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Steering Indian agriculture, a long-term perspective with special reference to natural resins and gums

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Abstract : India would be the most populous country by 2050 with 1.6 billion of population. Nevertheless, the agricultural land will remain the same or even less due to various types of human activities as well as other adversities like climate change, constraints in agri-resources, effect of green house gases, post harvest losses etc. This good impose serious problems in the agriculture and related economy. The author has suggested some remedial measures with long term perspective to steer up the Indian agriculture in the right direction with special focus on the production of natural resins & gums.

Keywords: Steering Indian agriculture, Long term perspective, resins & gums

INTRODUCTION

Importance of agriculture varies widely in the context of the country. For India, it is not just a matter of food security but is also means of income/livelihood for over half of the population. Besides, India has only 2.3% of the geographic area of the world with a load of supporting 18% of global human population. Judging from the global trends in occupational distribution of human population, it is obvious that the segment of population dependent on agriculture would continue to diminish in years to come. A recent study¹ has shown that the global agricultural population decreased from 49 to 37% between 1980 and 2011. The percentage does not tell everything; in terms of real numbers it in fact grew from 2.2 to 2.6 billion during the same period, which means that an addition of about 400 million to address the increase in the food demand due to growing population during the same period. Interestingly, according to the same report the active agricultural population of India grow by 50% during 1980-

2011. FAO projects predict that the global agricultural population will diminish by 0.7 percent during 2011-2020. The relative contribution of Indian agriculture to domestic GDP would continue to fall from the present 14%, but from the stand point of employment and food security Indian agriculture would continue to be a vital sector of the country. We also have to prepare the Indian agriculture to meet the rising demand with reduced manpower coupled with a number of challenges, prevailing and emerging.

Challenges ahead

From a long-term perspective, Indian agriculture has to face a number of challenges in order remain adequate and healthy. The following are some of key areas which need to be considered.

Population threat: India would be the most populous country by 2050 with 1.6 billion of population, adding around 400 million, equivalent to US population by 2050. It has to increase its agricultural production to meet this addition to the population amidst challenges in multiple fronts.

Climate change: A plethora of new problems due to climate change, such as changes in the overall precipitation; rainfall pattern and intensity; increase dry land area; natural resource constraints would dampen the impact of new technologies for enhanced productivity. Indian Council of

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Agricultural Research (ICAR) has already taken up initiatives for development of climate resilient agricultural production systems through special schemes and its network of institutes².

Economic growth vs environment protection: In a country like India, compulsions for achieving higher economic growth often override considerations of environment protection, in contrast to situations in developed countries. Analogous situation is also observed in agriculture to achieve high productivity to sustain a desirable growth rate in production leading to land degradation; long-term sustainability through natural resource management needs to be given more attention in forthcoming years.

Constraints in agri-resources: Decrease in water availability would adversely affect the productivity of esp. cereal crops. The projected water requirement for irrigation by 2050 is around 807 billion cubic meters compared around 557 in 2010. Energy and water poverty is looming large and would continue unless drastic measures are taken up. India is presently negative for energy balance and renewable energy needs to be harnessed in a big way. The estimated annual solar insolation across the country is over 5000 TWh, whereas the present generation capacity is meagre 200 thousand MW. We foresee solar, wind, hydro and biogas energy farms getting integrated with agricultural production and processing in future.

Carbon budgeting: Climate change related disasters would drive the world towards more disciplinary measures against countries with regard to emissions. Carbon budgeting would permeate various human activity domains.

Pollution concerns: In the foregoing discussion, the general tendency to neglect environmental protection by developing countries like India, due to zeal for economic progress has been pointed out. Pollution level will continue to grow due to unbridled growth vehicles, lack of controls over industries, etc. An interesting and disturbing finding has been recently reported from a study of direct effect of short-lived climate pollutants (ozone and black carbon) on the agricultural yields; this is apart the indirect effect due to climate change³. The study has revealed that loss in wheat yields in 2010 was around 19% (eq. to 24 m tonnes) due to such pollutants. This impact has been found to vary with States; absence of required data limit the analyses of impact such factors. With the increasing trend of pollution due to urbanization, the adverse impact of pollutants on

crop productivity would be expected to increase in our country. This adds another dimension to the factors to be taken account to sustain the agricultural yields, despite improved varieties and production technologies.

