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Indigenous Technological Knowledge on soil and water management from Himachal Himalaya

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Over a millennium indigenous people of Himachal Pradesh have evolved a large number of practices locally called Indigenous Technical Knowledge (ITK) relating to soil and water management systems suitable for different agroclimatic conditions of the state. The ITK regarding soil and water management systems were collected and compiled through PRA and household interviews in the remote and rural area of Himachal Pradesh. In several parts of the Himachal Himalaya, villages are located at the foothills or in the valleys. Villagers often harvest rainwater by building small water storage ponds commonly called *chal*. In hills, there is traditional practice to plough the fields early in the morning before dew or fog is evaporated for the conservation of water. Spring water is collected in small reservoirs scattered at intervals on the high uplands and then drawing water from these ponds when required. Heavy snow is melted with the help of ash. Ash is spread / broadcasted over field for weed control, surface soil crust breaking, and making soil more porous by conserving the rainwater. In Kinnaur district, soil mulching is done with *Pinus*, *Chilgoza* needles and grasses from the *kandas*/hill top. Mulching conserves soil moisture in the field and also helps in maintaining the soil temperature. In the lower areas of Himachal Pradesh during the rainy season, roof water is collected in dugout structures known as *diggi* in Kangra and *khatis* in Hamirpur and Bilaspur district. *Khatis* provides stored water, which is the main source of water. Farmers have been managing soil and water by making arrangements for the safe disposal of excess water.

Keywords: Traditional Knowledge, Soil management, Water management, Himachal Himalaya, Himachal Pradesh

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Himachal Pradesh lies between 30°22' and 33°12' North latitude and between 75°22' and 79°4' East longitude. Himachal Pradesh is mountainous with altitude varying from 350-7,000m amsl. The land area of the state can be divided into three zones; the lower hills (350-1,500 m amsl) valleys are very fertile and can be subjected to intensive cultivation; Mid hills zone (1500-2500 m amsl) is suitable for agro-horticulture based production system; High hill or Alpine Zone (above 2,500 m) remains frozen during most part of the year. Good water management is one of the important cultural practices, which can be used for soil management and checking the population of many insect pests. Flooding of fields has been reported to be effective against many soil borne insects. Alternate flooding and draining has been reported to reduce the incidence of insect pests[1]. Flooding of agricultural field with glacial water and use of natural ingredients i.e. *kuhls* (small water channels) help to remove toxic salts and sweep the insect pests of agricultural crops. Heavy snowfall in hilly areas is good source of water. The ash is spread over the snow that helps in the conservation of snow into water very effectively. This water is collected by digging small ponds near the natural slope of land and their *kuhls* are built along the hill gradients for irrigation[2]. The amount of moisture in the soil has a profound effect on the survival of many insect pests. Drip irrigation will favour a crop rather than a weed and will provide the crop with a competitive advantage[3]. Farmers of Himachal Pradesh have over the ages evolved and practiced a number of soil and water management systems suitable for different agroclimatic conditions of the state.

Methodology

For collecting information on indigenous technical knowledge (ITK) based technologies, the field surveys were conducted in the rural areas of Shimla, Kinnaur, Lahual-Spiti, Mandi, Hamirpur and Bilaspur districts (Fig. 1) belonging to the different agro-

