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Indigenous technical knowledge documentation for sustainable use in Rainfed agriculture

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Abstract
Indigenous Technical Knowledge (ITK) is the accumulated skill and technology of a community that has been passed on from one generation to another generation. These traditional techniques are still having great relevance in agriculture. Due to uneven distribution of rainfall in time and space and low input levels, the productivity of rainfed agriculture has been very low which needs to be enhanced considerably for long term agricultural sustainability. This objective can be accomplished by resorting to various water conservation techniques particularly traditional practices based on ITK. Some of the ITKs for water in rainfed agriculture being practiced by farmers in India, are badi cropping- most of the indigenous and drought resistant varieties of fruits and vegetables are used which are compatible with socio-economic conditions, incorporation of organic residues- adding the ash of leaves and branches of shrub in the soil, aids the water holding capacity and the smoothness of soil, making entire field into smaller plots- it helps in moisture conservation of soil by utilizing maximum irrigation water efficiently in undulated lands, summer ploughing- this practice enhances water holding capacity of soil by virtue of keeping it in fine tilth which helps in improving moisture level of the soil and increases the possibilities to improve the productivity of rainfed crop sowing red gram with rice- the seed of red gram is sown on the bunds of paddy field to arrest soil erosion and accrue additional income, many such indigenous technologies are available locally which need to be documented systematically for widespread application. It is also important to create awareness and popularize the ITKs among farmers in large scale for economic productivity and long term sustainability.

Keywords: Indigenous technical knowledge, rainfed agriculture, productivity, sustainability

Introduction
Farmers in India have a bundle of knowledge on agriculture and natural resources management, which are conventionally being applied by them themselves. This knowledge is based on insights gained through many generations (Singh, R. K. 2007) [8]. ITK is dynamic, changing through indigenous mechanisms of creativity and innovativeness and contact with other local and international knowledge systems. ITKs are often elaborated and adapted to cultural and environmental conditions. They pertain to various cultural norms, social roles or physical conditions. The diversity of IK deals with the trial and error problem solving approach. It is influenced by the adaptive skills of local people, usually derived from many years of experience, time tested practices in nature, strategies and techniques developed by the local people to cope with changes in their socio-cultural and environmental conditions and accumulated by farmers through constant experimentation and innovation. Majority of farmers in the country are small-scale farmers with multiplicity of social fabric. The knowledge systems of these farmers have not been recorded systematically; hence they are not easily accessible to agricultural researchers, extension workers, and development practitioners. The treasure of knowledge with these marginalized section of the society could be potentially used for scientific application, while their voices are often seldom heard. Rainfed agriculture still being practiced predominantly in the country on one hand, with the issues of climate change and natural resources degradation, this knowledge could be identified and put into potential use with evidence based scientific application.
Looking at the importance of role of indigenous knowledge in sustainable use and management of agriculture and natural resources, an attempt has been made to document some the ITKs which are being practiced by the farmers in rainfed agriculture.

ITKs in rainfed agriculture
Variety Conservation: The farmers have developed a set of strategies to select the seeds, maintain seed stocks and anticipate climate changes.

The indigenous paddy varieties have become an integral part of the farming system and are maintained and developed on account of indigenous ways. It is argued that these strategies are important and are part of the local culture. Farmers have succeeded in conserving these varieties by mass selection (Singh and Sureja, 2008) [7].

Rainfall forecasting: For predicting the rainfall and weather conditions, different biophysical indicators are considered. Forecast of rainfall is done by elderly men (often called wisemen). The forecasts are based not only on biological indicators, such as the fruiting of mango trees, movement of ants, plying of certain birds, insects, but also on the basis of spiritual indicators. Based on prediction of rainfall crops sown in the year are planed. In years rain forecasts are good, women tend to prepare more rice seeds and maize varieties that are short. In dry years, they prepare more drought resistant plants, such as stalked foxtail millet, *Kodo, Kutki, foxtail millets, finger millets, kulthi* and sorghum varieties.

