

## Traditional Knowledge for Agro-ecosystem management

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*Received 2 June 2005; revised 29 July 2005*

Indigenous people have evolved Traditional Knowledge, which are ecologically sound low cost sustainable technologies to deal with issues related to various agro-eco-systems. Growing commercialization and industrialization over the last two decades has eroded this commitment adversely affecting the quality of care in the context of the global change. Common characteristics of traditional knowledge, key facts and figures of traditional wisdom, successful examples of traditional knowledge for soil and water conservation, food and medicines, insect pests management, and future of traditional knowledge in the global scenario are discussed.

**Key words:** Traditional Knowledge, Agro-ecosystem Management, Traditional Agriculture, Water conservation, Soil conservation, Insect pests management

**IPC Int. Cl.<sup>7</sup>:** A01C7/00, A01C15/00, A01N25/00, A01N27/00, E02B5/00, E02B7/00, E02B11/00, E02B13/00

The knowledge that indigenous people have regarding ecology, biodiversity and land use management is embedded in their belief system, their culture and religion. They have evolved ecologically sound biotechnologies to deal with issues related to Agro-ecosystem Management. Traditional Ecological Knowledge was perceived as a social responsibility albeit a paid one. Growing commercialization and industrialization over the last two decades has eroded this commitment adversely affecting the quality of care. In the context of global change, scientific validation of traditional knowledge has assumed greater significance. The way in which traditional societies perceive and manipulate biodiversity, both in space and time, to ensure the stability and resilience of the ecosystem is significant for land use and Agro-ecosystem management.

Around the world, there is growing interest in finding alternatives to the industrial farming methods that have emerged during the 20<sup>th</sup> century. The deleterious effects of pesticides, inefficient fossil fuel usage, inputs of chemical fertilizers, genetic monocultures and factory farming of livestock have become increasingly apparent. One approach is to build upon traditional methods, which got evolved over the first 10,000 years of agriculture. They produced a tremendous variety of domesticated crops and livestock, and systems of farming. Fortunately,

there is still a vast store of farming know-how in India. Many traditional farmers in the developing world are still practicing farming methods that are in balance with the surrounding ecosystem, stable sustainable and highly efficient. Some times farmers, who have been portrayed as ignorant and not adaptive, have actually been utilizing very sophisticated methods of agricultural productions for centuries. Such traditional wisdom can perhaps enable the developed world to grow food with fewer chemical inputs, slow erosion, control pests and decrease our dependence on fossil fuels.

Traditional knowledge in Indian agro-ecosystem can be classified as per the following basic categories:

1. Traditional wisdom during Shifting Cultivation.
2. Traditional wisdom during Nomadic Pastoralism.
3. Traditional wisdom during Continuous Cultivation.
4. Traditional wisdom during Mixed Subsistence Farming.

Based on a literature survey following common characteristics of traditional knowledge can be considered common and important <sup>1,2</sup>:

1. Focus on risk reduction.
2. Year round vegetative cover of soil.
3. System diversity: Farm system based on several cropping system, cropping system

based on a mixture of crops and crops with varietal and other genetic variability.

4. Trophic complexity approaching natural system. Multiple interactions between plants, weeds, pathogens and insects.
5. High net energy yields, as the energy inputs are relatively low and low levels of inputs and high degree of self-sufficiency.

Traditional farmers constantly search for and promote novel changes in the crop cultivation. They acquire new varieties for exchange, while traveling, through purchase from markets and natural hybridization. This is actually one of the key features of traditional wisdom. Traditional farmers also experiment with new varieties and breed plants purposefully through selection according to feasibility and vigour of plant in their ecosystem, to create new strains according to their needs. They generally collect the seed of new varieties for evaluation. They grow in small area (experimental plot) and monitor the adaptability, resistance, vigour, yield, etc. Once they are satisfied that a variety has been proven itself to be of value, then they multiply the seed material and grow as main crop. This constant experimentation and selection (basic method of breeding) has created the diversity of crops upon-which we now depend<sup>3</sup>.

