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Mapping indigenous climate resilience practices in animal disease management and feed storage protection in Himachal himalayas

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ABSTRACT

The present study focused on validation of indigenous climate resilience practices in animal diseases and feed storage management based on 1,605 farmers' perceptions in eight districts in north-western Himalaya. The importance of the study in Himalayan regions was asserted by changed climate indicators like increased temperatures and receding rainfall in fragile and sensitive mountain ecosystem. The climate of surveyed districts varied from sub-humid and sub-temperate climate having elevation 700–1300 amsl to sub-tropical climate having elevation up to 700 amsl. The use of drek plant (*Melia azedarach*) for skin diseases of animals; turmeric rhizome and taramira for deworming in young calves; mixture of lassi, gur, azwain and fern plant for bloat (Aphara); banana and jamun leaves for haemorrhagic disease in animals and extract of tobacco leaves for scabies diseases in sheep and goat were followed by 4–90% surveyed farm households in Kangra, Kullu, Una, Hamirpur and Mandi districts. Seed storage is an important factor as about 6% of losses exist due to non-availability of proper facilities in India. Seeds of crops were treated before sowing with a mixture of ash and cow dung by 15–77% farmers in seven districts except temperate regions of Lahaul and Spiti. Food grains were stored in a large spindle shaped basket made of bamboo (*Perru*) safe from pests and diseases by 10–86% farmers in Kangra, Hamirpur, Chamba and Mandi districts and higher perceptions were observed in majority of farmers in Kangra districts. Practices like use of match box sticks, dry leaves of Bangru (*Mentha arvensis*), Kali Basuti (*Adhatoda* sp.), Safeda (*Eucalyptus citrodora*) in wheat storage pests and use of walnut leaves (*Juglans regia*), pieces of resin rich wood (Jugnu) and wood ash for food grains storage were followed by 10–79% farmers in Kangra, Una, Hamirpur, Chamba and Mandi district. The study concluded that farmers of mountains possess Indigenous Traditional Knowledge (ITKs) and climate resilient practices for animal disease management and seed protection to mitigate the impact of climate change).

Key words: Indigenous climate resilience practices, Traditional knowledge, Livestock diseases management, Seed storage protection

Indigenous knowledge and wisdom is getting worldwide importance for sustainable eco-friendly agriculture. In modern agriculture chemical methods are used for providing quick response, but their continuous use adversly affects environment, biodiversity as well as on human health. These are hazardous and remain in the environment for long duration and then enter the food chain. Some insect pests have acquired resistance against many of these chemicals (Prakash *et al.* 2016). The traditional knowledge has been developed by the people through their own experimentation, observations and years of individual and collective experiences in different regions to meet their demand. The main constituent of indigenous knowledge is the medicinal use of plants and animals products. India has been rich in traditional and indigenous knowledge for animal healthcare and crop protection. Indigenous knowledge has been passed from one generation to other orally only though some practices are documented there is threat of extinction of this knowledge. In order to replace synthetic pesticide, the best option is to adopt indigenous traditional knowledge for animal healthcare and food storage. Seed storage is important as about 6% of losses due to non availability of proper occur facilities in India. Thus, there is a need to promote and document old indigenous methods as they are readily available, cost-effective, biodegradable, eco-friendly and do not cause any health hazards to the farmers and can be used by present and future generation. The present study focuses on validation of indigenous climate resilience practices used in animal disease management with relevance to climate change in mountain agriculture.

