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Challenges and Opportunities for Organic Agriculture and the Seed Industry

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Foreword

Organic Agriculture and an Ever-green Farm Revolution

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Abstract
Sustainable food and nutrition security, under conditions of diminishing per capita arable land and irrigation water resources, and expanding biotic and abiotic stresses, including potential changes in climate, calls for accelerated scientific efforts in the development of technologies and agronomic management procedures which can help to enhance productivity in perpetuity without associated ecological harm.

I coined the term, "ever-green revolution" about 15 years ago to emphasise the need for paying scientific and social attention to yield-enhancing approaches which can help to harmonise current and future needs of food and other agricultural commodities. Today, there are uncommon opportunities for fostering an organic farming revolution by harnessing the tools of frontier science.

Ever-green revolution, soil health cards, efficient micro-organisms, nutritious cereals and bio-happiness\

Introduction
In January 1968, I made the following statement at the Indian Science Congress Session held at Varanasi in India, to emphasise the need for a proactive action-reaction analysis while bringing about changes in farming methods (Swaminathan, 1968).

"Exploitative agriculture offers great dangers if carried out with only an immediate profit or production motive. The emerging exploitative farming community in India should become aware of this. Intensive cultivation of land without conservation of soil fertility and soil structure would lead, ultimately, to the springing up of deserts. Irrigation without arrangements for drainage would result in soils getting alkaline or saline. Indiscriminate use of pesticides, fungicides and herbicides could cause adverse changes in biological balance as well as lead to an increase in the incidence of cancer and other diseases, through the toxic residues present in the grains or other edible parts. Unscientific tapping of underground water will lead to the rapid exhaustion of this wonderful capital resource left to us through ages of natural farming. The rapid replacement of numerous locally adapted varieties with one or two high-yielding strains in large contiguous areas would result in the spread of serious diseases capable of wiping out entire crops, as happened prior to the Irish potato famine of 1854 and the Bengal rice famine in 1942. Therefore the initiation of exploitative agriculture without a proper understanding of the various consequences of every one of the changes introduced into traditional agriculture, and without first building up a proper scientific and training base to sustain it, may only lead us, in the long run, into an era of agricultural disaster rather than one of agricultural prosperity."

The term, "green revolution" implies advances in crop production through the pathway of productivity improvement and since this is the only pathway available to population-rich but land-hungry countries, I coined the term, "ever-green revolution" fifteen years ago, to stress the need for ensuring that productivity improvement today is not at the expense of possibilities for productivity improvement in the future (Swaminathan, 1996). For achieving such an ever-green revolution, there is need for greater scientific efforts in the development of eco-technologies based on appropriate blends of traditional ecological prudence and soil fertility replenishment and pest management methods with frontier science and technologies. E O Wilson (2002), supporting my concept of ever-green revolution, made the following remarks:

"The problem before us is how to feed billions of new mouths over the next several decades and save the rest of life at the same time, without being trapped in a Faustian bargain that threatens freedom from security. The benefits must come from an evergreen revolution. The aim of this new thrust is to lift food production well above the level attained by the green revolution of the 1960s, using technology and regulatory policy more advanced and even safer than now in existence".

Science and Organic Seed

To ensure that organic farming leads to higher productivity per units of land and water, it is essential that research in the following areas is intensified.

Soil Health Management

The earlier methods of soil fertility management, like shifting cultivation, are no longer relevant today due to population pressure on land. Cereal-legume rotations or inter-cropping are important for replenishing soil fertility. Efficient green manure plants like the stem nodulating *Sesbania rostrata* and bio-fertilizers comprising efficient micro-organisms (Teruo Higa, 1998) have to be packaged in an integrated nutrient supply system, which includes the application of compost, organic manures and plant residues. Inputs are needed for output. For example, the rice plant needs for yielding a ton of rice at least 20 kgs. of nitrogen along with appropriate quantities of P, K and micro-nutrients. Research on soil health management in order to ensure adequate soil fertility for high productivity should receive high priority. The EM (efficient microorganisms) methodology of *Higa* needs greater emphasis.

All organic farmers should be provided with Soil Health Cards to monitor regularly the physics, chemistry, microbiology and erodability of their soils. Care of soil health is fundamental to a productive agriculture.

