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STUDY ON PLANT-BASED TRADITIONAL KNOWLEDGE FOR PEST AND DISEASE MANAGEMENT OF CROP PLANTS IN POKHARA METROPOLITAN CITY WARD NO.32, KASKI

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ABSTRACT

Indigenous traditional knowledge (ITK) is knowledge belonging to a particular community or the native group that has been developed over time and still continues to grow with time. A case study was conducted from March to Mid-May of 2023 in villages of ward no.32 of Pokhara metropolitan city, Kaski district of Nepal to explore the indigenous practices followed by traditional farmers of Pokhara-32 for the management of pests and diseases of major crops using plants and their by-products. The data was collected via in-person interviews with the local farmers. A total of 40 farmers were considered for interviews that used a pretested questionnaire. From the interviewed respondents, many common practices using the plants and their by-products in pest and disease management were noted down such as the use of plant debris and wood ashes, intercropping, green manuring, mulching, and using some local plants as pest and insect repellent. A total of 19 plant species were found to be used by local farmers for pest and disease management. During the study, it was discovered that farmers are slowly starting to shift towards the use of chemical insecticides and pesticides. In the study, it was discovered that almost all the farmers are using insecticides and vitamins to increase their yield. The study recommends the concerned stakeholders need put more focus on the preservation of the ITK, document all the indigenous knowledge, and aware people about the importance of indigenous knowledge in producing healthy and organic crops.

Keywords: Diseases, indigenous knowledge and practices, pests, plant uses

INTRODUCTION

Indigenous knowledge is the knowledge of the indigenous people inhabiting the different geographical regions of the world with their own language, culture, tradition, belief, folklore, rites, and rituals (Chettry and Belbahri, 2009). Traditional or Indigenous Technical Knowledge (ITK) is the actual knowledge of a given population that reflects the experience based on tradition and includes more recent experiences with modern technologies (Gopi *et al.*, 2016). Indigenous practices are an unwritten body of knowledge. It is held in different brains, languages, and skills in as many groups, cultures, and environments as are available today. ITK is the storage house of knowledge, skills, and techniques for the management of the farming system. They are transferred through the sharing of cultural and traditional information (Singh, 2007).

Management of crops in general and pest management approaches, in particular, are different among traditional farmers practicing

traditional farming systems in different regions of the country because of differences in indigenous knowledge they accrued over generations of their close contact with nature (Chettry and Belbahri, 2009). The methods of controlling pests and diseases and building soil fertility and structure were indigenous since farming did not include chemical pesticides or fertilizers (Talukdar *et al.*, 2012). Pest is an all-harmful organism including weeds, plant pathogenic fungi, and viruses that attack cultivated plants and their products. They damage the vegetables and cause a heavy loss in the economy. Common insect pests of crops are grasshoppers, fruit flies, caterpillars, beetles, etc. (Allam, 1969). Plant disease is a dynamic process in time and space caused by the continuous irritation of a susceptible host due to a biotic or abiotic agent in a conducive environment which results in loss of crop or yield or both above the economic threshold level.

ITK is sustainable as it has evolved after many years of observation and experience. They are important tools for advancement as ITK are farmers friendly, innovative of site-specific crop management practices, conservation of natural resources base, resilient and adaptation to changing climate and food security (UNFCCC, 2013). Traditional farm practices should be promoted and encouraged among the farming communities as an effort not only to tap local knowledge but also to make use of locally available resources in crop management (Narayanasamy, 2001). Plant protection has become a serious matter due to climate change. The ecology and biology of different insect pests are also changing, making pest control mechanisms more difficult and complex (Singh *et al.*, 2012). Chemical pesticides are used in agricultural fields indiscriminately, resulting in resistance development to pests and environmental degradation (Gill and Garg, 2014). ITK being applied in pest management has inherent characteristics of culture and environmental compatibility as well as sustainability with cost-effectiveness (Pradhan *et al.*, 2017). However many of the indigenous pest management have not been properly documented and are slowly fading. The specific objective of this study is to document the plant-based indigenous practices for pest and disease management in the study area as well as to document the plant's local and botanical names with their uses in pests and disease management.