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MATERIALS AND METHODS

The data collection with respect to use of indigenous

climate resilience practices and farm household surveys were carried in 12 sites, *viz*. Malan (45 farmers), Palam Valley (130) and Kotla (203) in Kangra District; Bajaura (38) in Kullu, Akrot (286) and Dalautpur (106) in Una, Sujanpur in Hamirpur, Lagga (104) in Chamba, Sangla (112) in Kinnaur and Bohar (133) in Mandi. The sites were located in eight districts of Himachal Pradesh comprising four agro-climatic zones and elevation from 400 to 2700 amsl. About 1605 farm households during 2010–2017 were surveyed through PRA techniques during farmers awareness programme (*Kisan Melas*) organized in different sites to validate the use of Indigenous Traditional Knowledge (ITKs) and climate resilient practices in livestock and storage grains pest management in the face of climate change followed by farmers of the regions. The interactions were initiated related to Indigenous Technical Knowledge with older farmers, elders and women of different districts. The questionnaire was structured with special emphasis to changing climate. The participatory rural appraisal (PRA) technique was used during the farmers awareness programme organized on "Weather, Climate and Farmers" under *Rastriya Krishi Vigyan Yojna* (RKVY) and India Meteorological Department (IMD) funded projects during 2010–2017. In eight districts of Himachal Pradesh 12 awareness programmes were organized. During the awareness programme farmers, after imparting training on use of ITKs, climate change and use of weather forecasts, were grouped on the basis of age and gender to discuss the practical utility of ITKs in the animal disease management and agricultural activities. The ITKs documented were discussed with all farmers group and their plausible significance in agriculture was explained in detail to know the extent of using ITKs in their agricultural activities in the face of climate change. Local climate resilient practices and preventive measures used by farmers under various districts of Himachal Pradesh for foodgrain storage and animal disease management without the use of any chemicals were documented.

RESULTS AND DISCUSSION

Local practices for animal diseases management: Leaves of Drek plant (*Melia azedarach*) were used to cure skin diseases of animals and humans. It might be due to presence of triterpenoids, saponins, alkaloids, and antifungal and insecticidal property of the leaf (Azam *et al.* 2013). The milk yield was increased when treated with such leaves as per the perception of farmers. The ITK is followed by 52% farmers in Malan, 71% farmers in Palam valley, 44% farmers in Sujanpur and 40% farmers in Bohar (Table 1). Similarly, decoction of *Calotropis procera* leaves was applied to skins of camels, horses and donkeys suffering from eczema twice a day (Raval 1997). Similarly, Neem (*Azadirachta indica*) leaves were crushed with mustard oil and applied on animals' body (Saha *et al.* 2014). Also, paste of boiled leaves or bark of *Calotropis procera* was smeared over swollen region of animal body to reduce it (Srivastava *et al.* 2006). *Cedrus deodara* oil was applied against itching and also massage of turmeric and mustard oil for skin disease was reported to be beneficial (Kanwar *et al.* 2005). During high temperature or severe summer conditions, domestic animals were fed mustard oil before rainy season to make them healthier, increase disease resistance and heat stress tolerance by the buildup of fats. The practice was followed by 40% farmers in Malan, 68% farmers in Palam valley, 90% farmers in Akrot, 82% farmers in Kotla, 58% farmers in Sujanpur and 72% farmers in Bohar in Mandi. The higher percent perceptions were reported in Akrot in Una region (90%) and lowest (40%) in Malan of Kangra region (Table 1). Turmeric rhizome, Taramira (*Eruca sativa*) and Kakroan (*Roylea cinerea*) were used for the treatment of worm infestation. Similarly, Akashmoni (*Acacia auriculiformis*) seeds and roots of *Alstonia scholaris* were crushed with water and juice was given orally for the treatment of worm infestation (Saha *et al.* 2014). Also, leaves of Neem (*Azadirachta indica*) and seeds of Palash (*Butea monosperma*) crushed and boiled in water were given to animals to treat worms (Nag *et al.* 2007). They are easily available in local areas of Kangra, Chamba, Hamirpur, Una etc. and can be fed to the animals orally for treatment of worm infestation probably due to the antibiotic nature of alkaloids and anthelmintic, antimicrobial and antibacterial activity present in these crops (Rizwana *et al.* 2016). The practices were followed by 68% farmers in Malan, 76% farmers in Palam valley, 86% farmers in Akrot, 82% farmers in Kotla, 64% farmers in Sujanpur and 81% farmers in Bohar. The lowest percent perception was reported in Sujanpur (64%) and highest (86%) in Akrot of Una (Table 1). Paste of Taramira was used for deworming mostly in case of young calves due to its anthelminthic properties. In young calves deworming was done by paste of Taramira (*Eruca sativa*) and was practiced by 40% farmers in Malan, 46% farmers in Palam valley, 14% farmers in Akrot, 22% farmers in Kotla, and 44% farmers in Sujanpur, Hamirpur. The lowest percent perception was reported in Akrot in Una (14%) and highest (51%) in Palam valley (Table 1). Similarly, *Calotropis procera* was used to control worm infestation on the tails of cattle (Srivastava *et al.* 2006). Farmers use Lassi (whey), Gur and Azwain for Bloating (Aphara) in animals. In another study, to cure bloating Methi (*Trigonella foenum-graecum*) seed decoction was given orally to animals (Saha *et al.* 2014). Fern plants generally grown on conglomerate stone were also fed as immediate cure for tympany disease in animals specifically during south-west monsoon season. Azwain (*Trachyspermum ammi*) and Lassi reduce the froth and gases were released. Azwain oil contains thymol, which was used in the treatment of gastro-intestinal ailments and has fungicidal and antimicrobial activity. Seeds of azwain also have carminative property (Bairwa *et al.* 2012). These methods were followed by 58% farmers in Malan and 47% farmers in Palam valley. These practices were followed only in Malan of Kangra, Palampur region and Palam valley (Table 1). Similarly, mango leaves slurry were fed to the cattle for bloating and stomachache and in some cases

