Malthus and Mendel: Population, science and sustainable food security

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The year 1998 marks the bicentenary of Thomas Malthus' essay on the impact of population growth on world food supply. His fears relating to an exponential growth in population have come true, while his apprehensions relating to the rate of growth in food production lagging behind that of population growth rate have not materialized. In check-mating Malthusian fears, scientific advances in crop improvement based on Mendelian genetics have played an important role. As we approach a new millennium, the question arises whether Malthusian fears will still come true in the years ahead. Can recent advances in molecular genetics, information, space, renewable energy and management technologies help promote sustainable food security? These questions will be discussed at an inter-disciplinary dialogue to be held in Chennai in the last week of January 1998.

Malthus and Mendel

Thomas R. Malthus in his essay on 'The principle of population as it affects the future improvement of society' published in 1798, warned that 'the period when the number of men surpass their means of subsistence has long since arrived'. Two centuries ago when Malthus wrote his essay, the global population was less than a billion. Now the population exceeds 6 billion.

In spite of a 6-fold increase in human population since 1798, there is enough food on the market today for all who have the requisite purchasing power. The average life span of human beings has gone up considerably all over the world. While the death rates are dropping rapidly, birth rates have not shown a commensurate decline in most developing countries. Consequently, the human population will increase by another billion during the next 11–12 years. In addition to population increase, the following trends raise the question, 'will Malthusian fears come true in the early part of the coming millennium?'

- Diminishing per capita arable land and irrigation water availability.
- Expanding demand for food, particularly animal products, as a result of higher purchasing power and increased urbanization.
- Stagnation in marine fish production since 1990.
- Increasing environmental damage and distinct possibilities of adverse changes in climate and sea level.
- Fatigue of the green revolution due to technological stagnation, leading to a decline in the per person world grain production from 415 kg in 1985 to 360 kg in 1996.

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The above situation has led experts like Lester Brown of the World Watch Institute to predict that China and India may have to import each year over 240 and 40 million tonnes of food grains respectively by the year 2030. The entire world trade in food grains now is about 200 million tonnes. From where will such quantities of food grains come and what will be the impact of such large imports on world grain prices?

During the last 30 years, technology and public policy have played a dominant role in averting famines of the kind Malthus anticipated. The last big famine in the Indian sub-continent was the Bengal famine of 1942–43. In the technological transformation of Indian agriculture, genetic tools based on Mendelian laws of inheritance have played a catalytic role. Starting with the commercial exploitation of hybrid vigour in maize in the US nearly 60 years ago, significant advances have taken place in the genetic enhancement of the production potential of many economic plants and farm animals including fish. The introduction of a semi-dwarf plant habit in wheat and rice, the exploitation of hybrid vigour in rice and the genetic manipulation of yield and quality in several crop plants marked the dawn of the era of the green revolution in the late sixties. High-yielding genetic strains coupled with appropriate agronomic and crop protection practices and opportunities for assured and remunerative marketing, have helped to keep the rate of growth in food production above the rate of population growth in most developing countries, except in parts of Africa.

In spite of significant gains in improving the productivity and profitability of major cropping/farming systems, there are some sad features of the global food and nutrition scenario, as pointed out at the World Food Summit held in Rome in November, 1996:

'An estimated 841,000,000 people, i.e. one in every five persons in developing countries, now go to bed hungry (food–energy deficient).

'Some 150 million children are underweight, 230 million are stunted and 50 million children are wasted.

'Vitamin-A deficiency affects 40 million children. About 29% of the world's population is at risk of iodine deficiency. World-wide, about 2 billion people are affected by iron deficiency.'

The FAO World Food Summit resolved 'to reduce the number of undernourished people in the world to half its present level by 2015'.

Contemporary experience indicates that while emergency feeding programmes are necessary in special circumstances, improving household access to food through poverty reduction is the only sustainable solution to the problem of endemic hunger. It is in this context that the following comprehensive definition of Food Security adopted at the Science Academies Summit held at MSSRF in July 1996 assumes relevance.

- That every individual has *the physical, economic, social and environmental access* to balanced diet that includes the necessary macro- and micro-nutrients, safe drinking water, sanitation, environmental hygiene, primary health care and education so as to lead a healthy and productive life.
- That food originates from efficient and *environmentally benign production technologies* that conserve and enhance the natural resource base of crops, animal husbandry, forestry, inland and marine fisheries.