MATERIALS AND METHODS

Study Area

This study was carried out in Pokhara-32, coveringSatmuhane, Chainapur, Kholakochheu, Badare, and Rajakochautra, a small multi-ethnic ward of the Pokhara Metropolitan City covering a geographical area of 12 to 13 square kilometers. It lies in between the $28^0$07′21.5″ N to $28^0$08′30″ N latitude and $84^0$06′12.3″ E to $84^0$06′30″ E longitude. It shared its border with Rupa Lake, one of the seven lakes of Pokhara, and Rupa Rural Municipality in the east, and in the west are Ward no. 30 and 33. Ward no. 31 lies in the north and to the south is the Tanahun district. Though small, many ethnic groups are residing in the study area. The major ethnic groups are Brahmins, Chettri, Gurungs, Thakuris, and Newars. Each of these ethnic groups and sub-groups has its own distinct culture, language and traditions. Agriculture is mainly potato *(Solanum tuberosum*), mustard (*Brassica campestris*), maize (*Zea mays*), and paddy (*Oryza sativa*) based. Due to the prevalence of rainfall (1.6mm), low temperature (18^0C to 21.5^0), and high humidity (88% to 94.2%), there are various pests and diseases in crop plants causing a loss in yields resulting in reduced production in the

study area. Farmers in the study area follow a number of traditional practices for managing pests and diseases in crops using many local plants and their by-products.

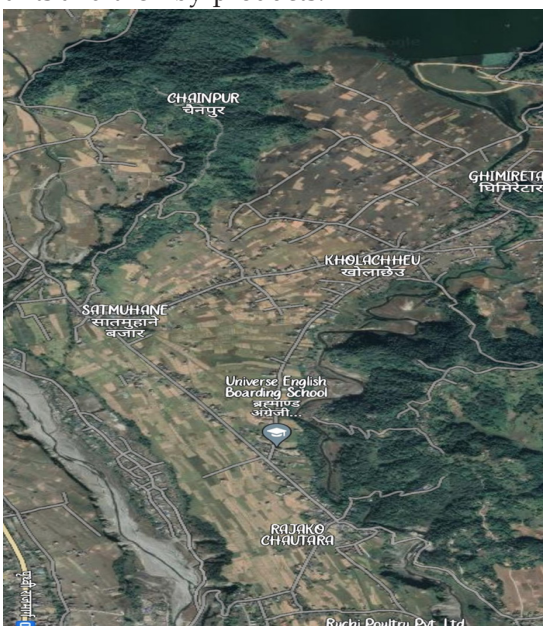

Figure 1: Map of study Area (Source Google Earth, 2023)

Data collection

The primary data was collected through direct field visits, group discussions, and interviews with semi-structured questionnaires. A key Informant survey (KIS) was carried out with an older generation and a younger generation of the community. Focus Group Discussions (FGD) were conducted to gather information regarding the use of plants as indigenous technologies to manage pests and diseases. The plants were collected and identified with the help of local farmers and Google Lens. Then the identified plants were brought home and processed for herbarium preparation for preservation following the method of Rao and Sharma (1990), and deposited at the department of Botany, Prithvi Narayan Campus, Pokhara.

Ethical consideration

During the study, all the ethical consideration was taken into account. Before interviewing the local farmers, permission was taken from the authorities as well as from the local farmers. Importantly, there was no use of any form of coercion or bribery to answer the questions. Local farmers were given due respect before questioning.

Respondents Profile

During the field visit, a total of 40 respondents were interviewed, out of them 23 were males, and 17 were females aged between 30 to 70 years old. 15 (37.5%) were illiterate, 18 (45%) had a primary level of education, 6 (15%) had a lower secondary level of education, and only 1 (2.5%) had a higher secondary level of education. It was found that the majority of the knowledge on indigenous technological knowledge on the use of plants to control and manage pests and diseases was known through their grandparents, parents, or other relatives (47.5%) while some were received through farmers 20%, direct observation 22.5% also through the internet 10% in recent days.

