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GUEST EDITORIAL

## Feeling the ‘pulses’ for the second green revolution

During the last few decades there has been a frustrating call, rather a cry, for a repeat of the green revolution that our country experienced between 1960s and 1980s. It is widely acknowledged by experts that this cry emerges due to two related problems; first, the green revolution that accelerated the food production of the country lost its steam within a couple of decades and second, the tools, techniques and wherewithal used during this first phase of green revolution were no more sufficient to keep the steam on. Clearly, if we do not address these problems immediately and fail to re-accelerate the pace of green revolution, the increasing gap between the demand for, and production of food grains would begin to haunt our country again. In other words the country is looking towards another revolution – aptly termed as second green revolution. While efforts are on to prepare the ground for this second phase, or for an ‘Ever Green Revolution’, it would be wise to introspect the reasons for the deceleration of the first phase.

The process of green revolution began as if it is an eternal programme that would be sustained based on the then freely available genetic material and knowledge base. In particular, these ingredients include genetic material of major crops such as wheat, maize and rice, knowledge of breeding techniques that were not brought under patenting regimes and the availability of synthetic fertilizers. Through a wise combination of these ingredients and well thought out All India Coordinated Research Programmes (AICRP) that networked the agricultural scientists across the country for different crops, a phenomenal increase in the country’s food production was achieved. Unfortunately, within a few decades, as these ingredients were exhausted, the accelerated increase in productivity could not be sustained and the yield levels began to plateau off creating a serious concern. It is worth noting that to a greater extent, though well executed, this first phase was more an opportunistic harvesting of the then existing advantages than a well planned long-term programme of the country. This is evident in several ways:

First, we never planned for a long-term strategy to generate the knowledge base required for keeping the engine of green revolution running. There were hardly any pro-active steps taken to build bridges between the corridors of knowledge generation (viz. institutes of science and technology) and institutes or universities affiliated to the Indian Council of Agricultural Research. There was not only a reluctance, but even a discouragement for agricultural scientists who wanted to build these bridges. On

the other hand, the science and technology institutes meant for knowledge generation also remained as ‘elite islands’ insulating themselves from the country’s real needs in agriculture. This resulted in a huge knowledge gap between the country’s preparedness in science, and, the requirements of agricultural research. The problem was further accentuated by the resurgence of the global culture of patenting new technology and knowledge products. In other words the knowledge base that was freely available during the first phase of green revolution, could no more be assumed to be so in the future and we had not laid a strong foundation to meet this contingency.

Second, during the first phase, the genetic material that pushed the yield potential of major crops such as wheat, maize and rice could be accessed freely by our agriculture scientists. Our green revolution programme was initiated with the assumption that these inputs would continue to be freely available. Thus we never planned a long-term strategy to create novel genes and gene combinations required to address emerging issues in agriculture – barring the segregating material from the diverse genotypes. But the world has changed; novel genes – both natural and synthetic, are owned now by the scientists and private organizations and need to be paid for to use them. In fact India had to pay royalty for the *cry* genes used in cotton and in other breeding programmes. We may have to even buy the new tools of breeding as they are becoming increasingly patent protected.

Third, despite the fact that Indian diet is predominantly plant based and most of our protein is derived from pulses, we hardly planned for a parallel green–protein revolution. Thus though green revolution helped feeding our hungry millions, liberated our country from visible hunger and also buffered us against natural calamities we were otherwise prone to, it gradually exposed our hidden hunger due to protein deficiency. This is because the efforts of green revolution were not uniformly spread across the diverse crops that the Indian diet was based on. The first phase of the green revolution was predominantly a starch revolution. The major emphasis was on starch crops, viz. wheat, rice, maize, sorghum and a few locally important millets (e.g. finger millet). The emphasis on cereals was at the cost of a general neglect of pulses almost till recently. In fact as early as 1966, Norman Borlaug warned both India and Pakistan on the danger of such biased emphasis on cereals. He reiterated this again during 1975: *As early as 1965, I anticipated the dilemma of rapid increases in wheat yields and an adverse, indirect, negative effect on grain legume and oil-seed production.*

...with a concomitant adverse effect on diets. I urged both the governments to launch aggressive research programs to increase the yield of these crops (Borlaug, N. E., In *Nutritional Improvement of Food Legumes by Breeding* (ed. Max Milner), John Wiley, 1975). But we did not take notice of these early warnings and continued to focus almost entirely, though inevitably, on starch crops and completely neglected pulses, oilseeds and locally relevant minor millets. As a result, we lost area under minor millets, consumed protein-poor food and struggled for meeting our oil needs during 1980s.

