A dialectical perspective of agricultural research for sustainable development

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In spite of increased food production in the country due to green revolution, current levels of production cannot be sustained to meet the growing needs of the country. This is because of concurrent degradation of environment in terms of salinity, water-logging, soil erosion and air as well as water pollution, etc. How do we maximize productivity to meet the food needs of the country without deteriorating the environment? This is a challenging task and it requires altogether a different approach in the very basic methodology of agricultural research. We discuss this approach – an approach based on dialectical principles. A dialectical perspective as against the hitherto practised reductionist approach, is presented in relation to sustainability in agricultural production with several illustrative examples.

OUR country has now a massive infrastructure for agricultural research, education and extension development in terms of ICAR research institutions as well as the state agricultural universities. The efforts of the scientists working in these organizations coupled with the hard labour put in by millions of farmers across the country have brought in what is popularly known as the green revolution. This has made it possible for the total food production to rise from about 50 million tonnes in 1950 to about 190 million tonnes in 1995. However, what we have achieved is in terms of the physical access to food. We have not been able to insure its economic access, the majority of the population not having adequate income to buy the food they need. The disparity between rich and poor farmers has increased despite the green revolution technology being neutral to scale, but of course, not resources neutral[1]. Moreover, major advances in development in general and agricultural production in particular have also brought in its wake serious environmental degradation in terms of salinity, water logging, soil erosion, air and water pollution. Out of the total geographical area of 329 million hectares, around 175 million hectares have been affected by one form of degradation or the other.

We have, in fact, adopted a high-entropy agriculture wherein the aim is to use high energy flow to create more wealth even if it means degrading the environment and incurring greater losses in the form of soil erosion and loss of pest resistance. Of late, there has been growing concern on this account at the global level, the emphasis having shifted to stressing the low-entropy agriculture wherein the nature is not exploited in the production process but is instead harmonized so that the entropy of the environment decreases and sustainability in agricultural production is promoted. However, whether these so-called 'eco-farming' methods will bear fruit in providing the increased production rapidly to take care of the need of the ever-increasing population is debatable. It therefore seems that we need to look into the production process itself, particularly at the fundamental level to discover how it affects the environment in addition to being affected by it. It is only when we are able to understand the feed-back and feed-forward mechanisms of such a process in relation to environment that we can discover ways and means for incorporating sustainability in agricultural production. It seems this calls for altogether a different approach in the methodology of agricultural research itself – an approach based on *dialectical principles*. In what follows, I discuss this approach in agricultural research.

Reductionist approach in agricultural research

In crop sciences, the reductionist approach makes us regard each plant as a separate element existing in an environment consisting of soil, water, air, sunshine, etc. as well as other neighbouring plants. Each plant experiences and grows in response to its environment but the reciprocal phenomenon of the reaction of the environment in response to the plant itself is ignored. The interaction between the two is regarded as unidirectional in this approach – from environment to the plant but not vice-versa. We regard the properties of the plant as wholly predictable, barring random errors. But we know that for soil, plant seedling is the environment and the soil undergoes significant changes as a consequence of

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plant growth and that such changes in turn feed back on the plant's condition. In fact, air, water and soil interact directly with plant life and can be regarded as an integral part of it. For instance, if the soil is wetted, it is estimated that 10 million or so microbes living in cm^3 of it begin to produce and remove gases from the atmosphere and to interact at many different levels. The reductionist approach fails to take this into account. The competition of certain weed species with certain crops is a serious problem for farmers which is normally tackled by application of herbicides. But not all weeds are bad for crops and weed species compete among themselves. By using broad-spectrum herbicides, beneficial weeds, those that compete with harmful weeds are destroyed along with the harmful weeds they displace. This results in a weed problem created partly by the very operation that is supposed to cope with it. The same is true for insects which are selected for genetic resistance to insecticides by the very insecticides used to control them. In other words, the greater the cure, the greater the problem just because we isolate particular causes and tackle them in a reductionist fashion.

Dialectical perspective and sustainable development

If we look to the concepts of *part* and *whole* of a given system, we find that they have a special relationship to each other, in that one cannot exist without the other, in more or less the same fashion as the concept of *up* cannot exist without the concept of *down*. What constitutes the part is defined by the whole under consideration. Moreover, parts acquire properties by virtue of being parts of a particular whole, properties they do not have in isolation or as parts of another whole. Things which follow such properties are called *dialectical*. The Bressanone Conference held in 1981 showed for the first time the usefulness of dialectical approach as a critique of the current state of biological theory[3].

If the dialectical perspective is taken for the process of food production, we have to, by necessity, take not only environmental factors into account, but consider them as parts of the whole system. A dynamic view is to be associated with the system. As production requirements change (increase) due to population increase and rise in income levels, the environmental components are to be adjusted and vice-versa. In fact, both at the macro- as well as at the micro-levels, we have to look for concepts which are akin to dialectical ones in nature. In that case, increase in production will take into account the changes in environment. Both will go hand in hand as parts of the whole which itself will change over time. But this is what *sustainability* in production is about since it will lead to development of technologies which would meet short-term requirements while maintaining the ability to meet long-term needs. A dialectical view, therefore, seems to be necessary for developing methodologies which lead to sustainable agricultural production.

