

Population, Environment and Food Security

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SUMMARY

Most developing countries are characterised by both high population growth and pervasive poverty. There is extensive prevalence of nutritional anaemia among pregnant women, resulting in low birth weight children which leads to several health problems in the child's later life as well as adverse effect on brain development. The paper discusses at length how we can foster a 'children for happiness' movement. Gender justice and social and economic equity are vital for success in achieving a balance between human numbers and the supporting capacity of our life support systems. Introduction of National Programme for ensuring food and health security to every individual has been emphasized. There is need for implementation of integrated Monsoon Management Strategy developed during 1979-80. Micro level management which promotes the use of precision-farming techniques involving plant-scale agronomy rather than just area based approaches has been advocated. Sustainable food production can be achieved only by conserving genetic variability and using it for the purpose of enhancing the productivity, profitability and stability of major cropping systems.

We have to view food security from the view point of physical, social, economic and environmental access.

Key words: Population policy, Ecosystem, Sustainable food security, Plant-scale agronomy, Genomics and molecular genetics.

1. Introduction

It is a privilege to write an article in memory of the late Dr PV Sukhatme. I had the great good fortune of knowing Dr Sukhatme for over 3 decades. He is one of the greatest scientists, visionaries and clear thinkers ever born in our country. He was deeply concerned with issues relating to poverty, population and malnutrition. Hence, I wish to deal with some of these issues in a paper dedicated to his memory.

2. Children for Happiness

In 1952 the Queen of England congratulated 255 people on their hundredth birthdays and 1135 couples on their 60th wedding anniversaries. By 1996, these

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numbers had risen to 5218 and 11688, respectively. The data reveal an exponential rise in the number of centenarians with a doubling time of 11 years, and of diamond weddings with a doubling time of 19 years. An analysis by Prof Perutz [1] indicates that such an exponential rise coincides with the beginning of a steady rise in real wages. Another important factor is the steady improvement in medical treatment at old age from 1946 onwards. While attending to the problems of the aged is becoming an important one in many industrialised countries, fighting the famine for jobs for the youth assumes greater urgency in our country.

More than half a century ago, Albert Einstein suggested that 'we shall require a new manner of thinking if mankind is to survive'. In a recent paper, Kenneth Smail [2] argues that this new thinking should focus on population issues. According to him, "all of world's people must come fully to terms with the fact that a person's biological right to have children must be mediated by his or her social responsibility not to have too many". This is essential to resolve the growing tension between two apparently irreconcilable trends, namely, demographic projections that world population will reach 10 to 12 billion by the year 2050; and scientific estimates that the Earth's long-term sustainable carrying capacity at *an adequate standard of living* may not be much greater than 2 to 3 billion. Consuming more than the earth can regenerate is not a problem that lies in the future. Many non-renewable and renewable resources are already being used in an unsustainable manner. Today, our planet is getting polarised both in demographic and economic terms. Most developing countries are characterised by both high population growth and pervasive poverty. At the same time, a minor fraction of the world's people consume a disproportionate amount of natural resources.

The economic inequity prevailing among members of the human family is growing. According to UNDP's Human Development Report of 1996, "the assets of the world's 358 billionaires exceed the combined annual incomes of countries with 45 percent of the world's people". Unsustainable lifestyles on the part of a billion and unacceptable poverty on the part of another billion thus coexist. As we near the end of this millennium, we can be proud of the collapse of skin color based apartheid. What however is disturbing is the spread of economic and technological apartheid.

The industrialised countries are now in a state of transition to 'knowledge-based economies', economies which are directly based on the production, distribution and use of knowledge and information. Knowledge is being codified and transmitted through computer and communication networks in the emerging 'information society'. Employment in the knowledge-based

economy is characterised by increasing demand for more highly skilled workers. Economic growth is being increasingly determined by the configuration of national innovation systems, which consist of the flows and relationships among academia, industry and government in the development and dissemination of science and technology.

It is in this context that the extensive prevalence of nutritional anaemia among pregnant women, resulting in low birth weight children, is a cause for serious concern. There is increasing evidence of the adverse impact of low birth weight on brain development in the child. In addition, low birth weight leads to several health problems in the child's later life (Table 1).

