bond donors, more than ten hydrogen-bond acceptors, more than five rotatable C–C bonds, and a large polar surface area. This is especially noticeable among natural products with a reversible mechanism of enzyme inhibition, and is seldom found among anti-bacterial agents with an irreversible mechanism of enzyme inhibition. While this may lead to moderate levels of bioavailability and corresponding dosage regimens to achieve the required efficacy, there may be a latent advantage in such complex structures. This complexity may enable such compounds to adopt a discrete set of molecular conformations, which can engage in similar though slightly different bonding patterns of comparable binding energy with the target enzyme from different species and strains of pathogens.

Target enzymes, i.e. enzymes that the drug inhibits, are rarely 100% identical across different species of pathogens or among the strains within a species. There are always some structural differences between them that may affect the binding site of the drug. In such cases it would be advantageous for the drug to bind only to the invariant groups with the required binding energy, and/or to adopt a discrete set of molecular conformations that can engage in similar though slightly different bonding patterns of comparable binding energy. A natural product with a complex structure may be more versatile at this than a synthetic compound with a simpler structure.

This interesting notion or hypothesis has little published data to support it at present. It may be useful to obtain 3D-structural data on these drug–enzyme complexes for a range of pathogenic species or strains. Until such data are available, this hypothesis may suggest why natural products play a prominent role as anti-infective agents so far, and may indicate a hitherto unexplored hypothesis as to why natural products are important for anti-infective drug discovery. It may be valuable for this to be tested. This may suggest that the screening of synthetic compounds may be one of several ways forward, for anti-infective drug discovery. It is of interest to note that the development of combinatorial chemical libraries based on natural products with biological-pharmacological activity is being revived and may become (again) an established trend in drug discovery.

In addition to the established and well-known approaches for drug discovery, namely combinatorial chemistry and high-throughput screening, structure-aided ligand design, mechanism-based ligand design, and analogues of existing drugs with improved properties, it would be beneficial and important for natural products research to get the attention and support it needs and deserves.

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Technologies for sustainable rural development in the Central Himalaya

During the last few decades the distinct features that have characterized the Central Himalayan region are population growth; continued dependence of a large section of the population on land resources, especially the traditional subsistence agriculture resulting in degradation and depletion of land resources, and consequent decline in land productivity and increase in poverty along with lack of proper roads and communication facilities.

The crisis of the environment and the problem of livelihood security of the poor are so interconnected that their solutions are also found together. A sustainable utilization of the remaining land resources through careful management by the communities themselves can help conserve the resources and bail them out of poverty.

Technology is needed to uplift the economic and social status of the villages in the region. It is also required for improving utilization and conservation of natural resources leading to sustainable development. Adoption of improved technologies will lead to employment and business opportunities, and eventually eradicate poverty.

Several technologies have been adopted by government and non-government agencies for demonstration and dissemination among various interest groups as livelihood options for the rural poor living in the remote hills of the Central Himalayan region. They are labour-intensive strategies for action that address poverty issues and rebuild the environment. They suit the local mountain conditions and can help revitalize the community-based livelihoods. Widespread demonstration and dissemination of the following technologies can promote gainful employment opportunities in non-traditional land-based activities as well as other off-farm activities.

Some key technologies of prime importance identified for the Central Himalayan region are:

1. Agro-food processing: It is an important technology due to its impact on overall national economy and the role of sustainable development. It helps in improving life in terms of nutrition and habitat-planning. It involves preparation of jam, jelly, squash, juice, sauce and pickle from cultivated as well as wild/edible fruits and vegetables. This is slowly gaining popularity in the region due to changes in consumer taste, food habits and lifestyle, convenience, nutritional value, longer shelf life and purchasing power. This is complemented by cultivation of cash crops such as medicinal and aromatic plants, gladiolus, bamboo, tea and large cardamom. Mushroom cultivation and apiculture have also been adopted in certain places. As fertilizer, insecticide and pesticide application is negligible they have a premium as organically grown.

2. Soil fertility improvement through vermicomposting, biocomposting and biofertilizers has helped rejuvenate soil health. However, it still needs to be disseminated more extensively for effective farm management and ensuring proper yield.

3. Polytechnology: During extreme winter, productivity of vegetables and other plants like nursery seedlings is retarded and damaged due to low temperature and frost. The polyhouse and polypit can

save extensive loss by controlling the temperature inside them. It is aptly known as the 'poor man's growth chamber'. It is a simple, inexpensive and effective technique for raising and protecting plant material from severe winter temperature. It has an added advantage of CO_2 fertilization effect and reduced need for watering. There is less insect and disease damage and uniform plant size. The low-cost, polyethylene-lined tanks for water harvesting are imperative for overcoming water scarcity by accumulating rainwater and rooftop run-off.

