Indian Seed Sector : The Way Forward

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Dear Members of NSAI,

It gives me immense pleasure to be with your again this evening. On your Foundation Day on 30 October, 2010, I had spoken on a subject entitled "Revitalizing Indian Seed Sector for Accelerated Agricultural Growth". Today, I have decided to speak on Indian Seed Sector : The Way Forward.

Let me first of all thank National Seed Association of India (NSAI) and the organizers to have invited me again to speak on a subject of my choice. Hence, I will avail this opportunity to speak this time on strategic issues which could provide a "Way Forward" and bring in 'Change' that our agriculture needs today. You would agree that horizontal expansion is no more a choice. Hence, vertical expansion is the only best option to move forward. For this, improving productivity through good quality seeds of improved varieties/hybrids is the best possible alternative. Business as usual will not work. Hence, we must move forward with faster pace to accelerate agricultural growth for meeting the growing demands for food, fodder, fiber, fuel etc.

Need for a Second Green Revolution:

The "Green Revolution" ushered during the late 60s and 70s is recognized to be a turning point in our Indian Agriculture. It is well known that the introduction of high yielding, semi-dwarf and fertilizer responsive varieties of wheat and rice led to a dramatic shift from "food scarce" to "food secure" status in the country. This success was the result of holy alliance between policy makers/administrators and the hard working farmers.

In order to meet the growing demands for our increasing population, likely to be 1.7 billion by 2050, we shall need to double our food production. This can only be possible by bridging the existing yield

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gaps through improved productivity and by integrated natural resource management. Hence, the second Green Revolution would demand much faster growth of seed sector – especially to meet the demand of hybrid seeds and to replace old with new high yielding varieties.

In this context, we must accelerate the growth of seed sector as our national priority. For this, a Mission on Seed Production is urgently needed.

Policy Led Growth:

The success achieved with the introduction of high yielding varieties of wheat and rice and the hybrids of maize, millets and cotton could be sustained due to sound policy support provided through establishment of public sector organizations, such as the National Seeds Corporation (NSC), Tarai Development Corporation (TDC), State Farms Corporation of India (SFCI) and the State Seed Corporations (SSCs) during the Green Revolution period. The seed sector grew steadily in the subsequent period with the establishment of several private seed companies dealing with both field crops and vegetables. Supported by the release of a large number of crop varieties, the growth of the seed sector, predominated by the public seed companies has reached to an annual turnover of about Rs. 500 – 600 crores by late 80s (Dravid, 2011).

In real sense, growth of private sector began in early nineties when ICAR took a bold decision of providing breeder seed of parental lines of public bred hybrids and varieties freely to the private sector in order to ensure higher productivity of major crops. This enabled private seed companies to grow much faster even with limited R & D capacity. For this reason, we find today that some of the local seed companies are highly successful and building their capability further.

At this juncture, the New Policy for Seed Development (1988) also came in as a major driver for faster growth of the seed sector with liberal policy of importing seed and planting materials of best varieties and to make them available to the farmers. This resulted in substantial private investments in the seed sector (4 to 5 times) and also increase in the overall turnover (Dravid, 2011). Hence, an enabling policy environment does help in the introduction of good technologies including seed and planting materials of superior hybrids, new crops and even ornamental plants for extending required benefits to the Indian farmers.

Technology Led Growth:

The most dramatic change in the seed scenario was experienced in the first decade of current millennium. Again, this could be attributed to a combination of two important policy decisions. First, the introduction of PPV&FR Act, 2001 and the second release of Bt cotton in India in 2002. The enactment of the PPV&FR Act has reposed much needed confidence in the seed industry both in terms of intellectual property and higher investment in R&D. The rapid expansion of Bt cotton production area (reaching to ~90% in 10 years) has enhanced the demand for Bt cotton hybrid seed by 220% (Dravid, 2011). The adoption of Bt cotton technology increased production by 139%. India could turn into a net exporter of cotton from being an importer just a decade ago. In this case, the private sector took the lead in accessing the technology from the MNCs. On the contrary, the public seed sector, solely depending on public research technology / varieties and hybrids and not having the necessary financial strength and flexibility, could not reap the benefits. Thus, time and again, the Indian farmers have shown their receptivity and inclination to adopt any new technology which promised higher production and profitability. It is also evident that if the technology is promising, the farmers are willing to invest. All these factors led to higher growth of Indian seed industry (around US $ 2000 million), with a potential to grow by 60% in the next 5 years (Dasgupta and Ferroni, 2012)

