Pulse yields: Feeling the pulse

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Pulses are perhaps the most neglected components of our food grains during the green revolution and if we need to stabilize our nutritional base in the most eco-friendly and energy-efficient manner, we ought to alter our mindset from treating pulses as 'marginalized' crops. We argue here that the pulses are not as low in their yield performance as is generally projected and that this perception of lower yields is owing to a set of confounding issues. Nonetheless, we show that pulses are poor in harvesting the solar energy and in converting it to biological yield. We dissect the reasons for this inefficiency and trace that the inputs supplied to pulses is one of the major factors limiting the pulse yields. Accordingly, we call for an attitude change in our breeding protocols, production system and policy structure for pulse cultivation.

With the growing demand for nutritional security, pulses are becoming ever more important as a plant-based source of protein in human nutrition. Besides, the newly emerging, strong consciousness for health among the human populations is creating a genuine need for adopting a nutritionally complete but a predominantly vegetarian-based diet. This trend, conspicuous among the affluent countries is spreading to other human societies as well owing to the realization that a predominantly plant-based food system is healthy, eco-friendly and energetically less expensive. Consequently, the vegetarian-based food profile with pulses as the major protein source is likely to become more widely adopted leading to a greater demand for plant-based nutrients.

Unfortunately, unlike those of cereals, the existing production levels of pulses cannot meet the emerging demands. Pulse production is low worldover and more so in the developing countries. The low production levels of pulses has been very frequently attributed to the inherently low levels of productivity in the pulse crops[1].

Pulse yields during Green Revolution

In fact throughout the Green Revolution (GR) period, the productivity levels in pulses have not increased *vis-a-vis* cereals and oilseeds; rather they have stabilized at almost the levels that existed before the green revolution[1,2]. Indeed there are no significant breakthroughs in the yield levels of pulses and this has been viewed as an embarrassing failure of the GR and of the scientists. Unfortunately such comparisons of pulses with other crops suffer from a lot of pitfalls and hence have led to a set of erroneous beliefs. Several issues that mask the virtual productivity levels and the difficulties of breaking the yield levels in pulses compared to cereals have not been considered. We explore these confounding issues and in the process attempt to identify the bottlenecks for the breakthrough in pulse yields. We shall first discuss these difficulties and masking features about the pulse yields.

Energy content of pulses

Pulses pack more of energy-rich protein and oil in their seeds compared to cereals. Consequently, their seeds are energetically more rich than cereals[3]. This means, for similar levels of the solar energy harvested per hectare, pulses would always yield lower biological yield compared to cereals[4,5]. Further, biosynthetic pathways involved in storing the energy-rich protein in pulse seeds burn out a lot more calories. In other words, there is an additional cost due to the process involved in storing protein and fat in the seeds which also brings down the amount of harvestable biomass in pulses. Consequently, yield levels in pulses and oilseeds are expected to decrease in proportion to the energy content per unit weight of their seeds and this obvious relation is not generally considered while comparing different crops[6] (Figure 1).

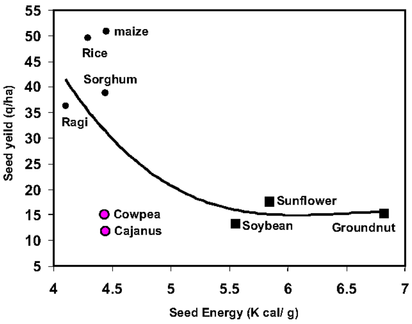

Figure 1. Relationship between seed energy content with seed yield of different crops (from ref. 6).

Solar energy utilization efficiency

Surprisingly, the negative relation between seed energy and seed yield does not seem to have affected improved production in oilseeds; the productivity levels of oil seeds have not stagnated as those of pulses. This means, even after discounting the energy richness of their seeds, pulses appear to be yielding low. One possible reason for such disparity could be that pulses harvest less solar energy in a given area and hence are low in their yield levels. This indeed appears to be true from a comparison of the solar energy conversion efficiency of pulses (Figure 2). The proportion of the solar energy harvested and/or converted into the total biological energy (i.e. for total biological yield) including that spent for storing the protein and fat, is very low in pulses compared to cereals and oilseed crops. In other words, pulses seem to suffer from a poor harnessing and conversion efficiency of solar energy and this could very well be the reason for their existing low yield levels. It might therefore be more pertinent to examine why pulses are inefficient in harnessing the solar energy.

