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Agriculture in Hilly and Mountain Landscape : An Interdisciplinary Perspective

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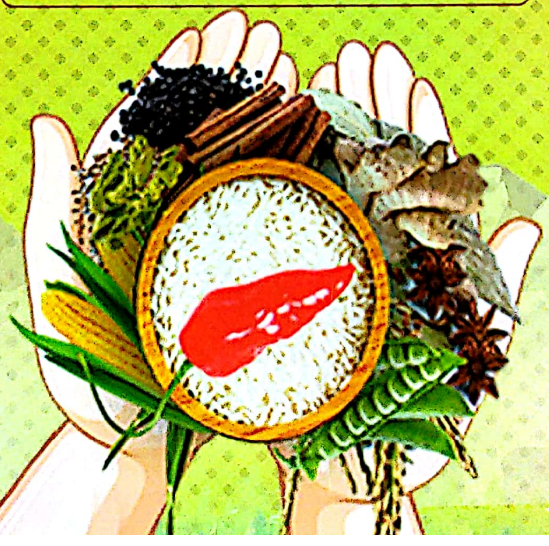

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Agriculture in Hilly and Mountain Landscape : An Interdisciplinary Perspective

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LP-1

Status of Indigenous Knowledge and Cultural Heritage Among the Mountain Communities

S K Roy, T Athare and Rajesh T
ICAR-ATARI, College of Agriculture Shivajinagar, Pune-411005

Introduction

Indigenous Technical Knowledge (ITK) refers to the unique traditional local knowledge existing within and developed around the specific conditions by women and men indigenous to a particular geographic area. Indigenous knowledge is knowledge that is spatially and culturally context specific, collective, holistic, and adaptive. It provides specialized information to a certain culture or community and serves as the foundation for a variety of other activities, including farming, health care, food preparation, education, and environmental preservation. This indigenous knowledge that people in a given community have developed over time and continue to develop, is based on human experiences on a mass scale, dynamic and changing, tested in most cases over centuries of use, endowed with the highest possible adaptability to local culture and environment and put greater weightage on minimizing risks rather than maximizing profit. Indigenous technical knowledge (ITK) covers a wide range of subjects, viz. crop production, livestock rearing, natural resource management, food preparation, healthcare, insect pest management and many others (Shubhendu Roy, 2015).

Indigenous technical knowledge (ITK) is knowledge of a particular community developed over a long period spanning multiple generations and continues to evolve with experience. This local knowledge is accepted and validated by society over time, which becomes a part of people's social and cultural lives and consequently becomes the indigenous technical knowledge (ITK) belonging to a particular society (Chhetry, 2009). As early as 1987, Paul Feyeabend defined this knowledge as that knowledge often encoded in rituals and the cultural practices of everyday life of individuals. Later, the work of the International Union for Conservation of Nature (IUCN) gave rise to the term 'traditional ecological knowledge' (TEK) (Williams, N.M, 1988). With the course of development in the field of knowledge, TEK began with ethnobotany and proceeded to people's understanding of the ecological processes in nature and their connection with the environment in which they live (Berkes,1998). Different terms used to refer to ITK include indigenous people's technical know-how and people's knowledge (Singh,2008). Thus, indigenous technical knowledge (ITK) is the knowledge of the local environment that is produced, held, and practiced by indigenous people and communities (Goldman, 2016). In this paper, we conceptualize ITK as the unique, cultural inheritance that is traditional and has evolved in and around particular cultures indigenous to a specific region (Ghosh,2011). ITK passes from one generation to another and establishes with experience over the years to become accustomed to the local environment and culture (Husain, 2019).

ITK is sustainable since it has grown over many years of observation and practice. Moreover, since time immemorial, indigenous groups have had cultural know-how related to their crop management and production practices. Therefore, indigenous knowledge is valuable for advancing creativity in location-specific crop management practices, safeguarding natural resources, adaptation, resilience towards the changing climate, and securing food systems (Naharki, 2020). Indigenous knowledge within international law and as such is vulnerable to abuse and disownment.

