health and productivity in this agriculturally important region.

The agro-climatic conditions of NER favour production of enormous amounts of biowaste under different land uses and farming systems. These are potential sources of organic carbon and plant nutrients. The biomass production in weeds roughly ranges from 5 to 20 tonnes/ha depending upon the weed species, season and growing conditions[3]. Around 9 million tonnes (mt) of crop residues (rice, maize, pulses and oilseeds) are produced annually in NER[4]. Even considering half of these residues to be available and 40% loss of the nutrients contained therein, these crop residues can add up to ~10,000 tonnes of N, ~2000 tonnes of P_2O_5 and ~35,000 tonnes of K_2O to the soil. Around 15 mt of animal dung produced annually can also supply substantial amount of nutrients to the soil. Besides nutrient supply capacity, biowaste can improve the soil organic carbon, moisture retention capacity, buffering capacity and many other desirable attributes of soil quality. In fact, these benefits of crop residues (through mulching or *in situ* incorporation) have been witnessed in many studies undertaken in different rice and maize-based cropping systems of NE India. The biowaste can alternatively be utilized for production of quality organic manure within a short period of 50–80 days using earthworms and cellulose-decomposing microorganisms, either alone or in consortia[5]. Such methods need to be standardized and popularized among the farming community. Further, development of appropriate techniques for *in situ* utilization of such biowaste is also necessary for improving soil health under hilly conditions of NER. Improvement of compost through mineral amendment or microbial culture is another viable option. One of the possible ways of improving nutrient content in the compost is by inoculating nitrogen-fixing microorganisms and phosphate-solubilizing microorganisms. The culture of efficient strains of nitrogen-fixing bacteria such as *Azotobacter*, *Azospirillum*, *Pseudomonas*, etc. can be inoculated in the compost either during composting or in the final compost to increase their nitrogen content. Similarly, phosphate-solubilizing microorganisms such as *Aspergillus awamori* are inoculated to enhance P content in the compost.

To conclude, as utilization of biowaste has great potential to improve the health and productivity of acid soils in NER, there is urgent need to develop appropriate technology for efficient utilization of the abundantly available biomass for production of quality organic manure. Techniques for *in situ* utilization of biomass also need to be evolved and popularized among the farming community for improving soil health and crop productivity of NE India in perpetuity.

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Occurrence of endangered orchid *Cymbidium whiteae* King and Pantl. in North Sikkim

Sikkim Himalaya is recognized as a paradise of orchids in India. The Sikkim orchids are well explored and documented[1–4]. During the residency of the first British political agent John Claude White, Lady White collected a beautiful orchid from the capital town of Sikkim, Gangtok. This plant was later named after her as *Cymbidium whiteae* in a monumental work[2]. Because of its beauty and horticultural potential, this magnificent species was cultivated throughout Europe and the West. Extensive collection from the wild for cultivation and export dwindled its natural population. Keeping this in view its collection and export was banned on 8 July 1910 by The Chogyal, King of Sikkim[3], many decades before the existence and implementation of modern CITES rules. This endemic, rare, cherished and prized species with extremely restricted distribution in Gangtok town only is listed in almost all the flora works, taxonomic works related to orchids, garden-cultivated plant books, Red Data books, IUCN books and Appendix II of CITES checklist[3–8].

This species was spotted in its type locality Gangtok up to early sixties[9,10] and was growing at Deorali near present forest secretariat (U. C. Pradhan, pers. commun.), but later disappeared. The causes for its disappearance are thought to be clearing of natural forest for the development of township as well as the increased vehicular emission and human concentration[10]. After its disappearance from type locality Gangtok, it was thought to be extinct from wild and efforts were made for its conservation in its homeland, Gangtok by a local nurseryman and orchid enthusiast, who reintroduced it in cultivation from Europe with the joint efforts of Writhlington School in Great Britain[11]. After more than a century of its discovery, very few plants were found growing in another locality, Rumtek[10]. This is a rural area near Gangtok, where dense and humid natural forests still exist. There are chances of seed dispersal from Gangtok to Rumtek and vice versa because both fall in the same altitude and latitude with hardly a couple of kilometres aerial distance.

In December 2011, I also found one more population of *C. whiteae* when it was in full bloom near Hee-Gyathang, lower Dzongu, North Sikkim, between 900 and 1200 m (Figure 1). This locality lies at the fringe of Khangchendzonga

Figure 1. *Cymbidium whiteae*. ***a***, Habit; ***b***, Flowering branch; ***c***, Close-up of flower.

Biosphere Reserve (KBR) and is more than 50 km away from the previous localities. Moreover, the present population is on a completely different mountain ridge (at the base of KBR) and on a different aspect of slope. This natural refugium of endemic species needs to be conserved because the area is extensively under cardamom cultivation. More populations can be found in similar landscapes in Sikkim or near KBR after a thorough search. To mitigate direct or indirect threats to this species, it is imperative that the local community be mobilized to improve their understanding about this plant in particular and other endemic and endangered flora in general. For *in situ* conservation of this endemic and rare species, the area should be covered under the protected area network.

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Sustainable water management in India with reference to flow irrigation projects

I have read the article by S. K. Jain with interest[1]. Instead of spending space recounting the many relevant issues and points in it, I may be permitted to draw attention to a couple of relevant points missing in this review.

In discussing the impact on water-related sectors (p. 179) it is stated that, 'A major boost to agricultural production and also to productivity of water in agriculture (more crop per drop) was achieved with the green revolution in the 1960s … Hence, another crop productivity revolution with respect to water is required … Obviously, there is considerable scope for improving water productivity in India.' Here, the reference is to the physical productivity of the crop under irrigation (more crop per drop). What is totally missing is the value productivity per drop.

It is really sad that in India this aspect of the most economic use of water for irrigation has not attracted the attention of engineers as well as the agronomists advising them. The problem is not serious in regions endowed with more than adequate water, surface and underground, for the crops grown or to be grown. But, in regions characterized by severe shortage of water for agriculture (not to speak of all other needs), it is important to use the water such that this scarcest of the inputs of agriculture produces the maximum value per unit of water used. This is elementary economic logic. (Indeed, any farmer with very limited availability of water compared to the agricultural land under his control to be irrigated, understands this.)

In India more than 40% of the total agricultural land is located in what is called the dry agricultural region (with less than 40 inches of annual precipitation), located mostly in the non-coastal part of peninsular India. A very large part of it does not receive even 25 inches in the year. And, this is the region that is