Lahee Method: The *Lahee* method of sowing the rice crop refers to when the germinated seeds are broadcasted in the well pulverized moist or the puddled soil. This practice is done in between 10 June to 15 July and is preferred in soils (*Tikara* soil) where water run-off is a major problem. Before broadcasting of the seed, about 20 *Paily* per acre (1 *Paily* = 15 kg.) rice seed is soaked in the water and kept over two days for premule initiation. In some parts of India this method is followed by using the green leaves of *Saaz* tree (*Terminalia chibula*). The farmers perceive that the leaves act as catalytic agent for a rapid germination of the rice seed and increase percentage of germination. The practice was accepted by the majority of scientists interviewed to be scientific and rational. The Ethno-botanist explained that some active acids are found in the leaves of Saaz tree, which rapidly activate the germination process of rice seeds. After making the well-pulverized soil or the puddling of land, seeds are broadcasted and planking is avoided in order to save the radical and coleoptiles.

Utera Cropping System: Utera cropping literally refers to "sowing of the next crop seeds before harvesting 15 days of standing paddy crop in order to utilize moisture efficiently" under rainfed agro-ecosystem. Utera cropping is only adopted in *Rabi* season. This system helps farmers to use the available moisture in rainfed areas and diversify the next cropping system by incorporating two or three pulse and cereal crops to reduce crop failure risks. For a successful Utera cropping system, seeds of the local pea, linseed, local variety of black gram and *lathirus (*lentil, *Lathyrus sativus*) are sown. In the paddy crop field, most of the paddy cropping area is done in a micro-environment by conserving water from natural resources. Just before the 15 days of harvesting of the paddy crop, the seeds of the above-mentioned crops are broadcasted. The environmental and economic sustainability of the Utera cropping system is assured by compatible ecological conditions and harvesting more than one crop at a time, without applying additional external inputs. Due to the popularity and sustainability of this system, ICAR got inspiration from this practice and implemented the NATP project during 1999 in some of the other areas in the State. The multidisciplinary scientific team has accepted that this practice is quiet scientific in terms of labour, energy, water availability, rainfall pattern, texture of soils and needs of the farmers under the rainfed agro-ecosystem (Singh, R. K. 2007) [8].

Making entire field into smaller plots: This practice conserves the soil moisture by utilizing maximum irrigation water efficiency. Fields are made into smaller plots due to undulated land. By this way they control erosion of fertile surface soil as well as aids in water conservation.

Badi cropping system: Most of the varieties involved in the Badi cropping model, are indigenous and drought tolerant. In addition to this, most of the tribal villages are located near to natural water resources from where they can use the water for irrigation through the traditional irrigation implements. The domestic wastewater is directed in the Badi cropping system, which facilitates for irrigation of the vegetable crops. The environmental and economic sustainability of the Badi cropping system is assured by availability of indigenous varieties of local food crops and the compatibility with culture, socio-economic and biophysical conditions.

Arresting soil erosion: A number of practices exist to improve the physico-chemical composition of the soil in Rajasthan, India, many of the tanks used for irrigation become dry. Large quantities of silt and organic matter collected during the water's journey are deposited in and accumulate in these tanks. Farmers collect this enriched soil and broadcast it on their fields to improve soil structure and organic content, improve soil fertility and to reduce salinity (Chadwick *et al.*, 1998) [1].

A study conducted by (Sinha *et al.*, 2015) [10] to identify indigenous soil and water conservation practices prevalent at Ambikapur block of Sarguja district in northern hill region of Chhattisgarh during 2012-13. Study revealed that with the help of long historical knowledge, traditions and experiences farmers have been developed indigenous practices for soil and water conservation. The most common practices followed by farmers are farm pond, well, fencing trench as recharging trench, brush wood structure, peripheral stone bunding, sand bag structure, borrow pit, dhodhi, fym pit, field earthen bund, tank silt application, deep ploughing, vegetative barrier, biasi and utera. These indigenous techniques of soil and water conservation are mostly individually managed. Presently the adoption percentages of these ITK are low i.e. 20-30% except 60% in summer ploughing and field boundary bunding.