Indigenous and traditional mountain growers have explicitly designed their agrarian systems to cover the soil from erosion, conserve water resources and reduce the hazards of disasters triggered by natural hazards. With climate change scenarios explosively suggesting that extreme weather events are likely to become more common and more violent in mountain areas, these agrarian systems can play a central part in climate change adaption strategies. Similarly, dependable long-term records of mountain climates live only for veritably many areas, similar to the mounts. Original environmental knowledge of hydrological events and the capacity to read avalanches can for illustration reduce the risks in mountains, while the memory of one event and the stories passed through generations can help experimenters understand literal variations in the weather patterns in areas where scientific data is lacking (www.fao.org).

Mountains play a crucial role in sustaining about 10 percent of the world's population directly. In addition, mountains sustain the life of people living in the plains as they are the major source of water supply as the majority of rivers originate from these ecosystems. Due to slope and topography hill soils are subject to soil erosion and many other natural processes which reduce soil fertility The major mountain ranges in India are the Himalayas and the Western Ghats. They traverse an arc of about 2500 km between the Indus and the Brahmaputra rivers. In India, the mountain ecosystem is spread over 12 states of India: Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and West Bengal.

Details of ITK for different aspects like rainwater management, methods to check soil and water erosion, Tillage and Intercultural Management, Pest and Disease Management, Veterinary Science and Animal Husbandry, Crops and Cropping Systems and Grain/Seed Storage.

Indigenous technical knowledge is specialized information specific to a certain culture or community. It serves as the foundation for a variety of other activities, including farming, health care, food preparation, education, and environmental preservation. It offers a tonne of room for creativity, particularly at the grassroots level (Patel *et al.*, 2016).

Rain Water Management

- Khatri: A water harvesting structure: The Khatri is generally located at the foothills, made up of hard and strong supada (cutstone). It is constructed by digging a horizontal tunnel of 3–4 m in length, followed by a vertical basin at the inner end. The tunnel is provided with steps going down the basin. On a particular hill, Khatri can be dug at different points but at the same level. The basic purpose is not to harvest the surface run-off but the rainwater that flows through the rocks and soils of hilly regions. Rainwater seeps into the Khatri through mountain slopes. Good quality water is collected in the basin, as the water filters down through the sand stone into the Khatri. The capacity of the Khatri varies between 30,000 to 50,000 litres. It is used for storing drinking water (Kangra, Himachal Pradesh) (Chandan, 2000).
- In Kinnaur district, the surface of the soil is covered with pinus, chilgoza needles and grasses from the kandas (hilltop). Mulching conserves soil moisture in the field and also helps in maintaining the soil temperature. The continuous use of chilgoza tree needles also increases the fertility of the soil. Farmers use pinus or chilgoza needles to cover the soil surface. A very thin layer of needles is spread over the soil. Mulching with FYM is also in use. This has been practiced in most of the villages in a hilly area in the Kinnaur district of Himachal Pradesh since time immemorial. This helps in subsistence farming in cold desert area (Himachal Pradesh) (Das P, 2003).

- Man-made tunnel for water harvesting: Ground water is available at different depths in different locations such as plain lands, slopy undulating terrains, etc. Water available in hilly areas runs almost parallel to the undulations. Intercepting the water-table by digging below the slopes and oozing water is possible by digging tunnels. The water is used for drinking and irrigation purposes. This is an age-old practice in hilly and slopy lands of the Kasaragod district of Kerala. A large number of tunnels exist in Bayar village. About 30-35% of the total cultivable area is irrigated with tunnel water. About 40% of total families are dependent on tunnel water for drinking purposes. Tunnels are dug in medium to hard lateritic soils, which are slopy in nature, needing no cement or extra input to plaster the walls. The tunnels are 5-6 feet in height, 2-3 feet in width and 10- 150 m in length. Its construction is done only by skilled workers. The person who digs the tunnel uses candles and kerosene lamps as a source of light. If the tunnel length is beyond limitation, air-ventilation of 1 meter size are made. Lateral tunnels are also made if the main tunnel does not yield water (Kerala) (Das, 2002).

