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ICAR

11th Professor Dayanatha Jha Memorial Lecture

Centrality of Science, Societal Goals and Agricultural R&D Priority Setting

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ICAR-National Institute of Agricultural Economics and Policy Research (NIAP)

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Eleventh Professor Dayanatha Jha Memorial Lecture

by

Professor Sachin Chaturvedi*

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Good Morning!

- Dr. Ramesh Chand, Member, NITI Aayog; (Absent)
- Dr. Suresh Pal, Director, ICAR-NIAP;
- Dr. N.S. Rathore, DDG (Education), ICAR;
- Dr. Trilochan Mohapatra, Secretary, DARE & Director General, ICAR;
- Dr. Pratap S. Birthal, ICAR National Professor, ICAR-NIAP
- Dr. P. K Joshi/Dr. Maurya
- Ms. Jha

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At the outset, I would like to pay my tributes to Dr Jha, and would like to congratulate NIAP for keeping the flame alive. Dr Jha, with his erudite interventions always stood for high standards in our academic deliberations.

When we were transitioning from NATP to NAIP, I had an opportunity to work with him and the World Bank team, which was headed by Eija Pehu and Dr Williem Janssen. Later, Dr. Mruthyunjaya took over as the head of the team. The idea was to draw scenarios to capture conflicting trends for prioritization of the funding in the NAIP. During several of these meetings, I could interact with Dr Jha, and Dr Suresh Pal was also part of our team at that point.

Friends, Ladies and Gentlemen,

- Let me at the outset mention different initiatives undertaken by the Government in the recent- past such as Per-Drop-More Crop, Soil Health Cards, Digital India, Make in India, and Skill India, which may be leveraged to explore and expand technological trends and choices for overall growth of agriculture sector in India.

- As I talk to you about the Centrality of Science and R&D priorities in the agriculture sector, I would like to focus on some areas that Dr Jha would have emphasized us to dig a little deeper for further insights.

- The adoption and diffusion of related technologies has to have the local context, local needs and local relevance. In that background, the localization of S&T interventions become relevant and desirable for making technological diffusion and acceptance convincing, without any or minimal negative consequences in a long -run.

- As we view the contemporary developments, India's farmers are facing challenges from two sides. While the first set of factors relates to their capacity to create value in their product; the second set of factors evict their capacity to realise value of their produce.

- The recent incidences of farmers ending up their lives and tendencies of farmers to shift out of agriculture are exemplified by the march of the farmers in Maharashtra for demand of justice and are pointers to these two frailties that have come into the agriculture system.

- Linking the agriculture sector with the manufacturing sector of the country can be hugely effective in minimising the capacity deficiency in both creation and realisation of values by the Indian farmers.

- Needless to add that the production capacity of Indian farmers can be enhanced remarkably if they are in a position to absorb advances in agricultural technology achieved, so far, by the Indian R&D institutions.

- I feel we should not be hesitant to adopt much advanced but simpler technologies and cultivation practices from other countries like Israel, Brazil, China, the Netherlands. The main issue is productivity per unit area. Even many small countries we can learn from when we talk about wheat, rice, corn, cotton and almost all the oil crops.

- Four Sections: Innovation System; Panel Date Analysis on Mechanisation; High-end Trade; External Agri Services

I. R&D Efforts and Innovation

- A look at the R&D efforts in agriculture, with centrality of science, reveal that such advances have been made in the fields of breeding, soil science, pest control, agronomy and many other relevant domains.

- However, there has been disproportionately a large emphasis on some of them at the cost of others, not only for raising productivity of grains and other agricultural products, but also for ensuring that they are more resistant to natural calamities, pest infestation, and other factors, often beyond the control of farmers.

- Even with optimal potential increases, productivity in agriculture can not necessarily be ensured, only through improving quality of planting materials or seeds, or other related inputs.

- In my view, central question, at this point, before us is at two levels— (a) select focussed R&D on crops with national goals using high-end technologies; and (b) how to further deepen the connect between the agriculture sector and the manufacturing sector. We need to explore this linkage - we need to promote this linkage for promoting Make in India and for promoting and enhancing overall viability of farms and associated non-farm sectors.

