchard to promote cross pollination among them. Alternatively hand crosses may be carried out in the needed parental combinations. The resulting progeny may be subjected to selection based on rigorous norms in the first phase. (2) Apart from sieving out desirable variants in the first phase for commercial exploitation, the diverse selections *recovered with a little low selection pressure* may be carried forward for the second cycle of inter-mating, which would facilitate pooling up of the most desirable genes by the following selection process in the second phase of the breeding cycle.

❑ Another procedure that would result in release of perceptible levels of hidden genetic variability in a plant species is through mating extreme phenotypic forms resulting from disruptive selection in nature. In this case the genes that got fixed in a co-adopted genetic complex due to the operation of disruptive selection in nature shall be recombined.

If these plant types could be isolated and hybridized an avalanche of genetic variability that was hidden could be released and exploited. It must be understood that this is not same as the first strategy elucidated above. In the above case, geographical isolation comes into play creating isolation barriers although the isolated types do share a common genetic background, as a result of intermating among them before geographical isolation came into play. In the case of disruptive selection, nature never permitted gene sharing among these extreme phenotypic forms.

❑ The normal breeding procedures are time consuming taking a minimum period of a decade or so to achieve tangible results in terms of clones with desirably superior characters for quality and yield. To cut short the time lag particularly to enhance one or two attributes controlled by one or two genes, mutational rectification of specific defects may be planned. An otherwise promising clone / variety possessing an excellent genetic base but for certain specific genetic lacunae, may be chosen for this project. The somatic tissues, probably stem cuttings with dormant buds may be treated with chemical mutagens (specifically alkylating agents) which are known to bring about functional alteration of genes with antimorphic effect. The very first generation (M1) itself may throw some useful somatic mutations that can be siphoned off through vegetative propagation. This work should be well directed with specific objectives. Nevertheless, as an off-shoot, it should be possible to recover wider induced mutational events that could form good breeding materials. Apart from recovering desirable somatic mutants, the seeds of M1 generation could be advanced to M2 generation to recover wider induced genetic variance.

❑ Potential of individual parents may be indicated by their growth vigour, based on the number of flushing stems in given surface area multiplied by the area of the top of bush. Specific traits such as leaf colour, leaf angle, pubescence, weight or size of 'two leaves and a bud' and leaf area index may be chosen as useful selection criterion. It may be mentioned that pubescence is strongly and positively related to quality. The initially selected ones may be raised vegetatively, pruned and allowed to re-grow. Where re-growth has reached a desirable level, the growth may be measured by weighing the prunings. Otherwise, the bush top could be levelled ready for plucking and the foliage recovered above the level surface may be weighed. Later leaves may be harvested from each bush. The comparative data on weights from individual bushes shall indicate the promising selections. The preliminary estimate of fermentability may be assessed based on chloroform test. Another useful parameter for quality could be the 'phloem index'. The proportion of '*theaflavins*' in leaf may be estimated by chemical analysis as this attribute too is indicative of quality potential.

❑ Finally I understand that Tea Breeding is beset with the limitation of a narrow genetic base in the current phase. Hence the primary task to push up the efficiency of Tea Breeding Programmes should be in widening the genetic base by incorporating higher degrees of genetic diversity. This is a very comprehensive task and several genetic strategies have to be put in place to achieve the success in this task. This topic being very vast, it has to be treated separately.