Dialectical approach in agricultural research

The reductionist approach hitherto used involves searching for levels of inputs, either singly or jointly, which optimize the output levels for crops/livestock/fisheries, etc. in a given region. Often the physical optima for different input levels are uneconomical as well as affect the environment adversely. If the latter is taken into account, we have a situation of constrained optimization which will give less output than predicted previously. This brings in a conflicting situation. For meeting the growing demand of production due to population growth and rise in income levels, higher levels of input and therefore increase in cost are now inevitable. We have, therefore, to search for a technique which can conserve input use and thereby reduce cost. This can be achieved by adopting the dialectical perspective in which bilateral relationships between output and input use are exploited along with the interaction effects with other parts of the total system. We have to take into consideration all the factors even if they seem to be hardly related to the problem. A very general approach like this will reduce to the particular solution if the seemingly unrelated factors show feeble interactions. Whereas if we ignore them, we have no means of recovering the interaction effects, should they turn out to be important later on. It is important to note that the approach will also depend upon whether we are investigating at the micro- or the macro-levels. A few examples can make this clear.

When we talk about the land use for agriculture, we have to take into account those changes in land use which cause changes in its relationships with water, weather, air quality as well as wildlife. We cannot just think of only 47% of land use meant for cultivation in isolation. We have to consider also the land that is not cultivated like forest, pasture, wasteland, culturable waste, etc. A mosaic pattern of land use needs to be established which combines field crops, perennial crops, orchards, forests, etc. in such a way as to benefit the whole region rather than maximizing production of each plot separately. Mixed land use provides buffers against several unexpected events and pest damage in addition to preserving soil fertility and spreading the demand for labour. The Government of India formulated the National Land Use Policy probably from this angle. Similarly, when we talk about water policy in relation to agriculture, we have to approach it holistically taking into account its relationships with all other environmental components. The National Academy of Agricultural Sciences, New Delhi, has recently brought out a publication, covering all aspects, entitled *Agricultural*

Scientist's Perceptions on National Water Policy[4], after intensive debate and discussion during the Second Agricultural Science Congress held at Andhra Pradesh Agricultural University, Hyderabad in January 1995.

Agricultural, industrial, energy and environmental policies are to be tuned to each other to attain sustainable development in the country. In agricultural planning, we simply cannot isolate the problem for developing a strategy for increasing food production. We have to consider the rural infrastructure, the industry, the foreign exchange, the nutrition, the health of agricultural workers and consumers and a host of other interacting factors. For instance, reliable all-weather transport is highly desirable for achieving a high level of intensity of farming, labour input per hectare, wage rates and rate of growth in non-farm employment. Due to lack of investment in such infrastructure, the long-term food security is doubtful. At present we are confining only to the species of crops already domesticated in the past. More diversity can be created by domesticating new species. Farming techniques need to be developed which include crop rotation, recycling of crop residues and use of soil micro-flora and invertebrates to promote soil fertility.

It seems the dialectical approach amounts to conducting research on each and every farm holding of the country as the ecology resource base and socio-economic condition of every farm are usually different. Not only that, the detailed knowledge and experience of the concerned farmer about his own farm are to be wedded to the theoretical knowledge of the farm scientist which he wishes to apply on that farm. In fact, often the sustainable agriculture that we are talking about is inherent in the experience of the farmer himself which he and his forefathers have learned from nature. What is probably required is to give a technical re-orientation to his knowledge and experience so as to increase his farm productivity. A collaborative and more intimate relationship between the farm scientist and the farmer is thus called for.

The dialectical approach is very similar, though not identical, to systems approach. In crops, integrated pest management (IPM) is one example of such a system which has helped improve pest management programmes by determining exactly when pesticide applications are necessary. The concept has now been extended to what is known as integrated crop management (ICM) which includes pest management, fertility management, crop rotations, production record analysis and variety selection. In such a system the inputs are optimized at the micro-level relative to yield, profitability and environmental impact. A well-developed ICM system utilizes a system of Best Management Practices (BMPs) to achieve the most profitable and environmentally sound yield level, known as maximum economic yield (MEY). No doubt MEY will be somewhat lower than the maximum potential yield for the given soil–crop–climate system. Such a system requires an in-depth study of appropriate BMPs through research projects, coupled with on-farm demonstrations and extension/consultancy programmes for site-specific management planning. These BMPs may change as economics change and/or as new technology becomes available. The Cropping Systems Programme adopted by International Rice Research Institute[5] involving rice-based cropping systems that are more productive than the existing systems, acceptable to farmers and sustainable over time is another example of this kind. The research approach is focussed on on-farm research with farmers participating in the research process. Research was conducted in farmer's fields in a defined rice environment and problems were fed back to discipline researchers to make their research focus relevant to farmers' problems.

Conclusions

In short, the intrinsic complexity of the agriculture system has to be fully recognized in the dialectical approach. What is needed is neither a labour-intensive agriculture nor an energy and capital intensive agriculture, but somewhere in-between – an agriculture based on thought-intensive technology in which the object of research is not to find new inputs but rather to find ways to reduce input use for reduction of cost. It seems the new paradigm of the method of agricultural research in years to come will have to be viewed in a dialectical perspective. It is only then that we can ensure ecological sustainability coupled with economic efficiency. Due to in-built dynamism in such an approach, we can meet current needs in agricultural production without sacrificing the prospects for meeting the needs of future generation. In other words, a dialectical perspective for agricultural research is expected to lead to sustainable development.

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