- Very often we hear that Indian R&D in agriculture needs to concentrate on creating pre-harvest and post-harvest technologies, which can contribute significantly in productivity growth. It is important that when

we talk of pre-harvest technologies, we emphasize also on developing agricultural implements for land development, irrigation, etc.

- Technology advancements from the perspective of Responsible Research and Innovation (RRI) call for emphasis on access, equity and inclusion. A redesigning of a linkage between the agriculture and the manufacturing that does justice to Access, Equity and Inclusion (AEI) is the need of the day.

- Christopher Freeman and Luc Soete have worked extensively on how R&D priorities influence competitive edge of economies. According to their paper of 1997, the classical economists "were well aware of critical role of R&D in economic progress though different terminologies might have been used". For instance, Adam Smith (1776) emphasized on the use of machinery that came from manufacturers and all machines made by philosophers or as Adam Smith described men of speculation.

- Freeman and Soete analysed how technical progress became feasible with a large number of patents taken out by mechanics or engineers during the middle of the last century, and it is still dominant when we discuss modern industrial R&D.

- The industrial research and experimental development has intense sectoral specificity which should not be overlooked as one takes a macro view of innovation and R&D. The broader classifications that came up of low, medium and high technologies, actually push further this generalisation. The frameworks from the OECD, both the Frascati manual and the Oslo manual also facilitate adoption of these principles.

- The work of Franko Malerba (2004) identified role of specific sectors within the framework of sectoral innovation system, which again emphasised that innovation may move forward with centrality of science but at the sectoral level. However it has to be set in the context where its relevance may be easily realised.

- Globally with the Green Revolution, production of cereals, fruits and vegetables and other crops have leapfrogged several times across the countries. The import dependence of several countries for cereals and other items from food security point of view for sensitive crops has declined and ability to export commercial crops has gone up.

- This is particularly true for the country like India where food security has always received the highest attention of the policy- makers. The

production of commercial crops including fruits, vegetables, etc. has scaled many peaks with each passing year, and has led to higher foreign exchange earnings. Countries like Brazil, Australia, New Zealand and United States have also achieved distinctions across different categories of agricultural products and exports in the realm of cereals and other areas like fisheries, rubber, soybean, fruits, etc.

- However, there exists a disconnect with the manufacturing sector ,which is quite evident when we see the limited exports in production of farm-gadgets by countries even when a large number of population is dependent on agriculture. As discussed earlier, lack of mechanisation of agriculture has been well documented for resulting low per capita earning in several rural areas across developing countries.

- This has been a key concern viz. a viz. issues related to mechanisation. In this regard, we may have to explore institutional and other measures for overcoming structural rigidities that foreclose options for promotion of mechanisation.

- The group of countries that have excelled in development and exports of pre- and post- harvest machinery make it clear how advantage comes in when production cost and burden of labour both are reduced drastically

when one opts for mechanisation. The irony is most of the times farmers are not getting labours when they need. For example, the cost of harvesting cotton alone is about 25% of total value (Rs.10/- per Kg is harvesting cost when farmer hardly gets Rs. 40/- per Kg of cotton). In case of mechanization, the harvesting cost will come down to Rs.5/- per Kg easily. Farmers in Punjab are already experiencing it. One of the best examples is Combine Harvestor.

II. Agricultural Implements: International Experience

- Agricultural mechanisation is a key for raising farm productivity. Most of the global players engaged in exports of farm implements are also relatively better off in terms of their agricultural exports.

- It is interesting to note that some of the emerging economies which are also expanding exporter of agriculture produce are the ones, which have also excelled in exports of farm implements.

- Demand for farm mechanisation has contributed to innovation and production of implements. While producing such implements for the domestic farmers, many countries have acquired global competitiveness. These global competitive exporters are either better off in technology or in prices, but most of them find their way to access to the global market in terms of exporting farm implements.

- For example, technologically though not superior, China produces 95 mercantile items and more than 3000 different models of agricultural equipments; and many of them are exported to the global markets due to price competitiveness (Yuan, 2005).

- With increase in production of farm implements, there is positive impact in terms of intensity of mechanisation in the economy of the exporting country, leading to rise in agricultural productivity (De Janbry and Sadoulet, 2002) and subsequently contributing to rise in production in several other economies.

