AGRICULTURE IN THE EARLY XXI CENTURY:
Agrodiversity and Pluralism as a Contribution to Ameliorate Problems of
Food Security, Poverty and Natural Resource Conservation

Reflections on Issues and their Implication for Global Research

EXECUTIVE SUMMARY

Issues Paper Commissioned by the GFAR as a Basis to Elaborate a
Global Shared Vision on Agricultural Research for Development

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Introduction

As part of GFAR’s efforts to formulate a Global Shared Vision, this paper was assigned the function of analysing significant global changes and trends in agriculture and their implications for a Global Research Agenda. While previous efforts in global research aimed mainly at increasing overall food production, GFAR’s ToR recognised the need to focus them on production increases leading to the eradication of poverty, the improvement of food security and the conservation of natural resources.

Previous versions of the Draft were discussed with GFAR’s Secretariat and Management Group. The final discussion will take place in Dresden, as a last step in the process of improving the final version. This draft covers a wide range of issues, which have been organised around five main themes: Global Trends Affecting Agriculture; Impacts of Global Trends on Agriculture; Reflections on Trends and Impacts; Towards a Knowledge Agriculture; and Towards a Global Research Agenda.

Global Trends

Globalisation appears as the dominant pattern promoting positive changes in the economic world. But the rural poor has not benefited from it, and in many cases has been negatively affected, reducing their spectrum of opportunities to make a living. In spite of their global nature then, the change process and impact of these patterns are not the same for all developing regions or social groups. With this caveat, the following are trends that seem to have a special impact on the future evolution of agriculture.

Trade Globalisation. Trade in agricultural commodities is expected to go up in the coming two decades, from 187% for beef and 139% for rice to 62% for coarse grain and 29% for root and tubers. It should improve food security by increasing access to food, but trade of poorest countries has fallen from 4% in the ‘60s to 1% in the ‘90s.

Nature of Food Demand. Urbanisation is rapidly becoming the predominant pattern for human settlements throughout both the developed and the developing world. Total rural and urban population are expected to be about the same by the year 2020. Urbanisation widens the gap between type of food produced on farm and that consumed in the cities, turning farm output into a less important component of food supply.

Poverty Persistence. The number of people living on less than $1-$2/day in 1998 (1.2 and 2.8 billion respectively) was almost the same, or larger, than that in 1987. Based on the experience of the last decade, poverty reduction in the coming decade will make little progress. The proportion of people living on less than $1/day will only be reduced from 24 to 22%. Under a scenario of inclusive growth poverty could reduce by half.

Food Production. From the early 60s to the late 80s developing countries increased their cereal production by more than 100%. Of the total increases 33% were attributed to improved varieties, 33% to each irrigation and inorganic fertilisers. Since then yields for cereals under intensive cropping are leading to a steady decline in world growth rates of cereals production, from 2.9% in 1967-82 to 1.8% in 1982-94. As a
result of these, and of higher demands, developing countries that were net exporters of agricultural products ago are now net importers. In addition, chemical contamination of waters in adjacent rivers and lakes from high-input agriculture is affecting that source of aquatic food, supplying 18% of the total world catch.

**Environmental Concerns.** Civil society and consumer concerns over natural resource conservation and food safety are increasingly affecting technological practices for food production and processing. Such concerns refer to the possible effect of agricultural management practices on environmental pollution, global warming, biodiversity, deforestation, water use, health, and even societies’ views on the role of the rural landscape and their eventual consequences on life quality.

**Science and Technology.** Scientific advances are shaping a new tecno-economic paradigm. Biotechnology has the potential to increase crop adaptability for the marginal conditions of subsistence agriculture, and also to control specialised food systems in commercial agriculture. But so far biotech labs are not addressing the problems of poor farmers on marginal lands, as they cannot afford to pay for “appropriable” technologies. Information and Communication Technologies (ICTs) can facilitate participation, improve resource management, design land use policies, and increase the precision of agricultural practices, provided that their demand for people with higher education and skills are met. Concern for natural resource conservation is taking the agronomic sciences to bring the biodiversity, synergistic relationships and spatial heterogeneity that characterise ecological systems into the design and management of agroecosystems; while struggling to articulate the resulting “niche-oriented” supply with the “commoditised” demand of prevailing food systems.