Greenhouse gas (GHG) emissions: The GHG emissions in 2000, as estimated by International Food Policy Research Institute, contributed by agricultural activities was around 150-220mt CO₂e (carbon dioxide equivalent) and would rise to 240-330 mt CO₂e by 2050 without any interventions.

Post-harvest losses: The information available on post-harvest (PH) losses in India is highly variable and does not provide realistic situation. We believe that substantial portion of food is lost at PH stage due to a number of reasons; fruits and vegetables are worst affected, in this respect. This aspect needs to be addressed through appropriate govt interventions perhaps through private partnership.

Need to change

Aforementioned consideration is an attempt to draw attention to some of the key areas to be addressed in the realm of agriculture through long-term and strategic planning, which affect various sectors and commodities under the umbrella of agriculture. But, unfortunately precise understanding of facts, projections and remedial measures is limited due to absence of required information/data, both temporal and spatial, at the national level, in several fronts. Thorough analysis is therefore needed to formulate appropriate top-down measures to drive Indian agricultural development in the right direction. There is also compelling need to identify crops/sectors in view of resources available, constraints foreseen and changes in demand pattern of various commodities in years to come. We also have to ensure that the profitability in agriculture is ensured and sustained. Lack of adequate profitability in agriculture is dampening the interest of farmers in agriculture these days. This sentiment is more markedly seen among the youth. Realising this, ICAR has recently launched ARYA (Attracting and Retaining Youth in Agriculture) to stimulate the youth to take up agriculture. We have to shift from livelihood to profitable agriculture through suitable production systems. We also have to look into newer and underexploited agricultural opportunities.

Preoccupation with food security had probably been the main focus in agricultural development plans in the past. We have to integrate farming of more and more non-

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food commodities to meet the growing and changing demand of various biological products in the light of several trends mentioned above. A number of opportunities await proper harnessing such biofuels, biopolymers and plastics, natural resins/gums, etc. Ensuing section deals with one such agricultural sector, which offers tremendous scope for development.

The NRG sector

There is thrust towards better harnessing of natural materials for safer products especially in applications related to food, cosmetic and pharmaceutical industries. From this standpoint, natural resins, gums and gum-resins (NRGs) are one such class of farm produce, which is useful to human society. NRGs of commerce are basically obtained from plant, animal and microbial sources. They are located in storage structures, exudates, cell wall components of the plants and extracellular products of microorganisms. Lac is the only resin of animal origin, derived from the protective secretions of lac insects⁴.

Important NRG-producing countries are: natural resins – USA, China, Russia, Indonesia, Thailand and India; gums – Sudan, India and Nigeria and gum-resins – Afghanistan, Iran, Spain, Ethiopia and Somalia. India is among the leading producers of NRGs in the world. India is the one of the largest producer of natural resins, gums and gum-resins (NRGs) along with China, Indonesia, Russia and Brazil. India is the world leader in production of guar, karaya and psyllium gums as well as lac.

The production level of NRGs India in 2013-14 was ~8.90 m tonnes and had been growing during the last decade; doubled since 2006-07. The export of NRGs in 2013-14 was ~6.2 m tonnes. Guar holds the largest share of NRGs produced in India. Recently, guar gum, with 18-19% share, topped as agri-export commodity of the country, earning Rs 213 billion in 2012-13. NRGs are also important source of subsidiary income to farmers in around 70 disadvantaged districts, identified by the Planning Commission. Guar cultivation is an excellent source of income for farmers in drier tracts of north-eastern states (Rajasthan, Gujarat, Haryana, Punjab, etc.), as rain-fed crop. With enhanced interest in safe and natural material for consumption in various areas, the demand is expected to grow steadily in future backed by good marketing support.

NRGs: Sectoral analysis

For a healthy sectoral growth, any stimulus in demand

should be coupled with matching increase in production. Therefore, the system has to have mechanisms to vary production at will, on short-term basis. While there is scope for increasing the seed gum and lac production through horizontal expansion of area, increasing exudate gum production is constrained as gum production requires well developed old trees. Thus increasing production base of exudate gums requires long time to enable establishment of trees/plantations. Therefore, a nation-wide mission mode approach is proposed for establishment of important gum-yielding trees under long-term developmental programmes and waste lands could be earmarked for this purpose. Guggul should receive high priority on the species to be promoted under this programme. The accrued environmental benefit of such an initiative through carbon sequestration besides livelihood enhancement cannot be overemphasised.