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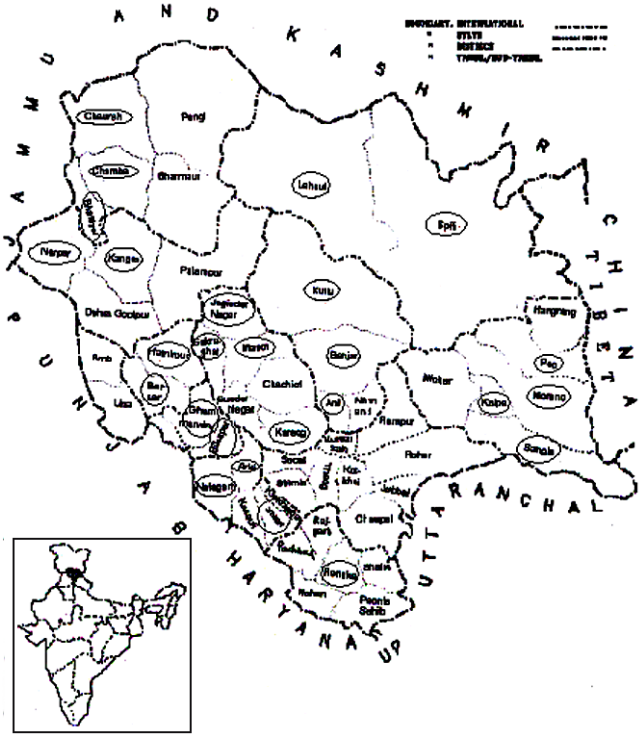

Fig. 1 — Participatory Rural Appraisal (PRA)

ecological zones of Himachal Pradesh. For this purpose, one block was selected randomly from each selected district and from each selected block one *panchayat* was selected randomly. For the survey, the panchayat *Pradhan* and farmers were contacted and information about the ITKs, which are being adopted by the farmers was collected through PRA (Participatory Rural Appraisal) techniques (Fig. 2). The interactive PRA techniques were used to ascertain the required information using a well structured and pre-tested schedule[4]. The whole information was subsequently compiled and is presented.

Results and discussion

Indigenous rain water harvesting methods

In several parts of the Himalayas, villages are located at the foot hills or in the valleys. Villagers often harvest rainwater by building small water storage ponds, commonly called *Chal*. The number of such ponds in the village varied from 30-40 along both side of the hill water streams. Each water pond is 3,600 cm long 3,600 cm wide and 36 cm deep. During rainy season water got stored in these water ponds *Chal*, which not only act as a water reservoir for the village the whole year but also control the floods in the low hill area during rainy season. These water ponds are not used for human drinking water but provide drinking water to cattle and for irrigation purposes (Fig. 3). Mountain communities have a customary and indigenous basis of organization and functioning. In the effective management of common property resources, community organization takes a variety of forms. On most valuable and important common natural resource is water. The conservation and management of water resources is typically unique to their home mountain eco system. Through experience and traditional knowledge communities in different parts of Indian Himalayas have developed indigenous network of *Jal Talais* (*Chal/Khal*) along the face of the hill slides to tap the rainwater. These appear like small basins or trenches of flowing water from a far distance are in fact rectangular earthen pits. Each earthen pits measure 2m in length with 1m width and a depth of 1m. The excavated soil serves to have the periphery in raised earthen mounds planted with indigenous species of grasses. The *Jal Talais* (*Chal/Khal*) are built almost equidistant, in symmetrical rows along the land slope. The distance between two *Jal Talis* is marked by another smaller earthen pit of about 24 cm × 24 cm × 40cm in which indigenous plant tree species are planted.

The entire community of the village irrespective of any caste, creed and religion uses stored water in the ponds. Every year these ponds are cleaned by the entire community of the village. This ITK is practiced throughout the hilly areas of Shimla district of Himachal Pradesh since time immemorial. This ITK practice is simple and easy to follow, technically feasible, wide use, compatible with existing farming system and internal resources of the household, help to recharge the uphill water streams, act as water reservoir during scarcity period, eco-friendly and inputs easily available. In plains and valley occurrence of dew and fog are very common after receding of monsoon. After monsoon, the humidity remains quite high (85%). During night, time temperature falls down sharply resulting in the condensation of vapours into water. As they are heavier they fall on soil surface and make the top soil wet. In hills, there is traditional practice to plough the fields early in the morning before dew or fog is evaporated. By ploughing moisture is mixed with soil particles in the plough layer, i.e 96 cm × 100cm. This moisture is retained by soil for a long time. Natural

fog or dew is harvested to add moisture to the agricultural field. High atmospheric humidity is used for retaining moisture in the soil. This ITK has been practiced in most of the villages in hilly areas of Himachal Pradesh since ancient times. This ITK practice is very effective and convenient, cheap and easy to adopt, low capital investment, retention of moisture contents in soil and enhances crop productivity.