Table 1 : Percentage of infants with low birth-weights

South Asia	%	South East Asia	%
Bangladesh	50	Indonesia	14
India	33	Laos	18
Nepal	26	Malaysia	10
Pakistan	25	Phillippines	15
Sri Lanka	25	Thailand	13
		Fiji	18
		Vietnam	17

Source: Dr. S. Gopalan, NFI Bulletin, July 1998

On the one hand intellectual property is becoming globally the most important asset, while, on the other hand, every third child born in India and several South Asian countries is handicapped at birth in relation to opportunities for the full expression of the child's innate genetic potential for mental and physical development. *Such inequity at birth is the cruelest form of social inequity.*

It is clear that human numbers should go down. The pathway to achieve this goal was indicated by the French mathematician Marquis de Condorcet, who wrote in 1795, "Population growth can be limited if people have a duty towards those who are not yet born; that duty is not to give them *existence* but to give them *happiness*" In my view, such a change in mind-set is fundamental to achieving population stabilisation in India and other developing countries.

How can we foster a 'children for happiness' movement? It is obvious that this involves having children by choice. Unless such a movement gains strength, any rational analysis of the reasons why we should reduce human numbers will have no impact in the real world. Taking our country, which

has now the highest annual net increase in population in the world, there are states, like Kerala, where population growth is already negative (TFR - total fertility rate - of 1.7). There are other states, like Uttar Pradesh, where the TFR exceeds 3.5. The desired demographic transition to low birth and low death rates has yet to take place in most parts of the country, except in the states of Kerala, Tamil Nadu, Goa and Mizoram. Andhra Pradesh is also now in a state of demographic transition. It is now recognised that such a wide variation within India in achieving a demographic transition to low birth and death rates is because of variations in factors like infant and maternal mortality rates, female literacy, gender equity, age at marriage and the effectiveness of the family planning services. Gender justice and social and economic equity are vital for success in achieving a balance between human numbers and the supporting capacity of our life support systems.

Inter-state variation in human and social development indicators sheds light on the pathways we should adopt for achieving a balance between human population and the supporting capacity of the ecosystem. In 1995 a Government of India Committee for drafting a national population policy statement for the consideration of Parliaments which I chaired, recommended a paradigm shift in our population stabilisation strategy, with a view to achieving a national TFR of 2.1 by the year 2010. A few of the major recommendations of this Committee are given below.

Paradigm Shift Recommended by the Swaminathan Committee (1995)

Existing	Swaminathan Committee
Strategy Target and technology driven approach	Human & social development centered. Effective implementation of Minimum Needs Programme
Think and plan centrally and act locally	Think, plan and act locally and support nationally
Awareness Generation National slogans, symbols, and educational strategies	Sensitisation and self-awareness of rural and urban communities concerning the population - supporting capacity of their ecosystem
Planning Tool Five-year plan of the Department of Family Welfare, Government of India	Socio-demographic charter for the village/town prepared by the people
Delivery Service Contraceptive services	Integrated health security including reproductive health and user-preferred family planning devices.

To reduce IMR, MMR and low birth weight among children, it is essential to work for food security at the level of each individual, since the household is not a homogenous unit with reference to nutrition. Women and girl children often tend to be relatively under-nourished.

A demographic transition to low birth and death rates can be achieved if population policies are rooted in the principles of ecology, social and gender equity and opportunities for food, health, literacy and work for all. The Expert Group therefore recommended a "pro-nature, pro-poor, pro-women and pro-democratic choice" approach to population policies.

Bold political commitment and action are essential for achieving our population goals. Maharashtra introduced many years ago an Employment Guarantee Scheme from its own resources. Similarly, Tamil Nadu introduced 18 years ago a universal Nutritious Noon Meal Programme for all school going children. A study sponsored by the Government of Tamil Nadu in 1996 for initiating a Hunger-Free Area Programme in the State has revealed that the following 7-point Action Plan can help to eliminate both protein-calorie undernutrition and hidden hunger sooner than most believe possible.