Modern intensive agro ecosystems have become more susceptible to disease and pests, and to climatic variations. The high yielding varieties tend to be high yielding only when supplied with intensive inputs and ideal growing conditions. Traditional varieties are of value to us because they embody characteristics that are potentially valuable, but which have not been yet exploited. In the future new varieties will be needed which can survive in adverse environmental conditions. The genetic resources needed to develop such new strains will probably emanate from the diversity of plants in the traditional agro eco-system.

#### **Indian traditional knowledge for soil and water conservation**

The history of water conservation techniques in dry zone of Maharashtra goes back to 400 years, where the rainwater runoff flowing in small weirs obstructed watershed commands. People were educated especially during the droughts; *Phad* system was well known in Kolhapur. *Bhudaki*, as a special character of irrigation was specific feature in Kolhapur region. Percolation tanks were designed for the water conservation vis-à-vis agriculture development in the

drought area of Maharashtra. It was a local water harvesting technology adopted not only for irrigation purposes but also for developing agro-forestry and social forestry along with watershed-development programme for the management of agro ecosystem in the particular areas<sup>4</sup>. There is much other traditional wisdom that is most common in different parts of India for soil and water conservation is given in Table 1.

#### **Indian traditional knowledge for food and medicine**

Living and working in the forest has been the way of life of our ancestors and they were in complete harmony with the nature. The use of numerous plant species for food, medicine, fuel, timber and various other purposes by mankind has been well documented in ancient Hindu literature. The old villagers and herbal practitioners known as *Vaidyas* of Uttar Pradesh have very good knowledge of the plants of their surroundings. Traditional knowledge on medicine since the time of Great sage *Charak* has led to the discovery of many important drugs of modern era<sup>5-8</sup>. Indian traditional knowledge in food and medicine have been summarized and presented in Table 2.

#### **Indian traditional knowledge for insect pests management**

The theory of ecological prevention and cure in controlling the insect pest of terrestrial higher-grade animals and plants has been in practice in long time and has achieved remarkable success<sup>9</sup>. Some examples of traditional pest control methods are given in Table 3.

#### **Conclusion**

Because of fragile nature of ecosystems, utilization of traditional wisdom is of paramount importance. Fortunately, India has much indigenous technical traditional wisdom. Therefore, there is a need to enmesh these practices along with other conventional measures for agro-ecosystem management and promoting low cost sustainable development of agro-ecosystems.

Traditional farming has been replaced by modern intensive farming systems. This change of practice indicates the loss of farming system that was stable, sustainable for decades and from which many valuable lessons can be learned. Traditional farming