Small ponds for spring water harvesting

Spring water is collected in small reservoirs scattered at intervals on the high uplands and then water is drawn from these ponds when required. It is a common practice in cold deserts and temperate wet Himalayas. Water from these ponds is used for irrigation and domestic purposes. Small ponds are prepared for water storage. These ponds are made up of concrete stones. The walls of ponds are cemented with sandy loamy soil, so that water doesn't pass through these walls. The muddy contents settle down and collected water become clear, transparent and consumable. The stored water is collected and distributed to the desired place through diversion channels. This ITK has been practiced in most of the villages in hilly areas of Himachal Pradesh, where water accumulates easily in low layering ponds. This practice completely compatible with the existing farming components is simple, easy to prepare and uses local raw materials.

Farm pond for water harvesting

Farm ponds are useful during the period of water scarcity. Rain water during spring season and snow melted water of glacial during winter are harvested in farm pond and used for irrigation and other domestic uses. Farm ponds are constructed near the house and field. These types of ponds are also constructed near the road side and forest area which provides sufficient water to the livestock during grazing and migration. These farm ponds are constructed by digging the soil 120-150 cm near the natural slope of land and the walls of these ponds are piled with stone and other concrete like materials so that water doesn't percolate through these walls. Different rainwater channels are diverted into these ponds for storage of water (Fig. 4). The ITK practiced in most of the villages of Kangra, Hamirpur and Mandi district of Himachal Pradesh since time immemorial, is simple and easy to prepare, ecofriendly, maximum use of local raw materials and retention of water quality during storage.

Harvesting of water from snow melting

Snow melted water is harvested for irrigation and other multiple purposes. Heavy snow in winter provides good source of water. Heavy snow in hilly areas is a good source of water. Heavy snow is melted with the help of ash. Ash is spread over the snow. Ash contains certain substances, which help to convert snow into water. This water is collected in the large ponds. Ponds are dug at a suitable place, where runoff water is collected and then with diversion channels water is distributed to the agricultural land for irrigation. The ITK practiced in most of the hilly areas of Shimla, Kinnaur and Lahual –spiti of Himachal Pradesh since time immemorial uses local raw materials, cheap and has no adverse effect, and retention of overall quality of water during storage.

Use of ash for rain water conservation

Mixing of ash with household waste and human excreta helps in weed control, surface soil crust breaking, and rain water conservation. It is used for nutrient availability and recycling. The inhabitants of the entire region use cattle dung, shrubs, and bushes as the main source of fuel. Ash available, there upon are mixed with household waste of human excreta. Some times ash is also broadcast in the fields. Ash primarily meets the deficiency of potash. This ITK practice has been practiced throughout cold desert farming of Lahual-Spiti and Kinnaur districts of Himachal Pradesh as well as other parts. This practice is widely used, technically feasible, inputs easily available, compatible with internal resources of the household, eco-friendly, nutrient availability, nutrient recycling, enhance soil fertility, crop production, weed control, helps in surface soil crust breaking and rain water conservation.

Spade insertion as indicator for irrigation

Insertion of spade or digging of soil is used to test moisture contents of soil. It is a local practice to ascertain the optimum utilization of water and its penetration up to root zone of the soil profile. Moisture contents in the soil particles are necessary for increasing soil fertility. Both under rainfed and irrigated land, farmer test moisture content of soil with the help of spade digging. Farmers regulate irrigation to desired soil depth by inserting spade (*belcha*) to the soil. If it is completely inserted from front portion, it is considered to be properly irrigated. Similarly in other cases, soil is thrown upside with spade and it splits into small pieces (soil particles),

this shows proper irrigation (Fig. 5). This practice of hilly area of Himachal Pradesh, which is a good indicator for the farmers to estimate proper irrigation of agricultural land is simple and easy to adopt, saves time and labour, cheap and easy to practice.