Methods to Check Soil and Water Erosion

- Bench terracing for rainwater management: The terraces are constructed across the slopes (along the contour). The size of the terrace is decided by the prevailing degree of slope and is supported by risers of suitable height and width. The risers are sometimes made up of loose boulders supported by grasses which provide strength to the risers owing to the binding action of the roots. The roots of grasses help to drain excess water. Usually, farmers keep the risers towards inner slopes, whereas in paddy growing areas they are erected to facilitate the ponding of water in the field. The bunds are used for growing palatable grasses for livestock and trees such as bael, shisham, mango, etc. are raised for fuel, fodder and fiber. Sometimes on the risers khus grass is also established. In lower regions, the terraces are known as khet (Hilly areas of Western Himalayas) (Verma, 1998).
- Grassed water ways to avoid water logging in terrace farming: It is a common practice during the preparation of a field, the slope is kept inside which is provided with a channel to take excess water from the field to a safer place and dispose to stream or nala through grassed water ways. This grassed water ways are positioned in such a way that they don't hinder any agricultural activity such as ploughing, hoeing and harvesting. This practice helps to avoid waterlogging during torrential rains which is a requirement for growing maize, capsicum and tomato in the rainy season (Upper North West Himalayas) (Verma, 1998).
- Interplot stone bunding for soil conservation: Cultivation of sloppy lands is done by constructing terraces comprising of plots and sub-plots by using small stones. Stone wall fencing is also constructed for individual land holdings. Terracing of slopy lands helps in conserving soil and moisture and prevents soil erosion. This also helps to carry out other field operations including proper use of irrigation water for checking the surface runoff (cold deserts of Western Himalayas) (Das, 2002).
- Gully erosion control is done in a 3-tier-system, where the first check is attempted by vegetative (*Ipomea* sp.) barrier across the gully. The second and third tier is done by bamboo structure and loose boulders (Lower areas of Western Himalayas). (Das, 2002)
- Conserving topsoil by autumn irrigation: The practice of irrigating fields in autumn to prevent the top layers from being eroded in West Himalayan cold deserts. It also eases ploughing in the spring by keeping the soil moist. This technique helps in timely ploughing and meeting the requirements of a short growing season. The moist upper layer of soil which gets frozen

in winter also serves as protection against wind erosion (Cold deserts of Western Himalayas) (Das, 2002).

Tillage and Intercultural Management

- Halod or bushening in standing paddy: Halod or bushening is a practice of ploughing in dry sown paddy in standing water at 25 to 30 days after sowing. This is useful to suppress the weeds and thinning the excessive plant population. Thus the weeds and excess rice seedlings get incorporated into the soil leading in way to green manuring (Hilly areas of Himachal Pradesh, Ranchi of Jharkhand) (Singh 2000).
- Soil burning (sudu mannu) to raise vegetable nursery: Soil is burnt to reduce damping off of seedlings and the weed population, sterilize soil and have a priming effect (Hilly and Coastal zones of Karnataka) (Anonymous 1999c).
- Rotational farming with pulse crops for soil fertility and disease management: At the relatively lower altitudes of the Western Himalayan cold deserts, rotational farming is traditionally practiced for enhanced production. Barley, pea and wheat constitute common rotation. This practice balances soil fertility and avoids the spread of diseases from one crop to another. Pea cultivation after barley helps to fix atmospheric nitrogen. Soil compactness induced by barley cultivation also serves as check against wind erosion (West Himalayan cold deserts, Himachal Pradesh) (Das, 2003).
- Private and community fodder wood blocks: Fodder tree forests in the vicinity of villages either on the forest land or community lands/private lands are jointly managed by the managers to meet their fodder need for cattle during lean months, *i.e.,* winter season. A few species thus managed are *Quercus* spp. (oaks), *Grewia ooptiva* (buel), *Celtis australis* (khirak), *Bauhinia variegata* (kachnar), *Albizzia chinensis* (ohi), etc. (Mid and high hills, foothills and sub mountainous regions of Himalayas) (Das, 2002).
- Jhuming or shifting cultivation: It is also known as podu cultivation that involves cultivation of crops on steep slopes by clearing forest, bushes, etc. upto stump level in December to January, leaving the cut material for drying and then finally burning it to make the land ready for dibbling of seeds of different crops before the onset of rainy season. After two to three years the area is abandoned for regrowth and a new site is selected to repeat the process. Earlier this system was good but now due to an increase in both the population and the effective area under this farming system, it is considered to be hazardous because it is leading to resource degradation and ecological imbalance due to deforestation, increase of soil erosion and silting of reservoirs, which further lead to floods. Various research institutes of ICAR, Government of India and State Governments of North-eastern parts recommend agro-horti-silvipastural systems as an alternative to shifting cultivation. Yet this system forms an integral part of the socio-cultural fabric of tribal life of North-eastern parts (Hills of North East India) (Das, 2002).