Table 1. Farmers' perceptions on ITKs for animal diseases management and storage of food grains in different districts of Himachal Pradesh (% response)

Name of ITK/District	Malan (Kangra)	Bajaura (Kullu)	Palam valley (Kangra)	Kukumseri (Lahual & Spiti)	Akrot and Dalautpur (Una)	Kotla (Kangra)	Sujanpur (Hamirpur)	Lagga (Chamba)	Sangla (Kinnaur)	Bohar (Mandi)
Animal diseases										
Leaves of drek plant for skin diseases	52.0	–	71.0	–	–	–	44.0	–	–	40.0
Mustard oil feeding to animals for health and resistance for disease and heat stress	40.0	–	68.0	–	90.0	82.0	58.0	–	–	72.0
Turmeric rhizome, Taramira and Kakroan bael mixture for worm infestation in animal	68.0	–	76.0	–	86.0	82.0	64.0	–	–	81.0
Paste of Taramira for de-worming in young calves	40.0	–	46.0	–	14.0	22.0	44.0	–	–	–
Lassi, gur and azwain mixture for bloat and tympany disease	58.0	–	47.0	–	–	–	–	–	–	–
Fern fronds tympany disease in animal.	59.0	–	49.0	–	–	–	–	–	–	–
Leaves of banana and Jamun in Haemostatic	54.0	–	55.0	–	–	51.0	61.0	–	–	–
Tobacco leaves extract for scabies in sheep and goat	–	4.0	20.0	–	–	–	–	–	–	–
Seed protection										
Seeds treatment with mixture of ash and cow dung to control soil pests and diseases	54.0	12.0	77.0	–	32.0	40.0	62.0	48.0	15.0	65.0
Food grains storage practices Seed storage in bamboo basket sealed with cow urine and dung against pests and diseases	54.0	–	86.0	–	–	40.0	80.0	10.0	–	23.0
Match box sticks for stored food grain pests	10.0	–	24.0	–	40.0	54.0	44.0	–	–	33.0
Dry leaf of wild pudina, Kali Basuti and Safeda for pests control in stored wheat	50.0	–	70.0	–	–	64.0	74.0	–	–	-
Walnut leaves, pieces of resin rich wood and ash for storage of food grains and seeds.	52.0	–	79.0	–	54.0	–	66.0	12.0	–	42.0

