take back their designated faculty members. Moreover many distinguished senior scientists, who retire from these institutes, can be inducted as adjunct professors in the universities.

There will be an exit point after B Sc. But the syllabus should be designed for an integrated M Sc and oriented for a research career. Students should carry out project work in the research institutes under DAE/DST/DBT/CSIR as part of this course, to motivate and expose them to research.

Some of us are trying to catalyse such a joint programme between Mumbai University and DAE. But irrespective of our progress, such programmes should be initiated from other universities, many of which are in fact better equipped than Mumbai University. In our opinion, starting these integrated M Sc programmes through the existing university network will ensure better and faster returns on investment than through a couple of green-field institutes.

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Freshwater shortages and strategy for wetland rice cultivation

For centuries, lowland rice (wetland rice or paddy rice) cultivation has been practised in submerged soils in Asia. Historically, wetland rice cultivation in Asia has been targetted at lands that are flooded or are prone to flooding during the wet/monsoon season. A large tract of low-lying lands, including valley bottoms in the inland valley systems, and parts of the Indo-Gangetic Plains, which get submerged under water during the monsoon rains, were deemed most suited for wetland rice cultivation. Wetland rice is able to take advantage of the benefits associated with flooding of the soils.

However, in the recent past, rice cultivation in the country has spread to non-traditional rice-growing areas such as Punjab and Haryana. The spread of irrigated rice in Punjab and Haryana has been stimulated by simple economics in favour of the crop. Indeed, in these states irrigated rice has emerged as a commercial crop. Rice crop, especially in Punjab and Haryana, is generally grown on relatively light-textured soils, as opposed to heavy-textured soils in traditional rice-growing areas in the country, under copious irrigation.

The traditional method of growing lowland rice involves preparation of land by cultivation in the flooded or water-saturated state (termed puddling), followed by transplanting young rice seedlings into the puddled paddies, and growing the rice crop in submerged condition until a few days prior to maturity.

Wetland rice cultivation is often cited as an example of the sustainable system[1]; the benefits associated with growing wetland rice in submerged soils are documented and include weed control, maintenance of soil fertility and preferential accumulation of organic matter and its maintenance[2–5]. However, in the wake of water shortages, it is suggested that rice should be grown under alternate water management practices with increased water productivity. Rice productivity under alternate water management (non-submerged) practices is lower than under flooded conditions; in addition, the soil fertility status also is impacted[5]. Moreover, unlike rice grown in submerged soil conditions, continuous rice systems under arable conditions show a decline in yield and are unable to sustain productivity even at a moderate level. The main reasons suggested for this include general decline in fertility and diseases that adversely affect root growth and yields of rice cropped in aerobic soils[6].

A number of studies made in Asia and elsewhere indicate a reduction in rice yields when lowland rice varieties are grown in aerobic soils compared to those grown under flooded soil conditions. The decrease in rice yields varies depending on the adaptability of the rice varieties to aerobic soil conditions, management of macro and micronutrients, weed control and management of diseases such as nematodes in aerobic soil conditions[6–9]. Research is needed in the development of improved rice varieties, crop and water management practices and sustainability of aerobic rice under continuous cropping. Clearly, research issues relating to the potential of aerobic rice and its sustainability will only be judged by long-term studies in the future, although research has been initiated in this important area by scientists at the International Rice Research Institute, the Philippines and their collaborators[9,10].

In view of the sustainability in terms of both productivity and soil fertility, it is suggested that growing of wetland rice in the future should be targetted to specific hydrologic niches: on lands that are flooded or which have shallow groundwater table, and within 20–30 cm of the soil surface during the cropping season. By targetting wetland rice cultivation to these specific niches, farmers would continue to reap the benefits associated with the traditional method of growing rice in flooded soils. Simultaneously, attempts should be made region-wise to identify suitable and economically viable alternate crops to replace wetland rice. Cultivators practice farming to earn their livelihoods and make profit; farmers adopt production systems that satisfy their family needs and are economically viable and sustainable.

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