**Changes in the Public Sector and Civil Society.** NARIIs confront increasing difficulties to sustain their level of operation, their capacities eroded by policies aimed at dismantling the public sector. In developed countries such processes are accompanied by growing investments from the private sector, which is making significant contributions to the development of embodied technologies for commercial agriculture. Such trends are not evident in the developing world, but non-governmental and civil society organisations are playing an increasing role in the empowerment of small farmers to use local knowledge in the conservation of natural resources and the development/adaptation of improved technologies.

**Impact of Global Trends**

The above trends could affect agricultural development in ways that outgrow their potential benefits. The following are some of the possible impacts.

**Production Efficiency.** Production increases in high-input agriculture are the result of decreasing responses to greater external inputs, i.e. ‘getting more with more’ on the basis of ‘throughput’, and not of higher bioeconomic efficiencies. In many cases such systems are ‘profitable’ due to government subsidies, as without them they would not be competitive.

**Food Security.** Econometric analysis are optimistic about the possibilities of meeting future world food needs; the problem being not so much availability as income to access the food supply. Others warn that the world could be rapidly approaching its
agricultural carrying capacity, given inherent ecological limits to a sustainable production growth. Declining yield growth rates under ever increasing inputs raise questions about the capacity of existing systems to both keep up with increasing overall food demand and make food accessible to all people around the world. Under these circumstances, and given trade globalisation, it is argued that production inefficiencies could be reduced by moving commercial agriculture away from subsidised economies to developing countries, benefiting both consumers and competitive producers.

**Poverty and Equity.** Increased agricultural production and lower prices have benefited mainly the urban poor, but have not had the same effect on rural areas, where overall poverty remains at relatively high levels. Poverty persistence in the midst of increases in overall food production serves to highlight difficulties in bringing marginal areas - where most rural poor people live - into high input/modern agricultural strategies. On the commercial side an increasing proportion of today's food supply is the result of long chains of value adding, where farmers’ share in decision making and final price is ever smaller. The development of rural communities is then no longer dependent on farming efficiency but on their capacity to attract agroindustrial investments, with a higher share of value added and higher employment requirements than primary sector production.

**Environmental Conservation.** High-input agriculture seems to be taking natural resources into a danger zone; by either ‘polluting’ the environment through the inefficient application of agrochemicals, or ‘degrading’ land through the mining of soils in areas of heavy land pressures. The impact of *pesticides* on rural population health is increasing, especially in developing countries where safety measures are not properly followed. In resource-rich areas *land degradation* is associated with the decline in species and cycles providing ecological ‘life support services’. In low-income countries declining soil fertility is the major problem, leading to land "mining" (86% of countries in Africa have negative balances of nutrients larger than 30 kg. of NPK/ha/year). Mining is also a problem for groundwater-based agriculture, responsible for 10% of the total production. Water tables are rapidly falling in many parts of China, India, Mexico and elsewhere. As agriculture consumes 70% of the total water used, the quantity and quality of water available could become a limiting factor for agricultural development in the XXIst century.

**Dynamics of Research and Development Systems.** Scientific advances, and the application of intellectual property rights to the life sciences, are having a significant impact on the institutional organisation of agricultural R&D. The commercial appropriation of many of biotechnological products is setting the stage for a redefinition of public-private relations in technology development. On the one hand they represent new opportunities for the flow of additional resources into agricultural R&D. On the other associated linkages between private science and technology development lead to the generation of ‘embodied’ technologies not easily adaptable to the heterogeneous agroecological circumstances, and low capital availability, of developing countries. Public sector R&D could then play a key role in applying biotechnology and ICTs to the small-scale, diversified and heterogeneous “problematique” of small farmer agriculture, not yet attractive to the private sector.