Table 1— Traditional soil and water conservation techniques

S No	Indigenous practices	Crops/plants grown	Purpose/benefit	State where followed
1	Vegetative fencing/barrier	Kiluvai ( <i>Blasmo dendron verii</i> ) and <i>Agave</i>	Reduce water run off and velocity and to increase in filtration opportunity time	Karnataka
2	Mixed intercropping as vegetative barrier	Groundnut, pigeonpea and pulses	Run off management.	Andhra Pradesh
3	Relay cropping	Onion-rabi sorghum or chick pea	Reduction in run off and better utilization of soil moisture.	Karnataka
4	Spur structure		Protection of crop land from erosion by diverting the run off.	Jharkhand
5	Mixed cropping ( <i>Mishrabele paddati</i> )	Onion+chilli+cotton	Reduction in run off and better utilization of soil moisture.	Karnataka
6	Pre-emergence soil stirring		Removal of weeds, loosen the soil for conserving moistures.	Uttar Pradesh
7	Compartmental bunding; Loose boulder checks; Peripheral stone bunding; Strengthening bunds by growing local grasses and Field bunding		Soil conservation and runoff management.	Andhra Pradesh, Orissa, Maharashtra
8	Bunds protected with vegetal cover		Protection and strengthening of earthen bunds and to reduce soil erosion and run off losses	Gujarat
9	Bandh system of cultivation		Harvest run off for assured rabi crops in rain fed areas;	Madhya Pradesh
10	Live bunding	By raising cactus	Reduce runoff and check soil erosion.	Uttar Pradesh
11	Cross ploughing		Check run off and soil loss	Uttar Pradesh
12	Mixed cropping		Run off management and better utilization of soil moisture	Uttar Pradesh
13	Green capping		Reduce soil erosion and velocity of run off and to increase time of concentration.	Madhya Pradesh
14	Stabilization of field boundary bund; Plantation of grasses on field bound; Stabilization of field boundary bund	With <i>Vitex negundo</i> ( <i>Nirgundi</i> ) With <i>Agave</i> spp.	Reduce run off and soil loss.	Maharashtra
15	Peripheral bunding; Use of stone and bags; Vegetative barrier across gullies	<i>Agave</i> spp, <i>Ipomoea</i>	Gully control and run off management.	Andhra Pradesh, Karnataka
16	Nala plugging		Control of flow of water in nalas (gullies area, carrying water) to minimize further development of gully and lateral recharge of water.	Uttar Pradesh
17	Conservation furrows with traditional plough ( <i>Oodu ulavu</i> ); Interropping; Wider row spacing, deep interculturing; Tank silt application	Groundnut+pigeon pea	<i>In situ</i> moisture Conservation.	Karnataka, Orissa, Andhra Pradesh
18	Wider row spacing		Sustain crop production during deficit rainfall by moisture conservation, weed control and increase aeration.	Gujarat

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S No	Indigenous practices	Crops/plants grown	Purpose/benefit	State where followed
19	Repeated tillage during monsoon season		Soil moisture conservation for sowing of winter crops.	Haryana
20	Crop residue in the field		Prevent sheet erosion and increase <i>in-situ</i> moisture conservation.	Gujarat
21	Application of groundnut shells by mulching and incorporation; Ploughing across the slopes; Planting of potato across the slope; Strengthening of bund; Leveling the plots by local leveler; Furrow opening in standing crops with local implement hoe ( <i>Dawara</i> ); <i>Haveli/Bharel</i> system by impounding rain water in Kharif and taking rabi crops on conserved moisture; Mulching during rabi in sugar cane fields; Off season tillage; Mulching with sal leaf in turmeric; Collecting the silt from the foot hills and reusing in the fields, Land preparation with harrow ( <i>Kulav</i> ) to loosen soil, Hoeing with local hoes in Kharif and Rabi crops, Inter culturing operation ( <i>Aantar khed</i> )		Moisture conservation.	Andhra Pradesh, Karnataka, Orissa, Maharashtra, Gujarat, Madhya Pradesh, Uttar Pradesh, Haryana
22	Formation of broad bed and furrows with indigenous plough ( <i>Kodai ulavu</i> ),		Harvest rainwater and dispose of excess water.	Karnataka
23	Ploughing/deep ploughing		Harvest early showers.	Maharashtra.
24	Field boundry bund		Harvest rainwater and conserve soil.	Uttar Pradesh
25	Percolation pond/tank ( <i>Khet Talawadi</i> )		Harvest run-off water of individual field.	Gujarat
26	Small check dams		Harvest run off water for drinking and irrigation purpose.	Gujarat
27	Small Masonry irrigation tank		Store run off water for irrigation.	Gujarat
28	Recharging of wells through farm pond		Harvest run off water and to recharge ground water.	Gujarat
29	<i>Nala</i> check with soil filled in cement bags		Water harvesting for irrigation.	Karnataka
30	Opening up set furrow, sowing across the slope		Harvesting rainwater in soil profile.	Gujarat
31	<i>Nadi</i> farming system		Collect run off during <i>Kharif</i> season for pre-sowing irrigation ( <i>Palewa</i> ) of <i>rabi</i> crops.	Uttar Pradesh
32	Compartmental bunding		Retention of rain water for run off modulation.	Uttar Pradesh
33	Inter culturing (Hoeing) and earthening in standing crop		Harvesting rain water and to provide soil mulch and for easy penetration of pegs of groundnut in the soil.	Gujarat

