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Do we need to keep Increasing Crop Productivity for all Times to Come?

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In the first editorial of the Journal of Agronomic Research entitled *The Changing Scenario of Agriculture* published on December 26, 2017 [5], I had discussed various forms of agriculture and stressed the need of sustainability in food production. In particular, I described *dialectical agriculture* [4] as the one based on *dialetic* [2, 3], a thought process given by Hegel, a German philosopher, that moves in a three-beat rhythm. It begins with an idea- a thesis- then proceeds to develop into its opposite, the antithesis; after that the mind sees the relatedness of thesis and antithesis and weaves them together into a synthesis. This synthesis, in turn, becomes another thesis, and the dialectic continues. To give an example, let us consider the cultivation of a crop on a given piece of land in a given season. It can be regarded as a thesis. In the next season on the same piece of land, it is not cultivated i.e. kept fallow which being opposite to cultivating, is antithesis. In the third season, synthesis is brought about by cultivating the same crop again. If one looks upon it from the 'soil' point of view, in the first season, the organic matter of soil is used to grow the crop; in the second season as the land is kept fallow, the organic matter of the soil is not used. On the contrary the piece of land builds up the organic matter of the soil. In the third season when the crop is cultivated again the built up soil matter is used in its cultivation. The consumption of organic matter for cultivating the crop in the first season is replenished in the second season with its renewed use in the third season thereby preventing the loss in soil fertility. One needs therefore to 'invent' a management practice as the situation demands and keep on doing it as a regular process in crop husbandry. In other words, while non - dialectical view only looks at the crop under cultivation, a dialectical view considers the land, soil, water and other components along with crop variety in totality so

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that possible interactions amongst the components are also exploited along with multidirectional causation with feed forward and feedback mechanisms.

Ever since, around 200 years ago, when Thomas Malthus linked food production with the population, the strategy has been to produce enough food to provide for increased population. But barring those countries that have slowed their population growth rate the number of hungry people in the world remains approximately the same. This is because the increase in food production is offset by the increase in population so that the per capita availability of food remains practically the same. Increased population has therefore become a central issue. The present global population of 7.33 billion is expected to become 9.54 billion by 2050. The present food grain production is therefore required to be more than doubled to meet the requirement of this expected population by 2050. Not only agriculture, in fact, almost all sectors are affected by it. We go for any activity and we have *crowds, crowds,* and *crowds*. Demographers and population scientists have no doubt been making efforts to arrest the growth of population by suggesting the adoption of relevant policies. Even if the policies succeed, the population will still grow for a long time by sheer momentum. So the problem of agriculture is in fact to produce more and more *in spite of population pressure.*

We have already reached the limits of increasing food production by expansion of acreage – the horizontal dimension. And since *green revolution* we have been exploiting the vertical dimension of increasing the crop productivity. Prospects seem good if we are able to adopt biotechnological methods and advantages of genetic modification in *crop plants, livestock, poultry and fishery etc.* But there is a catch. We may not be able to achieve quantum jump in productivity as we need to increase productivity in a sustainable manner. This means development and adoption of technologies that would meet short-term requirements while maintaining the ability to meet long-term needs. In other words, a country's natural resources – the land, water, and genetic endowment – are to be used in a manner that is environmental friendly, economically viable and meets the concern of the society. This puts a constraint on the use of inputs indiscriminately for increasing production.

The process of grain production is normally taken as unidirectional in which relevant inputs are responsible for the output – the production – much like independent (cause) and dependent (effect) variables in statistics determining the direction of the causal relationship. But what happens if the cause flows in both directions? The process of production affects the environment in terms of the soil health and the ecosystem surrounding the plants, in addition to being affected by them. Plants make ecosystem and ecosystem makes the plants. In intensive cropping systems for instance, plant growth extracts nutrients from the soil that adversely affects its health. If the soil health is to be preserved at some desired level for future use, the production process gets constrained in that the production would become *less* than what it would be if we ignore the effect of increased production on the characteristics of the soil. We have then to determine by how much the production gets lowered in maintaining the soil status. At the same time when the soils deteriorate, as a feedback, the plant productivity goes down. We need then to determine by how much the soil erosion is to be prevented to maintain the crop productivity at the same level. This means the sustainable growth strategy would have to take into account, both, the environmental effect of the crop production process as well as the feedback from the quality of environmental resources to crop productivity. It seems the sustainable food strategy works in much the same way as the dialectical view point stated above.