**Reflections on Trends and Impacts**
The proposed vision is built on three elements: 1) food security, 2) poverty eradication and 3) a more sustainable use of natural resources. It is a moving target, difficult to obtain, that helps to identify and focus on the most important and effective areas of intervention. Prevailing trends suggests that by the year 2025 aggregated agricultural production should be enough to meet the global market demand for food.

But if in the coming decades we are to ensure that all poor people are well fed, we should undertake the challenge of increasing production in subsistence systems where a high proportion of the rural poor live, while, at the same time, minimizing the negative environmental impacts of high input agricultural paradigms associated with commercial agricultures supplying urban populations. In other words to approximate the proposed vision we need to attain the following goals:

1. Maintain 2-3% annual increase in food production world wide to assure global food security.
2. Assure an adequate regional localization of production specially in food deficit regions. Given the projected levels of regional food gaps trade alone could not assure regional food security.
3. Develop technological options less dependent on chemical inputs and more environmentally sustainable.
4. Improve the productivity of marginal lands and poor farmers.
5. Contribute to development processes that lead to economic growth without excessive economic concentration, urbanization and equal distribution of incomes and wealth.

Prevailing technological patterns are leading agriculture into the use of inefficient high-input models that degrade the environment. In addition, such capital-intensive models can not be applied to subsistence farming, which is forced to deplete the natural resource base. The challenge to R&D systems is twofold: i) increase the productivity of resources available to subsistence systems on low potential lands - where a high proportion of the rural poor live; and ii) minimise the negative environmental impacts of high input technologies associated with commercial agriculture, while increasing their productivity.

Towards a Knowledge Agriculture

A new agricultural pattern is needed to cope with envisaged demand for and required accessibility to food, while conserving the resource base. It will have to combine production intensification with sound ecological management. This new paradigm needs then to expand on the prevailing input productivity focus to search for the bioeconomic efficiency of whole systems, blending scientific and local knowledge on synergetic processes in diversified agroecosystems. The following are the main characteristics of this ‘Knowledge Agriculture’ paradigm (KA).

Plays a Multifunctional Role. Although the production of food and other primary goods is still the most important agricultural role, its use of the land yields a wide range of non-food goods and services that could be grouped according to their:
- economic functions, to sustain development, especially in developing countries;
- social functions, that maintain the dynamism of rural communities to improve their economy and life quality, and to capitalise on local knowledge for the development of sustainable innovations; and
- environmental functions, resulting from agro-ecosystems that optimise the beneficial linkages between agriculture and the ecological functions of the natural environment.
Driven by Pluralistic Participation. KAs manage larger ecological and economic diversity, in which trade-offs between private benefits and social costs require the full participation and collective action of all members of the community. Innovations should then be the result of complex social processes that lead to deliberate changes in the management of natural resources, driven by the private and collective intentions of interested actors. This requires for innovations to be developed at social levels of aggregation congruent with the rural space of the problem or opportunity on hand; and in a framework where actors can perceive the common reality that makes them interdependent; design processes for decision-making and conflict resolution; and organise themselves to operationalise the management of resources.

Based on Agrodiversity. A type of diversity resulting not only from genetic and species composition of production systems, but by their spatial and/or temporal arrangements. Such a diversity is fundamental to a productive, efficient and sustainable agriculture, by contributing to the ecological integrity of agroecosystems through, *inter alia*, the:

- Regulation of the sedimentary cycle;
- Buffering of the hydrological cycle;
- Maintenance of soils exchange capacity;
- Disposition of wastes and dead organic matter;
- Renovation of soil fertility; and
- Control of pests, through natural predators, parasites and pathogens.