RESULT

Plant-based Traditional Practices

Farmers of the study area were found to be using the following six types of plant-based traditional practices to manage pests and diseases in crop plants as well as increase soil fertility.

Local Species for green manuring

The study found that farmers used *Sesbania rostrata* (Dhaicha) as the green manure. Along with Dhaicha (*Sesbania rostrata*), a fermented mixture of Asuro (*Adhatoda vasica*), Titepati (*Artemisia vulgaris*), and Khirro (*Sapium insigne*) were the others that are used as the green manure in the nursery of the paddy. It was believed that the use of this practice makes

the soil fertile and free from pests and diseases which ultimately helps in the better yield of the crops. A fermented plant extract mixture of Titepati (*Artemisia vulgaris*), Angeri (*Melastoma malabathricum*), and Banmara (*Chromolaena odorata),* was used against the insect. The plants are crushed with water and kept for fermentation for 15 to 20 days. After fermentation, the soil is drenched with it. Its unpleasant smell repels insects and pests.

Mulching

After the plantation of species like ginger (*Zingiber officinale*), farmers immediately covered the beds with mulches consisting of Titepati (*Artemisia vulgaris*), mustard debris, Chilouney (*Schima wallichii*), and Banmara (*Chromolaena odorata*) up to 7 to 8 cm thickness. Farmers believed that the mulches suppressed the weeds besides protecting the crop from pests and diseases like soft rot and improving the germination in the ginger.

Intercropping cereals

Almost all the farmers in the study area were found to be engaged in intercropping. Some knew the benefits while others do to maximize all the use of the land they have in their names. Legumes like beans were mixed cropped with maize whereas soybeans were planted at the edge of the field during paddy cultivation. Lentils were rarely cultivated with potatoes. Legumes help in nitrogen fixation resulting in making the soil fertile at the same time with correct intercropping like *Solanum lycopersicum* and *Tagetes erecta* which helps to control pests and diseases for one another. Some of the crops that are found intercropped in the study area with their reason are shown in Table 1.

Table 1: Intercropped plants

S.N	Intercropped plants	Objectives/ Expected Outcomes
1	Maize and beans (*Zea mays* L. and *Phaseolus vulgaris* L.)	Beans help in nitrogen fixation which makes the soil fertile and increases the maize productivity as well as helps to protect the maize from insects like whitefly, termites, etc.
2.	Maize and pumpkin, cucumber (*Zea mays* L and *Cucurbita maxima* L., *Cucumis sativus* L.)	Pumpkin and cucumber spread once they grow and cover the grounds of the maize which prevents weeds from growing.
3.	Wheat and maize (*Triticum aestivum* L.and *Zea mays* L)	These two crops are intercropped to maximize the use of the land and reduce the tillage.
4.	Tomato and carrot (*Solanum lycopersium* L. and *Daucs carota*)	Tomato protects the carrot from pests while carrot helps to enhance the flavor of tomato.
5.	Potato and radish (*Solanum tuberosum* L. and *Raphanus sativus*)	Improve the soil nutrient and help to maximize the use of the land these crops are intercropped.
6.	Tomato and marigold (*Solanum lycopersium* L. and *Tagetes erecta* L.)	Marigold helps to protect the tomato from pests.

7.	Mustard and lentils (*Brassica campestris L.* and *Lens culinaris* Medik.*)*	Lentils help in nitrogen fixation and prevent weeds from growing.
8.	Finger Millet and beans (*Eleusine coracana* Gaerth. and *Phaseolus vulgaris* L.)	They are intercropped to make the soil fertile from nitrogen fixation.
9.	Wheat and peas (*Triticum aestivum* L. and *Pisum sativum* L.*)*	Peas help in nitrogen fixation making the soil fertile for a greater yield of wheat.