At present, a decelerating productivity growth rate, increasing prices and demand for food grains, fragmented land holdings, shrinking natural resources and the challenges of climate change have emerged as the major concerns for the policy makers and the scientists alike. For raising the agricultural productivity, seed is recognized to be the cheapest, yet most critical single input. Use of good quality seeds can result in as much as 15-20 percent yield increase. Therefore, any attempt to turn around our agricultural productivity will largely depend on higher replacement rate of quality seeds of high yielding varieties / hybrids. Unfortunately, in spite of several efforts to ensure availability of good quality seeds of high yielding varieties/hybrids, the replacement rates in most of the field crops are much below the optimum level (Singh and Chand, 2011).

As per available data, the availability of quality seed is sufficient to meet our requirement (Table 1). It is encouraging that both private and public sectors are contributing towards it (Table 2).

Table 1. Year-wise requirement and availability of quality seeds (in lakh quintals)

Year	Requirement	Availability
2004-05	110.83	132.27
2005-06	107.08	140.51
2006-07	128.76	148.18
2007-08	180.74	194.31
2008-09	207.28	250.35
2009-10	249.12	279.72
2010-11	290.76	321.36
2011-12	330.41	353.62

Source: Directorate of Economics & Statistics, Ministry of Agriculture, GOI (http://dacnet.nic.in/eands)

Table 2. Total seed production by the public and private sectors

Year	Total seed production (lakh qtls)	Share of private sector (%)	Quantity of seed produced by private sector (lakh qtls)	Quantity of seed produced by public sector (lakh qtls)
2003-04	132.27	47.48	62.80	69.47
2004-05	140.51	45.02	63.26	77.25
2005-06	148.18	46.80	69.35	78.83
2006-07	194.31	41.00	79.67	114.64
2007-08	194.23	42.59	82.72	111.51
2008-09	250.40	39.78	99.61	150.79
2009-10	280.00	38.93	109.00	171.00

Source: Singh, Harbir and Ramesh Chand (2011) and Seeds Division, Department of Agriculture & Cooperation, Ministry of Agriculture.

However, many a times the seeds of new improved varieties are not available to the farmers. We also need to undertake an authentic assessment of the state-wise seed requirement of different crops, actual availability of quality seed of new improved varieties and the desirable seed replacement rates (SRRs). In certain cases, the subsidy

linked to the certified seed of field crops of large volume and low value has proved counter-productive to the improvement of seed/ variety replacement rates (SRR/VRR). Instances of purchase of seed grade groundnut or pulses for consumption as food commodities are also common, as the prices of the certified seed are lower than the commercial grain, which are generally in short supply (SA Patil, Personal Communication). Extending the scope of government subsidy even to truthfully labeled (TL) seed of promising hybrids, produced by private companies, following the model of Bihar Govt. would be yet another bold policy decision, as already recommended by Hooda Committee report to the Government of India.

Varietal Denotification – A Priority:

A review of existing list of released and notified varieties do reveal that many old varieties are still find place in package of practices.

It is high time that we denotify such old varieties that have no demand or relevance in the present context. It needs major scrutiny and concerted action by the Govt. both at the Central and State level. Continued production of seed of old varieties by many State Corporations is rather counter productive. Hence, the existing mis-match has to be corrected at the earliest possible, both in terms of indents and denotification as a matter of high priority. A time bound action in this regard is thus warranted.