Components of the Action Plan

- Identification of the ultra-poor families by the rural population (studies reveal that about 12 percent of the population fall under this category).
- Information empowerment on anti-poverty projects based on both computer aided extension and household entitlement cards (giving information on government projects, disaggregated by gender, age, social and economic status).
- Elimination of protein-calorie undernutrition, by ensuring that the targeted public distribution system reaches the ultra-poor.
- Elimination of hidden hunger caused by deficiencies of micronutrients, particularly iron, iodine and vitamin A; the role of horticulture, inclusion in the diet of millets and other micronutrient-rich grains and fortified salt and other products should be given integrated attention.
- Promoting the biological absorption and retention of food through the provision of safe drinking water and better environmental hygiene; attention to primary health care, and the provision of user-preferred contraceptive services.
- Ensuring economic access to food through multiple livelihood opportunities based on micro-level planning, micro-enterprises and micro-credit, all based

on marketing opportunities. All development programmes must be subjected to an employment impact assessment.

According special attention to children and women and bringing to them the benefits of all programmes sponsored by Central and State Governments and international agencies like UNICEF. Special emphasis should be given to reproductive health and to the elimination of nutritional anaemia among pregnant women, so as to ensure that new born baby does not suffer handicaps in later life due to low birth weight. Avoiding low birth weight children by eliminating nutritional anaemia among pregnant women should be an important criterion in the measurement of the impact of hunger-free area programmes.

The National Agenda for Governance issued recently by BJP and its alliance partners states, "We will ensure food security for all and create a hunger-free India in the next five years". Time is opportune now to introduce a National Programme for ensuring food and health security to every child, woman and man in the country. At the same time, we should not neglect issues relating to food production and availability since our agriculture is still described as a "gamble in the monsoon", I would like to deal with the management of monsoons.

3. Monsoon Management and Sustainable Food Security

Over a year ago, scientists discovered a rise in ocean temperature off the coast of Peru. That was the first sign of El Nino, a climate anomaly witnessed periodically. The severe tornadoes that hit Florida and California early this year, as well as the drought-induced forest fires witnessed in the Amazonian region and in Indonesia during the past 10 to 12 months have both been attributed to this weather phenomenon. Recently, when I was in Ghana, President Rawlings attributed the food shortage in that country to drought caused by El Nino. Several climate experts expect El Nino's effects to weaken soon.

We have been fortunate to have had a series of normal South-West monsoons during the last 10 years. It is hoped that this year's monsoon will also be satisfactory. The last serious droughts were in 1979-80 and 1986-87. During 1979-80, when I was the Principal Secretary of the Union Ministry of Agriculture, an integrated Monsoon Management Strategy was developed consisting of the following major elements.

First, establish in every district a **Crop-Weather Watch Group** consisting of climatologists, farm scientists, representatives of farmers' and womens' organisations, concerned officers of government and representatives of financial

institutions and mass media. The tasks to be addressed by such a Group include monitoring monsoon progression, development of contingency plans and alternative cropping strategies to suit different weather probabilities, building seed reserves of alternate crops and intensifying efforts in the area of water harvesting and minor irrigation. The aim is both to maximise the beneficial impact of a good monsoon on agricultural productivity and minimise the adverse impact of aberrant rainfall through efficient water saving and use, crop life saving practices and contingency land use plans.

Second, demarcate in each district the most favourable areas (MFA) from the point of view of intensifying agricultural production through appropriate public policies and investment, particularly in minor irrigation and water management. MFA areas are those where the moisture retention capacity of the soil is high and where irrigation facilities are either available or can be created compensatory production programmes designed to offset to the extent possible crop losses in the drought or flood affected areas, can be introduced in MFA areas.

Third, develop strategies for introducing effecting relief and rehabilitation measures in the areas most seriously affected (MSA) either by drought or floods. In chronically drought prone areas, such measures should include earmarking community land for establishing cattle camps to save the lives of farm animals and identifying aquifers which can be conserved as "ground water sanctuaries" for being tapped for the supply of drinking water only when absolutely essential.

