also it is not considered a requirement for the onset of LIPs, though rifting can increase melting rate appreciably apart from magma generated through lithospheric thinning caused by the plume head[7]. Further, current geodynamic, geochemical and isotopic data are inconsistent with models invoking pre-Deccan rifting and separation (plate break-up and separation) of Seychelles–Mascarene microcontinent from India, which post-date the main flood basalt volcanism – and this post-eruptive rifting is confirmed by the presence of extensive parallel dyke swarms along the coast cutting the upper part of the Deccan succession[5].

The debate for and against the plume hypothesis appears unending. Presently, for every argument upholding the hypothesis, a counter argument is advanced rejecting the contention and a consensus appears elusive. Major objections to the plume hypothesis are that the postulate is flexible regarding its source, width, mode of eruption and its duration, its shape and structure, fixity, longevity and geochemistry[3]. It emerges from the prolonged plume debate that intraplate volcanism, undoubtedly, can arise through a number of routes besides plumes and hence the plume concept possibly cannot be totally ignored. As described by a pro-plume scientist[4], 'because a mature physical theory of plumes developed rather slowly over two decades, plumes have been invoked perhaps excessively by some enthusiasts, while skeptics complained not without justification, that plumes were ill-defined concept that could neither be tested nor well justified'. Far from it, 'plume hypothesis is relevant enough to observations and supporting knowledge to be a fruitful one to pursue further'.

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OPINION

Methane emission, rice production and food security

S. Seshadri

The three major greenhouse gases (GHGs) – carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) – have significant fluxes from agro-ecosystems. Methane is the second most important GHG after CO_2. Its concentration in the atmosphere has more than doubled over the last 200 years, and in particular has increased by about 50% in the last 40 years. Irrigated rice production, a major food source for a large portion of the world's population, has been reported to be a major anthropogenic source of methane[1]. Global emission estimates for this source range from 20 to 100 Tg yr^{-1}, which may be 4–30% of the total anthropogenic contribution to the atmosphere, making it one of the sources with the largest uncertainty[2]. Rice-field soils, characterized by waterlogging, O_2 depletion, high moisture and relatively high organic substrate levels, offer an ideal environment for the activity of methanogenic bacteria[3].

Now methane has been designated as the climate culprit. According to Reiner Wassmann, coordinator of the Rice and Climate Change Consortium at International Rice Research Institute, Philippines, rice is the only crop that emits such a large amount of GHGs. There is also a stress that Asian countries have to look at rice production to reduce GHG. The recently concluded Intergovernmental Panel on Climate Change (IPCC) summit has also recommended improved rice cultivation techniques, and livestock and manure management to reduce CH_4 emissions[4]. It is explicit that rice and livestock are targetted for CH_4 emission reduction. It is high time that rice cultivation is looked into as an important activity that is not related to food security but as the global climate change agent.

Globally rice production has been estimated to double by the year 2020 in order to meet the demand of an increasing population, which may increase methane production[4] by up to 50%. India should also increase food production by 5 million tonnes per year to keep pace with this increasing population and to ensure food security. India has recently indicated that it would reject proposals to limit GHG emissions because stricter limits would slow its booming economy and have serious implications for poverty alleviation programmes. These observations could change the projected GHG production figures of India and may have serious implications in the coming days for Indian agriculture and its participation in global climate change programmes. There is a possibility that India might be forced to expand its cultivable area or convert rainfed areas in the form of wet agricultural lands through construction of dams and/or interlinking of rivers, etc.

In this context, discussing the above based on the following questions will allow us to draw a clear mandate for future climate change, rice promotion, GHG mitigation and India's participation in climate change programmes. (a) Is the availability of organic carbon content in soils the only reason for enhanced methane production? If so, what is the water to organic matter ratio required for the hyper production of methane or to keep the production at optimum levels? In such cases, is it possible for us to create such conditions in natural environment? (b) Do we have technologies to mitigate/quench methane production or capture in rice fields/wetlands through some other means? (c) What role does the soil carbon play in an agricultural system apart from plant promotion and acting as a substrate for methanogens to produce methane? (d) If the paddy fields are culprits, what will be the case of shallow/stagnated water bodies and those with higher organic carbon content? (e) Of late, there is greater momentum of organic cultivation of foodgrains. They seem to fetch good profit for farmers even in wetland areas. Will methane mitigation have any implication on organic cultivation? (f) It has been reported[5] that fertilizer application may lead to a reduction of methane emission from wetland rice fields to the tune of 57%. This is new and supplements the earlier impression that considerable methane produced by methanogens in rice paddies is consumed by methane-oxidizing bacteria associated with the roots of rice[6]. Will this have any impact on the global organic agricultural movement or do we need to stay with chemical fertilizer application in the agricultural fields? (g) In such cases, is it necessary to have a relook at soil pollution and the subsequent water pollution due to fertilizer application and soil quality management related to GHGs? (h) Considering the vulnerability, is it good to encourage organic cultivation of rice in lowland areas? (i) Will there be a moratorium on cultivation of rice also, if our GHG emission crosses the limit through these so-called water bodies and rice fields? (j) Will India be forced to pay for the GHG credit for pollution in the international market? In such a situation, would our farming community be forced to shoulder the burden?

Considering all the above, it is time for us to start discussions in this direction at the policy level to protect rice farming, farmers and sustained food security in India. As rice is the staple food for people living in Asia, especially in India, this needs urgent attention to solve a crisis that may arise in future as a result of the GHG mitigation measures of IPCC. I believe a strong follow-up action at policy, scientific and implementation levels after a series of debates on the above would help devise best remedial measures and possible alternatives to have a foolproof food security programme in India and Asia to feed the population without much difficulty.

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Biotechnological intervention in jatropha for biodiesel production

Padma Nambisan

Energy demand in India is increasing at the rate of 6% annually compared to 2% for many other countries. Currently, imported petroleum crude supplies about 70% of the energy requirement. Vegetable oils, fats and their derivatives have been proposed as an alternate renewable and eco-friendly energy source. As India imports more than 40% of its edible oil requirement, it has to depend on non-edible oils for biodiesel. Various non-edible tree-borne oils such as neem, mahua, jatropha and pongamia, are available in the country. However, oil yields are insufficient to meet the demand.

Biotechnology could contribute to yield improvement strategies in the following ways:

1. Improving seed yield

Mapping genes and breeding: Genetic analysis in species with a view to identify quantitative trait loci (QTLs) for useful characters inherited in a multigenic fashion is now possible even without prior information of allelic differences because of the development of molecular techniques such as RAPD and AFLP, which directly detect variation at the DNA level rather than at the phenotypic level. To begin with, an elite mapping population with the desirable characteristics that breeds true would have to be established in jatropha. Information from the elite mapping population data could then be used to rapidly screen germplasm of jatropha to identify DNA markers or major QTLs associated with high yield and the same could be used in marker assisted selection (MAS) breeding strategies to jumpstart genetic improvement of jatropha for yield characteristics.

Interspecific and intergeneric crosses: It is possible that variation within a spe-