Need for Enhanced Replacement Rate:

For achieving the desired levels of Seed Replacement Rates (SRR), adequate seed of good variety needs has to be produced first. Each state needs to prepare a State Seed Plan to meet the region – specific requirements. The list of recommended varieties must be revisited and finalized in consultation with the scientists of the State Agriculture University, ICAR Institutes in that region, Crop-Coordinators, State Agriculture Department officials and the seed producing agencies.

In last two decades the ICAR institutes and SAUs have made significant progress in meeting fully the breeder seed (BS) requirement. In less than a decade, even the breeder seed production has been doubled from 62231 q (2005-06) to 122633 q (2010-11) (Fig. 1). However, production of certified seed by following an efficient chain of BS -> FS -> CS, is still a major concern. States must ensure

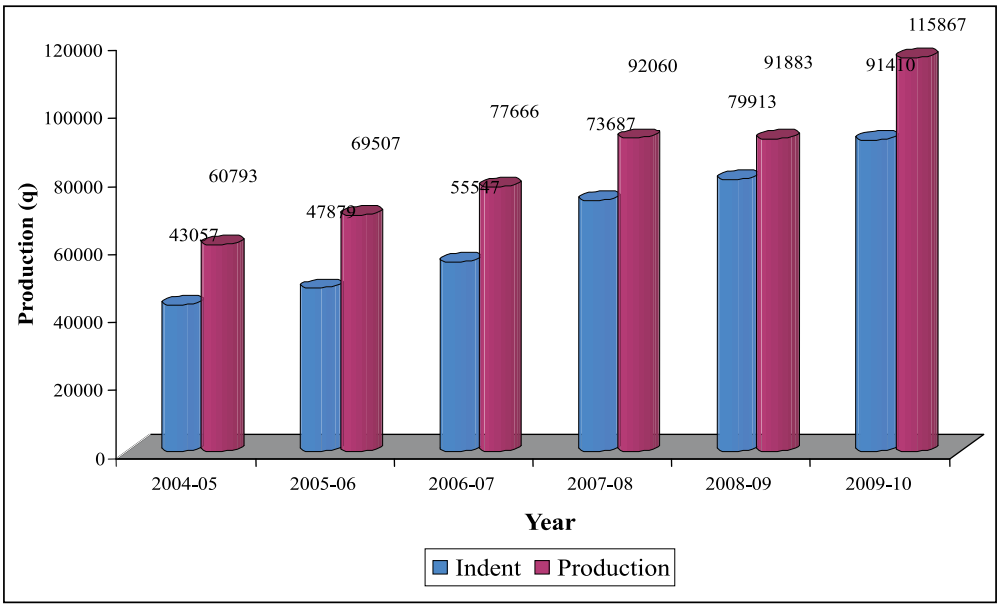

Fig. 1. *Breeder Seed Production*

production, multiplication and replacement of seed to increase the SRR progressively, especially in respect of regionally important varieties.

Also, as a social commitment, the seed producing companies have to come forward to include some low-profit crops in their baskets in the interest of small/resource poor farmers. In this context, an effective partnership between public and private seed organizations will be highly desirable. Even emerging concept of contract farming through Public-Private-Partnership will be highly beneficial.

The state departments may consider procuring quality seeds of improved crop varieties through a Contract Seed Production system by allotting the same, as per their requirements, to the public or private sector companies. This will ensure timely availability of sufficient quantities of seed of the desired (new improved) varieties. A fair competition will keep the rates reasonable, whereas by participating in such activities the private sector can contribute towards their social responsibilities.

Good Future Prospects:

A perusal of the data (DSR/ICAR, 2012) shows that the production of Breeder Seed in different crops is adequate to achieve a desired seed replacement (i.e. around 30% in self pollinated species, 50% in crops pollinated species and 100% in hybrids). Yet the organized seed sector is estimated to cater to only 25-30% of total seed requirement

in the country (Agrawal, 2012; Rabobank, 2012). Hence, even if the SRR is increased to 50%, the domestic seed market will exceed to US$ 5000 million thus bringing India's position to 3rd rank. It may be noted that China with almost similar area under cultivation as India, has an annual seed market of ~US$ 9000 million and is ranked 2nd globally. Hence, sky is the limit and I see no reason why we can not achieve first position globally.