The above three-pronged strategy will help to minimise both human sufferings and crop losses when monsoon behaviour is abnormal and results in drought or floods. The Rural Godown Scheme, also introduced in 1979, was designed to promote the decentralised storage of harvested produce, so as to prevent distress sales by farmers when the harvest is good and panic purchase by consumers when crop losses are high.

The India Meteorological Department is now in a position to make fairly accurate long and medium term weather forecasting. Our electronic communication network, including radio and television is now very extensive. The emergence of grassroot democratic institutions, with one third representation to women provides unique opportunities for improving the productivity and stability of dry farming areas, which constitute nearly 60% of the cultivated areas, through group endeavour in water saving and sharing. We should train in each village panchayat atleast one male and one female member in the science and art of monsoon management. Such trained members can be designated "**Climate Managers**". Wherever possible, the concerned Agricultural University

or ICAR Research Institute should provide such village level Climate Managers information derived from computer simulation models, so as to help them to be prepared to handle both adequate and aberrant monsoon rainfall.

The need for a micro-level understanding and management of temperature and precipitation is evident from the fact that through the monsoon rains during last year were normal in national terms, the total food grain production decreased by 4 million tonnes due to climatic variations at local level. Micro-level management promotes the use of precision-farming techniques involving plant-scale agronomy rather than just area based approaches. Plant scale agronomy is knowledge and information intensive and affords opportunities for making farming intellectually stimulating, in addition to being economically rewarding. It is in this field that the panchayat level Climate Managers can play a valuable role in collaboration with farmers' and womens' associations and agricultural extension personnel.

The National Agenda for Governance of BJP and Alliance Partners states, "we will earmark 60% of the Plan funds for public investment in agriculture, rural development and irrigation". It is important that this commitment is converted into programmes which will enable our 100 million farming families to help the country to maintain not only food self-sufficiency, but also political independence.

In the last years of his life, Mahatma Gandhi often stressed that the first and foremost duty of independent India is to create an enabling environment where every citizen can earn his or her daily bread. Food insecurity at the level of the individual today is more due to a famine of jobs and purchasing power, rather than due to a shortage of food in the market. The National Agenda for Governance commits itself to "give to the entire national development efforts a human face with total eradication of poverty as the ultimate goal. For this **Berozgari Hatao** - eradicate unemployment - is our call". It is clear that a high percentage of new livelihood opportunities has to come from agricultural and agro-industries sectors. This again stresses the urgency for according on-farm and off-farm employment high priority. This in turn will call for greater investment in water conservation and sustainable use, post-harvest technology and rural roads and markets.

El Nino reminds us of the weather phenomena beyond our control and of the need to be prepared to face different contingencies. Pokhran teaches us that given a right blend of political will and scientific skill, seemingly impossible tasks can be achieved. What is now needed is the translation of these lessons in the field of agriculture resulting in the professionalisation of

agricultural planning and action at all levels, starting with the village Panchayat. If this is done, the old saying that "Indian agriculture is a gamble in the monsoon" can be replaced by the saying "India's agricultural strength lies in its ability to manage the monsoons."

4. Challenges and Opportunities

Sustainable food security at the level of the individual involves

- availability of food in the market
- access in economic terms
- absorption in the body, through the provision of safe drinking water and environmental hygiene.

At a meeting of Science Academies held at MSSRF, Madras, India in preparation for the World Food Summit in November 1996, it was agreed that national food security systems should ensure:

- that every individual has the *physical, economic, social and environmental access* to a 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.

Immediately after World War II, food security was considered only in physical terms (*i.e.*, adequate production and availability). In the seventies it became clear that economic access to food is equally important. In the eighties, it was recognised that food security has to be considered at the level of the **individual and not merely of the household**, since within a household women and girl children often tend to be more under- and malnourished. In the nineties, it is becoming evident that environmental hygiene and safe drinking water as well as the intake of the needed micronutrients are equally important. Poor environmental sanitation and unclean drinking water affect adversely the biological absorption and retention of food. Thus, today we have to view food security from the viewpoints of physical, social, economic and environmental access.