Moisture conservation through mulching

In Kinnaur district, surface of soil is covered with *Pinus, chilgoza* needles and grasses from the *kandas* (hill top). Mulching conserves soil moisture in the field and also helps in maintaining the soil temperature. However, continuous use of *chilgaza* tree needles 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 Farm Yard Manure is also in use. This practiced in most of the villages in hilly area of Kinnaur district of Himachal Pradesh helps in subsistence farming in cold desert area (Fig. 6). This ITK practice is cheap and simple to adopt, conserve soil moisture, boon to the rural peoples for increased crop production & higher soil fertility and maximum use of local raw material.

Roof water harvesting

Water harvesting during summer is necessary to tide over water shortage. The roof water harvesting becomes available for household uses as well as for irrigation purposes under rainfed farming. In the lower areas of Himachal Pradesh during the rainy season, roof water is collected in dugout structures known as *Diggi* in Kangra and *Khatis* in Hamirpur and Bilaspur districts. Dugout structures are cemented internally to avoid water infiltrations. The structure is dug in hard rocks. This stored water is then made available for irrigation purposes through small water channels. These dugout structures are underground and have definite outlets at the top of these structures. This practice common in most of the village in Himachal Pradesh, is useful for household uses as well as irrigation purpose. This practice is made from local raw materials, simple and easy to prepare, tide over water shortage during summers and retention of overall quality of water during storage.

Water storage for domestic and irrigation purposes

In most villages of district Hamirpur, the farmers experience an acute storage of water in summer. During this period, most of the natural sources of water like the wells and *bories* dry up and farmers have to bring water from far-flung area. For this purpose, the farmers of these regions of the district have to make water logging structures commonly known as *Khatis.* These *khatis* provides stored water, which is the main source of water for various purposes during summer season (Fig. 7). *Khatis* are made on the concrete hard rocks (conglomerate) and subsurface seepage from the unconfined aquifer is the main source of the water. The *Khatis* are constructed by digging rocks (where water is collected from sub-surface runoff) on the concrete hard pan of the rocks. The stored water is the main source of water during the summer season. The stored water is used for drinking and other domestic purpose. The strata are rich in silica that eliminates the impurities in the stored water. Evaporation and seepage/Infiltration losses of the water are also minimized in the concrete hard pan of the rocks, where these *khatis* are constructed. These *Khatis* are prevalent because there is no other source of water for drinking and other purpose (like irrigation) in the region for the summer season. This practice common in most of the villages in district Hamirpur as well as other parts of the state is based on use of local manpower resources, low cost of investment is required, provides stored water, which is the main source for various purposes during the summer season and strata are rich in silica, which eliminate the impurities in the stored water.

Water diversion channels

Farmers have been managing soil and water by making arrangements for the safe disposal of excess water. They make diversion channels at the toe of the rivers. Water collected at the toe, fall on the lower terrace. Generally, diversion ditches were constructed along with the contour lines and across slopes in order to interrupt surface runoff and diverted it to suitable outlets. However, for a wide terrace, they are made perpendicular to the toe at appropriate locations and this is done according to the rational decision of farmers who have years of practical experience (Fig. 8). The diversion channels, variable is size and made by digging the channel in the water logged areas are cemented with the clay loamy soil (Fig. 9). This practice is useful in maintaining the terraces free of water logged conditions. It also helps in controlling the soil erosion and maintaining optimum moisture conditions in the terraces. This method practiced in most of the villages in hilly area of Himachal Pradesh is based on the use of local manpower resources, used for avoiding waterlogged conditions and helpful in


Fig.2 Participatory Rural Appraisal


Fig.3 Recharging up hill water stream


Fig.4 Farm pond


Fig.5 Spade insertion


Fig.6 Mulching


Fig.7 Terracing with water channels


Fig.8 *Bories*


Fig.9 *Kuhl*


Fig.10 Water channels

maintaining optimum moisture conditions in the terraces.