Built on the Use of Science for the Sustainable Management of Natural Resources. Developed and applied at different scales in the agroecosystem:

- At farm level, to promote synergetic relationships among components of production systems, including external inputs, e.g. i) direct sowing and cover crops, that protect soil surface by increasing organic matter content, maintaining the biomass, and improving soils biological activities; and ii) crop-livestock interactions and legume rotations, to improve the flow and recycling of nutrients;
- At watershed level, to diversify agroecosystem structures across the landscape, combining the greater resilience of species-rich agroecosystems with the larger yields of annual species in ‘patchy’ land uses, where high yield monocropping systems alternate spatially/temporally with forest/pastures.

Governed through Decentralised Decision-making. Agricultural impacts on the ecological integrity of agroecosystems affect the socio-economic relationships across landscapes. There is a need then for organisational structures that allow a collective management of spatial externalities (water erosion and integrated pest management are just two examples of the need for collective action). Given heterogeneity among levels of aggregation, decentralising decision-making to organisations at the micro and macro-watershed levels appears as an appropriate structure to facilitate the development of sustainable KAs. They should:

- discuss the identification of technological demands at the ‘micro’ level; through a closer interaction between actors representing the environmental and productive perspectives of agricultural land uses; and
- contribute at ‘macro’ levels to i) the identification/development of opportunities for adding value to primary products; and ii) gathering and disseminating information related with production-conservation trade-offs.

Towards a Global Research Agenda
Developing KAs to their full potential requires of activities in the scientific and institutional fields. The former to integrate what is known and ‘fill the gaps’, and the latter to provide incentives and mechanisms to reorient production and distribution patterns towards a more sustainable and equitable resource use. The implementation of a GRA needs then of a concerted action in two inter-related areas of analysis: Research and Institutional Organisation.

Research Areas. Although knowledge areas and themes are certainly not new, it is the integrated nature of the approach and the foci which will make KAs’ research unique, and complementary to that developed by the private sector.

- In the search for biodiversity, research on germplasm conservation should cover the whole spectrum of agroecological zones, including not only crop and animal species but also those in the soils biota. That on enhancement, however, should concentrate on crops used by poor farmers and on low-resource areas, focusing biotechnological efforts on the adaptability of ‘above- and below-ground’ species to existing natural resources and socioeconomically feasible systems in such areas.
- In the field of synergetic relationships, knowledge on the maintenance of soil organic matter and the role played by the quality of organic resources on patterns of nutrient availability should serve both productivity of natural resources in poor areas and efficiency of utilization of exogenous inputs in capital intensive systems.
- An important research theme in spatial heterogeneity is the key processes involved in the up- and down-scaling of information linking agroecological phenomena across the hierarchy of agroecosystems, to identify the pros and cons of agricultural ‘externalities’ among different ‘patches’ in the landscape.
- In the area of institutional economics research should focus on the design of mechanisms to facilitate negotiations among actors on land uses and technological needs, and the identification/development of marketing strategies.

The Global Research System. The implementation of a GRA needs a multi-institutional organisational framework, aimed at developing and taking advantage of a wide array of collaborative arrangements bringing together very diverse institutional partners from the public, private and civil society sectors. Development of a Global Research System must then be seen as an organisational process aimed at:

- the progressive strengthening of each participating institution;
- a systematic learning process in relation to research collaboration, strategic alliances and partnerships; and
- the setting up mechanisms for the participation of all institutions in the management of resources potentially important for the achievement of common objectives.

Given the decentralised governance that characterise KAs, the building blocks of a Global System could be agroecosystem organisations integrating the complementary capabilities of heterogeneous actors operating in them. Such ‘innovation networks’ could be developed through alliances among international, governmental, parastatal, industrial, producer, non-governmental and community organisations to pursue common purposes. These voluntary organisations should:

- Create flexible environments to build and disseminate knowledge through learning processes based on the interaction among members;
- Allow consensus-building on strategies and operational methods, followed by the assignment of responsibilities to carry out agreed tasks;
- Facilitate the establishment of strategic alliances among actors, and to mobilise resources behind concerted efforts.