Wood Ashes

From the study, we found that many farmers liked to use wood ashes. They spread the ash on the ground around the base of the plant or dust from above to cover the leaves, stems, or other shoot parts. Farmers believed that the wood ashes helped to protect the crops from pests like ants, aphids, grasshoppers, etc. as well as to enrich the nutrient status in the soil.

Burning of the residue of plants

The farmers of the study area were found burning the residue of the plants after crop harvest if the pest infestation was too high. It was done to kill the egg, larvae, and pupa of insects as well as to kill the spores of the fungus that may be still present in plant debris. With the burning of those plants, ashes obtained helps to enrich the nutrient in the soil as well as to protect the newly sown seeds and seedling from pests.

Uses of locally available plants

Many farmers were found using locally available plants against pests and diseases as well as nutrient media to the soil. Plants like Neem (*Azadirachta indica*), Asuro (*Adhatoda vasica*), Banmara (*Chromolaena odorata*), Ginger (*Zingiber officinale*), Garlic (*Allium sativum*), and Marigold (*Tagetes erecta*), Titepati (*Artemisia vulgaris*) were used on pests and against some diseases.

List of Plants Used for Pest and Diseases Management

In the present investigation, all the plants used in the traditional practices of pest and disease management in crop plants were identified in the study area. The number of families (13), genus (19), and species (19) were identified. Among them, herbs 9 (47.37%), shrubs 5 (26.31%), and trees 5 (26.31%) were identified. Different parts of the plants were used by local people of the study area such as leaves, rhizomes, seeds, fruit, bulb, flower, and whole plant. Among these parts used for pest and disease management as well as nutrient media for the soil, Leaves of 13 species of plant are found to be the most frequently used followed by rhizome (2 species), seed residue (1 species), Fruit (1 species), bulb (1 species), Flower (1 species), and whole plant (1 species) as shown in Table no.2.

Table 2: Uses of locally Available Plants for Disease and Pest Management

S.N	Local Name	English name	Scientific name	Family	Plant parts used	Application
	Asuro	Malabar nut	*Adhatoda vasica* Nees.	Acanthaceae	Leaves	Used as green manuring, pesticide against diseases like leaf hopper, and aphids.
	Titepati	Mugwort	*Artemisia vulgaris* L.	Asteraceae	Leaves	Leaves are used as mulching material in ginger. It protects the ginger from rot while leaf extract and water extract are used as insecticides and pesticides.
	Chilouney	Needletree	*Schima wallichii* (DC.) Korth	Theaceae	Leaves	It is mainly used as a mulching material. It is found to be effective in the management of soft rot in ginger.
	Khirro	Tiger's milk spruce	*Sapium insigne* (Royle) Benth. Ex Hook.	Euphorbiaceae	Leaves	Leaves are used as a material for mulching to prevent weeds from growing and as green manuring in the field to make the soil free from pests.
	Nim	Neem	*Azadirachta indica* A. Juss.	Meliaceae	Leaves	Leaves are used to store the paddy as its smell is believed to repeal the pests and diseases like root-knot.
	Bakainu	Chinaberry	*Melia azadirach* L.	Meliaceae	Leaves	Leaves are used inside the granaries against pests like grain moths.
	Angeri	Singapore Rhododendron	*Melastoma malabathricum* L.	Melastomat-aceae	Leaves	Used against cuts made by worms and aphids.
	Dhaincha	Prickly sesban	*Sesbania rostrata* Bremek. Oberm.	Leguminos-ae	Leaves	It is used as organic matter in the soil. It also helps in nitrogen fixation.
	Tori (kalo tori)	Mustard	*Brassica nigra* L.	Brassicaceae	Seed residue (Pina)	It is used to prevent wilting and sapling dying and damping off in paddy.

