



Crop science and ethics

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Being a crop scientist today is not easy. Although crop research was chiefly responsible for last century's fourfold increase in average yields and sixfold rise in total harvest, biological agricultural science is increasingly equated with threats to human health, environmental degradation and, above all, genetically-modified "frankenfood". In order to continue their contribution to human development, crop scientists must regain credibility and public acceptance. That process might begin by analysing, from an ethical perspective, trends in the world around us and the scientific challenges they pose.

► **Basic trend: uneven distribution of food.** While world food production has increased dramatically, an estimated 820 million people are still undernourished. Our latest projections, which put that figure at 580 million people in 2015, are no cause for celebration. Imbalances in the availability of food are mirrored by the uneven application of improved production technologies. While this is due mainly to factors outside the realm of science, scientists bear part of the responsibility for the choice of crops that have been addressed and the types of ecological conditions and production systems that have been targeted.

► **Truly "global" trend: globalization.** The ever increasing mobility of capital, labour and goods has offered opportunities to poorer countries. But whatever its potential benefits, the balance is mixed. Globalization is inextricably linked to privatization, a growing trend also in science, where knowledge is being privatized through intellectual property rights.

Globalization also results in concentration - the world's top 10 seed and agro-chemical industries account for an estimated 85% of the world market. How will these trends affect the direction of scientific research, particularly in view of evolving food needs?

► **Emerging response: diversification of crops and diets.** Along with rising incomes and urbanization, global food demand is becoming



more diversified and quality-oriented. But diversity is not just for the urban rich. For the poor, too, diversity in food production and consumption is essential, for increased intake of micronutrients. Diversification of crops and products and increasing nutritional qualities demand a sophisticated scientific approach. The ethical issue is, again, how choices are made and priorities are set with respect to the needs of underprivileged target groups.

► **Background trend: agricultural services to society.** Agriculture provides more services to society than just producing calories or income per hectare. The sector is increasingly held responsible for environmental services, such as preservation of watersheds, protection of agricultural biodiversity, carbon sequestration and production of renewable energy. The ethical question for the scientist is how to provide an objective, scientific basis - including indicators of environmental, economic and social impact - for balanced, sustainable agricultural growth.

► **Overwhelming trend: the information revolution.** Despite the "digital divide" that limits the access of the poor to information technology, developing countries are quickly taking advantage of IT in the field of agricultural science and its application. On the Internet, however, scientific excellence and nonsense exist side by side. While IT may become a great transboundary equalizer, the need for reliable sources of scientific data is growing. The ethical issue here is whether scientists, in private and public sectors alike, are sufficiently sharing their results, including their doubts and failures.

The challenge facing crop science is clear: to contribute to poverty alleviation, food security and a balanced diet for a growing world population through development of intensive cropping systems that have beneficial - or, at least non-harmful - effects on the environment and provide a range of services to society. FAO sees the following five main scientific issues:

► **Responsible use of land and water.** Balancing the water requirements of agriculture with those of population and industry forces crop science to re-examine yield performance. Expressing crop yield per unit of water, rather than unit of land, may drive a significant shift towards other crops. This is happening in China, where we expect a major shift from rice to wheat over the next 25 years. Research is also needed on simple techniques, such as water harvesting, that reduce risk and increase yields, on water-saving strategies in irrigation, on better adaptation of crops to limited water availability and on development of new, drought-tolerant lines. The revolution in molecular genetics promises to make it possible to target quantitative trait *loci* and thus increase the efficiency of breeding for some traditionally intractable agronomic problems.

► **Harnessing diversity.** That nine plant species provide more than 75% of human food is largely the result of agricultural science's selective focus, which has neglected a wide range of other species adapted to different ecological niches. Domestication of new crops is time consuming, but there is great scope for the improvement of locally important minor crops. Food insecure populations would also benefit from greater attention to multipurpose species, such as sorghum, which has great potential as a source of food, sugar, animal feed and bio-energy. Not enough research has been devoted to biological nitrogen fixation, despite its potential for enhancing the performance of crop legumes and for transferring nitrogen-fixing capabilities to non-leguminous crops. Also needed is a fresh look at the use of perennial crops, because of their lower fertilizer needs and their role in soil conservation. Finally, crop diversification strategies could help mitigate or reduce green house gas emissions and favour carbon storage.

► **More empirical and integrated approaches to sustainability.** A farming system can be called sustainable if organic matter, nutrient cycling, soil structure, erosion and ease of root penetration are all at acceptable levels, and if this results in crop yields that are fully satisfactory compared to potentials, and if rates of off-site losses are acceptable. But to ensure that advances in crop science can be adapted to the scale and reality of production, research institutions must become more closely involved with *real* farms on a long-term basis.



A pragmatic, empirical approach is urgently needed at a time when crop science is becoming too atomized and specialized to be able to perform the integrating function needed for achieving sustainability.

► **Genetically modified organisms.**

Ultimately, biotechnology will allow a more precise adaptation of genotypes to environmental conditions, nutritional and dietary needs, and market preferences. But it arouses two distinct concerns. First, is it increasing the amount of food in the world and is more food accessible to the hungry because of it? A second concern - more frequently posed - is genetically modified crops (GMOs) and their possible negative effects on health and the environment. We cannot yet predict the adverse effects of the inserted gene itself nor the way in which the inserted gene may alter expression of existing genes. No human health problems resulting from biotechnology have been documented to date, but this lack of evidence is not the same as knowing that genetic modification *is* safe. Internationally, food safety is addressed in the FAO/WHO Codex Alimentarius, and the effects of living modified organisms on biodiversity by the Cartagena Protocol of the Convention on Biological Diversity. But international and national regulation and risk assessments are relatively new, and public trust in these processes is low.

► **Transparency of information and decision making.** Much public concern over crop science derives from a feeling of being left out or, worse, of not being told the truth. Science could have done much more to win public support by being more open about its pioneering work in molecular biology and genetic engineering. *Post-factum* attempts to overcome consumers' doubts have not allayed entrenched suspicions. Calls for labelling of foods containing ingredients from GMOs highlight the need for transparency. Some leading food companies have excluded genetically engineered ingredients from their products, but others are lobbying strongly against public pressure to segregate GM foods. The net result is a polarization that continues to perturb public administrations and industry. Scientists have an absolute moral responsibility in providing objective, peer-reviewed information to the public and to refrain from publicizing immature, insufficiently tested results - positive or negative.