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S No	Indigenous practices	Crops/plants grown	Purpose/benefit	State where followed
34	Inter cropping	Coriander with Bengal gram, cotton with black gram	Protective irrigation.	Karnataka
35	Earthen check dams		For irrigation.	Madhya Pradesh
36	<i>Talab</i> /pond making		Runoff conservation for irrigation, domestic and allied use.	Madhya Pradesh
37	Sand mulching, cultivation; Stone bunding; <i>Murram</i> bunding and conservation of bench terrace; Deep ploughing and gravel sand mulching; Retention of pebbles on the soil surface and retention of sun flower stalks; Planting of sweet potato along the ridges; Bunding/ <i>Bandhan</i> making/pal making and strip cropping; Stone cum earthen bunding; Stone cum vegetative bunding and stone bunding; Grass plantation on field boundaries; Strengthening bunds by growing local grasses; Cover cropping; Surplus waste weir at the outlet of the field; Cris cross ploughing ; Earthen bunds ( <i>Kuchha pala</i> )		Soil and moisture conservation.	Andhra Pradesh, Karnataka Orissa, Madhya Pradesh, Jharkhand, Uttar Pradesh, Gujarat
38	Stabilized grassed waterways		Soil, plant nutrients, and water conservation, and land degradation control.	Jharkhand
39	Line sowing behind the plough		Soil and water conservation and better utilization of soil moisture and reduction in cost of inter cultural operation.	Orissa
40	Vegetative barrier supported with small section bund		Soil moisture conservation and to avoid encroachment by wild animals.	Uttar Pradesh
41	Small cross sections earthen bund across slope		Reducing slope length and to increase of infiltration opportunity time for in-situ moisture conservation and minimizing erosion.	Uttar Pradesh
42	Summer ploughing		Conservation of early showers from tillage to harvest, facilitating timely seeding and weed and insect control.	Uttar Pradesh
43	Contour cultivation (operation across slope)		Eliminating slope length, creating barriers for water flow, enhancing soil moisture status.	Uttar Pradesh
44	Ridge and furrow planting		Conservation of rain water, modulating excess water, control soil loss and boosting productivity.	Uttar Pradesh
45	Negative barriers ( <i>Munj</i> and <i>Khus</i> ) on field boundaries		Soil moisture conservation and save the crop from wild animals.	Uttar Pradesh

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S No	Indigenous practices	Crops/plants grown	Purpose/benefit	State where followed
46	Conservation furrow ( <i>Gurr</i> )		Reduction of run off and soil moisture conservation.	Uttar Pradesh
47	Mixed cropping	Pearl millet + green gm (4 kg/ha + 5 kg/ha), pigeon pea + black gm (3 to 9 kg/ha + 5 - 6 kg/ha); Pigeon pea + cluster bean (4 kg/ha + 6 kg/ha) and chick pea + mustard (60-65 kg/ha + 3 to 3.5 kg/ha)	Soil moisture conservation, increase of productivity of soil and ensure the production of at least one crop.	Uttar Pradesh
49	Loose stone surplus bund		Prevent loss of fertile soil and riling of cultivated land.	Andhra Pradesh
50	Brush wood structures across the bund		Check soil loss.	Orissa
51	Application of tank silt		Improvement of nutrient. status of soil, improvement in soil moisture holding capacity of amended soil and enhancement in water storage capacity of tank.	Madhya Pradesh
52	Green manuring with sun hemp; Sesbania and cow pea		Improve organic matter for soil fertility improvement, weed control, soil and water conservation.	Madhya Pradesh
53	Growing of vegetative barrier on field boundaries	<i>Saccharum munja</i>	Check soil loss by wind erosion.	Haryana
54	Using Role to predict the rain fall amount for ploughing the field,		Rain water management.	Andhra Pradesh
55	Moving the ant with their eggs; Bathing of house sparrow in the dust and putting down the ear by ass during foraging		Forecasting rain.	Uttar Pradesh
56	Run off collection pits for augmentation of ground water		Well recharging.	Gujarat
57	Percolation well/wide diameter dug out well		Intercepting, collection of percolating water.	Uttar Pradesh
58	Collection of sub-surface run off water and recycling in Diara land		Mitigate drought.	Uttar Pradesh
59	Rain water harvesting from roof top and road surfaces		Recharge the well.	Haryana
60	Farm pond to store water in the pond		Ground water recharge and/or supplemental irrigation.	Andhra Pradesh
61	Dug wells		Domestic and agricultural uses.	Madhya Pradesh
62	Green manuring		Increase soil fertility.	Uttar Pradesh
63	Construction of ditches and percolation pits		Ground water recharging, to increase the ground water level.	Gujarat
64	Bund farming of pulse crops in Kharif under rain fed situation	Pigeon pea, (Black gram)	Enhancement of income per unit area.	Orissa
65	Crop stubbles/residue management		Improve organic matter in soil and to improve water holding capacity of soil.	Madhya Pradesh