Sustainable food production can be achieved only by conserving genetic variability and using it for the purpose of enhancing the productivity, profitability and stability of major cropping systems. In the coming millennium,

we have to produce more food and other agricultural commodities but produce them differently to avoid long term harm to the ecological foundations of agriculture. This challenge can be met only by harnessing the tools of genomics and molecular genetics and integrating them with location-specific conventional breeding. This is why well defined and implementable biosafety protocols are essential at the national, regional and global levels.

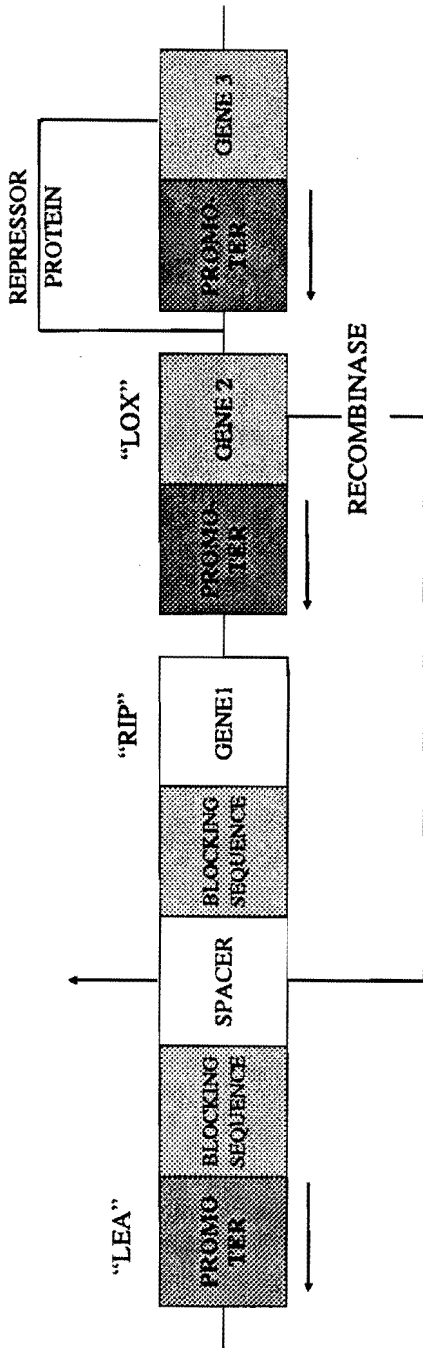
Most countries, which have ongoing programmes in the area of genetic engineering, have national biosafety regulations. Available evidence, as for example from cotton, indicates that data from genotype \times environment interactions are essential before GMO's are recommended for widespread cultivation. Apart from this, no major risk has been observed in USA, where the largest number of field trials with GMO's is in progress.

The Conference of Parties to CBD have established an open-ended Working Group to develop an internationally acceptable biosafety protocol. This Group has met several times and has made good progress. It is essential that this exercise is completed soon, so that the benefits of scientific progress can be taken to farming families world wide.

The other major challenge at both national and international levels is the integration of the principles of ethics and equity both in technology development and public policy. It will be useful to take the example of much debated "Terminator" mechanism of embryo death in F_1 seeds. In March 1998, the US Department of Agriculture (USDA) and the Delta and Pine Land Company obtained jointly a patent (US Patent No. 5,723,765) for a process titled "Control of plant gene expression". This technology is to ensure that F_1 seeds do not germinate, thus preventing seed saving for the cultivation of the F_2 generation. The genetic mechanism involves 3 components.

- A gene coding for a toxic substance which is lethal to the plant embryo. This gene is linked to a blocking sequence which prevents the activation of the toxic gene.
- A gene termed LOX, which contains the information for a protein which cuts out the blocking sequence linked to the toxic gene.
- A repressor gene with the code for a protein which suppresses the LOX gene.

To switch off the repressor gene and to switch on the LOX gene, the antibiotic tetracycline is used as a chemical trigger. The choice of tetracycline is based on its non-occurrence in nature, thereby eliminating the possibility of an accidental triggering of seed sterility (Fig. 1).



Gene 1: Ribosome inhibitor protein ("RIP"). This gene codes for embryo toxin linked to a blocking sequence which prevents the activation of the toxin gene.