- It is observed that excess production in the domestic economy often ends up with augmented exports. Therefore, there is an invariable concomitance between agricultural exports and farm implements where the former is induced by the latter. The experiences of some of the key exporters of agricultural machineries including the Crains group confirm to the above trend.

- The implications of farm mechanisation are not restricted to the domain of agricultural production or agricultural productivity, but goes beyond the realm of farm production. Agricultural mechanisation has directly supported agricultural production in Africa and several countries in Latin America (De Janbry and Sadoulet, 2001). Agricultural employment is indirectly affected by farm mechanisation in Asia.

- Success of agricultural mechanisation is closely linked with value chain approach in agriculture. Comprehensive mechanisation in green production, Post-harvest activities, food processing, market activities and

rural services for farm implements can help in providing thrust to production of farm implements and promoting rural development.

- Farm mechanisation has been a key driver for reducing poverty through enhanced productivity and reduction of input costs. With small farm implements like, small scale Chinese single cylinder diesel engines and power 2 wheeler tractors (WTs), marginal and small farmers have used their land intensively, leading to increase in their family income in several countries. Many of these countries are in the immediate neighbourhood, including Bangladesh and Sri Lanka.

Empirical Analysis

- For empirical analysis, we have chosen the experiences of countries of the Crains Group. These countries are widely believed to be globally competitive in the production of agricultural products. The Crains Group was active in the WTO negotiation on Agreement on Agriculture in the 1990s.

- For the empirical analysis we have chosen all the products under agriculture (i.e., chapter 1-24 at 6 digits HS classification).

- This includes animal and animal products, fruits and vegetables, Oils and fats and processed food. For analytical convenience, we have classified these products into food products, cash crops and other agricultural products. Identification of mercantile products under agricultural implements is a cumbersome procedure.

- There is no special code designated for the group. However, we have identified 57 products as agricultural implements, 105 products as food products, 288 cash crop products and 336 other agricultural products in the sample prepared for the panel data analysis. In total there are 786 items covered for this analysis.

- Agricultural implements are divided into two groups namely, food enhancing implements and other implements. While the category of food enhancing implements covers 16 items, other agricultural implements group has 41 HS products.

- The main purpose of this analysis is to examine the implications of farm implement exports on agricultural exports in case of countries in the CRAINS group.

Results

- The trend in exports of agricultural implements indicates that top 10 exporters share around 74 per cent in the global market in 2016.

- Among the top exporting countries, China and India are the only developing countries ranked as third and eleven in the ranking. The share of China in the global share has increased from 2.5 per cent to 11.2 per cent whereas share of India has gone up from 0.2 per cent to 1.9 per cent during 2003 - 2016.

- Moreover, in case of developed countries, this share has been stagnating or in some cases, even declining for some time. For instance in case of

the United States, the EU, Japan and Canada etc. it has declined consistently.

- However, while analysing the exports of food implements per agricultural worker, one can see that developed countries have maintained a very high per capita export of agriculture implements as compared to developing countries.

- Such as the United States ($1880.79), the United Kingdom ($5007.09), Japan ($975.97), etc. for 2016 have maintained high per capita exports of food implements. On the other hand, the same in case of developing countries like India ($4.41) and China ($8.39) is low but growing fast to catch up with the rest of countries.

- A similar trend is reflected in Cairns group. The per capita implements exports in agricultural sector in the developed countries in the group is high whereas the same in case of emerging economies like Brazil, Indonesia, South Africa is low but rising at a fast pace. The total food implement exports in Cairns group in 2016 have been $3739.38 million with a total agricultural working population of 139.83 million.

- In order to check the relationship between exports for agricultural products and exports of implements, this study uses panel data analysis.

- For the analysis, exports of agricultural products and agricultural implements have been taken from UN Comtrade (2018) database for 17 countries for the time period of 2004-2015. The total agricultural exports have been divided into three categories namely, food crops exports, cash crops exports and others agricultural exports, whereas the total exports of

agricultural implements are sub-categorised into food implements and other agricultural implements. The food implements are those products which are used directly for production of cereals and other food crops. The other two variables in the panel data are representing country and time period.

- This panel data analysis tests the hypothesis that rising exports of agricultural implements would induce growth in agricultural exports.