Pest and Disease Management

- Kerosene oil for killing borers: Farmers use kerosene to kill the tissue borers. A flexible metallic wire is inserted through the hole made by the borer into the gallery to clean it. Then a small bung made of cloth soaked in kerosene oil is inserted into the hole and finally, it is plugged using a paste of cow dung and clay. The insertion of metallic wire into the gallery causes physical injury to the larvae and they are destroyed. The vapor of kerosene suffocates the pests (Himachal Pradesh) (Chander and Mukherjee, 1994).

- Ploughing, hoeing and basin preparation for insect control: Cultural practices like ploughing, hoeing and basin preparation expose soil inhabiting insects, pests and other arthropods and nematodes to harsh weather and to natural predators. Insects are most vulnerable when in the pupal stages and most insect-pests pupate in the soil which furnishes a protective habitat. Birds like the king crow, the myna, the starling, etc. pick up the exposed pupae following these cultural operations. Insects such as grasshoppers, crickets, mole-crickets and borers lay their eggs in the upper layers of the soil. Their eggs subsequently desiccate. Many insects like cutworms, grubs of the root borer and white grubs which feed on the root system of the plants are also exposed to the vagaries of the elements during basin preparation and hoeing (Himachal Pradesh) (Verma, 1998).
- Control of insects by use of neem leaves: Neem leaves are used as an insect repellent (Kasaragod, Kerala) (Verma, 1998).
- Hand picking of pests: Hand picking of pests and their destruction is another time-tested method of pest control. Right from picking lice from human hair, clothes and even animals to the manual separation of pests from stored grain. This method can prove effective in curtailing pest incidence on some crops. Tobacco caterpillars, sugarcane top borer, epilachna beetle, etc., can easily be eliminated. The handpicked insects are destroyed by immersing them in kerosinized water or by deep burying. Some insects are destroyed by light traps (Himachal Pradesh) (Das, 2002).
- Control of insect pests in vegetable crops:A weed, locally known as mirchiya (*Corallocarpus epigeos*) and which grows abundantly in marshy land, is used for the purpose. The morphological characteristics of the plant are similar to makoya (*Solanum nigrum*) having chili-shaped violet-colored flowers. About 2–3 kg of the weed leaves are crushed and mixed in 15 L of water. This solution is sprayed over an area of 1 nali in June–July in vegetable crops especially capsicum and cucurbits to control insect pests; for example, aphids on capsicum, fruit and stem borer in brinjal (eggplant), and fruit fly on cucurbits(Kumaon hills, Uttarakhand) (Chander and Mukherjee, 1994).
- Control of aphids in oilseed crops: Aphids are the major pests of oilseed crops, causing heavy yield loss. Therefore, to minimize the problem farmers crush 2–4 kg leaves of herb rambas (*Verbascum* sp.) and mix in 15 L of water. The solution is sprayed on the crop at 50 ml per nali in mid-February to control aphids (Kumaon hills, Uttarakhand) (Singh, 2014).
- Control of white grub (kurmula) in grain crops: During field preparation, farmers broadcast the mixture of salt and Dichlorovas or Nuvan in the field for white grub control. Since white grub is one of the major problems during the kharif (rainy) season, therefore, this practice is used for various rainfed crops such as upland spring or jethi rice, finger millet, black soybean, horse gram, etc., (Kumaon hills, Uttarakhand) (Singh, 2014).

Veterinary Science and Animal Husbandry

- Control of diarrhoea with black soybean: Black soybean is grinded and mixed with water. It is given to animals suffering from diarrhoea for two to three days. The mixture of black soybean flour and ragi flour in water is also fed to the animal (Kumaun hills, Uttar Pradesh) (Das, 2002)
- Herbal treatment of dysentery and diarrhoea: Feeding of *Leucas lanata* (Safeda) and bamboo leaves cures diarrhoea. Also feeding 200 g of *Cissampelos pareira* (Batauva) in maize husk cures diarrhoea and dysentery (Mid hills region of Himachal Pradesh) (Das, 2003).