Water harvesting and artificial recharge

Virda: virda is an indigenous rainwater harvesting system that was evolved centuries ago in Banni grassland of Kachchh, Gujarat, India. Animal husbandry is the major occupation of local people called as maldharies, and agriculture is not possible due to low rainfall and inherent salinity present in soil and water. The indigenous water harvesting system based on traditional knowledge is found to be highly effective in sustaining livelihoods of people and life of animals. Success of virda is evident from the fact that the method, developed centuries back, is still found in existence and operational. This indigenous technology developed by the maldharies learnt over the generations based on their wisdom and experience, is not only a traditional method rather it has also been embedded into their culture. Quality of virda water is found suitable for drinking purpose. Thus, virda is a unique water culture for the maldharies community of Banni. Moreover, suitable scientific interventions are suggested to

integrate with traditional knowledge-based indigenous technology for further improvement (Machiwal *et al.*, 2018) [3].

Sowing red gram with rice: Red gram crop is taken on the natural drains and fish ponds with an intention to provide the defense by its deep root system to control soil erosion. Apart from it, the *Kali soil*, which is most fertile is found to be best suited for tall varieties of paddy under low land areas. The seed of red gram is sown on the bunds of paddy field. The reason behind sowing red gram on bunds is to make sure of getting additional income from the pulse crop. The network of roots of red gram facilitate in controlling the soil erosion during rainy season. The environmental sustainability of the red gram crop is assured by growing it in each year by every farmer. While, the economic sustainability of red gram sowing is assured by exchanging it with the flowers of *Mahua* (*Madhuca latifolia*, used for making varieties of ethnic foods and medicines) and black gram seeds.

Resource conserving indigenous seed and cropping technologies: Farmers use high seed rate to maintain optimum plant population and close planting to utilize rainy water to maximum extent and to reduce moisture losses.

Zabo Farming System: *Zabo* is a local term which means impounding of water. This indigenous farming system of Nagaland is excellent example of rainfed farming on sloping land. Under the system, perennial streams emerging from the forest are diverted to water harvesting pond and stored water is utilized for agriculture and animal husbandry. Water harvesting tank is constructed above the agriculture field for irrigation application through gravity flow. Another small pond is dug at the upstream of the main tank to act as silt retention tank. Thus clean water is stored in the main tank. The pond bottom is puddled through movement of human, cattle, and wooden sticks to minimize the percolation losses (Singh, R. K. 2018) [9].

Incorporation of organic residues: Farmers collect the leaves and branches of shrub and other weed species from the forest and crop field during summer season and spread it over entire field. These leaves and branches are set on fire before the onset of monsoon, thus adding the ash in soil. The water holding capacity and the smoothness of soil are improved in addition to improvement in the fertility level.

Adaptation of location specific indigenous varieties: Various location specific indigenous varieties were found, which are being conserved and cultivated. These varieties are found to be compatible with the existing rainfed agro-ecosystems and local needs of farmers. Since majority of the farmers are poor and cannot afford the improved rice varieties, therefore they totally depend on these indigenous varieties even though low yielding.

Indigenous water resource management practices in Nepal: Indigenous water resource management methods from different countries in the Hindu Kush-Himalaya have also been described. The art of rainwater collection as a principal source of water has been in practice in Nepal since ancient times. This practice was most common among *Brahmin* community. Planting *TuIsi* plant in a specially built structure called, *Maeri* was considered an essential religious practice in every house and a small pond would always be built close to this for storing water (Sharma *et al.*, 2009) [12]. The soil excavated while constructing such pond would be used in building *Maeri* and every morning all the members of the family would use this place for bathing. The water wasted during bathing was stored in this pond and used for a kitchen garden close by or else used for cattle watering.