In addition, many of the Indian seed companies are now capable of undertaking seed production for export, particularly to SAARC, African, Central Asia, South East Asia and the Pacific Countries. The advantage of diverse agro-climatic conditions, developed institutional infrastructure and availability of skilled human resource can certainly make Indian seed business globally competitive. India's seed export can be increased many fold from current US $ 400 million (Dravid, 2011). Adoption of OECD Seed Schemes by India and inclusion of Indian released crop varieties in the list, as well as India's participation in SAARC Seed Forum, have lately expanded the scope of Indian Seed Sector in this regard. Hence, forward looking initiatives in this context will be highly beneficial to Indian seed sector. For this, we need to strengthen our efforts on market intelligence and have required bilateral relations and partnerships built. We need to have an aggressive approach now and develop strategy to capture seed markets abroad in a well planned manner. NSAI could bring out a policy paper on this aspect soon.

Investment Towards Innovation:

The seed sector had been quite active to outscale new innovation in agriculture. Such innovation encompasses development of superior hybrids, transgenics and advanced seed treatments.

As already stated, the production of hybrids needs to be promoted aggressively to improve productivity especially in crops like rice, maize, sorghum (rabi), pigeon pea, rapeseed mustard, castor, a number of vegetables etc. Farmers' interest will be equally taken care of, if as a policy Government extends similar subsidy support as provided to public bred hybrids. A policy decision by the ICAR to provide freely the parental lines of new vegetable hybrids to private seed companies under bilateral agreements will indeed be a progressive step. Acceleration of hybrid seed production in these crops both by the Public and Private Seed Companies is the need of the hour. Hence, a collective and rather time targeted approach

by DAC, ICAR and NSAI would go a long way in meeting soon the national targets. On the other hand, better climate resilient hybrids and varieties in all major crops need to be developed both by the public and private research institutes.

Role of Biotechnology:

We must not loose focus on the application of biotechnology to develop new improved varieties with special traits, particularly to provide effective and durable solutions against abiotic and biotic stresses. It will be appropriate to generate much needed awareness among farmers, civil society organization and the policy makers about the potential of plant biotechnology as well as its safe application. We must ensure that our regulatory process efficient and safe from environment and health point of view. It is also quite clear that the science-led innovation would need sound investments in the R&D both by the seed sector and public institutions. Research is needed not only to meet the growing demand for high quality seeds of improved varieties/hybrids with high productivity under a wide range of conditions with specialty traits, but also innovating quality enhancement technologies such as cereals with higher proteins, minerals and vitamin contents. The Golden rice, QPM and Fe and Zn enriched millets are some such examples. The public sector institutions in the National Agricultural Research System, comprising SAUs and ICAR institutes, have no doubt, contributed significantly towards varietal development, hybrids in field crops and vegetables. They have also worked on seed production and variety maintenance methodologies; seed quality standards and testing protocols; seed processing and storage requirements and molecular technologies for quality assurance and enhancement. However, much more advancement is needed from the public sector in the field of transgenics, especially in varietal background.

Investments in AR4D:

It is encouraging that for advancement in research and technology development in agriculture, the ICAR got enhanced plan allocation this time by almost 2.5 times (from Rs. ~10,000 crores in the XI Plan to Rs. ~25,000 crores) in the XII Plan period (2012-17). I do hope that the seed technology would get further strengthened significantly.

The private seed sector is also expected to make significant investments in the AR4D. The major share of investments in agriculture

by the private sector pertains to Seed and Biotechnology Research, which is about 33% of the total (Pray & Nagarajan, 2011). In fact, the introduction of the New Policy for Seed Development in 1988 had a positive effect on the investments by the private sector. An IFPRI study estimated these investments around ~US$ 250 million in 2008-09, with predominant growth in seed and plant bio-technology sector, which grew by >10 times between mid-1990s and 2010.