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S No	Indigenous practices	Crops/plants grown	Purpose/benefit	State where followed
66	Inter row cropping		Increase the moisture use efficiency, risk coverage due to failure of any of the comparative crop and to utilize the moisture availability period specially on medium deep soil.	Madhya Pradesh
67	Mixed cropping	Pearl/millet, guar and green gram	Better utilization of soil moisture and reducing the risk of crop failure.	Haryana
68	Deep ploughing		Break down the hard pan and improve water Infiltration.	Gujarat
69	Rain water harvesting in kund/tank		Drinking and establishment of trees.	Haryana
70	Farm ponds		Water harvesting and recycling and for fish production.	Uttar Pradesh
71	Planting trees	<i>Acacia</i> sp.	Reduce salinity of soil.	Uttar Pradesh

Table 2— Indian Traditional Knowledge in food and medicine

S No	Herbs/biologicals used	Plant parts used	Purpose/benefits	Place of adoption
1	<i>Allium stracheyi</i> (Jimbu) and <i>Angelica glauca</i> (Chora).	Plants	Condiments	Bhagirathi valley
2	Prepared by mixing <i>Rhododendron arboreum</i> flowers, <i>Rumex hastatus</i> leaves (Almoda), coriander and spices.	Flower and leaves	Salad locally known as <i>Athana</i> .	Bhagirathi valley
3	<i>Berberis</i> spp., <i>Rubus</i> spp., <i>Pyracantha crenulata</i> (Ghingaru), <i>Prunus cerasoides</i> (Chuli), <i>Viburnum mullaha</i> (Mayon), <i>Ribes orientale</i> (Kirmola), <i>Pyrus pashia</i> (Mol) and <i>Myrica esculenta</i> (Kaphal).	Ripe fruits	Consumption	Bhagirathi valley
4	<i>Viburnum mullaha</i> , <i>Prunus cerasoides</i> , <i>Ribes</i> and <i>Rosa brunonii</i> (Rangeela)	Fruits	Preparing jams and pickles.	Bhagirathi valley
5	<i>Urtica parviflora</i> , <i>Paeonia emodi</i> (Dhandra), <i>Fagopyrum esculentum</i> (Kanlai), <i>Phytolacca acinosa</i> (Jarkya) and <i>Diplazium esculentum</i> (Lingra)	Plant species	Supplement diet	Bhagirathi Valley
6	<i>Agave americana</i> , <i>Angelica glauca</i> , <i>Betula utilis</i> , <i>Carthamus tinctorius</i> , <i>Eleusine coracana</i> , <i>Fagopyrum esculentum</i> , <i>Ficus auriculata</i> , <i>Glycine max</i> , <i>Grewia optiva</i> , <i>Jnglans regia</i> , <i>Macrotyloma uniflorum</i> , <i>Pinus roxburghii</i> , <i>Pyracanthacrenulata</i> , <i>Pyrus pashia</i> , <i>Quercus lucotrichophora</i> , <i>Ricinus communis</i> , <i>Rubus ellipticus</i> , <i>Solanum hispidum</i> ,	Indigenous herbal preparations	Treatment of various disorders of human beings.	Uttar Pradesh
7	Mahua ( <i>Madhuca longifolia</i> Koen.)	Root paste	Stomach ulcer and scorpion sting.	Madhya Pradesh
8	Mahua ( <i>Madhuca longifolia</i> Koen.)	Gargle of bark decoction	Gum swelling	Madhya Pradesh
9	Mahua ( <i>Madhuca longifolia</i> Koen.)	2-3 Mahua leaves with common salt	Worms of wound in livestock.	Madhya Pradesh
10	Mahua ( <i>Madhuca longifolia</i> Koen.)	Mahua cake smoke	Keep snake away.	Madhya Pradesh
11	<i>Ficus racemosa</i> L.	Decoction	Leucorrhoea, diabetes and rheumatic diseases	Madhya Pradesh
12	<i>Ficus racemosa</i> L.	Bark	Astringent and tonic	Madhya Pradesh
13	<i>Ficus racemosa</i> L.	Flowers	Bronchitis and cough	Madhya Pradesh
14	<i>Ficus racemosa</i> L.	Flower paste	Take out the pierced thorn	Madhya Pradesh
15	<i>Ficus racemosa</i> L.	Fruit paste	Toothache	Madhya Pradesh