Lasun	Garlic	*Allium sativum* L.	Amaryllida-ceae	Bulb	It is used as an insect repellent.
Dalle Khursani	Chilly	*Capsicum annum* L.	Solanaceae	Fruit	It helps in the management of insects and pests like ants.
Adhuwa	Ginger	*Zingiber Officinale* Rosc.	Zingiberaceae	Rhizome	It is used to control the population of leaf-cutting wasps in plants.
Simali	Chinese chaste tree	*Vitex negundo* L.	Verbenaceae	Leaves	It is used in the storage areas to control pests.
Banmara	Catweed	*Chromolaena Odorata* (L.) R.M. King and H.Rob.	Asteraceae	Leaves	It is used as an insect repellent as well as green manure.
Sayapatri	Marigold	*Tagetes erecta* L.	Asteraceae	Leavesand Flowers	It is used as an insect and pest repellent (moths).
Tulsi	Basil	*Ocimum tenuiflorum* L.	Lamiaceae	Leaves	It is used to control pests and insects.
Pudina	Mint	*Mentha spicata* L.	Lamiaceae	Leaves	It is used as an insect repellent like grain moths.
Besar	Turmeric	*Curcuma longa* L.	Zingiberac-eae	Rhizome	Used as insecticides like leaf mines and aphids.
Dhaturo	Datura	*Datura stramonium* L.	Solanaceae	Leaves	Leaves extract is used as a pesticide against ants, worms, and aphids.

List of Diseases/Pest in Crops Plants with Plants Used in Remedy

From the study, we found that *Solanum tuberosum* L. and *Oryza sativa* L. are very susceptible to diseases and pests while *Allium cepa* L. is the least susceptible to diseases whereas *Azadirachta indica* was found to be most used as the remedy for diseases and against pests.

Table 3: List of Diseases/Pests in Crops Plants Based on the Respondents

S.N	Local Name of Diseases/Pests	Common Name of Diseases/Pests	Host Plant	Plants used for Remedy
1.	Seto rog	Sheath Blight of rice	*Oryza sativa* L.	*Brassica nigra* *Zingiber officinale*
2.	Jarama gatho parne rog	Root-knot	*Solanum tuberosum* L. *Solanum lycopersicum* L.	*Azadirachta indica*, *Brassica nigra*
3.	Maruwa rog	Blast diseases of Rice	*Oryza sativa* L.	*Artemisia vulgaris*, *Azadirachta indica*
4.	Oelaune Rog in Leaves	Wilting in leaves	*Solanum tuberosum* L. *Solanum lycopersicum* L.	*Brassica nigra*
5.	Pyaji daduwa	Purple Blotch	*Allium cepa*	*Azadirachta indica*, *Allium sativum* *Brassica nigra*
6.	Paxaute daduwa	Late blight	*Solanum tuberosum* L.	*Brassica nigra*

7.	Agaute daduwa	Early blight	*Solanum tuberosum* L.	*Brassica nigra*
8.	Dhawase thople rog	Gray leaf spot	*Zea mays* L.	*Artemisia vulgaris*, *Azadirachta indica* *Brassica nigra*
9.	Kharane rog	Powdery Mildew	*Cucumis sativus* L. *Cucurbita maxima* L.	*Melia azadirach*, *Schima wallichii*,
10.	Khairo chakki	Brown rot	*Solanum tuberosum* L.	*Sapium insigne*, *Artemisia vulgaris*, *Chromolaena odorata*
11.	Berna Kuhine	Damping Off	*Oryza sativa* L.	*Brassica nigra*
12.	Seto Dhusi Rog	Downy Mildew	*Brassica oleracea var. capitata* L.	*Azadirachta indica*, *Schima wallichii, Sapium insigne*
13.	Rato Kamila lagnu	Red ant	*Solanum tuberosum* L. *Capsicum spp.* L	Mentha spicata, Ocimum tenuiflorum
14.	Dharke Gobare	Stem Borer	*Zea mays* L.	*Azadirachta indica*, *Artemisia vulgaris*, *Adhatoda vasica*
15.	Gulabi Gobare	Pink Borer	*Oryza sativa* L.	*Azadirachta indica*, *Artemisia vulgaris*, *Adhatoda vasica*
16.	Makai ko Lahi	Maize Aphid	*Zea mays* L.	*Azadirachta indica*, *Artemisia vulgaris*, *Chromolaena odorata*
17.	Dhan ko Patero	Rice Ghundi Bug	*Oryza sativa* L.	*Ocimum tenuiflorum* *Curcuma longa*, *Zingiber officinale*
18.	Dhan ko Khapate	Rice Hispa	*Oryza sativa* L.	*Chromolaena odorata, Allium sativum, Ocimum tenuiflorum*

