of the therapeutic chemical compounds desired, e.g. authentic source of 'Nagakeshar' is the anther of *Mesua ferrea* L. However, flowers of *Mammea longifolia* Planch. & Triana and *Calophyllum inophyllum* L. are adulterated with the genuine sample[2]. Fulfillment of increased demands is becoming difficult day-by-day with declined availability of resources due to over-exploitation, which leads to use easily available plant parts from the same or different plants, e.g. root of *Sida cordifolia* is recommended in 'Deshmula', but the whole plant or aerial parts of the same or different species of genus *Sida* are found to be traded. In view of the above facts, use of such plants as a common drug can be accredited only after standardization, analytical and biological studies to assure quality, safety and efficacy of the final herbal products.

The World Health Organization has developed guidelines for carrying out standardization procedures of raw herbal products which include pharmacognostic tools such as morphological, histological, physico-chemical, analytical and toxicological parameters, heavy-metal estimation and radiobiological contamination in plants[3]. Other factors such as the use of fresh plants, temperature, light exposure, period and time of collection, method of collection, drying, packaging, storage and transportation of the raw material, and age and part of the plant collected can greatly affect the quality and consequently the therapeutic value of herbal medicines. In such cases, where the active principles are unknown, markers should be established for analytical purposes. However, in most of the cases these markers have never been tested to see whether they really account for the therapeutic action reported for the herbal drugs[4,5]. Strict standardization procedures and pharmacognostic studies of medicinal plants would drastically reduce ill-effects due to wrong prescriptions of traditional herbal medicines. This will be helpful in identification procedures that guarantee the utilization of the appropriate raw material and for quality-control standards demanded by legislation.

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ANURADHA S. UPADHYE*
ANAGHA A. RAJOPADHYE
BHAGYASHRI B. KUMBHALKAR

Plant Science Division,
Agharkar Research Institute,
G. G. Agarkar Road,
Pune 411 004, India
**e-mail: upadhye.anuradha@gmail.com*

Potential of renewable energy in meeting future needs of electricity

In an article analysing the future Indian needs of electricity and the possibility of meeting them by renewable energy, Sukhatme[1] concludes that renewable energy sources alone will not suffice for meeting requirements and that nuclear energy will have to assume a significant role. Electricity requirements and its growth have been estimated by Sukhatme using the methodology adopted earlier by Goldemberg *et al.*[2]. A conservative estimate of 2000 kWh of electricity per capita has been arrived at in an austere model. This is validated using correlation analysis between electricity consumption and human development index. Thus he estimates that India should have electricity generation of at least 3400 TWh per annum for a stabilized population of 1.7 billion by 2070.

However, a significant underestimate occurs in Sukhatme's estimation of the potential of Indian renewable energy sources, in particular solar energy. Assuming that limit to exploitation of solar energy in India will arise from availability of open non-agricultural land, he estimates approximately 10,000 sq. km (1 million hectare) will be available for solar energy utilization. However his 'thumb rule' estimate of 4 ha/MW as land required per site seems to be an overestimate, as may be seen from the following data (Table 1) pertaining to photovoltaic (PV) power plants of varying capacities established mostly during the last two years (2009–2011).

It is evident that an average figure of 1.25 ha/MW is reasonable for a solar PV farm. It may also be noted that the Indian plan under the Jawaharlal Nehru Solar Energy Mission assigns significant role for rooftop PV panels, thus reducing the need for additional open land further.

As far as solar thermal plants are concerned, they require even less land per megawatt, by definition, as they concentrate incident solar energy before conversion. As an example, the solar thermal plant being established at Mathania, Rajasthan will generate 140 MWp in a solar field area of 22 ha, giving a ratio of 0.16 ha/MW for the solar field alone.

Even assuming 1 million hectare land availability as a limitation, India has a solar potential (PV + thermal) of well over 800 GWp, which can generate electrical energy of 1400 TWh/year at a realistic plant load factor of 0.2. As the solar energy conversion efficiencies and plant load factors used in the above calculations are all based on currently established values worldwide, there should be no technical uncertainties in achieving this level of performance.