Fortunately, thanks to the oil seed mission, the demand for oil could be partly 'managed' during the past three decades; but, protein-crop production continues to be on the deficit, severely affecting the health of the millions. In fact since three decades, not keeping pace with the increasing population, pulse production in the country has stagnated at around 12–14 MT prompting us to import 2–3 MT every year (Ali, A. and Gupta, S., *Curr. Sci.*, 2012, **102**, 874–881). Two recent news events that appeared almost on the same day, during July 2016, are clear indications of steps we are forced to undertake to correct the deficit in our protein production: (a) Prime Minister Narendra Modi during his recent visit to Mozambique, signed an agreement on 11 July 2016 for the import of pulses; (b) Karnataka government independently announced incentive strategies to promote pulse cultivation among farmers. All such events, while re-establishing the fact that there are critical loopholes in our belief of having achieved self sufficiency in food grains, stand as stark evidence of the consequences of the neglect of pulses during the first green revolution. Clearly it is time that our agricultural research and field level food production programmes begin to feel for 'pulses' and change our policies towards pro-'pulses'.

Neglect of pulses during the first green revolution is reflected both in research programmes and social investment in legumes. While there was an exclusive AICRP launched on each of the major cereal crops such as rice, wheat, maize, sorghum, etc. all the dozen and odd pulse crops were pooled into one coordinated project called AICRP on Pulses till very recently. In other words the number of scientists working, the associated infrastructure provided and research budget allocated to improve the pulses were not even a tenth of that invested on cereals. As Norman Borlaug points out, '*Grain-legume and oil-seed legume crop research. ....remain even today the ugly duckling of agricultural crops. Very little research money is being allocated to the improvement of this diverse group of crops that is so important to human diets in the developing countries.*' Sadly this neglect is even more historical and social in India; even the farmers treat pulses as secondary or tertiary crops and grow them in very marginal lands – under conditions where none of the important cereals could be grown.

One of the major reasons for such a social and policy neglect of pulses has been the belief that they are of very low yield potential compared to cereals. This however is partly a misconceived view and is more 'apparent' than real. Since protein is energy rich compared to starch, synthesizing a gram of pulse seed requires more molecules

of glucose than that needed for a gram of cereal or millet. Thus, even if pulses are as efficient as cereals in harvesting solar energy, their biomass yield would be inevitably lower owing to the rich protein content of their seeds (Sinclair, T. R. and De Witt, C. T., *Science*, 1975, **189**, 942–944). Further, precisely for this reason, to achieve the same levels of yield, pulses require more inputs and more care than cereals – a privilege they are always deprived of. In other words, the apparent lower yield levels of pulses do not reflect their inability to respond to inputs and to the genetic improvement programmes. In fact it has been shown that given enough inputs such as water and associated resources, yield potential of pulses can be substantially enhanced (Brahmaprakash, G. P. *et al.*, *Curr. Sci.*, 2004, **87**, 859–861). Sadly, their 'apparent' lower yield potential has led to a second kind of neglect of pulses both by the farmers and by the agricultural research programmes: Farmers cultivate pulses in the most marginal conditions and provide least inputs further pushing down their potential. Research programmes in the last forty years have invested very minimal resources to improve the genetic potential and production conditions of pulses. Consequently, the actual potentiality of pulses has not even been realized, let alone achieved.

In the few experimental trials that did provide pulses the 'King'ly inputs and novel treatments such as 'nipping' (Reddy, C., Genetic, epigenetic and physiological basis of asymmetry in plant growth and development: Testing the role of auto regulated flow of resources in soybean (*Glycine max* (L.) (Merill)), Ph D thesis submitted to UAS Bengaluru under the supervision of the author, Annual Reports of AICRP on Pulses (Chickpea), 2006–08), it has been demonstrated that their yield potential can be enhanced even up to fifty per cent! In other words, if we provide the inputs that they deserve, pulses would be equally responsive to investment in research. Thus a second green revolution can be achieved if the 'pulse's are properly 'felt' and, 'fed' well. That the pulses are indeed 'the ugly duckling' and could surely turn out to be a lovely 'swan song' to accomplish the second green revolution is evident in several other ways. Almost all legumes are good nitrogen fixers and hence serve as good green manure crops and soil conditioners. Some of the pulses such as horse-gram are among most adaptable drought-resistant crops. As a source of protein, they are the most energy efficient, and hence eco-friendly compared to meat. Some legumes such as groundnut and soybean in fact double as oil and protein sources. More importantly, unlike in cereals, their genetic potentiality is yet to be exploited owing to lack of investment in research in them. Therefore, investing in pulse crops would be more rewarding and sure to help pushing the pace of green revolution for the next two to three decades.

Hopefully, the Indian Council of Agricultural Research would give this Cinderella a chance to shine and dance at least during this 'decade of pulses.'

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