animals were fed coconut oil or coconut milk mixed with paddy husk thrice a day for three days (Majhi *et al.* 2008). For tympany, mixture of wheat flour, punarnava (*Boerhavvia diffusa*), ajwain (*Trachyspermum ammi*), methi (*Trigonella foenum-graecum*), jaggery, onion, asafoetida (*Ferula asafoetida*), garlic and turmeric were used along with mustard and turpentine oil (Kanwar *et al.* 2005). Also, mixture of harad (*Terminilia chebula*), black salt, nosadar (Ammonium chloride) and jaggery boiled in water were given to improve digestion. In another study, chaulai (*Amaranthus viridis*) seeds were mixed with water and given orally to cure tympany in animals (Nigam and Sharma 2010). Banana leaves and Jamun (*Syzygium cumini*) were perceived to be good in haemorrhagic disease in animals and used by 54% farmers in Malan, 51% farmers in Kotla, 61% farmers in Sujanpur and 55% farmers in Palam valley. The lowest percent perception was reported in Kotla of Kangra (51%) and highest (61%) in Sujanpur (Table 1). Extract of tobacco leaves was used in sheep and goat for scabies treatment due to presence of nicotine and many other alkaloid and used in skin disorders (Charlton 2004). It was practiced by 4% farmers in Bajaura of Kullu and 20% farmers in Palam valley (Table 1). Also, mixture of turmeric (*Curcuma domestica*) and mustard oil were applied for treating skin diseases (Kanwar *et al.* 2005).

Seed borne diseases protection: The practices were followed in major rural areas where seeds were treated before sowing with mixture of ash and cow dung to prevent from pests and diseases. Ash acts as mechanical barriers to pests and it contains silica which restrict insect feeding and restrict fungal multiplication of pathogens and cow dung antibacterial activity. It also helps to conserve the moisture present in seeds. This method was practically used by farmers of Una, Hamirpur, Bilaspur, Chamba and lower parts of Kangra. Seed protection techniques were used by 54% farmers in Malan, 12% farmers in Bajaura, 77%

farmers in Palam valley, 32% farmers in Akrot, 40% farmers in Kotla, 62% farmers in Sujanpur, 48% farmers in Lagga, 15% farmers in Sangla and 65% farmers in Bohar (Table 1). Local farmers in Uttarakhand Himalaya also use cow dung ash, cow dung and cow urine for seed protection (Mehta *et al.* 2012).

Local practices for grains storage: Foodgrains were stored in a large spindle shaped basket made of bamboo (*Perru*) and entirely sealed with cow dung mixed with cow urine to protect grains from pests and diseases for long time. This practice was followed in Kangra, Chamba, Mandi districts of Himachal Pradesh. In this practice no weevil attack is observed even under longer storage period. The ITK was followed by 54% farmers in Malan, 86% farmers in Palam valley, 40% farmers in Kotla, 80% farmers in Sujanpur, 10% farmers in Lagga and 23% farmers in Bohar Mandi. These practices were largely followed in Palam valley (88%) having more relative humidity during SW monsoon season and lowest (10%) in Lagga of Chamba district which has temperate climate with elevation of 1700 m amsl (Table 1). Similar practices were reported in village Vallabh Rao Palem of Andhra Pradesh for storing paddy seeds for long duration. They build a structure out of paddy straw, which is locally called *Puri* for storing paddy seeds for longer duration without reducing its quality (Majhi *et al.* 2008). Similar, indigenous storage structures fabricated with a poultice made up of tank silt, rice bran and paddy straw were used by farmers of Dindigul district of Tamil Nadu known as Kulumai and indoor grain storage structure are used for storing various foodgrains, especially paddy grains. It protects the grains from insect pests, diseases and even from rats and rodents. These structures provide keeping quality for about 3 years for paddy grains without much deterioration in quality compared to modern structures. After filling the grains it was covered with lid. Storage capacity is around 600–700 kg and is a stationary structure (Borthakur *et al.* 2012).