Sustainable organic farming will also need bioremediation agents which can help to improve soil health through the sequestration of salt, heavy metals and other yield reducing constraints. A consortium of micro-organisms each capable of performing important functions like nitrogen fixation, phosphorus solubilisation, and sequestration of salts and pollutants will have to be developed for each major agro-climatic and agro-ecological farming system.

The other area of research which is essential for sustained high productivity is integrated pest management, involving concurrent attention to pests, diseases and weeds. For this purpose, there is need for a biosecurity compact, which will help to manage not only pests, diseases and weeds, but also invasive alien species and mycotoxins in food. Sanitary and phytosanitary measures and codex alimentarius standards of food safety need to be integrated in organic production protocols.

As population pressure on land and water increases, there will be need for productive genotypes of crop plants which can perform well under conditions of soil salinity, alkalinity and acidity. Special Genetic Gardens will have to be established for halophytes and drought tolerant genotypes. Also, suitable donors for salinity tolerance and drought tolerance will have to be used in anticipatory breeding for adaptation to climate change and sea level rise. MSSRF scientists have been able to develop sea water tolerant genotypes of rice, mustard and legumes using the mangrove species, *Avecinnia marina* as donor. Similarly, *Prosopis juliflora* is being used as donor of genes for drought tolerance. Such pre-breeding work needs to be integrated with participatory breeding with farm women and men so that location specific varieties can be developed. Genetic diversity is essential to avoid vulnerability to pests and diseases. Therefore, gene deployment strategies will have to be developed for each agro-ecological region jointly by scientists and farm families. Successful organic agriculture will need a paradigm shift from purely experiment station based research to participatory research in farmers' fields.

Teruo Higa's complex culture of naturally occurring beneficial microorganisms such as phytosynthetic bacteria, lactic acid bacteria, yeasts, fermentative fungi and actinomycetes has multiple uses. It can be used to purify water and sewage, solve sanitary problems, and improve the environment. There is need for more research on such consortia of micro-organisms.

Recent research at MSSRF by Drs Loganathan and Sudha Nair and has led to the isolation of a bacterial strain capable of fixing nitrogen and solubilising phosphate. This strain named *Swaminathania Salitolerans gen.nov.sp.nov* was isolated from the rhizosphere, roots and stems of salt tolerant wild rice associated with mangrove species. Field trials in rice using this microorganism are now in progress.

Sustainable organic agriculture will need more science and not less. Artificial barriers should not be created among scientific methods. What is important is to harness all the tools that traditional wisdom and contemperory science can offer in order to usher in an era of bio-happiness. The first requirement for bio-happiness is nutrition and water security for all and for ever. This is the challenge before all involved in organic farming and the seed industry.

The seed industry has a particularly vital role to play in ensuring genetic diversity in crop plants and to providing organic farmers with genotypes based on a pyramiding of genes for tolerance to major biotic and abiotic stresses. There is also need for greater attention to under-utilised or orphan crops, since many of them are not only nutritious, but also capable of performing well under fragile and rainfed environments. In order to change the mindset relating to nutritious millets, FAO should change the terminology from "coarse cereals" to "nutritious cereals". The global food basket is getting narrow and there is need to enlarge the food basket by including in the diet a wide range of cereals, millets, grain legumes, vegetables and tubers. In the past, human communities depended upon several hundred species of plants for their nutrition and health security. Diversified farming systems and dietary habits are essential to confer benefits on both the producer and the consumer from organic farming methods.

Crop husbandry and forestry are the major solar energy harvesting enterprises of the world. An ever-green revolution will help to optimise the capture of solar energy and the production of farm commodities through a symbiotic interaction between solar and cultural energy. This is the pathway to sustainable food security and bio-happiness.

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Challenges and opportunities in organic seedproduction

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For every species, variety or other group of plants, there are always two reasons for seed production . In the first place it is the production of commercial seeds, the basic propagation material to grow the crop. But, contrary to any industrial production, the product itself is also maintained by seed production. Seed cannot be produced out of any raw element, only by reproduction of itself (in case of F1hybrids through parent lines, but that is of no importance in this sense).

For that reason seed production cannot be regarded apart from maintenance and plant breeding.

Some difficulties or restrictions that can be encountered during seed propagation has an origin during earlier generations. In a wider perspective, the breeding methods used are not only determining the quality of the seeds, but also can influence, restrict or stimulate the sustainability of the maintenance of our cultivated crops as a cultural heritage.