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Table 2— Indian Traditional Knowledge in food and medicine

S No	Herbs/biologicals used	Plant parts used	Purpose/benefits	Place of adoption
16	<i>Ficus racemosa</i> L.	Seed oil	massage over the chest Pneumonia.	Madhya Pradesh
17	<i>Ficus racemosa</i> L.	Seed cake, few drops of its decoction is put in nostrils, resulting into vomiting and relief.	Snakebite.	Madhya Pradesh
18	<i>Boehmeria platyphylla</i> , <i>Debregeasia salicifolia</i> , <i>Ulmus wallichiana</i> and <i>Prunus cerasoides</i>	Bark paste	Fractured bones in livestock	Bhagirathi valley
19	<i>Anaphalis triplinervis</i> (Bach) and <i>Rumex hastatus</i>	Leaf and root extracts	Laceration of foot ( <i>Khurya</i> ) in livestock	Bhagirathi valley
20	<i>Rhus punjabensis</i>	Seeds	Poisoning caused due to intake of <i>Rhododendron arboreum</i> leaves in livestock	Bhagirathi valley
21	<i>Rheum australe</i> (Dolu)	Roots	Cuts and wounds of animals.	Bhagirathi valley
22	<i>Aconitum heterophyllum</i> (Atis) and <i>Swertia chirayita</i> (Chirata)	Plant juice	Curing fever	Bhagirathi valley
23	<i>Quercus leucotrichophora</i>	Leaves	Curing a local fever, <i>Ghichak</i> .	Bhagirathi valley
24	<i>Rheum australe</i> and <i>Eupatorium adenophorum</i> (Basing)	Leaf extract	Cuts and burns	Bhagirathi valley
25	<i>Bergenia ciliata</i> (Gheepati) and <i>Mentha longifolia</i> .	Leaf and leaf extract	Stomach disorders	Bhagirathi valley
26	<i>Angelica glauca</i> , <i>Adhatoda vasica</i> (Basak) and <i>Picrorhiza kurrooa</i> (Kutki.)	Leaf and leaf extract	Cough and cold	Bhagirathi valley
27	<i>Swertia chirayita</i> , <i>Berberis ciliata</i> , <i>Rheum australe</i> , bark of <i>Zanthoxylum armatum</i> and <i>Juglans regia</i> .	Leaf and leaf extract	Body pain, headache and toothache	Bhagirathi valley
28	<i>Cedrus deodara</i> and <i>Daphne papyracea</i> (Satpura).	Oil	Rheumatic pains.	Bhagirathi valley
29	<i>Melia azedarach</i> (Bakain) and <i>Daphne papyracea</i> .	Fruits and seeds	Skin diseases	Bhagirathi valley
30	<i>Valeriana hardwickii</i> and <i>V. jatamansi</i>	Root decoction	Urinary and related problems	Bhagirathi valley
31	<i>Cedrus deodara</i> and <i>Thalictrum foliolosum</i> (Mamira)	Bark and root paste	Externally applied for piles	Bhagirathi valley
32	<i>Jurinea macrocephala</i> (Dhoop), <i>Juniperus</i> spp. (Dhoop-lakkad), <i>Tanacetum longifolium</i> (Guggal), <i>Skimmia laureola</i> (Kedarpati) and <i>Valeriana</i> sp	Plants	Incense.	Bhagirathi valley
33	<i>Primula macrophylla</i> (Jayan) and <i>Saussurea obvallata</i> (Brahmkamal)	Flowers	For local festival, <i>Fulal</i>	Bhagirathi valley
34	<i>Andrographis paniculata</i> leaf powder, <i>Evolvulus alsinoides</i> plant, and roots of <i>Aristolochia indica</i> , <i>Cryptolepis buechananii</i> , <i>Jchnocarpus frutescens</i> , <i>Rauvolfia serpentina</i> and <i>Rhinacanthus nasutus</i>	Plants as antidote @ 50g/day for 3 days (orally administered)	Snake bite and scorpion sting	TamilNadu
35	Half-teaspoon of common salt is taken in palm, 4 to 5 drops of kerosene is added to wet it. It is thoroughly mixed and applied on the site for 2 to 3 minutes.	Centipedes bite	Vomiting, palpitation, burning sensation, inflammation associated with unbearable pain	Andaman
36	Bark, fruit and root of <i>Juglans regia</i>	Plants as pigments and tannins	Dyeing of wool	
37	Roots of <i>Berberis asiatica</i> (Kilmora), <i>Rheum emodi</i> (Dolu), <i>Rumex nepalensis</i> (Sayama) and <i>Rheum</i> sp ( <i>Tatori</i> ).	Plants as pigments and tannins	Wool dyeing in yellow and pink colour	Kumaun Himalaya