***Kuhls* or water channels for irrigation**

It is a time-tested fact that communities made water channels for glacial and spring water in order to ensure the irrigation of agricultural lands. Irrigation is necessary for all the crops sown in cold desert of hilly areas for increased and sustainable crop production. If the river has steep gradient, water is diverted into canal some distance upstream and led along a contour so that it can flow to the fields by gravity. *Kuhl* or water channels are made near or around the natural slope of land by digging channels with spade and these channels (40 cm × 50 cm) are cemented with sandy loamy soil (Fig. 10). This method practiced in most of the villages of Bilaspur and Mandi districts of Himachal Pradesh is simple and easy for adoption, maximum use of local raw material and man power resources, ecofriendly, provides good source of water for irrigation and other domestic purposes and cheap and easy to prepare.

Irrigation through *kuhl* and soil beds

During summer, there is scarcity of water, so farmers adopt various methods for irrigation of

agricultural land. It also checks the loss of nutrients by leaching. Irrigation provides uniform watering of the plants. This practice also checks the loss of nutrients from one place to another, i.e. with surface runoff water. Irrigation is done by constructing small beds in the fields. In the initial stage of watering from the *kuhl* it is done by *Urma* that is made from animal's (buffalo, oxen) horn. The *kulhs* are prepared by digging about 6 cm in depth and breadth with the help of spade. The wall of *kulhs* is cemented with soil. The water is stored in beds and diverted thorough *kuhls* to the agriculture land. In the entire Spiti valley, the first irrigation is done 40 days after sowing of crops (April-May). This practice is the main source of crop irrigation and is optimum ally use of manpower resources, simple and easy to practice, enhances soil productivity and equal distribution of water and conserves soil nutrients.

Indigenous drip irrigation method

Water drops from earthen pitcher act as a counterpart of modern drip-irrigation. It is a cheap, easy and water saving method of irrigation. The water is harvested with the help of pitcher. Pitcher is placed in soil and the new plant is planted close to it. The pitcher is filled with water during summer months (April-June) and stone slate lid is placed on it. The roots draw water from pitcher, which in turn reduces the mortality. The pitcher once filled, supply sufficient water for at least two weeks and then it is again filled and so on. This practice prevalent in most of the villages of Shimla district is based on maximum use of the local raw materials and manpower resources, boon to rural people for irrigation, cheap and easy preparation and irrigation to overcome drought conditions.

Indigenous Technologies on rainwater management systems

Farmers of Himachal Pradesh have over the ages evolved and perfected a number of rainwater management systems suitable for different agro-climatic conditions of the state. Farmers have been managing soil and water by making arrangements for the safe disposal of excess water. They make diversion channels at the toe of the rivers. Water collected at the toe, fall on the lower terrace. Generally, diversion ditches were constructed along with the contour lines and across slopes in order to interrupt surface runoff and diverted it to suitable outlets. Insertion of spade or digging of soil is used to test moisture contents of soil. Moisture contents in the soil particles are necessary for increasing soil fertility. During rainy season, water stored in these water ponds *Chal*, not only act as a water reservoir for the village the whole year but also control the floods in the low hill area during rainy monsoon season. These water ponds are not used for human drinking water but provide drinking water to cattle and for irrigation purposes.