The principal operational implications of the Science Academies' concept of food and nutrition security are the following:

1. The *physical dimensions* of food and nutrition security will involve a transition from chemical- and machinery-intensive to knowledge-intensive and eco-friendly farming technologies.

2. The *economic dimensions* of food and nutrition security require the promotion of sustainable livelihoods through multiple income-earning opportunities, such as can be offered through crop–livestock–fish integration, agroprocessing and agribusiness. Also, a job-led economic growth strategy involving micro-level planning, micro-enterprises and micro-credit will be necessary to achieve the goal of work opportunities for all.

3. The *social dimensions* of food and nutrition require addressing gender, class and ethnic discrimination against marginalized sectors of society, who consequently tend to be the most nutritionally insecure.

4. The *environmental dimensions* of food and nutrition security will involve attention to soil health care, water harvesting and management and the conservation of biodiversity, as well as to sanitation, environmental hygiene, primary health care and education.

Transition from Mendelian to molecular plant and animal breeding

The stagnation in maximum yield levels during the nineties in crops like rice and wheat has been a cause for concern. Also, further increases in productivity will have to be achieved without associated ecological harm. Productivity-increasing technology and food-loss reduction strategies, such as improved storage, processing and marketing should be ecologically sustainable, economically viable and socially equitable. Cost and risk must be low and return must be attractive, if the poor are to derive benefit from new technologies. Recent research