4. Briquette fuel from waste, especially pine needles and agricultural weeds: Extensive areas of mixed forests are being replaced by pine due to acidification of soil by pine needles. Briquettes made of pine needles and weeds can be used for cooking and warming up homes in winter. Frequent removal of needles will lower the acidification effect on soil.

5. Zero-energy cool chamber is an on-farm storage chamber that works on the principle that evaporation causes cooling. It is constructed with locally available materials that keeps the temperature 10–15°C less than the ambient temperature and maintains high humidity and helps preserve field harvest of fruits and vegetables.

6. Utilization of grassland and wasteland for fodder cultivation and biodiesel-yielding plants such as *Jatropha curcus* and rehabilitation of degraded land.

However, small landholdings and non-availability of good-quality planting material are major issues of concern and have resulted in much lower success, especially in the agrofood-processing venture. Dissemination and adoption of new technologies has always been a problem in this region due to low educational level, lack of awareness and reluctance towards modernization, lack of market network coupled with poor training/extension facilities extended due to hostile climate, difficult terrain and remoteness.

These hindrances can be overcome by strengthening farm-management practices through vigorous extension education and training for the growers. Cooperatives and contract farming may solve the problem for small landholding to improve yield and quality. Major agrofood-based industries need to come forward and actively participate as well as share both the risks and profits to boost the economy of the region. The government needs to ensure a fair marketing network for the produce.

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Sacred groves in Meghalaya

Indigenous knowledge systems or traditional practices of different communities are so valuable that they are the source of solution of many present-day problems. Sacred groves (SGs) in India refer to tracts of usually virgin forests of varying sizes which are communally protected, and which usually have a significant religious connotation for protecting the community[1]. Biologically they are rich patches of undisturbed forests and serve as a natural habitat for many endemic, rare, primitive and economically valuable plants along with a good number of wild animals, birds, reptiles, amphibians, variety of butterflies and insects[1–6].

The people of Meghalaya practice an age-old tradition of preserving primary forest patches near their settlements as part of their culture and religious belief. These fully developed, virgin forest patches popularly known as SGs are called Law Kyntang, Law Lyngdoh and Law Niam in Khasi, Khloo Blai, Khloo Blai Lyngdoh in Jaintia and Kanggimin Bol-Waarangni Biap and Asang Khosi in the Garo Hills[2–4,7]. The indigenous people of Meghalaya believe that their sylvan deities live inside these SGs. They also believe that these deities would be offended if any damage is caused to the plants and animals in these SGs. Hence nobody collects anything from the forest, not even fallen branches of trees[3]. Trees like *Castanopsis tribuloides* var. *ferox* (Fagaceae) are not allowed to be cut by the local people[8]. The power over these forests and responsibilities for their maintenance are designated by the village council[7].

According to the State Forest Department, SGs cover an approximate area of 1000 sq. km in the State. Tiwari *et al.*[2] have documented 16 SGs in Garo Hills, 48 in Khasi Hills and 15 in Jaintia Hills. Barik *et al.*[4] reported 12 new SGs from Khasi Hills. SGs are the remnants of relict virgin forests which are quite different from the surrounding degraded forests. Thus these serve as micro-level biodiversity hotspots[1–7]. Haridasan and Rao[9] reported the occurrence of about 54 species of rare and threatened plants in the SGs of Meghalaya.

In a recent study carried out for the documentation of the ethnobotanical wealth of Jaintia hills[7], seven new SGs were identified, viz. Khloo Blai Lyngdoh Nongbah, Khloo Lyngdoh Poh Nongrim Mukhla–Nongbah Elaka (Figure 1), Khloo Blai Lyngdoh Nongjngi, Khloo Blai Poh longniang Nongjngi, Khloo Blai Lyngdoh Nongthymme Nongjngi–Nongjngi Elaka, Khloo Blai Lyngdoh Mynso–Mynso, Elaka and Khloo Basan Shangpung–Shangpung Elaka.

Thus SGs serve as a gene bank of the ecosystem in a degraded environment, signifying some religious and ritual centric beliefs or taboos. However, a religio-

Figure 1. Khloo Lyngdoh Poh Nongrim Mukhla sacred grove of Nongbah Elaka.