In plains and valley, occurrence of dew and fog are very common after receding of monsoon. After monsoon, the humidity remains quite high (85%) and during night time temperature falls sharply resulting in the condensation of vapours into water. As they are heavier they fall on soil surface and make the top soil wet. During summer, there is scarcity of water, so farmers adopt various methods for irrigation of agricultural land, because irrigation is necessary for the adequate growth and yield in various crops. It is a time-tested fact that communities made water channels for glacial and spring water in order to ensure the irrigation of agricultural lands. Irrigation is necessary for all the crops sown in cold desert of hilly areas for increased and sustainable crop production. It also checks the loss of nutrients by leaching. Irrigation provides uniform watering of the plants. This method also checks the loss of nutrients from one place to another, i.e. with surface runoff water. Flooding of agricultural field with glacial water and use of natural ingredients i.e. *kuhls* (small water channels) help to remove toxic salts and sweep the insect pests of agricultural crops. Heavy snowfall in hilly areas is good source of water. The ash is spread over the snow that helps in the conservation of snow into water very effectively. This water is collected by digging small ponds near the natural slope of land and their *kuhls* are built along the hill gradients for irrigation[2].

The amount of moisture in the soil has a profound effect on the survival of many insect pests. The quality and quantity of nutrients available in the host plants are also greatly affected due to change in the soil moisture level. In situation, where crops are not solely rainfed, the management of water may be used as a means of pest control. Drip irrigation will favour a crop rather than a weed and will provide the crop with a competitive advantage. Flooding is also an effective practice for the control of number of weeds and of course is usefully employed in this way with vast areas for pest management. However, water supplies are managed primarily to promote healthy

and vigorous plant growth with pest control usually only considered of secondary importance[3]. In most villages of district Hamirpur the farmers experience an acute storage of water in summer. During this period, most of the natural sources of water like the wells and *bories* dry up and farmers have to bring water from far-flung area. For this purpose, the farmers of these regions of the district have to make water logging structures, commonly known as *Khatis*. These *khatis* provides stored water, which is the main source of water for various purposes during summer season. Farm ponds are useful during the period of water scarcity. Rainwater during spring season and snow melted water of glacial during winter are harvested in farm pond and used for the multiple purposes i.e. irrigation and other domestic uses. Water drops from earthen pitcher act as a counterpart of modern drip irrigation. It is a cheap, easy and water saving method of irrigation. Ash is spread / broadcasted over field for weed control, surface soil crust breaking, and making soil more porous by conserving the rainwater. Ash also contains some minerals, which act as insect pest repellent. Spreading of ash on standing crops like *onion, brinjal, tomato and cucumber* to protect them mainly from the pumpkin beetles, *handa* beetles, leaf defoliating insects, leaf miners, thrips and aphids is quiet useful. This is because it is a source of phosphorus for plants and it also acts as a physical poison usually causing abrasion of epicuticular waxes and thus exposing pests to death through desiccation. It also interferes in the chemical signals emanating from the host plants thus obstructing the initial host location by pests. The treated foliage further becomes unpalatable for foliage feeders[2]. In Kinnaur district, surface of soil is covered with *Pinus, Chilgoza* needles and grasses from the *kandas* (hill top). Mulching conserves soil moisture in the field and also helps in maintaining the soil temperature. Mulching, besides conserving moisture during summer months also protects the crop from damage by shoot borers[5-7]. Mulching conserves soil moisture, helpful to increase the fertility of soil also exposes and sweeps the land dwelling insect pests.

Learning from ITK can improve understanding of local conditions and provide a productive contest for activities designed to help the communities. In addition, the use of ITK assures that the end user of specific agricultural development projects are involved in developing technologies appropriate to their needs[8]. Although women have long been key food producers and "managers" of their environments and play a central role in the sustainable use of biological resources and life support systems, especially in the conservation and enhancement of water resources, The stability and sustainability of the intricately interwoven ecosystem of forest, crops, and water depended on the practices and knowledge systems of the local women. Their collection of water is vital to the continued flow of resources that maintained the local economy in a sustainable way. The introduction of new water harvesting technologies is resulting in women increasingly losing control in areas where they once had considerable control. In India, for example, the shift from subsistence to commercial agriculture has led to a reduction of women's sphere of influence. There is then the immediate danger that women's ecological knowledge will be "packaged as a product to be collected, owned, and sold in the marketplace of ideas of the scientific community" without them being compensated in any way.