Inputs and pulse yields

It is important to assess whether the low levels of pulse productivity is due to their innate inefficiency or due to the lack of resources (inputs) offered to them. One way of dissecting these issues is to offer a comparative analysis of the inputs offered to cereals and pulses during the period of green revolution. Extent of irrigation offered to the crops could be used as a good surrogate of the inputs supplied and thence the investment made in different crops. While it is true that the extent of irrigation required *per se* could be crop-specific, we are using irrigation here as a very suggestive index and hence our analysis is not likely to be confounded by these difficulties. We compared the per cent increase in yield with the per cent increase in the area brought under irrigation of different crops during GR. Clearly additional per cent area brought under irrigation during the GR period, is substantially higher for cereals than pulses (Figure 3) and there is a strong positive correlation between the per cent area brought under irrigation and the increase in productivity in a crop during the GR period. Thus the extent of inputs and investments made for the cultivation of a crop appears to be a significant factor influencing its productivity levels. In this context, the poor efficiency of pulses could very well be due to the 'marginalized' treatment given to them. This relation is very clear even within cereals: those crops that received higher attention during the GR period were brought under irrigation relatively more than others and accord-

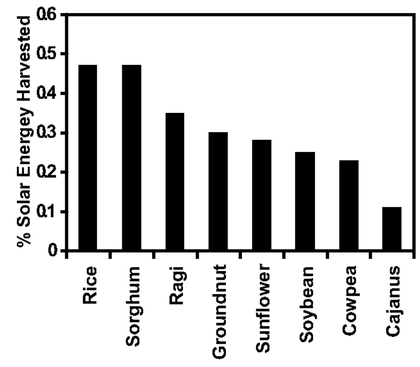

Figure 2. Per cent solar energy harvested and converted to biological yield in different crops (from ref. 6).

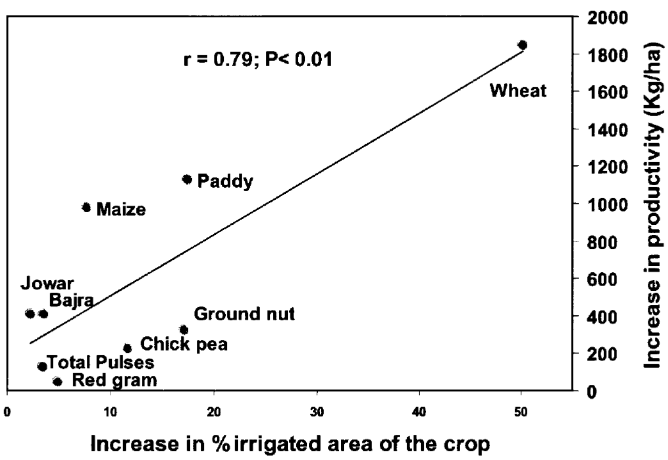

Figure 3. Relation between per cent increase in productivity and area under irrigation for the period 1995 to 2000 (from ref. 2).

Table 1. Per cent increase in productivity of mostly rainfed and mostly irrigated cereals and pulses. The comparisons are drawn for the period 1950–2000 except for soybean for which the period compared is 1970–2000 (data from ref. 7)

Crops	Cropping system	% Increase in productivity
Cereals	Mostly rainfed (Jowar, coarse cereals and bajra)	116.32
	Mostly irrigated (Paddy, wheat)	199.60
Pulses	Mostly rainfed (All pulses except soybean)	18.18
	Mostly irrigated (Soybean)	62.60