Table3— Indian Traditional Knowledge in pest management

S No	Indigenous practices and components used	Used against	Crops
1	Mix dried <i>neem</i> ( <i>Azadirachta indica</i> ) leaves (2-5%) with rice, wheat and other grains	Storage pest	Cereals and pulses
2	Dry leaf powder of <i>Senwar</i> ( <i>Begunia</i> ), wild sage ( <i>Lippia geminata</i> Kunth.), Bael ( <i>Aegle marmelos</i> ), Wild, basil ( <i>Ocimum americanum</i> ) @1 : 100 part	Storage pest.	Paddy
3	Neem kernel 5 kg in 100-l water, keep it for 8 hrs. Add 100 ml teepol or 100 gm soap and spray @ 500-l water/ha	Green plant hopper.	Rice
4	Garlic 1 kg + Dried Tobacco Leaf 200 gm + Washing soap 200 gm in 5 liter water @ 150 liter water /Acre	Gandhi Bug.	Rice
5	Dipping of gunny bag in the oil of white batch ( <i>Acorus calamus</i> ) 0.1% with water for 5 minute then dry the bag and use	Storage pest	<i>Vigna radiata</i> .
6	Spray of 3% neem oil	Yellow mosaic disease	Urd ( <i>Vigna mungo</i> ).
7	Application of <i>neem</i> cake	Stem borers and white ants	Rice and sugar cane fields
8	Puddling of green twigs and leaves of <i>neem</i> in fields	Plant hoppers and whorl maggots	Rice and maize
9	Soil application of <i>Madar</i> ( <i>Calotropis procera</i> ) leaf powder	Nematodes	Pigeon pea
10	Application of <i>Argemone</i> sp, <i>Acacia</i> sp & <i>Calotropis</i> sp leaf powder	Root Knot nematode.	Pigeon pea, chick pea and vegetables
11	Kernel extract of Karanj ( <i>Pongamia glabra</i> ), Mahua ( <i>Madhuca longifolia</i> ), Bada Kulanjan ( <i>Alpinia indica</i> ), Castor ( <i>Ricinus communis</i> ) and white kaner ( <i>Nerium indicum</i> ) root extract @ 1.5%.	Insect pest of citrus group	Citrus
12	Neem seed kernel powder 1 kg in 5-l water	Citrus leaf miner	Citrus
13	Kernel of yellow Kaner ( <i>Nerium indicum</i> ) 15-30 gm + Soap 15-30 gm + Water 10 l	White Fly, thrips and caterpillars.	Vegetables
14	Neem leaf 1 kg in 10-liter water and keeping 4 days in shed	Pest in kitchen garden.	Vegetables
15	Tobacco leaf or <i>Calotropis</i> leaf 1.5 kg + water 3-l, followed by boiling and cooling. Mix in 15-l water and use	Different pests	Vegetable and crops
16	Placing of Naphthalene bolls monthly basis in upper 3 leaf sheath of coconut	Black headed caterpillar.	Coconut