Lac is another exciting subsector as it is the source of resin of unmatched versatility. The lac production systems had evolved historically since the emergence lac as product of commerce. The phases can be traced as: Collection from forests; unsystematic cultivation (past) ! Organised cultivation; livelihood support to economically constrained farmers (present)! Large-scale profitable production systems; industrial production (emerging). In future, the production system design needs to take into consideration several aspects, which have been discussed in the introductory section.

NRGs: Challenges

Besides, the factors affecting agriculture in general discussed earlier, the following challenges are viewed as the key ones specific to the NRG sector:

Climate change would throw newer threats affecting productivity and sustainability – seed gums, lac.

- Favourable for exudate gums
- Fluctuations in supply and price
- Mechanisms to ensure adequate supply of quality material (NRGs) at reasonable price
- Stringent quality check mechanisms
- Novel areas of application; molecular tinkering

NRGs: Strengths

- USP- Safe, human & environment friendly for food, cosmetics and pharmaceuticals
- Growing demand for natural additives/materials for human-related applications
- Wide variation of molecular structure.

Multifunctional potential for wide range of applications

- Complex and diverse molecules providing hand for modification for specific applications

The NRGs, as a sector is viewed as an important avocation for the farming community, especially in areas unfit or less fit for other agricultural activities. It is also seen as a potential tool for changing economic condition of the farmers, from livelihood to profitable enterprise besides promoting a healthier world, interlacing ecological development^{5,6}.

NRGs: Research and Development

An article published a few years back, authored by 53 experts, contains the top hundred questions of importance to future of global agriculture⁷. A similar exercise was subsequently done by ICAR in the national context. It is worthwhile looking at some of the points raised in the former article relevant to NRG sector in general and the Institute in particular.

The relevant issues for the Institute from the foregoing article appear to be: i) prediction of critical impacts of climate change; ii) increased rainwater harvesting on local hydrological axes; iii) combinations of forestry, agroforestry, grass cover, water-collecting systems and storage facilities, drought-resistant crops and water-saving technology; iv) sustainable soil management; v) improved resilience of agricultural systems to both gradual climate change and increased climatic variability and extremes; vi) long-term carbon sinks on farms (e.g. by soil management practices, perennial crops, trees, ponds, biochar); vii) best integrated cropping and mixed system options for different agroecological and socioeconomic situations, taking account of climate and market risk, farm household assets and farmers' circumstances; viii) facilitation of institutional change and technical innovation to ensure that widest number of farmers are reached and engaged and viii) sustainable agricultural intensification to maintain livelihoods for smallholder farmers.

Development of any sector needs to be backed by efficient and relevant R&D systems. The R&D thrust areas for development of sector have listed below^{5,6}:

Production: Moving towards ideal input-output efficiency, reduced labour requirement and long-term sustainability.

- Deeper understanding of the underlying mechanisms of gum/resin production in plant/insect and

its use for enhanced production.

- Shift towards multispecies/integrated systems for enhanced stability
 - Harnessing genetic diversity of gum genes across different taxa
 - Gene mining and its harnessing for commercial production; bioreactors
 - Molecular engineering of NRG molecules for enhanced and specific performance
 - Processing protocols for meeting stringent quality requirements for food/pharmaceutical/cosmetic applications
 - Novel product lines: food processing, packaging, diapers, drug delivery systems, cosmetic products
 - Molecular engineering of NRG molecules for enhanced and specific performance
 - Processing protocols for meeting stringent quality requirements for food/pharmaceutical/cosmetic applications
 - Novel product lines: food processing, packaging, diapers, drug delivery systems, cosmetic products
 - The R&D would strategically aim at broad spectrum of consumption areas to buffer against erosion of any application. Continual development of newer products to ensure sustained demand
 - On-line and other IT-enabled technology delivery and information dissemination system
 - Real-time crop monitoring and advisory services
- All the R&D efforts should be driven to achieve higher and sustainable productivity with optimal inputs, ensuring high quality of NRGs and development of novel and specialty applications especially in low-volume high-value products. The application development should strategically aim at broad spectrum of consumption areas to buffer against erosion of any application. Emergence of new frontier areas would trigger paradigm shift in application domains. Continual development of newer products would ensure sustained demand for NRGs resulting in a sustained and healthy industry in the country. Advanced information and communication systems would lead to management of production systems at national level, for demand-production matching, on annual basis.

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