Organic seed is a crucial link in the chain from research, breeding, seedproduction to organic production. The aim is to provide the grower with appropiate and healthy seeds at a reasonable price. With organic seed the grower can complete the chain with organic input; for seed companies organic seed is the start for selecting and breeding appropiate organic varieties.

In this presentation I will restrict myself to practical aspects of organic seed production, especially vegetable seeds.

Professional organic growers, just like their conventional collegues, are making high demands on the quality of seeds. This means that seedproduction should take place under optmal and favourable conditions. Compared to conventional seedproduction there are several aspects that deserve extra attention.

Optimal Climate and Region

Since no treatment with chemicals is possible to control diseases or pests, it is important to find the optimal climate for a favorable development of the seedcrop. For the same reason it can be a solution to find a region where the crop is not grown whidely. Diseases and pests are then prevented because infection is unlikely.

Cultivation Methods

Depending the crop or species, a wide range of cultivation methods can be developed to improve seed production. Only a few examples are mentioned, like drip-irrigation in stead of watering over the crop, planting in a wider spacing for a drier microclimate in the crop, tieing up the crop on poles for the same reason, moderate fertilisation to stimulate a generative plant development. Although these measures can vary strongly for each species, they are applied in order to improve the condition of the seedcrop.

Diseases and Pests

One have to distinguish between diseases, wich are affecting de seedcrop, and diseases wich are seed tansmitting and therefore seedborn.

The first group can cause an increase of the quantity and/or quality of the seeds. The best way of precaution is to avoid a weak crop by improving cultivation conditions, like mentioned above. When diseases or pests appear, they can be treated with biological pesticides or predators, not different from organic production of vegetables. Sometimes, as far as the seeds are not affected, an infection of a seed crop is not as critical as with the vegetable crop. You can imagine that a light aphid infection does not harm the seeds, but makes a leafy vegetable unmarketable. The opposite case is when aphids can transmit seedborn virusses. Then the seeds are useless, while the vegetable could still be acceptable, at least partly.

Seed transmitted diseases are a serious problem, since disinfection afterwards is often impossible. Such diseases must be avoided. Sometimes the damage can be limited by harvesting the seedcrop in parts. This is done for example in tomatoes by harvesting weekly and in celery by harvesting the upper part of the crop separately from the lower part (a higher risk of septoria). When seeds are nevertheless infected, disinfection of the seeds is in some cases possible by warm water treatment.

Weeds

Weed cannot be eliminated by herbicides, so they must be avoided or removed mechanical or by hand. Weeds can have a negative influence in several ways. When there is much weed in the seed crop, the microclimate can get humid or oppressive, wich causes fungal diseases like botrytis. Like a wider plant spacing, a well weeded seed crop improves the quality of the seed.

Secondly weed causes contamination with weedseeds in the harvested seedlot, wich may be hard to clean. Espacially here, prevention is better than cure.

Seed processing

Threshing, cleaning and grading organic seeds show no differces with conventional seeds, since only mechanical machines are used. For pelleting or priming seeds some specialized companies have developed certified organic procedures with only natural compounds and elements. With the exception of chemical treatments and coatings, almost all seedtechniques are available for organic seed to meet the professional standards for high quality.

Genetic or variety aspects

Varieties are choosen and selected because they perform well at the organic vegetable grower. That will not mean that they always perform well during organic seedproduction. Some diseases are not of importance for the vegatble production, but can be a serious problem in seedproduction. This can be the case in some bianual crops and in some F1 hybrids.

Rust or Mildew can cause damage in the second season, after bolting. The vegetable grower only grows the young plant and is harvesting the crop before bolting, so he is not faced with the disease.
Some hybrids have parent lines, wich are inbred lines and weaker than the hybrid they are producing. Under organic conditions these parentlines are very hard to grow seed from. They might have a poor root system, or are succeptible for diseases (wich is not expressed in the hybrid).

These examples show that a successful variety for the organic market should be adapted not only from seed to crop, but from seed to seed. Organic varieties, bred under organic conditions fulfill these conditions better than conventional bred varieties. In most cases however, seed for the organic market depends on conventional breeding. When organic seed producers and growers are involved in an early stage during breeding, it will also be possible to develop adapted and high perfoming conventional varieties for the organic market.

Food and Agriculture Organization of the United Nations

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