- For testing the above hypothesis, three different fixed effect models have been used.

- The first model estimates the effect of exports of food enhancing implement on exports of food crops, the second model takes into account the effects of exports of total agricultural implements exports on total agricultural exports and finally the model estimates the effect of total agricultural implement exports on cash crop exports.

- The results show that, in all the three models, the increase in agricultural implement exports has increased the exports of agricultural exports and its effect is highly significant.

Table 1: Implications of Agricultural Mechanisation on Farm Exports- Panel Analysis for the Cairns Group

Dependent Variable	Independent Variables	Coefficient	Standard Error	t	P value	R Sq
1. Food and Food Products	Food Implements	10.5	1.5	7.01	0	0.34
	Constant	2543084	245829.3	10.34	0	
2. Cash Crops	Implements	10.19	0.99	10.26	0	0.53
	Constant	1890699	298895.5	6.33	0	
3. Agricultural Exports	Implements	36.32	3.12	11.65	0	0.63
	Constant	6331942	937700.2	6.75	0	

Number of Observations= 204

- It is evident from ICAR – UNCSAM (2017) that the Benefits of engineering R&D have not reached the farmers to its optimum level. Moreover, the pace of R&D and commercialisation are comparatively slow to fulfil the demands of the farmers, at large.

- There is a need to engage different stakeholders, including farmers, creditors, Gramin banks, policy makers and research/academic institutions to develop cost-effective, efficient and effortless technologies, keeping into consideration the needs of farmers in India.

- Training and testing modules for farmers under programs like Agricultural Mechanisation Submissions (SMM) can be helpful in making technologies and advance machines to the grassroots. Some of the measures include Establishment of Farm Machinery Banks, facilities of Prototype feasibility testing and FLDs, as well as promotion of custom hiring services, for high capacity farm equipment.

III. High-end Technology

- It makes clear why the traditional classification of economic activities into agriculture, manufacturing and services holds limited relevance today as the technological advancements are blurring away this distinction with greater integration of economic activities.

- The idea of addressing agriculture and the challenges faced by it in isolation would no longer work. The centrality of science must be leveraged to establish a coherent framework for interconnectedness

between the agriculture sector with the manufacturing and services sectors. As the data above shows immense linkages and cross dependence are there that we need to work on.

- They hold out lessons not only for agriculture policy but also for manufacturing policy. It largely reflects societal concern that the agriculture sector must address when one has to prioritise R&D budgetary allocations.

- Friends, India's experience with GM and Monsanto has given us several policy lessons. They should be absorbed for policy-making, and those lessons are becoming all the more relevant with the emergence and convergence of technologies.

- In several recent research articles, promising uses of CRISPR tools in agriculture have already been shown in crop- plant, and to this group I do not need to spell out the potential that seems to be emerging with SDN‑ 1 (Site-directed nuclease) in wheat, which may be used to provide resistance against devastating powdery mildew fungus, whereas more challenging, complex traits have been altered in corn and tomato. Similarly in maize, application of SDN‑ 3 to the Argos8 (also known as Zar8) gene promoter conferred constitutive expression of the endogenous gene and resulted in improved maize yield during drought stress.

- Literature also suggests that gene-editing technologies particularly CRISPR, is much less expensive and less time consuming, which means it can lead to heavy reduction in R&D expenditure and thus has the potential to produce affordable quality crop-seed varieties, which would be more accessible, and this may lead to equitable and inclusive development.

Agriculture patenting in India

- It is interesting to note that out of 1146 patents granted for CRISPR, between 2002 and 2016, main patent applicants included were from USA, China, France, Japan and South Korea. Not a single patent application was from India.

- Intellectual Property Rights play a very crucial role in augmenting R&D activities in any country. After the 2005 patent reform, there has been a significant increase in the patenting activity in India. Indian agriculture also experienced the impact of these changes. From 2007-15[†], IPO granted 1201 agricultural patents; of the total 80 per cent were granted to private companies, 12.2 per cent to public institutions and 7.8 per cent to

[†] Data from IPO and WIPO

individuals. It can be deduced that post- 2005 reforms most of the patenting activities were by non-residents and mostly were for chemicals.