17	Leaf extract of bael ( <i>Aegle marmelos</i> )	Blight disease	Tomato and onion.
18	Lantana and basil leaves extract	Leaf miner	Bean, brinjal, tomato, chili and onion.
19	Neem leaf powder @75kg/ha	Mustard sawfly, pod borer	Mustard, Pea and chickpea
20	Neem soaps @10-gm/ l of water	Cabbage pest	Cabbage
21	Spraying of 10% Oak leaf extract	Bud necrosis disease	Groundnut
22	20 kg Jowar leaf or coconut leaf or <i>Bougainvillea</i> leaf or Doob ( <i>Cynodon dactylon</i> .) in 50 liter water followed by heating 60° C for 1 hr followed by cooling. Use with 200 liter water	Viricide	All crops
23	Spraying of Neem kernel extract or <i>Melia</i> kernel extract @ 10%	<i>Earias vitella</i>	Okra.
24	Papaya leaf powder 1 gm/5 kg	<i>Callosobruchus chinensis</i> .	Pulses
25	Spraying of Chilli-garlic solution	<i>Chrysoperla</i>	Cotton
26	Tobacco decoction and 5% Neem seed kernel extract (NSKE)	Aphids	Cotton
27	Spraying of 5% NSKE with garlic	Jassid	Cotton
28	Use of <i>Parthenium</i> (decoction)	<i>Spodoptera</i> and other <i>Lepidoptera</i>	Cotton
29	Use of cow urine	Reddening of the leaf and boll rots	Cotton
30	Planting of <i>Bhindi</i> (okra, lady's finger) as a trap crop around the perimeter	<i>Earias</i> (spiny or Spotted bollworm).	Cotton
31	Planting of Sesamum is around the borders of the crop	Attracts parasites	Cotton
32	Use of Lantana leaf spray	Acaricide	Flowers and vegetables
33	Young leaves of <i>Toona hexandra</i> (Wallich ex Roxb) used as natural insecticide	Protect from insects	food grains
34	Leaf paste of <i>Toona hexandra</i> (Wallich ex Roxb) is used storing the grains for long duration	Protect from insects	food grains

is still perhaps the only sustainable system on marginal land. The challenge for the future is how to increase yields in traditional system while retaining a certain measure of their integrity.

In this era of globalization, India with its excellent and abundant traditional wisdom can be a key player in the organic management of agro-ecosystems. Documentation and dissemination of traditional wisdom can transform India into a major centre in the utilization of traditional wisdom towards organic management of agro-ecosystems.

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