CURRENT SCIENCE

Volume 111 Number 9 10 November 2016

GUEST EDITORIAL

Food for all in the anthropocene era

At the International Geological Congress held in August 2016 in Cape Town, the assembled scientists came to the conclusion that a new geological epoch – the anthropocene – needs to be recognized as the dawn of human influenced age (https://www.theguardian.com/environment/2016/aug/29/declare-anthropocene-epoch-experts-urge-geological-congress-human-impact-earth). Recently, Clive Hamilton has defined anthropocene in terms of the whole earth, and its functioning system. So, anthropocene cannot be viewed just in terms of biodiversity loss, climate change, etc. (*Nature*, 2016, **536**, 251; doi:10.1038/536251a), although each of these has an adverse impact on sustainable food security. According to the experts, this new epoch began in about 1950, and is likely to be defined by the radioactive elements dispersed across the planet by nuclear tests, although an array of other signals, including plastic pollution, soot from power stations, concrete, etc., also contribute. The Holocene era now giving place to anthropocene is ending with many achievements in science and technology but it is unfortunately characterized by environmental damage and the prevalence of unacceptable levels of hunger and malnutrition. The challenge now is, how we can shape anthropocene as an era where human activity leads to a better quality of life for all and to harmony with nature? Anthropocene should also be known for its human efforts to achieve sustainable progress under the circumstances of climate change, biodiversity loss, degradation of natural resources and significant changes in the functioning of the earth system. All these individually and collectively exert adverse impact on agriculture including animal husbandry, fisheries and forestry.

This guest editorial for achieving food for all is relevant to the Goal 2 of the UN Sustainable Development Goals (SDGs) has the following aim: *End hunger, achieve food security and improved nutrition and promote sustainable agriculture*.

Further, the Goal 2 of the UN SDGs targets 'Food and Nutrition Security' should be assured to every one of a projected human population of 10 billion people by 2050. As of today, more than 1 in 7 people do not have access to sufficient protein and energy from their diet. The UN FAO Report 'State of Food Security in the World 2009' reveals that the number of people suffering from micronutrient deficiency (i.e. hidden hunger) far exceeds those suffering from calorie and protein hunger. About two billion people today are known to be deficient for one or more micronutrients.

Elimination of the micronutrient deficiency needs novel approaches that are simple in practice yet more effective in achieving the goal. One such recent approach is the Farming System for Nutrition (FSN) conceived and developed by one of us (M.S.S.). It is discussed in a subsequent paragraph. The immediate question is how to achieve sustainable agriculture and food security during anthropocene which involves human impact on the functioning of the earth system in its entirety. In this regard, the target for concerted action needs to be world's 570 million small holder farms operating on less than 2 acres of land with labour mostly of the family members and far less energy from fossil fuels. This fraction constitutes globally an overwhelming 84% that is also highly vulnerable to climate shocks. We have discussed the influence of climate change factors (increase in average surface temperature, changes in precipitation resulting in floods and drought, leaching of soil nutrients due to widespread run off, reduction in freshwater availability, adverse impact on coastal agriculture due to sea level rise, outbreak of pests and diseases, often new and unfamiliar, etc) on agriculture. Needless to emphasize these in turn would cause serious damage to agri-horticultural crops, and farm animals which form the major domain of smallholder farms. Further, their lack of access to credit, financial services, technical assistance and markets leave them with very limited capacity and resilience to adapt to climate change risks. Far worse is the situation in smallholder farms managed by women farmers. It often leads to 'feminization of poverty' in the rural areas. If things are let go as business-as-usual, agricultural doom in anthropocene would be inevitable. What Martin Rees, former President of the Royal Society, observed in the context of the dawn of anthropocene might come true. He said 'the darkest prognosis for the next millennium is that bio, cyber or environmental catastrophies could foreclose humanity's immense potential, leaving a depleted biosphere' (cited in Carrington, D., 2016; https://www.theguardian.com/environment/2016/aug/29/declare-anthropocene-epoch-experts-urge-geological-congress-human-impact-earth).

