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HARNESSING INDIGENOUS TECHNICAL KNOWLEDGE FOR SUSTAINABLE AGRICULTURE IN ASSAM: A PATHWAY TO CLIMATE RESILIENCE

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ABSTRACT

Integration of Indigenous Technical Knowledge (ITK) into agricultural practices has emerged as a pivotal strategy in the face of increasing climate change to improve crop resilience and ensure sustainable farming. The paper focuses on ITKs followed in Assam, a north-eastern state famous for its mega biodiversity and indigenous farming traditions. Farmers in Assam have been using ITKs conventionally in adapting to climatic variability, efficient water management, reducing pest attack and soil fertility management etc. Traditional practices like crop diversification, agro forestry, and indigenous weather forecasting methods depict the adaptability and resilience of these systems against extreme events like floods, droughts, and erratic rainfall patterns. Beyond resilience, these methods contribute to ecological balance and food security, thus providing a very sustainable response to environmental challenges. The paper, therefore, underscores that the systematic documentation and integration of ITKs in modern agricultural frameworks will go a long way towards sustainable and climate-resilient farming. Though ITK is representative of the accumulation of adaptation to centuries at the local level, it can be far more effective when combined with state-of-the-art scientific research and therefore ensure solutions that are contextually relevant yet globally applicable. This also relates to the increasingly acknowledged potential role of indigenous knowledge in achieving global sustainability goals. A total of thirty (30) numbers of ITKs were documented in relation to their practice in cereal crops, fruit and vegetable cultivation and to control storage pests in Assam. The paper, therefore, advocates for an inclusive agricultural strategy as one paradigm shift by underlining how ITK may play its mitigating role in those aspects of climate change's impact. Its integration would therefore go to help not just the farmers in Assam themselves but also be a relevant model to foster resilience at a time when world agriculture faces the ongoing climate crisis.
Keywords: ITKs, Climate Resilient Agriculture, Sustainability, Assam

Introduction

The escalating threats posed by climate change have shifted the global focus toward sustainable and resilient agricultural practices. Agriculture, being highly dependent on weather and climatic patterns, is especially vulnerable to irregular rainfall, extreme temperatures, and natural disasters. These challenges not only threaten food security and rural livelihoods but also disturb the ecological balance, particularly in areas where traditional farming methods are still practiced. In this context, Indigenous Technical Knowledge (ITK) has emerged as a valuable tool for addressing the impacts of climate change. It represents the traditional knowledge, skills, and practices of local communities that have evolved over generations to sustainably manage natural resources and farming systems. Historically, chemical pesticides have been used extensively in agriculture since the 1800s, starting with arsenical insecticides and Bordeaux mixture. Though these chemicals provided quick relief from pests and diseases, their prolonged use has led to serious environmental and health consequences. There is now strong evidence that many chemical pesticides pose significant risks to humans, animals, biodiversity, and soil health (Boruah *et al*., 2020; Rana *et al*., 2018). In contrast, ITK offers eco-friendly and cost-effective alternatives that have long supported sustainable agriculture without causing harm to the environment.

ITK includes a wide range of practices such as crop rotation, intercropping, agroforestry, organic pest control, and indigenous weather prediction. These methods reflect a deep understanding of local ecosystems and have proven effective in maintaining soil fertility, controlling pests naturally, and reducing dependency on external inputs. Such practices are especially useful in resource-poor farming communities, where modern inputs are either too costly or unavailable. Despite the progress in scientific research, ITK remains relevant and is still widely used by farmers often without awareness of the scientific rationale behind them (Singh *et al*., 2020). Therefore, documenting and validating these practices is essential for their preservation and integration into modern farming systems.

Assam, a biodiversity-rich state in Northeast India, provides a compelling example of how ITK contributes to climate-resilient agriculture. The region is part of one of India's two biodiversity hotspots and is home to numerous ethnic communities such as the Ahom, Mishing, Deori and Karbi, each with their own unique agricultural traditions. These communities have developed climate-specific practices, such as using neem and other plants for pest control, adopting flood-resistant crop varieties, and constructing traditional irrigation systems suited to local topography (Boruah *et al*., 2020; Deka *et al*., 2023). These practices not only ensure productivity but also help farmers cope with the impacts of floods, droughts, and other climatic uncertainties.