Though it is difficult to have an accurate estimation, it is presumed that private sector is currently spending on R&D about 10-15% of the total turnover. The top 5 MNCs account for ~44% of the total R&D investments, whereas the remaining 56% is contributed by nearly 30 Indian companies totaling about Rs. 200-300 crores per annum (Industry estimates). Several companies are also raising funds through public issues and venture capitals to expand on R&D and general infrastructure. An estimated Rs. 1200 crores have been invested by the industry in the recent years in quality assurance, seed testing, processing and storage infrastructure (NSAI, 2010). Some of the big Indian companies have now turn over ranging between 500-1000 crores, which I consider a very significant development.

Promoting Hybrid Technology:

More public-private funding is needed to develop HYVs/hybrids for varying agro climatic regions. As already mentioned earlier, the government will also need to spend more and act fast on creating world class safety standards and approval protocols for GM crops.

The increased investments made by the private sector has resulted in better innovations and technology development over the years. There was a sharp rise in private sector hybrids/varieties during 2000-2010, as against the previous decade (Table 3). Also, the private sector's share in hybrids ranged from 31% in castor to ~90% in mustard (Table 4).

Similarly, the number of new hybrids/varieties coming from the private sector during 2005-2010 was 603, as against 346 notified varieties released by the public research institutes (Table 5). This is indeed a very significant shift in desired direction.

It is encouraging to note that the contribution of the private sector has been quite remarkable in the expansion of the vegetable basket both in terms of new crops and hybrid options (Table 6).

Table 3. Private Sector Varieties / hybrids in major field crops

Crop	Number of varieties and hybrids by decade		
	1980-1989	1990-1999	2000-2010
Rice	198	188	303
Wheat	84	66	112
Maize	43	64	113
Pearl millet	38	45	51
Sorghum	55	49	55
Cotton	72	78	95
Total	490	490	729

Source: Pray & Nagarajan (2012)

Building Public Confidence:

More and more private companies are now coming forward to participate in the AICRP trials and releasing varieties through this well established system of variety release, based on multi-location evaluation and collective decision making process. This is an encouraging trend. The private sector has also shown its confidence and interest in the national system by applying for the protection of their plant varieties with the PPV&FR Authority. Out of a total 4267 applications received (till Dec. 2012), by the PPV&FR Authority, 1796 were from the private sector, whereas of the 545 certificates issued, 92 were to the private sector, 447 to the public sector and 6 to the farmers (PPV&FRA website). While the Extant varieties were predominantly from the public sector, the private sector mainly registered in the category of New varieties.

To fulfill the social commitment, the private sector also needs to release and promote high yielding OP varieties of crops where hybrid technology is yet not feasible. To bridge the productivity gaps in less advanced states or in the difficult to reach areas the seed sector also needs to shoulder the responsibility of seed supply in these regions by expanding their network. The seed outlets can also function as a centre for access to knowledge and other agri-inputs such as pesticides, fertilizers etc.

Partnership for Prosperity:

India is a country of diverse agro-ecosystems and cropping preferences. It is predominantly rainfed (~60%) and size of the farm holdings are rather small (~67%). The wide gaps reported between the

Table 4. Number of hybrids in major field crops developed by private and public sector in India

Crop	Till 2001-02		2002-03 to 2009-10		Total		Share of private sector hybrids in total hybrids (%)
	Private sector	Public Sector	Private sector	Public Sector	Private sector	Public Sector	
Cotton	150	15	43	10	193	25	88.5
Maize	67	3	36	25	103	28	78.6
Paddy	12	4	11	15	23	19	54.8
Pearl millet	60	6	22	7	82	13	86.3
Sorghum	41	5	12	8	53	13	80.3
Pigeon pea			1	2	1	2	33.3
Sunflower	35	6	13	10	48	16	75.0
Jute				23	0	23	0.0
Mesta				11	0	11	0.0
Castor			4	9	4	9	30.8
Mustard			11	1	11	1	91.7
Safflower				2	0	2	0.0

Source: Harbir Singh & Ramesh Chand (2011), revised.