Gene 2: Termed "LOX gene". This gene produce recombinaase which cuts the blocking sequence, thereby activating toxin gene.

Gene 3: A repressor gene with the code for a protein which suppresses the LOX gene. Chemical trigger (Tetracycline) : Switches off the repressor gene and switches on the LOX gene

US Patent No. 5,723,765 granted to Delta and Pine Land Co. and the United States Department of Agriculture on March 3, 1998.

Fig. 1. Genetic mechanism for causing embryo abortion in F₂ seeds

The patent claims a very broad protection, covering plant cells, tissues, seeds and whole plants of any species containing the above combination of genes. The objection to this technology is based on considerations like the following:

- Farmers in India and many other developing nations save seeds for the next crop; in addition they also practice selection for local adaptation. It is economically and ecologically wrong to develop a system where farmers have no option except to buy fresh seeds each crop season.
- This technique will result in genetic homogeneity resulting in greater genetic vulnerability to abiotic and biotic stresses. It will lead to genetic erosion and the loss of valuable intra-specific variability.
- Accidental gene flow to non-target plants cannot be ruled out, thereby resulting in unintended problems of seed sterility.
- Since the mechanism involves a gene coding for a toxic substance which is lethal to the plant embryo, the potential adverse impact of this toxic substance on human nutrition needs careful study. Since the harmful effect may be visible in chronic doses only after a particular threshold is reached, it will be necessary to carry out the study over several years.
- If seed companies use tetracycline to set the cascade of toxin- gene activation in motion, every seed planted by farmers will have to be treated. What will be the impact of planting tetracycline soaked seeds on soil ecology, particularly on soil micro-flora and fauna?

There is need for a regulatory mechanism to consider such issues in an integrated manner.

6. Conclusions

Knowledge is a continuum. We should neither worship nor avoid a technique because it is either old or new. What is important is to subject our newly acquired powers to manipulate genes at the molecular level to a dispassionate analysis, from the viewpoint of bioethics and biosafety. There should be both legal and self-regulation in the design and implementation of such experiments.

Concerns rightly associated with techniques like "terminator" and cloning, should not however lead us to denying ourselves the uncommon opportunities now available for enhancing biological productivity without ecological harm through a blend of Mendelian and molecular methods of breeding.

The Universal declaration on the Human Genome and Human Rights adopted by the General Conference of UNESCO at its 29th session held in Paris on 11 November 1997, stipulates in Article 10 that "no research or research applications concerning the human genome, in particular in the fields of biology, genetics and medicine, should prevail over respect for the human rights, fundamental freedoms and human dignity of individuals, where applicable, of groups of people". The Declaration also affirms, "the human genome in its natural state shall not give rise to financial gains". **We need a similar declaration on the Plant Genome and Farmers' Rights.**

Agriculture occupies a pivotal place in the economy of many population-rich developing countries (Table 2). Its importance is even greater from the point of view of providing employment. Hence, agricultural scientists should take full advantage of all emerging technologies. In the field of genetic engineering, national policies are needed for strengthening biodiversity conservation measures as well as for access to genetic resources and for equity in benefit sharing. At the research level, cooperative networks, like the Rockefeller Foundation supported Rice Biotechnology Network, with help to ensure that, although the individual strengths of Network partners may vary,

Table 2: Importance of agriculture in domestic economy, 1994-95

Country	Share of Agri. in GDP (%)	Share of Agri. in Workforce (%)
India	29	65
China	21	71
Bangladesh	31	62
Pakistan	26	48
Sri Lanka	23	47
Phillippines	22	42
Egypt	20	33
USA	2	3
France	2	4
Italy	3	7
Germany	1	3

Source: World Development Report, 1997

their collective strength becomes considerable. Well defined principles of biosafety and bioethics should guide researchers. We should develop legal and institutional mechanisms for biosafety, bioethics and biosurveillance. If all these steps are taken both at the national and global levels, we can enter the new millennium with a sense of hope and optimism on the food front. This will be the best tribute we can pay to the life and work of Dr. Sukhatme.

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