The cellulose produced from such a biorefinery process is used to make greener versions of ethanol and plastics. Such a breakthrough will mean that a farmer could harvest two crops from every field, a grain crop and a biomass crop.

Agro wastes can be used as soil improver/fertilizer. For this, the post-harvest residue of cotton, castor, sugarcane trash, banana stems, etc. can be chopped *in situ* and sprayed with a microbial mixture. The consortia of microbes decompose it and convert it to useful soil nutrient, and also supply the much needed organic carbon for which our soils are hungry. Our chemical fertilizer utilization efficiency and economics are already badly affected due to lowering organic carbon in the soils of most of the states. Such an emphasis on agro waste use in farms will also help water-use efficiency.

We therefore need a much greater emphasis on this aspect as in the long run, even when we consider the aspects of sustainability, food will be of greater priority.

Lastly, though the author[1] arrives at the 'inevitable conclusion that renewable energy sources stretched to their full potential can at best contribute 36.1% of the total need' (by 2070), we must not forget the likely breakthroughs which can change the picture more favourable. Just two examples:

(i) Microalgae, as distinct from seaweed or macro-algae, can potentially produce 100 times more oil per acre than soybean or other crops, will be non-competitive with agriculture and can give much the needed breakthrough.

(ii) Another big hope will be organic/polymer solar cells. This is relatively a novel technology, but holds promise of a substantial price reduction and faster return on investment. These cells can be processed from solution and can be produced by roll-to-roll printing process, leading to inexpensive, large-scale production. With newer materials, their efficiency can dramatically increase.

Such new developments can hopefully raise the potential of renewable energy use more substantially than what is being predicted as 36%.

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Conservation of chironji and cultivation of off-season rainfed tomato

Sonbhadra District, a part of the Vindhyan zone, is one of the most backward districts of Uttar Pradesh[1]. Most of the people in this district belong to tribal communities/schedule caste. Their major sources of income are farming and collection and selling of minor forest-based products (as about 55.73% of the area is under forest; www.sonbhadra.nic.in.). Major crops are rice and wheat, but due to the lack of irrigation facilities, agriculture depends entirely on the monsoon leading to poor productivity of crops. Collection and selling of minor forest-based produce, especially chironji (one of the important multipurpose forest species) brings income to the local inhabitants. Chironji (*Buchnania lanzan* Spreng syn. *B. latifolia* Roxb), also known as char, piyal or achar belongs to the family Anacardiaceae (Figure 1). It is a subtropical, underutilized/underexploited nut fruit and is considered to be native to India. This multipurpose tree provides food, fuel, fodder, timber and medicine to the local community. It is a popular and edible nut fruit, eaten raw or roasted and also used in making dessert. Its kernel is rich in fat (59.0 g), protein (63–72%), starch (12.1%), minerals like calcium (279 mg), phosphorus (528 mg), iron (8.5 mg) and vitamins like thiamine (0.69 mg), riboflavin (0.53 mg), niacin (1.5 mg) and vitamin C (5.0 mg). It also contains 34–47% oil and provides nutrition to the local inhabitants[2]. During summer when green fodder becomes unavailable, local inhabitants use its leaf as green fodder for their animals, especially buffalo, goat and sheep. Its dried wood is utilized as a fuel. The timber of chironji is slightly resistant to termite and is utilized for making furniture, boxes and crates, desks, fine furniture, match boxes, mill work, moulding, packing cases, stools, tables and agricultural implements. Some parts of the plant are also used to cure diseases, for instance roots in diarrhoea, leaves for skin diseases and healing wounds, gum/resins in diarrhoea, and fruits in asthma and cough. Locals also earn money by collecting gum/resins and lac by rearing *kussumi* strain of lac on the chironji tree.

At present the plant is grouped as an underexploited and non-nationalized minor forest produce. It is free for collection, as a result of which the local inhabitants, traders and greedy merchants destroy the branches/whole trees during collection of its fruits without bothering about new plantations. This has led to the destruction of chironji plants in the forests. There is an urgent need to develop a

Figure 1. Foliage of chironji.