Table 5. Numbers of field crop varieties by public & private-sector institutions in India, 2005–2010

2010 Crops	Truthfully labeled/ notified private hybrids	Notified public varieties
	2005-2010	2005-2010
Rice	79[a]	240[b]
Wheat	40	95
Maize	136	87
Pearl millet	97	48
Sorghum	75	46
Cotton	255	70
Total	603	346

Source: Pray and Nagarajan (2011)

Table 6. New vegetable hybrids in India (1998-2005)

Crop	Public Sector	Private Sector
Tomato	3	160
Eggplant	8	218
Chilli	2	73
Capsicum	1	31
Cauliflower	1	35
Cabbage	-	20
Okra	2	32
Watermelon	2	25
Cucumber	2	10
Gourds	6	80

Source: NSAI (2005)

potential and realized productivity in most of the crops can be bridged to a large extent by using the seeds of improved varieties. A recent study shows that the use of HYV seeds was one of the key factors for an impressive increase in production from ~3.5 mt to ~11 mt in Bihar in the recent years (Yes Bank – Assocham, 2012). Adoption of single

cross hybrids bred by both public and private sector had doubled maize production as well as productivity in last one decade. These are indeed very encouraging development. Yet, on the contrary, the area under new maize hybrids is not more than 50%. Hence, we can still double our maize production by increasing area under new hybrids.

The fact that even today nearly 70-75% of the total seed requirements is met by the farm-saved seed, should also be seen new opportunity to expand and meet the diverse needs of our small holder farmers.

It is beyond doubt that public-private-partnership in seed sector is critical for future growth of Indian agriculture.

Traditionally, the private sector aims the sector of high profit (hybrids, transgenics and vegetable) seeds, while it is the primary responsibility of the public seed sector to meet the demands of high volume but low profit (OPVs of field crops) seeds. Now a time has come where the private sector will have to join hands with the public sector to cater to the resource poor farmers. On the other hand, the private sector can also benefit substantially by partnering with public sector by jointly developing or marketing public research led varieties/ hybrids/transgenics.

Several examples of partnerships have emerged in the recent past. Several public institution bred hybrids and OPVs of field crops have been commercialized by the private sector through non-exclusive licensing. The best example is of rice, in which about a dozen hybrids have been licensed to a number of private seed companies, including even MNCs (Table 7). This reflects robustness of our plant breeding research in the country.

In fact the success of licensing PRH-10 by IARI to 18 seed companies paved way to several replications of the P-P-P model. Similarly, a number of hybrids and parental lines of vegetables developed by IIVR, Varanasi, IIHR, Bangalore and IARI, New Delhi have been shared with the private seed sector for commercialization and breeding purposes through non-exclusive licensing. Some institutions are also sharing even advanced breeding lines with the seed companies on specific benefit sharing agreements.

A recent announcement from Syngenta, one of the 5 top MNCs, offering vegetable hybrids and breeding lines to the public sector researchers in the developing countries is indeed a welcome initiative in fostering mutual trust for building partnership.

Table 7. Public Private Partnership in Hybrid Rice

Hybrid	Developed by	MOU with
DRRH-2	DRR, Hyderabad	Sampoorna Seeds; Pratham Biotech Limited; Neo Seeds; Vick's Agrisciences; Charoen Pokphand Seeds; Bioseed Research; Zuari Seeds
DRRH-3	DRR, Hyderabad	DevGen Seeds; Kaveri Seeds; IFFSA; Ankur Seeds; Ganga Kaveri Seeds
Pusa RH 10	IARI, New Delhi	IFFSA; JK Agrigenetics; Nath Biogene; DevGen Seeds; Zuari Seeds; Advanta India; Yashoda Seeds; Namdhari Seeds; Amreshwara Agritech; Bhavani Seeds; Mahyco; Ganga Kaveri
PSD-1 & PSD-3	GBPUAT, Pantnagar	Syngenta India
CORH-3	TNAU, Coimbatore	Rasi Seeds
Ajaya, Rajalakshmi	CRRI, Cuttack	Annapurna Seeds; Vicky's Agrisciences
KRH-2	UAS, Mandya	Namdhari Seeds
Sahyadri 1	BSKKV, Karjat	Syngenta India
JRH-4 & JRH-5	JNKVV, Jabalpur	Vick's Agrisciences