Control of stored grain pests: The farmers in villages of district Kangra keep partially opened match box containing sticks in the storage bin to control grain pests of wheat and rice like beetle, weevils and lepidopterous caterpillar. The presence of phosphorous pasted on the box as well as sticks, probably released a gas (phosphene) to check the pests. This climate resilient practice was validated and followed by 10% farmers in Malan, 24% farmers in Palam valley, 40% in Akrot in Una district, 54% farmers in Kotla in Kangra, 44% farmers in Sujanpur, District Hamirpur, 33% farmers in Bohar, Mandi (Table 1). To protect wheat from pests, dry leaves of Bangru or wild pudina (*Mentha arvensis*), Kali Basuti (*Adhatoda spp*.) and Safeda (*Eucalyptus citriodora*) were placed into the base and top of the container of food grains. Leaves of these plants have antimicrobial, antibacterial, antifungal and insecticidal properties (Kumar *et al.* 2009, Gangwar *et al.* 2014, Husain *et al.* 2013). The practices were followed against pests (wheat) by 50% farmers in Malan, 64% farmers in Kotla, 74% farmers in Sujanpur and 70% farmers in Palam valley. The highest percent perceptions were reported in Sujanpur (74%) and lowest (50%) in Malan, Kangra (Table 1). Similarly, fresh/ dried leaves and branches of artemisia (*Artemisia vulgaris*), neem (*Azadirachta indica*) and bhang (*Cannabis sativa*) were used to repel insects and rats in and around granaries due to intolerable aroma of the shrub kept to protect seeds from diseases and pest in the storage container by the tribes of Meghalya and Manipur (Sinha *et al.* 2010). Another local practice to protect pulses from pests, is to treat it with little amount of mustard oil and then keep in sunlight for one day followed by storage in dry container. The probable reason ascribed to it indicated that pests were not able to puncture the grains and also sun drying damages existing insect, pest and their different stages. The Indigenous Traditional Knowledge was followed by 18% farmers in Malan, District Kangra, 32% farmers in Palam valley, 30% farmers in Akrot, 10% farmers in Kotla, 18% farmers in Sujanpur, District Hamirpur (Table 1). Similar findings were also reported for pulse storage, as they were rubbed with pork oil and dried before storing (Sinha *et al.* 2010).

Storage of food grain and seeds: Farmers of high mountains of Kullu district use walnut leaves (*Juglans regia*) pieces of resin rich wood (Jugnu) and wood ash in container for food grains and storage of seeds depending upon the availability of the plants in the region which reduced the attack of weevils. This was due to antimicrobial and antifungal property of walnut leaves (Pareira *et al.* 2007), ash dries the seed surface and also reduces the relative humidity of stored conditions. The ITK was adopted by 52% farmers in Malan, 79% farmers in Palam valley, 54% farmers in Akrot, 66% farmers in Sujanpur, 12% farmers in Lagga and 42% in Bohar. The highest percent perceptions were reported in Palam valley (79%) and lowest (12%) in Lagga of Chamba (Table 1). Similarly, for seed protection and storage, farmers in Uttarakhand use cow dung or wood ash with leaves of bach (*Acorus calamus*), peach (*Prunus persica*), neem (*Azadirachta indica*), Timur (*Zanthoxylum armatum*), walnut (*Juglans regia*), turmeric (*Curcuma longa*), lemon (*Citrus limon*), kerosene oil and lime powder for seed protection and seed storage (Mehta *et al.* 2012, Chandola *et al.* 2011).

Pulse grains were mixed with wood ash, cow dung ash, soap nut leaves, neem leaves, pongam (*Pongamia pinnata*) leaves and stored in bins and bags. The mixture acted as insect repellent and antifeedant. Another study indicated that farmers of Andhra Pradesh use earthen pots (Reddy *et al.* 2006) and place a layer of dry sand or cow dung and clay mix at the top to the thickness of 20 cm. The grains need to be dried before storage to reduce moisture content. There was complete protection to the storage grains by the enclosed storage structure from insect and pest infestation. For control of insect and pest curry leaves (*Murraya koenigii*) and Baer (*Ziziphus jujuba*) branches were spread over stored grains. The odour of the leaves repels the weevil and grain pests (Deka *et al.* 2006). For stored grain pests, Vitex leaf powder (5%) + Neem leaf powder (2.5%) + Turmeric powder (3%), *Eucalyptus* + wood ash (%), *Acorus*

tuber dust (3%) and *Annona* seed powder (5%) were applied in stored grains (Mohapatra *et al.* 2009). Leaves of Aak (*Calotropis procera*) and Neem were used for storage of wheat in Punjab due to insecticidal property (Dhaliwal *et al.* 2010).

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