DISCUSSION

The people of the study area are found to adopt major six plant-based traditional practices for pest and disease management and as nutrient media for the soil. Leaves of locally found plants such as *Schima wallichii*, *Artemisia vulgaris*, *Sapium insigne*, and seed pod of *Brassica nigra* are used as a mulching material for *Zingiber officinale* and *Curcuma longa.* Plant ashes and burning of plant residue are adopted by farmers against pests and insects. Farmers in the study area are intercropping cereals. Intercropping between *Zea mays* and *Phaseolus vulgaris*, *Zea mays* and *Cucurbita maxima, Cucumis sativus, Solanum lycopersium*, and *Raphanus sativus* mainly to control the pests and insects as well as to maximize the use of the land plot, for weed management, and to improve the soil quality by doing nitrogen fixation. Local species

like *Schima wallichii*, *Artemisia vulgaris*, *Sapium insigne*, *Adhatoda vasica*, *Azadirachata indica*, *Chromolaena odorata*, *Datura stramonium*, and *Sesbania rostrata*, are used as green manure as well as pesticides and insecticides. Local species like *Tagetes erecta, Ocimum tenuiflorum*, *Mentha spicata*, *Zingiber officinale*, *Curcuma longa, Allium sativum*, *Vitex negundo, Capsicum annum* are used against pests and insects like aphids, leaf mines, grasshopper, beetles. *Azardirachata indica* followed by *Brassica nigra* are found to be mostly used in diseases remedy. The majority of the plant species described by the people of the study area are *Schima wallichii*, *Artemisia vulgaris*, *Sapium insigne*, *Adhatoda vasica*, *Azadirachata indica*, *Chromolaena odorata*, and they are commonly used against diseases and pests, such as mulching material and as green manure too. Similar findings are reported by (Gopi *et al.*,2016; Budhatthoki *et al.*, 2020; Jaishi and Naharki,2020; and Khatri *et al.*, 2021). Current findings are mostly compared with Jaishi and Naharki (2020), Khatri *et al.*, (2021), and Gopi *et al.* (2016) who has done similar research but in different parts of the South Asian country mainly Nepal and India and in mid hill areas. Our findings regarding the plant-based traditional practices and the use of locally available plants are similar although there are some differences as well. In the study carried out by Gopi *et al*. (2016), it was reported that *Chromolaena odorata* is used as mulching material but our findings reveal that farmers use this plant both as the mulching material as well as an insect repellent. In the study carried out by Gopi *et al.* (2016) and Khatri *et al.* (2021) *Azadirachata indica* was found to be used only during the storage time mainly for pest management in the storage of paddy while in the current study, the farmers were found using it as green manure to control soil-borne diseases, pesticides as well as against the pests in the storage of paddy.

In the study area, it is found that the traditional knowledge on the use of plants on pests and disease management in crop plants is being transmitted without any systematic process to the younger generation which is resulting in the slow disappearance of the knowledge. And as the younger generation is only receiving incomplete knowledge they don't think they can use this knowledge to earn money in the long run, so they engage in other occupations. Thus, it has become important to document these traditional practices and knowledge of pest management. This information provided in the paper is limited and there is a scope to initiate further study.