- Cure for dysentery in cattle: For treating dysentery a red-hot iron is brought near the nose of the animals because it probably stimulates the defense mechanism that is involuntary contraction of gastrointestinal musculature which in turn may relieve constipation which is known to be the major cause of dysentery (Ladakh, Jammu and Kashmir) (Verma, 1998).
- Prophylectic measure against foot and mouth disease by applying Geru: Geru is applied on the horns of all the animals in the herd. It protects the animals from the spread of the disease (Kumaon hills, Uttarakhand).
- Prophylectic measure against FMD by feeding of eggs of a spider to the animals: The farmers feed the eggs of spiders with the flower of ragi to the animals. This protects them from the spread of FMD disease (Kumaon hills, Uttarakhand), Treatment for eye sores in cattle by human saliva: Human saliva is used in the suffering eyes of the cattle for curing eye sores. This is the best treatment for eye sores. Human saliva is antiseptic in nature and has an epidermal growth factor that initiates the healing process (Lahaul valley, Himachal Pradesh) (Das, 2003).
- Treatment for fractured bone in cattle: Farmers in hilly areas of Kardang village in the Lahaul district of Himachal Pradesh generally practice this method for treating fractured bone in cattle. Manu (*Inula recemosa*) is an herb used for the treatment of fractured bone. Manu is ground well, and its extract is spread on the fractured bone and covered tightly with the use of cotton. This practice helps in the repair of the fractured bone (Das, 2002).

Crops and Cropping Systems

- Determining quantity and uniformity broadcasting of seed: One handful of seed is uniformly broadcast by women of West Himalayan cold desert areas in three to four equal lots. The quantity of seeds is determined by the distance of furrows made during ploughing. For verification of properly spaced broadcasting a handful of soil is picked up at random from any part of the field and if in each pick there are seven seeds it is indicative of proper broadcasting (Himachal Pradesh) (Das, 2002).
- Crushing of coriander seeds for better germination: Coriander seeds in Kinnaur of Himachal Pradesh are crushed by trampling upon by leather shoes before sowing for better germination. While the exact use of this technique is a subject for research, it appears that this mechanical exercise exerts just the right pressure to break the hard testa without causing any injury to the seed itself thereby facilitating germination (Kinnaur, Himachal Pradesh) (Das, 2002).
- Reducing inbreeding by a selection of seeds from different villages: Seeds for future cultivation are collected from selected plots manifesting vigour, early maturity, disease resistance and higher productivity. After three to four years the seed source is shifted to other villages without diluting the selection criteria. This avoids inbreeding (West Himalayan cold deserts, Himachal Pradesh) (Verma, 1998).
- Traditional rainfed farming for soil conservation by cultivating close growing crops: Traditional rainfed farming is done irrespective of land with respect to slope and other characteristics. During the rainy season there are chances of sheet erosion but with traditional knowledge, crop rotation is adopted in such a way that during peak runoff period sowing of close growing crops provides protection to the soil. The crops are chosen as per their nutritive value (protein rich pulses and also coarse grains like Phaphra and Chulai (Valley regions, western Himalayas) (Verma, 1998).

- Circular/ rectangular sowing for increasing crop yield: Farmers in the hilly areas grow a crop in a circular or rectangular pattern of rows instead of straight-line sowing. This method requires more seeds. Farmers believe that this method of sowing gives more yield due to the higher plant population (Banaskantha, Gujarat) (Taral, 1991).
- Optimization of maize population by appropriate spacing: Maize is the major crop grown during the rainy season. It is recommended to sow maize in lines with 60 cm row to row and 20 cm plant to plant distance. But the farmers sow maize behind the plough by Kera method (hand-dropping of seeds behind plough) with row-to-row distance of 20 cm and dropping the seeds in the furrow at the step-to-step distance. Due to the small size of fields in hilly areas, the majority of farmers are using bullocks for ploughing and sowing and practically it is not possible to maintain a row-to-row distance of 60 cm with bullocks. When seeds are dropped at a step distance (approx. 60 cm) plant/m^2 area comes to be the same as that of recommended practice (Hamirpur, Himachal Pradesh) (Thakur *et al.*, 2000).
- Sowing of whole groundnut pods to facilitate germination after rain: In Saurashtra, landholdings are generally large because of the low value of land and lower population density. A farmer, on average, cultivates groundnut in about 20 to 30 bighas (about 3 to 5 ha). This requires large quantities of seeds for sowing. It is believed that seeds separated from pods by threshers have low germination rates because threshing damages the embryo. Hence women spend 2 to 3 weeks' time manually separating seeds from pods for sowing. In some regions of Jamnagar district, where minor irrigation facility is available, groundnut is grown before the monsoon. Others noted that pods that remain in the soil after harvesting germinated automatically after a shower and accordingly decided to sow whole groundnut pods instead of seeds. After furrows were covered by light planking, the fields were irrigated lightly before the rain (Jamnagar, Gujarat) (Godhani, 1995).