Figure 2. Freshly harvested tomato.

technology for easy multiplication and regeneration of chironji, and to popularize its importance among local inhabitants/tribals.

Due to seasonal drought in kharif for the last 7–8 years, the farmers of Sonbhadra District have not been able to harvest paddy crop. More than 60% of the farmers depend on paddy. However, erratic, uncertain rainfall and seasonal drought has resulted in poor production of the crop. Due to this and in response to the efforts of the Krishi Vigyan Kendra (KVK) and results of on-farm trails and front line demonstrations conducted by KVK, the farmers have shifted towards tomato cultivation (it was already known that tomato can be cultivated as off-season rainfed crop during kharif under upland condition). In the beginning the local cultivar named *Kajala* was popular, then Sel-7, Sel-22, DVRT-1, DVRT-2, H-86 and JK desi were popularized. In recent years hybrid varieties like 3585 of Sungrow, 2535 of Namdhari, US-404 of Agriseeds, NP-5005 (Lakshmi) of Nunhems Pro Agro are dominating and yield between 350 and 550 q/ha. At present, more than 12% of the area under paddy cultivation is converted into tomato cultivation. Robertsganj mandi has been established as a big and stable market for the merchants from far-off destinations.

The unique characteristic of this tomato crop is that without any irrigation facilities under upland condition, in sloppy, undulated and hilly tracts under low-land condition, in black cotton and red laterite soils, it is growing well and farmers are getting good returns (Figure 2). On the basis of economics we have observed that after spending Rs 50,000–60,000/ha, one is benefitted with a net return of around Rs 100,000–150,000/ha in a single cropping season. This indicates that the tribals of Sonbhadra district are marching towards self-sustenance with cultivation of off-season tomato. There will be more economic and sustainable growth if proper attention is paid to the conservation of forest resources as a whole and chironji in particular.

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Tricotyledony in *Hippophae rhamnoides* L. (Elaeagnaceae)

The phenomenon of typically dicotyledonous plants producing three cotyledons has been referred to as tricotyledony or tricotyly. More generally, the production of an abnormal number of cotyledons has been referred to as pleiocotyly. Molecular studies have shown that a few mutated genes could produce tricotyledonous traits in the model plant, *Arabidopsis*[1,2]. Tricotyledonous seedlings occur sporadically in nurseries of dicotyledonous plant species in over 15 families of plants[3]. However, the phenomenon has not been reported in seabuckthorn (Elaeagnaceae).

The actinorhizal plant seabuckthorn (*Hippophae rhamnoides* L., Elaeagnaceae) is dioecious and wind pollinated. Seabuckthorn berries are among the most nutritious of all fruits and have immense medicinal properties. Seabuckthorn is mentioned in the writings of ancient Greek scholars such as Theophrastus and Dioscorides. The medicinal value of seabuckthorn was recorded as early as the 8th century in the Tibetan medicinal classic *rGyud Bzi* (Four Text of Fundamental Tibetan Medicine). The shrub serves as a storehouse for researchers in the field of biotechnology, neutraceutical, pharmaceutical, cosmetic and environmental sciences[4].

During our study in 2009 to check seed viability of a 10-year-old seabuckthorn seed stock, we observed few seedlings with three cotyledon leaves. To check the frequency of tricotyledony in seabuckthorn, seeds from 30 different plants maintained in field gene bank (lat. 34°08.2′N, long. 77°34.3′E, altitude 3340 m amsl) at the Defence Institute of High Altitude Research, Leh-Ladakh were collected in 2010. Seedlings were raised in pots and emergence of cotyledon number was checked on each plant approximately every 3 days. Plants were scored in three categories: two full cotyledons, three full cotyledons and greater than three cotyledons. Tricotyledonous seedlings were transplanted into the greenhouse.

The observed tricotyledon frequencies among the 2798 germinated seedlings from 30 plants ranged from 0% to 6.4%, with an average of 0.64%. A rare single tetracotyledon seedling was also observed. Low frequency of tricotyledony has also been reported in *Brassica oleracea* var. *capitata* (0.6%)[5], *Crotolaria juncia*

Figure 1. Seabuckthorn seedling with three cotyledons and three true leaves.