Source: Viraktamath et al. (2012)

Germplasm Exchange:

As a result of the foresight of Indian policy makers and research managers, the National Bureau of Plant Genetics Resources (NBPGR) was established in 1976, which houses the world's third largest Gene Bank. This not only acts as a national repository of plant genetic resources, but also acts as an apex organization facilitating germplasm conservation, access and exchange for research purposes. Germplasm conservation through use can help in achieving sustainable agricultural growth and a share in the global seed trade. NBPGR has a rich collection of 3,95,000 accessions of >1500 plant species, which can be of great

significance in plant breeding programs. The national germplasm collection needs to be evaluated thoroughly and made available to Indian researchers, institutions as well as Indian seed companies having R&D capacity, since such research efforts will ultimately result in superior varieties hybrids for the benefit of small holder farmers. However, as these resources represent our invaluable national asset, utmost care is needed to develop guidelines on access and benefit sharing (ABS), on lines of standard MTA of the ITGRFA, with necessary safeguards. A sub-Committee constituted by the National Advisory Board (NAB) for the Management of Plant Genetic Resources is presently considering these issues for setting the guidelines.

Let me also point out that ABS should not be one way traffic. The germplasm available with private R&D institutions should also be shared as well as kept in the national gene bank for posterity. Somehow, this has not been happening. Hence, NSAI could debate this subject with its members and devise suitable strategy to let this happen in the larger national interest.

The Way Forward:

Finally, let me reemphasize some of the important issues that could provide Way Forward for faster growth of our seed sector. In fact, we must accelerate pace for seed development by defining a clear "Road Map" for future. In my view, priority action is needed in the following directions:

1. To have a **Seed Mission** initiated soon at the centre and state levels, adopting a synergistic mechanism of effective coordination and convergence. Such a Mission must ensure a rolling Seed Plan for every state and provide enabling environment for growth of both public and private seed organizations.
2. Promotion of hybrids/ HYVs in major field crops should be a high priority to bridge the productivity gap and increase production. In this context, the private sector has to play a major role, as seen in case of maize.
3. Immediate action is warranted for phasing out of all old and obsolete varieties through denotification and promoting only the best varieties and hybrids suitable for specific region / location, irrespective of whether they are from public or private sector.

4. A joint committee comprising representatives from the ICAR institutes, SAUs from the region, seed sector representatives and farmers' groups may preferred varieties at least 2-3 years in advance.
5. The State Governments may also consider an option of Contract Seed Production by advance indenting of the seed of desired improved varieties/hybrids to both public / private sector seed companies. Current practice of procurement of seed on tender basis has to be discouraged.
6. Outscaling innovation and adoption of cutting edge technologies, such as biotechnology and nanotechnology, would be critical for desired impact on livelihood of resource poor small holder farmers. For this role of seed sector is indeed important and must be appreciated.
7. The seed sector could also consider joining hands with other players in the agri-input sector not only for improved efficiency but also for serving better the farmers' interests.
8. Partnership between the public research institutions and private sectors are also desired in establishing Technology Parks in different regions to outscale innovation and disseminate technologies for the benefit farmers.
9. It will go a long way if Government also extends the benefit of subsidy to truthfully labeled seed of promising hybrids produced by the private sector.
10. Sharing of germplasm is imperative for crop improvement. However, while the national repository makes available the germplasm to the researchers and national seed companies, the private sector must also come forward and share their valuable germplasm with the public sector institutions for research purpose. Also these need to be stored in the Gene Bank for posterity.
11. The partnership between the Public institutions and the Private sector needs to go beyond mere commercialization of varieties, such as evaluation of germplasm and development of varieties with biotic and abiotic stress tolerance and desired quality traits.
12. The Indian seed sector today is well established with tremendous potential to grow beyond boundaries of domestic market. We must be proactive to explore export potential and create enabling environment. This can be achieved through a well planned strategy and targeted implementation plan.