Grain/Seed Storage

- Use of leaves of *Clerodendron phlomides* for preserving grains: Leaves of 'arni' (*Clerodendrum phlomides*) are used for preserving grains. The leaves of *Clerodendrum phlomides* are crushed to prepare its extract which is bitter in taste. Five hundred ml of the extract is mixed with 40 kg of grains to be preserved. The grains are dried and filled in big earthen pots. *Clerodendrum phlomides* are found in hilly areas. Satanabhai says that many farmers in his area used the extract for preserving grains (Panchmahal, Gujarat) (Charpot, 1998).
- Bamboo storage chamber for grains: Poor farmers in some parts of the temperate Himalayas have grain storage made of Bamboo. They are built in the safe vicinity of the farmhouse at some distance to protect from the fire which was a common feature in the early days as the entire structure is fabricated from wood (Temperate Himalayas of Himachal Pradesh) (Verma, 1998).
- Use of walnut leaves or bark for grain storage: Leaves or dried bark of walnut trees are mixed with the grains when stored (Kumaon hills, Uttarakhand) (Verma, 1998).
- Protection of grains from storage insect pests: Grains of cereals, pulses, oilseeds, etc. are treated with cow urine and are dried in shade overnight. These grains are stored in bins (metal or clay) along with dry leaves of walnut (*Juglans regia*), timur (*Zanthoxylum armatum*), and bakain (*Melia azedarach*) and sealed with the paste of cow dung and soil mixture to protect from storage pests. (Kumaon hills, Uttarakhand) (Singh, 2014).

- Storage of rice straw: Rice stalks are the major source of fodder during winter. Hence most farmers in hilly areas prefer tall rice varieties. After manual threshing, small bundles of the rice stalks are prepared. The bundles are placed in a conical heap-like structure called lutta on the mid-height of a pine tree by a trained villager. In the lean months, i.e., winter, when there is an acute shortage of fodder, the rice stalk bundles are taken out, chopped, and fed to cattle. (Kumaon hills, Uttarakhand) (Singh, 2014).

Conclusion

Indigenous technological knowledge practices are an essential knowledge resource that is native to rural communities. In hilly and mountain areas moisture conservation, soil fertility, nutrient management, etc. is the major task where the agronomical practices are less suitable where the land slope is more than 2% where mechanical practices and some indigenous technical practices help to conserve soil moisture like khatri, Man-made tunnel, to restore rainwater management, methods to check soil and water erosion, cultivating close growing crops. After sowing post emergence of the crop the major task is an attack of pests and diseases on average, account for 20-40% of yield losses worldwide at initial stage pest and disease control measures indigenous technology like Neem leaves are used as an insect, Hand picking of pests, Cultural practices like ploughing, hoeing and basin preparation expose soil inhabiting insects, pests and other arthropods and nematodes to harsh weather and to natural predators, ploughing, hoeing and basin preparation for insect control. After the harvest of crops storage facility is important where we can store output and increase shelf life in hilly areas good storage is a difficult task but some indigenous technologies i.e., Bamboo storage, traditional structures and earthen pots help to storage.

However, a good number of farmers practice these ITKs without knowing the scientific rationale behind using them. Environmentalists and agricultural extension personnel should take necessary measures to conserve and promote these traditional practices. The custodians of this knowledge base are older farmers who pass this information from one generation to another. The above techniques are more beneficial, easily adaptable, less costly, economically viable, and help in insurance against insect pests and disease occurrence in field crops, vegetables, fruit orchards, cattle and even in human beings. These techniques, however, require validation for future use. There is a necessity to combine ITK with the scientific cognizance strategy with its proper documentation of ITK is an essential step. Then comes the motivation of the new generation of farmers to adopt those practices and methods that are cheap and local and would effectively manage the pests without damage to the environment. Not only this, but the scientifically rational practices have chances of being replicated in similar hilly terrains of India and other countries of the globe for safe and secure ecosystems.

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