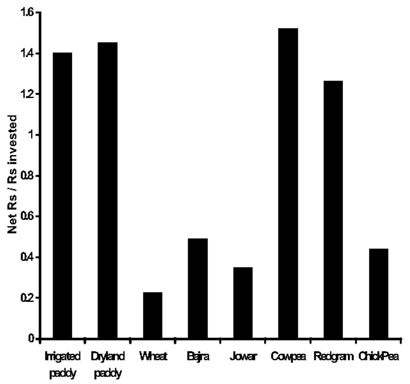

Figure 4. Net returns for every rupee invested in different crops.

ingly the productivity levels of such crops also increased correspondingly (Table 1). Crops grown under mostly rain fed conditions continued to be the poor yielders even among cereals.

In fact oil seed crops that were comparable to the pulses in their yield levels were shown to respond to added inputs following the 'Oil Seed Mission'. It is now well recognized that this ushered in the 'Yellow Revolution' (oil seed self-sufficiency) in the country.

Marginalization of pulses

Unfortunately pulses have always been a neglected lot, attitudinally as well; they were treated as 'marginalized' crops and it is not unlikely that if they are given sufficient inputs, their yield performance could be as high as those of the cereals. This is evident from the fact that soybean which is grown almost completely under irrigation has shown about 60 per cent higher productivity compared to other pulses during the period 1970 to 2000 (Table 1).

There are other but indirect suggestions that if and when pulse crops are offered higher inputs, returns from them could be as high as those from cereals. For instance two independent studies on the net returns for a rupee invested in different crops suggest that pulses are as much paying as are the cereals (one study is represented in Figure 4).

Thus even before the new strategies are adopted to improve pulse yields, it is important to realize that they are suffering from an attitude of neglect and marginalization. The high risks involved in pulse production is often cited as a reason for such marginalization. But it is not unlikely that risk *per se* can be minimized by offering better care and high inputs, which calls for a change in our attitude towards pulses. In fact, owing to this attitude, pulse genotypes are hardly screened for their response to high inputs – a successful strategy that contributed to most of the GR. Partly, the steady yield levels in pulses could very well be because there has never been a consciously driven selection for genotypes that respond to higher levels of inputs. Thus, this attitude has only contributed negatively to the pulse productivity and hence needs to be immediately addressed by all the policy makers, scientists, and planners.

Future thrust

Perhaps the most immediate need is for pulse scientists to assess whether indeed the pulses are capable of yielding better when supplied with high inputs and are supported with favourable cultivation practices. Preliminary work at our centre in pulses such as dolichos, pigeon pea and chickpea has shown that merely providing protective irrigation and treating the crops based on deficiency diagnosis *per se* could increase their productivity by almost 20–25%. Such assessment needs to be systematically taken up in all the agro-climatic zones such that the absolute potential of different pulse crops be properly inventoried. Based on these assessments breeders may have to create favourable environments while executing the selection process on pulse genotypes. Selecting pulse genotypes for the high input conditions might be the most rewarding process towards increasing the pulse production in decades to come. Parallely, production and protection managers need to undertake programmes to develop packages that suit these genotypes and that help realize their full potential. All these efforts would only be rewarding if there are policy decisions that favour pulse cultivation and induce the farmers to change their present attitude towards pulses.

1. Jeswani, L. M. and Baldev, L., *Advances in Pulses Production Technology*, ICAR, New Delhi, 1990.
2. Anonymous, Agricultural Statistics at a Glance, 2000.
3. Sinclair, T. R. and De Witt, C. T., *Science*, 1975, **189**, 565–567.
4. Ganeshaiah, K. N. and Uma Shaanker, R., *Curr. Sci.*, 1981, **50**, 942–944.
5. Sinclair, T. R. and De Witt, C. T., *Agron. J. A.*, 1976, **34**, 988.
6. Ganeshaiah, K. N., Uma Shaanker, R. and Uday Kumar, M., *Indian J. Exp. Biol.*, 1980, **18**, 700–702.
7. http://agricorp.nic.in/statistics/soya.htm

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