CONCLUSIONS

This study shows that people in the study area have some traditional knowledge of the uses of plants in pest and disease management. Altogether six traditional plant-based practices were found where 19 of the species under 19 genera of 13 families were recorded in the study area. Most of the plant species were found in the forest and near residential areas, and some of them were cultivated in home gardens. In the present study, it is concluded that many plants can be used to control pests and manage diseases as well as to provide nutrient media to the soil. Farmers identified and used a variety of plant products and extracts for pest control and to use as nutrient media for the soil. However, it is found that many farmers are slowly moving toward the use of chemical pesticides due to easier and faster results than the traditionally made botanical pesticides which take time to show results. Therefore, it is possible that in the near future, people are likely to use synthetic pesticides only. So to avoid it, people should be aware of the uses and the importance of traditional knowledge on the uses of plants and their by-products for pest and disease

management.

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REFERENCES

Alam, M.Z. (1969). Insect pests of vegetables and their control. *Public Agriculture Information Service Department Dacca.* 4-5.

Budhathoki, P., P. Ginawali, D. Baral, and A. Gyawali, (2020). Pesticidal potential of ethnobotanically important in Nepal. *Acta Scientifica Malaysia*. **4(2):** 45-50.

Chhetry, G. and L. Bekbahri (2009). Indigenous pest and disease management practices in traditional farming systems in northeast India. *Journal of Plant Breeding and Crop Science*. **1(3):** 28-38.

Gill, H.K. and H. Garg (2014). Pesticides: environmental impacts and management strategies. In: Pesticides- Toxic Effects, Solenski, and M. L. Larramenday (Eds). Intech. http://dx.doi.org/10.5772/57399

Gopi, R., R. Avasthe, H. Kalita, C. Kapoor, A. Yadav, A., S. Babu, and S.K. Das (2016) Traditional Pest and Disease Management Practices in Sikkim Himalayan Region. *International Journal of Bio-resource and Stress Management*. **7:** 471-476. http://dx.doi.org/ 10.5958/0976-4038.2016.00072.5.

Jaishi, M. and K. Naharaki (2020). Documentation of indigenous technical knowledge and their application in pest management in western mid hill of Nepal. *SAARC.J. Agric.* **18(1):** 251-261 (2020).

Khatri, S., S. Khanal, and S. Kafle (2021). Perceived attributes and adoption of indigenous technological knowledge on agriculture- a case study from Bhirkot municipality of Syangja district, Nepal. *Cogent Food and Agriculture*. **7:**1. http://dx.doi.org/10.1080/2331 1932.2021.1914384

Kumar, A., A.K. Mohanty, T.K. Borah, and A.K. Singh (2012). Evaluation of indigenous forest plant leaves for biomulching in organic ginger production and income generation under rainfall condition of neh region. *Indian Journal of Traditional Knowledge*. **11(3):** 487-482

Narayanasamy, P. (2001). Traditional pest control: a retrospection. *Indian Journal of Traditional Knowledge*,**1(1):** 40-50.

Pradhan, K. (2017). Identification and documentation of indigenous technological knowledge regarding pest control methods in agriculture. *International Journal of Agriculture Science*. **9(38):** 4580-4584.

Rao R.R. and B.D. Sharma (1990). Botanical Survey of India. A manual for Herbarium Collection.

Singh, B. (2007), Protection of indigenous knowledge and intellectual property rights (IPR). *The Tradition.* **5:**18-21.

Talukdar, R.K., S. Barman, and A. Hussain (2012). Documentation and perceived rationale of Indigenous Technical Knowledge (ITK) utilized in *Boro* rice cultivation by farmers of Kamrup District of Assam. *Journal of Academia and Industrial Research*. **1(7):** 412-418.

UNFCCC. (2013). Best practices and available tools for using indigenous and traditional knowledge and practices for the adaptation of gender-sensitive approaches and tools for understanding and assessing impacts, vulnerability, and adaptation to climate change. *United Nations Framework Convention on Climate Change.*