Depending on the local resources, ingenuity and skills, mountain communities have developed diverse indigenous practices for the management of water. Throughout Himachal Himalaya intricate channels, which use both perennial and seasonal sources to supply water in agriculture, can be observed. These channels are constructed, operated, managed, and repaired by local communities. Similarly, drinking water systems not only provide access to springs and groundwater but also harness rain water. While the existing indigenous practices fulfilled the need of water in the past. Such practices presently have become gravely inadequate and incapable to meet the ever-increasing demand for water by the mountain communities, as well as communities in the plains and urban areas. With the increasing scarcity of water in the mountains the local communities have been facing the issue of transporting water from distant places. Because of the huge costs of transporting water from distant places, protecting local water resources and improving indigenous water management practices have become imperative, if available water resources are to meet the present and future needs of the mountain communities. Considering the rapidly increasing demand for mountain water resources and to ensure adequate supplies of water for different purpose in future, identifying, developing, and implementing appropriate policies and programs for the management of local water resources in close

partnership with the local communities are essential. Yet, ITK is still an under utilized resource in the developing activities. It needs to be intensively and extensively studied and incorporated into formal research and extension practices in order to make agriculture and rural development strategies more sustainable[9].

Local water harvesting and management

In Himachal Himalayan region, water is a scarce commodity and improved water harvesting practices are critical for ensuring the availability of drinking water for mountain households, production of food grains, meeting the need for biomass, and for improved living conditions. More efficient water use and harvesting methods can also contribute towards improvement in the conditions of other natural resources and thereby contribute to the reliability of water supply systems. People's active participation in all aspects of water use, harvesting and management have contributed towards the greater equity and sustainability of local systems with the following considerations: compilation of relevant facts on people's institutions related to water harvesting and dissemination of these facts; study of women's role in water harvesting; study of water harvesting system's planning, implementation, maintenance, sharing, raising resources, and resolving conflicts; study of decentralized policy on water harvesting; study of the roles of different organizations in local-level water harvesting and their capabilities in terms of meeting new challenges; inventory of water harvesting technologies and their assessment in terms of costs, benefits, and potentials for replication; sharing information about different aspects of water harvesting; better understanding of social capital development and water harvesting practices in mountain areas, including the impact of cultures, local practices, and different policies and programs on water harvesting; training in both technical and farmer levels; exchange visits and study tours for greater awareness about sustainable water harvesting systems and study of the environmental impacts of different water harvesting systems

Loss or disappearance of indigenous knowledge, particularly from ethnic minority groups or tribes, is rapidly occurring due to the encroachment (intrusion) of State and market forces and the decease of elders carrying that knowledge. Once lost, orally based knowledge cannot be retrieved. The two profoundly different worldviews of scientists and indigenous communities, based on radically diverging assumptions about the nature of the world, stand in the way of real communication and understanding. An attitude problem derived from cultural barriers and political realities prevents both groups from acknowledging the value of each other's system of knowledge. Perceptual and language barriers obscure meanings. And because scientists represent the existing system of political domination over indigenous groups, their indigenous knowledge is viewed as subordinate to that of western science, giving rise to arrogance on the part of scientists. Integration requires that the two groups have a common ground, enabling communication. This does not mean that indigenous knowledge should be forced into formal science paradigms, as is currently being widely done. In fact, communication and collaboration rest on the sharing of a common culture, a common vision. Finally, any examination of indigenous knowledge systems must not be purely extractive, as it often is, for the generation of profits, scientific knowledge, or even dissertations and journal publications for scientists, anthropologists, and entrepreneurs who do little to compensate the indigenous originators of the knowledge. Knowledge gained through such examination must be analysed and returned to the communities in linguistic and symbolic forms meaningful to them, so that it is knowledge from the people and for the people. Participatory community based approaches involving the stakeholders in planning and implementation are necessary in order to create a higher ownership attitude. Clear messages on conservation tillage should be included in the normal extension packages and training of both village extension workers and farmers should be emphasized so as to improve their understanding and skills.

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