Summarizing, Sukhatme's estimates of the potential of renewable energy in the Indian energy basket requires significant upward revision. A total installed capacity of 1100 GW (hydro + solar + wind + biomass) producing electrical energy of 2500 TWh/year from renewable energy sources alone – out of the goal of 3400 TWh – by 2040 (Indian population at 90% of stabilized level) from renewable energy sources alone appears to be feasible, realistic – even conservative. This large potential of renewable energy should be compared with the projected plans for a nuclear power component

Table 1. Comparison of land used in photovoltaic (PV) power plants worldwide[4]

PV plant location	Power (MWp)	Site area (ha)	ha/MW	Year	Remarks
Perovo, Ukraine	100+	200	2.0	2011	c-Si PV modules; site has growth potential
Sarnia, Ontario, Canada	92	94	1.02	2010	Cd Te thin film PV modules
Finsterwelde, Germany	83	95	1.1	2010	c-Si PV modules
Montalto di Castro, Italy	72	80	1.1	2010	c-Si PV, tracking panels
Boulder City, USA	55	140	2.5	2010	CdTe PV, Nevada desert
Pocking, Germany	10	7.5	1.3	2006	Site area 32 ha includes sheep farm
Kolar, Karnataka, India[5]	3.0	4.2	1.4	2010	c-Si modules

between 208 and 275 GWe by the year 2050 (ref. 3), assuming availability of reactors and fuel from international sources and indigenous development as planned presently.

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K. G. NARAYANAN

'Malhaar',
903, 2K Cross, 9th Main Road,
Kalyan Nagar, I Block,
Bangalore 560 043, India
e-mail: kgnarayanan2@gmail.com

Biodiversity regain in abandoned tea plantations

India is the largest tea-producing country in the world and contributes 33% of the global tea production[1]. Much of this tea comes from the biodiversity hotspots in the northeastern regions and the Western Ghats. Due to market fluctuations, increasing costs of production and lease expiry, many coffee, tea and cardamom plantations have become unviable for active management, resulting in labour unrest[2]. In Thiruvananthapuram division of Kerala alone, 536 ha (55%) of the total 969 ha of the planted area was abandoned[3]. This has important consequences for biodiversity conservation and livelihoods.

The rather sudden and potential release of land due to plantation abandonment after decades or centuries of use has understandably led to a serious debate among the State Forest Departments and conservationists on the policies for future land use in plantations. When plantations are abandoned they are biodiversity-poor, susceptible to invasion by exotic species and economically not useful. But given the location of the plantations, they have a high potential for harbouring and facilitating biodiversity to exist in the landscape. Conservation schemes in and near large tea plantations face unique livelihood challenges that arise from the fact that plantation workers have become accustomed to mountain environments that provide conducive climatic conditions to pursue assured livelihoods.

We conducted field visits to several tea plantations in southern Kerala, such as Rosemala, Kallar in the Shendurni Wildlife Sanctuary, Bonacaud on the fringes of the Peppara Wildlife Sanctuary and Ponmudi and Kalakad Mundanthurai Tiger Reserve in Tamil Nadu. Tea habitats per se are poor in biodiversity unlike coffee and cardamom, which have native or exotic species tree cover, but tea plantations do facilitate movement of wildlife[4,5]. Abandoned plantations offer excellent opportunities to restore various forms of native biodiversity, but considerable effort from the landowners and the forest department is needed to restore the land to harbour native flora and fauna. Our recent study[6] has shown that this can be done. Tea plantations with planted shade trees are important for native species to colonize through frugivore activity[6]. When this is combined with active dispersal of seeds based on the life-history traits of the plant species, one can draw up a comprehensive protocol for restoration of native forests.

Conservation and livelihood challenges are formidable in geographies where plantations and Protected Areas (PAs) coincide. In the Thiruvananthapuram division, many plantation workers are struggling to find alternate livelihood sources after the plantations were abandoned. Many families are working as casual labourers in the road construction schemes, or in some cases like in Bonacadu, the workers themselves pluck the tea leaves and sell it to middlemen at low prices to sustain themselves. In Ponmudi, after the Ecologically Fragile Land Act (EFL) which restricts extensive modification of the land was enforced in 2003, many tea plantations could not sustain themselves (pers. obs.). In such cases where regulations like EFL exist, we suggest that plantation managers employ plantation workers and their families in restoration activities in parts of the plantations where such regulations are applicable. The wages for this can come from