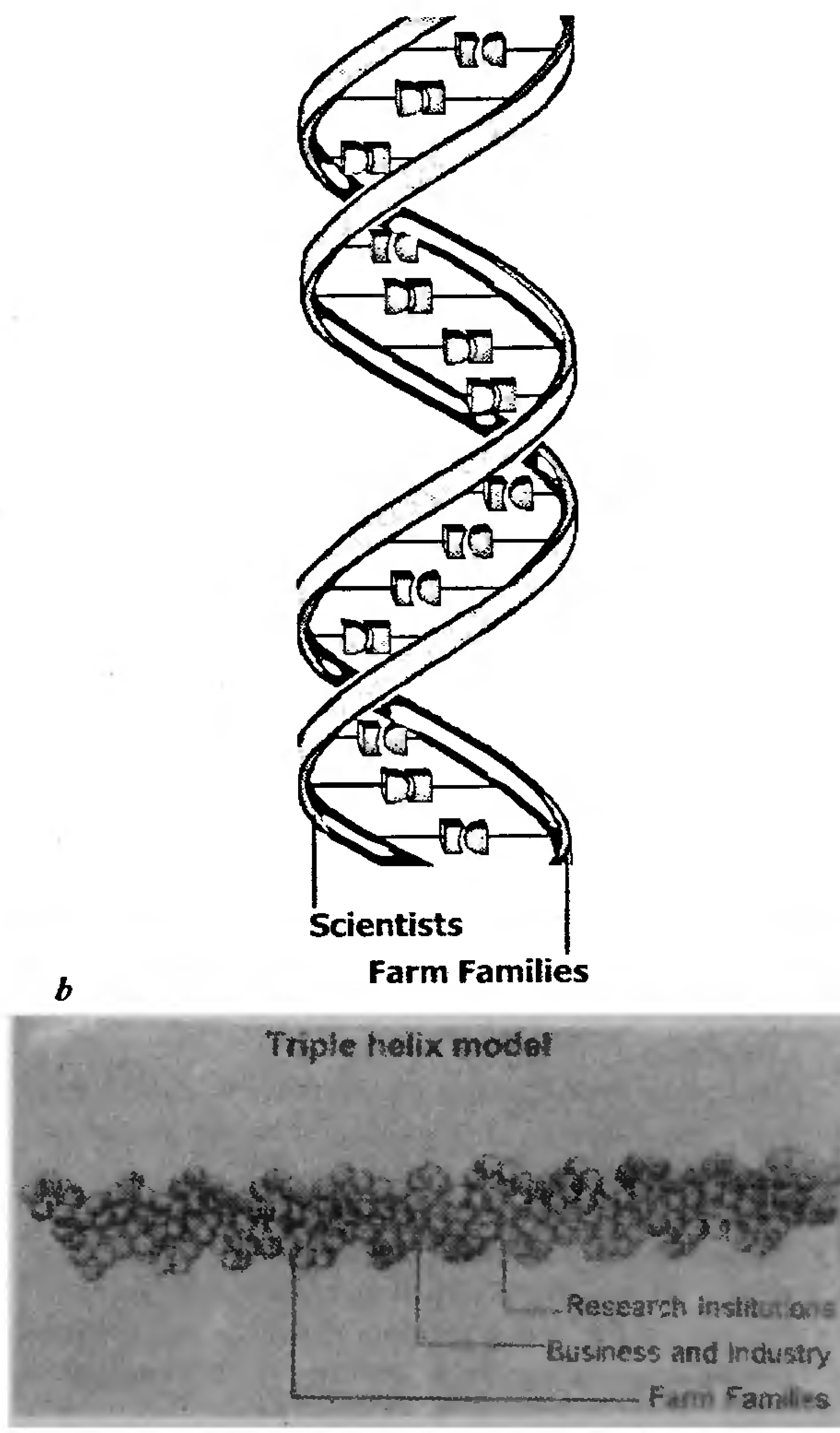

Figure 1. (*a*) Double and (*b*) triple helix models of partnership.

on ecotechnologies involving low external input sustainable agricultural practices suggests that farm yields can be doubled from the present level in many countries of Asia and Africa.

What will be the impact of transition from Mendelian to molecular genetics on the productivity, profitability, sustainability and stability of major farming systems? Can a blend of Mendelian and molecular breeding help to raise ceiling to yield and help in developing strains possessing resistance/tolerance to a wide variety of biotic and abiotic stresses? Can the benefits associated with genetic engineering and recombinant DNA experiments outweigh risks? Can an internationally accepted biosafety protocol be appended soon to the Convention on Biological Diversity? Will a blend of traditional and frontier technologies including bio-, information and space technologies help us to produce more agricultural commodities from less land and water without damage to the ecological foundations essential for sustainable advances in biological productivity? These questions need understanding and answer, if the Malthusian predictions are not to come true in the coming millennium.

Research for international and national public good

Recent trends in the privatization of agricultural research, globalization of economies, introduction of trade-related intellectual property rights (TRIPS) leading to a strengthening and widening of patent regulations; plant variety protection procedures and other forms of intellectual property rights (IPR) regimes lead to the question, 'will the economically and socially underprivileged sections of farm families tend to get by-passed by frontier science?' Should not research for public good get strengthened particularly in areas having a bearing on food and health security? What should be the future role of organizations like the Consultative Group on International Agricultural Research (CGIAR) and National Agricultural Research Systems (NARS) devoted to international and national public good? How can a symbiotic social contract be fostered between private sector companies and resource-poor families, with a view to including the excluded in terms of technological and skill empowerment? Who will carry out anticipatory research to help meet potential changes in temperature, precipitation, ultraviolet-B radiation and sea levels? Who will standardize technologies for managing the impact of climate on agriculture?

The urgent need for strengthening research for public good at the global and national levels is obvious. There is also need for new patterns of research organization which can help to (a) promote ecologically and socially sustainable agriculture in partnership with farm men and women, and (b) foster meaningful partnerships among 'public good' research institutions, private sector industries and farm families. Such 'double' and 'triple' helix models of partnership are shown in Figure 1.

In all such partnerships, principles of ethics and equity should guide the relationships among the partners.

Dialogue outputs

An inter-disciplinary Dialogue on the same topic as this article's title (Chennai 28–31, January 1998) will address such issues in order to promote a new paradigm of farm research rooted in the principles of ecology, economics, social and gender equity and employment generation.

The specific questions to be addressed are:

- How can the 1996 FAO World Food Summit goals be achieved sooner?
- How can the tools of frontier science and technology, such as biotechnology and information, space, renewable energy and management technologies be converted into powerful instruments for fostering a job-led economic growth strategy which can minimize human deprivation and optimize opportunities for children being born for happiness and not just for existence?
- How can agricultural and biotechnological research supported by public funds for public good and similar research supported by the private sector become mutually reinforcing, so that, irrespective of their individual strengths the collective strength of public and private sector R&D institutions becomes considerable.
- What changes are needed in research programmes for achieving an internalization of considerations of ecology and gender and social equity in technology development and dissemination?
- What changes are needed in the structure and strategies of national and international agricultural research centres to achieve the twin goals of poverty eradication and natural resources conservation?

The proceedings of the Dialogue will be published for widespread dissemination; in addition, the Dialogue will help formulate a framework for launching an *Ecology of Hope* initiative in agriculture. The purpose of this initiative will be to indicate sustainable options for achieving the goal of producing more food and other agricultural commodities under conditions of shrinking per capita arable land and irrigation water resources and expanding biotic and abiotic stresses.