- A look at the trend in patents granted from 2005 to 2017 shows a slowdown from 2007-09 onwards. The number of patents granted in soil machinery (A01B); planting, fertilizing (A01C); harvesting, mowing (A01D); threshing (A01F); and animal husbandry (A01K) have witnessed a decline with the exception of manufacturing of dairy products (A01J), which has remained steady.

- As per the IPC classification, class A01B (soil machinery), A01D (harvesting, mowing) and A01F (threshing) gives a broad representation of instruments used in agriculture. From 2005- 2017, a total of 97[‡] patents have been granted in these fields; a number much smaller than the patents granted in chemicals.

- In the context of patents granted to resident and non- resident agriculture research institutions, there exist a stark difference. Patents granted in classes of soil machinery (A01B); planting, fertilizing (A01C); harvesting, mowing (A01D); threshing (A01F); dairy products (A01J); and animal husbandry (A01K) showed that from 2007-2015, 80 patents

[‡] Data from IPO and WIPO

were granted to non-residents compared to 44 patents granted to residents. Within these patents, almost 80 per cent patents were granted to private institutions and the remaining were to public institutions.

- In India, agriculture research has from the very beginning been driven by public research institutions. In comparison, the share of private sector in agriculture R&D is much smaller. However, despite the difference, the patenting trends from 2007-2015 shows that it is the private sector which has churned out larger percentage share of patents despite it being a much smaller shareholder in agriculture R&D. The trend also brings forth the reality that despite being the larger shareholder the public sector is not moving. Now with Make in India, the importance of reviving and utilizing the edge which public sector institutions hold cannot be underscored, the vision of Make in India to generate income and employment in the agriculture sector will not be possible if the largest shareholder in agriculture R&D remains with this low share. However role of Indian public research institutions in terms of global public goods has an important role for which comparison on pretext of patents may not be relevant.

- Thus it is time to make full use of the capacities and further augment the public sector as a pivot of innovation and growth. The sector needs a

policy framework focussing on narrowly defined targets and milestones with public and private partnership for better results.

- It is also important for India to help a structured approach on our international engagement, an effort that help us scout for technology and keep the system linked with wider global developments. This involves a greater effort for industrialisation of Indian agriculture – learning from others and sharing our experiences with others.

IV. Need of External Agriculture Services

- Recently, USAID implemented two major projects with an overall budget of $ 3 billion, in Kenya and in couple of other African countries for developing hydroponics and dairy cooperatives.

- This has enabled not only the access to advanced technologies by African countries, but has also enabled absorption of technologies easier, as Indian entities- private companies and civil society organisations, were engaged in this facilitating exercise.

- Coming from similar developmental challenges and experiences, the process of absorption for partners from Africa became easier. In many other areas, wider global relevance of our developmental experience is

being viewed as an asset and as an opportunity as we talk of innovation system in agriculture.

- It may be timely to think of greater internationalisation of our knowledge dissemination through External Agriculture Services, where Indian agriculture professionals evolve mechanisms and modalities for locating dimensions of cooperation and sources of knowledge for giving shape to this new trajectory of experiences that India is going through.

- This may require greater institutionalised efforts for promotion of these professionals and their work. There are several global experiences with countries such as, USA, the Netherlands, Australia, and others, who have tried these efforts with much greater passion and commitment.

- Innovation is not only a supply driven outcome, but is also a demand induced phenomenon, which requires efforts for bridging gaps between the market and the production sites.

- When farmers are linked with market strategies, innovation automatically sets in, for example, the recent efforts of India to have an e-Platform for rural produce to come to the markets for reasonable prices, may eventually set the stage of demand estimation and its precise assessment.

- If this has to be extrapolated at the global level, decision support system (DSS) would have to be created for different analysis and bringing them to the end users, that is the farmers, in a format which is absorbable for them, and this happens only when information is turned into knowledge.

- Huge influx of information may not be relevant for farmers till the knowledge component is introduced. The DSS would eventually then help farmers to take a call and move forward, as all of us want them to enhance their earnings and agriculture to continue to remain a viable proposition.

- This, however, requires considerable internal reforms of the agricultural sector, R&D in particular, to help bridge the demand-supply mismatch across crops. The volatility in such mismatched conditions are urgently required to be moderated to create a win-win situation for both the agricultural and manufacturing sector.