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Dr. Rajendra S. Paroda is an accomplished plant breeder and geneticist by profession and an able research administrator. He has made significant contributions in the field of crop science research. He is known for modernization and strengthening the national agricultural research system (NARS) in India as well as in Central Asia and the Caucasus. He was instrumental in establishing the Asia Pacific Association of Agricultural Research Institutions (APAARI) and the Asia Pacific Seed Association (APSA), while serving with FAO in early nineties. Since 1992, he is continuing as Executive Secretary of APAARI. He was elected as first Chairman of the Global Forum on Agricultural Research (GFAR) and served from 1998-2001. Dr. Paroda was also the Director General, Indian Council of Agricultural Research (ICAR) & Secretary, Department of Agricultural Research and Education (DARE), Government of India during 1994-2001. He has the unique distinction of being the main architect of one of the world's largest and most modern national Gene Bank at NBPGR, New Delhi. He is Fellow of almost all the prestigious Science Academies in India and the Agricultural Academies of Russia, Georgia, Armenia and Tajikistan, besides that of Third World Academy of Sciences (TWAS), Italy. He had been the President of the National Academy of Agricultural Sciences (India) from 1996-2001 and was elected as General President of the prestigious Indian Science Congress Association for the year 2000-2001. In addition, he served as President of more than a dozen agricultural scientific societies in India. In recognition of his meritorious contributions to agricultural research, the President of India conferred on him the prestigious PADMA BHUSHAN in 1998. He also received several prestigious awards namely: ICAR Team Research Award (1983-84), Rafi Ahmed Kidwai Memorial Prize (1982-83), Federation of Indian Chamber of Commerce and Industry (FICCI) Award (1988), Om Prakash Bhasin Award (1992), Asia Pacific Seed Association Special Award (1995), Dr. Harbhajan Singh Award (2001), Dr. B.P. Pal Memorial Award (2003), Borlaug Award (2006) and Agriculture Leadership Award (2008), 1st Dr. A.B. Joshi Memorial Award (2012), Prof. Kanniyan Memorial Award (2012), Medal from Govt. of Vietnam (2012). In all, 13 Universities including Ohio State University, Indian Agricultural Research Institute, Agricultural Universities of Pantnagar, Kanpur, Jorhat, Coimbatore, Hyderabad, Udaipur, Varanasi, Srinagar, Meerut, Bhubneshwar and Punjab have conferred honory D.Sc. degrees on him. Dr. Paroda has also served as a member of many international organizations such as Australian Center for International Agricultural Research (ACIAR), Commonwealth Agriculture Bureau International (CABI), Finance Committee of the Consultative Group on International Agricultural Research (CGIAR), Global Biotech Advisory Council of Monsanto, Board of Trustees of IRRI, Chairman of ICRISAT Board of Trustees and Chairman, Program Committee of GFAR. In view of his outstanding achievements, both American Society of Agronomy and the Crop Science Society of America had awarded Dr. Paroda with their prestigious Honorary Membership in 2001. ICRISAT and Kazakhstan have named their Gene Banks after him. His passion as Chairman, Trust for Advancement of Agricultural Sciences (TAAS) is to link science to society through needed policy reorientation and to work for the overall progress of the resource poor farmers. He also served recently as a member of the World Meteorological Organization (WMO) High Level Taskforce and proposed a Global Framework for Climate Services. He is currently serving as Chairman of the Farmers' Commission of Haryana State, a member of the Rajasthan State Planning Board, and member of the ICAR Society as well as of Governing Body of ICAR. Dr. Paroda is serving since 2008 as Chairman, Program Committee of GFAR and currently also as Chairman of the Organizing Committee of Global Forum on Agricultural Research for Development (GCARD) to be held in 2012.

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