In general terms however this looks like a systems-theoretic approach to the problem. It is not. Take for example the Farming Systems Research and Extension (FRS&E) approach in which the whole farm of a given household is treated as a system with interdependent components under the control of the members of the household and their interactions with the physical, biological and socioeconomic factors *not* under the household's control. Intimate interaction between the scientists and extension personnel is ensured by undertaking technology development for identifying appropriate genotypes and agronomic practices for the given region, using statistically sound experimental designs on operational – scale plots in farmers' fields. Systems modeling can be undertaken by the mathematics of feedback and other relevant details about the interactions amongst the various components of the farming system. But this approach is not likely to include in the analysis the *anxiety* or the *conditions* that produce it due to lack of the format for the necessary equations. Agriculture is a life and death problem for farmers. If conditions turn out to be hostile to their farming practices, they are beset with anxiety. Such emotions are known to have their effects on their farms'

productivity. In dialectics, however, one can approach the problem of such a complexity even without knowing the exact form of the equations. This is because here the 'processes' are given more emphasis than the 'things' regarding thing as a snapshot of the process. The process means change and so the dialectics cover dynamics as well in its approach. The relation of continuity and discontinuity in the process is an aspect that systems theory does not deal with at all. In a way systems approach is to be subsumed under dialectics.

In view of the above it is apparent that there are hindrances in the exploitation of vertical dimension of increasing crop productivity. And even if we are able to overcome them the issue is how long it will last. Sooner or later the limits will be reached as has happened in the case of horizontal dimension. It seems therefore that we need to look for another dimension even now to take care of the alarming scenario of increased population pressure in the future. Is there one such a dimension? The dialectical approach can help in finding it out.

The usual approach in deciding upon the policies for growth in different sectors of economy like agriculture, industry, health, environment, education etc. is to treat them separately like different compartments of the economy with minor attention to linkages between them. A dialectical view on the other hand requires taking all of them together by exploiting interactions between them along with a multidirectional causation with feed forward and feedback mechanism. Each sector affects other sectors and is affected by them as well. For instance, a policy choice such as allocation of resources to health programs could affect the health outcomes of the people. But what would happen if health outcome of the policies result in public action to demand change in policies in other sectors too in the absence of appropriate linkages? Even in a developed country like USA, they don't have an agricultural policy linked to health policy.

Every five years the Federal Government of USA issues dietary guidelines for healthy eating in which it is usually suggested Americans reduce their consumption of meat and dairy and eat more plant based foods. Recently, there was some change in these guidelines to take into account the fact that lower meat consumption cuts greenhouse gas emissions, lessening the contribution their habits make to climate change. In other words they like to tell them to pay attention to how their food is grown, not just what's in it. They have given the following statistics on greenhouse gas emissions: Table1.

It is apparent that plant – based foods contribute much less to greenhouse emissions. Eating rice creates one-tenth of carbon emissions of that contributed by beef. A dietary pattern that is higher in plant-based food and lower in animal-based foods is more health-promoting and at the same time is associated with lesser environmental impacts – energy, land, and water use. Such a policy being environmentally friendly will lead to sustainability.

This gives us a clue to the other dimension that we are looking for. *Do we need to keep increasing crop productivity for all times to come?* Food production is linked with food consumption. Per capita availability of food is linked with per capita food consumption that we engage in ourselves. What we eat, how much we eat, whether we eat to live or live to eat etc. are no doubt our personal choices but dietary habits can be regulated by self will in times of exigencies. Instead of consumption *per se* one can stress *need-based consumption* that leads to sound health. So the strategy should be to *increase per capita availability of food* rather than to keep increasing crop productivity in spite of the population pressure. This attitude will prevent over consumption as at present and control enormous wastage that is taking place all along post- harvest operations to the plate of food that becomes available to us for eating.

Table 1. Kilos of carbon emissions produced per kilo of food

Lamb	39.2	Beef	27.0	Cheese	13.5	Pork	12.1
Turkey	10.9	Eggs	4.8	Rice	2.7	Milk	1.9
Lentils	0.9						

This would amount to reduced consumption. It can lead to decrease in demand and, if the food production and the population remain the same, to generation of surplus food grains leading to *increased* per capita availability of food. Such a policy seems to be another dimension away from the operations on the farm and can thus imply sustainability for all times to come.

In an article entitled 'A million species in danger' [1], the author Roni Dengler cited a U.N. report released in May, that one million species face extinction, more than ever before in human history and that humanity is responsible. The intergovern-mental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) based this assessment on some 15,000 sources that consider the causes and consequences of environmental changes over the past 50 years. The findings are very alarming and of the 25 percent of the world's plants and animals vulnerable to extinction, over 9 percent of domesticated mammal breeds used for food and agriculture may already have been lost.

The rapid decline of the natural world endangers global food security and quality of life. There are five drivers that are responsible for this grim situation:

- Land- and sea-use change i.e. the conversion of ecosystems to agriculture, aquaculture and other human developments
- Direct exploitation of organisms i.e. overharvesting, logging, hunting and fishing
- Climate change including rising sea levels and increasing extreme-weather events, wildfires, floods and droughts
- Pollution especially plastics
- Spread of invasive species, non-native organisms that can displace or kill native plants and animals

The authors of IPBES conclude by saying 'transformative change" – such as a new global approach toward consumption and waste - could turn the tables.

This view tallies with what has been stressed in this Editorial that we need not keep increasing the crop productivity. Instead we need to keep increasing the per capita availability of food by reducing need-based consumption and wastage implying sustainability in the availability of food for all times to come.

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