All these necessitate a change from chemically intensified agriculture to an evergreen revolution which was developed and defined by one of us (M.S.S.), (Swaminathan, M. S., *Biologist*, 2000, **47**, 85–89; and select set of articles bearing on evergreen revolution in the book *From Green to Evergreen Revolution*, Swaminathan, M. S. (ed.), Academic Foundation, New Delhi, 2010, p. 410) as achieving productivity in perpetuity without accompanying ecological and social harm. The major thrust in evergreen revolution is the replacement to a large extent of chemical fertilizers and pesticides to biological softwares (biofertilizers and biopesticides). Incidentally, the biological software produced by landless rural women generates income for them and it is characterized by *pro-nature*, *pro-poor*, *pro-women and pro-livelihood* attributes. The immense impact of biologically derived nitrogen fertilizers is the substantial reduction in the production and use of inorganic nitrogen fertilizer. Referring to the adverse impact on earth system in anthropocene, it is unfortunate that the earth's nitrogen cycle which had been stable during the past 2.5 billion years has now been vitiated. Consequently, huge amounts of nitrates are accumulating in land and aquifers that earth cannot recycle. An elegant analysis of the earth-system perspective of the vitiated global nitrogen cycle reveals the interactions among the nitrogen cycle, the carbon cycle and climate (Gruber, N. and Galloway, J. N., *Nature*, 2008, **451**, 293–296).

The ecoagriculture within the framework of evergreen revolution has been further refined by M.S.S. to provide agri-horticultural remedies for nutritional maladies. It is a farming system for nutrition (FSN). In a series of papers, he has discussed the material necessary for the elimination of malnutrition. He has specially mentioned naturally biofortified plants like *moringa*, tamarind, sweet potato, and other nutrition-rich crops which could make a substantial contribution to overcoming hidden hunger. Further, we should promote the establishment of Genetic Gardens of Biofortified Crops (*Curr. Sci.*, 2016, **111**(6), 965). In practice, farming system for nutrition could be designed to cultivate biofortified crops specific for remedying various micronutrient deficiencies prevalent in a given region. While this forms the method to alleviate specific micronutrient deficiencies, it should be followed by measurement to assess the impact of such nutritional interventions in improving the health status of children and women in particular suffering from hidden hunger. The measurement of nutritional status involves specific international standards and methods. The recent publication of *Global Nutrition Report – From Promise to Impact – Ending Malnutrition by 2030*, by the International Food Policy Research Institute (ISSN 2380–6443/ doi:http:11dx.doi.org/10.2449/9780896295841) is comprehensive in addressing the different dimensions of tackling malnutrition and finally measuring progress in attaining the targets. Monitoring periodically the nutritional status based on measurements is an integral part of the entire approach.

All the above will require greater nutrition literacy on the part of the consumer. For this purpose, Community Hunger Fighters could be trained who could suggest agricultural solutions for the major nutritional deficiencies prevailing in the area. The Genetic Gardens of Biofortified Plants will help to identify material for mainstreaming nutrition in the farming system. Farming systems are usually based on home needs as well as market opportunities and ecological security. What is now important is to add the dimension of nutrition security in the design of the farming system.

Having stated that farming systems during anthropocene would need appropriate modifications both for avoiding further damage to the earth system and also adapting to the changes which have already occurred, it is very obvious that chemical inputs which adversely impact earth's cycles and also contribute to greenhouse gases should be drastically curtailed. In this context, it must be mentioned that several long-term studies across several countries have shown that farming without excessive use of chemical fertilizers may not diminish yields; in fact, stabilize and increase yields in the long run (Pretty, J., *Philos. Trans. R. Soc. B*, 2008, **363**, 447–465; doi: 10.1098/rstb.2007.2163). Integrated nutrient supply and integrated pest management are part of the Evergreen Revolution methodology.

The possible adverse impact to humanity in general, and the basic need of food security in particular could be comprehended by the observation of Stefan *et al*. (*Ambio*, 2011, **40**(7), 739–761); which states: 'Effective Planetary stewardship must be achieved quickly as the Anthropocene epoch threatens to tip the complex Earth system out of cyclic glacial–*Inter-glacial pattern during which Homo sapiens have evolved and developed. Without such stewardship the Anthropocene threatens to become for humanity a one-way trip to an uncertain future in a new, but very different, state of the Earth System*'. That is the 'tipping point', likely to set in when the earth's average surface temperature rises by 1.5°C to 2°C in comparison with that in 1880. The current increase is about 0.98°C. Unfortunately, nothing substantial has been done by the national governments of the planet Earth to turn away from the current path of fossil fuel-energy based economic growth/gains. As *Nature* editorial (2011, **480**, p. 292) puts it, '*the science of climate change and the politics of climate change, which claims to represent it, now inhabit parallel worlds*'. Ending this dichotomy through political and public education is an urgent task for scientists.

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