Rain water collection: The technology of rainwater collection from rooftops in ferro-cement jars for domestic purposes is becoming more and more popular in the water scarce districts of Nepal, after its successful introduction in Daugha Village Development Committee (VDC) of Gulmi district- introduced as a pilot project by the Rural Water Supply and Sanitation Support Programme (Sharma *et al.*, 2009) [12].

Haveli Bundies: *Haveli* system of cultivation is practiced in black soils of Bundelkhand region.
The area is divided in small fields by constructing bunds. Rainwater is impounded in bunded fields during monsoon wherein rice is grown in *kharif* Many farmers prefer *rabi* crops. Direct sowing of *rabi* crops is generally done after draining the impounded water. In this way, only single crop in a year either rice in *kharif* or any *rabi* crop is taken under *Haveli* system (Singh, R. K. 2018) [9].

Ahar Pyne System: Ahar-pyne system is an indigenous irrigation technology of South Bihar which continues to irrigate substantial areas even today. This system has evolved from an understanding of the particular agroclimatic conditions of the region. An Ahar is rectangular embankment type water harvesting structures, i.e. a catchment basin embanked on three sides, the fourth side being the natural gradient of the land itself. Ahar beds were also used to grow a Rabi (winter) crop after draining out the excess water that remained after Kharif (summer) cultivation. Ahars differ from the regular tanks in that the bed of an ahar is not dug and usual tanks do not have the raised embankment of an ahar. While ahars irrigating more than 400 ha are not rare, the average area irrigated by an ahar during early 20th century was said to be 57 ha[2]. Water supply for an ahar comes either from natural drainage after rainfall (rainfed ahars) or through pynes where necessary diversion works are carried out. Water for irrigation is drawn out by opening outlets made at different heights in the embankment. Pynes are artificial channels constructed to utilise river water in agricultural fields. It is this system that made paddy cultivation possible in South Bihar, which is otherwise unsuited for this crop. In particular, it helped farmers meet the crucial water requirement for paddy during hathia i.e. the grain filling stage **(**Koul *et al.*, 2012) [2].

Khadin cultivation: Khadin cultivation is a typical land use system of runoff farming followed since 15th century in 100–200 mm rainfall zone in Jaisalmer district of western Rajasthan. Rainwater is conserved by constructing an earthen dam across the general slope of the farm in the valley bottom conserving maximum runoff within the agricultural field. With meager rainfall, only a Kharif crop is raised and in case of good rainfall, a *Rabi* crop may also follow. On an average, the cultivated area under each Khadin is 10-14 ha with an average dam size of 1.2-1.7 m height, 1.0-1.5 m width and 100-300 m length, depending upon catchment area arid

number of land holdings. The spillways and sluice gates are usually provided at a proper location in dam for draining excess water during flood conditions (Prasad *et al.*, 2004) [5].

Bamboo drip irrigation: bamboo drip irrigation is widely adopted by the tribal farmers of Jaintia and Khasi hills of Meghalaya. This is a good irrigation system by growing crop in areas where water becomes scarce in lean periods as the topography is undulating and hilly and the soils have poor water holding capacity (Singh and Gupta, 2002) [6].

Strategies for improved adoption of ITKs in rainfed agriculture

- Identification of various ITKs suitable for rainfed agriculture.
- Conservation of indigenous varieties of crops.
- Development of awareness programmes on ITKs for the farmers.
- Ensure availability of suitable implementation of ITKS and cost-effective by the improvement in existing ITKs so that these practices may be more adoptable among the farmers.
- A scientific study may change this Indigenous Technical Knowledge to Modern Technical Knowledge (MTK). Prevailing ITKs should invariably be given priority. All the ongoing projects on resource conservation and management should focus on the viable and appropriate ITKs relating to soil and water for sustainable development and dissemination of the local technology (Mishra, P.K. 2002) [4].

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