Sustainable agriculture emphasizes minimizing chemical use, improving soil health, protecting biodiversity, and ensuring long-term viability for farmers. Practices like Integrated Pest Management (IPM), agroforestry, and reduced tillage align well with ITK-based approaches. When combined with modern scientific techniques, these traditional practices offer context-specific, adaptive solutions that enhance both productivity and resilience. Climate resilience in agriculture refers to the capacity to prepare for, adapt to, and recover from climatic shocks while maintaining stable agricultural output. In Assam, ITK-based strategies such as crop diversification and local weather forecasting have significantly contributed to the resilience of farming communities.

The integration of Indigenous Technical Knowledge with modern agricultural frameworks holds great promise for addressing the dual challenges of climate change and sustainability. Assam's example shows how local wisdom, when scientifically supported and properly documented, can strengthen farming systems and offer replicable models for other vulnerable regions. Promoting ITK is not just about preserving tradition it is about building a more resilient and sustainable future for agriculture.

Materials and Method

The ITKs in relation to sustainable development in Agriculture were collected using both primary and secondary sources. A multistage random sampling technique was used to collect data with structured scheduled and personal interview across Assam. The Participatory Rural Appraisal (PRA) tools like transect walk and timeline methods were employed to follow up the ITKs. A total of thirty numbers of ITKs were documented in relation to their practice in cereal crops, fruit and vegetable cultivation and to control storage pests. Secondary data were collected from published research paper which are included in the reference section.

Result and Discussion

The agricultural landscape of Assam, a northeastern state of India, is deeply rooted in rich traditional knowledge and cultural practices. Farmers in this region somehow depend on Indigenous Technical Knowledge (ITK) to tackle various agricultural challenges such as managing soil fertility, controlling pests and diseases, ensuring crop diversification, and conserving water. These traditional practices include methods like composting and green manuring for soil enrichment, as well as agroforestry systems that combine trees, shrubs, and crops to optimize resource utilization and promote ecological sustainability. Such practices support crop diversification and help farmers adapt to changing environmental conditions. Findings from the study reveal that farmers in Assam have long employed a variety of indigenous methods to control pests and diseases affecting cereals, vegetables, fruits, and storage crops all aimed at ensuring long-term resource sustainability. Some commonly practiced traditional techniques in Assam include clipping the tips of rice (*Oryza sativa*) seedlings before transplanting, lighting torches in rice fields during the milky stage in the evening, applying goat dung to fields, spraying crops with cow urine, using neem leaves and seeds, applying *fut chai* (wood ash), using smoke to repel fruit flies, and painting citrus tree trunks with lime. These time-tested techniques reflect the community's deep understanding of local ecology and their efforts to maintain sustainable agriculture.

In Assam, farmers have long practiced various Indigenous Technological Knowledge (ITK) techniques in cereal crop cultivation, particularly in rice farming, to promote sustainable agriculture and climate resilience. One such practice involves lighting a flame in rice fields during the milky stage to control the Gundhi bug (*Leptocorisa acuta*), offering a non-chemical alternative to pest control that supports soil health and biodiversity. Similarly, the application of goat dung serves a dual purpose as manure and a plant protection measure, improving soil organic matter and enhancing water retention crucial under drought or irregular rainfall conditions. Farmers also use neem seed extracts by soaking powdered seeds in water for 24 hours, creating a natural insect repellent that is biodegradable and safe for the environment, while also preventing pest resistance. Clipping off the tips of rice seedlings before transplanting is another method used to manage rice hispa (*Discladispa armigera*), relying on manual techniques that do not harm soil or water. Organic waste materials such as pumelo peels are utilized to manage leaf folders and caseworms, helping to control pests without harming non-target organisms and supporting ecosystem stability. Insect-repellent properties of local plants like Germany bon and Posotia leaves are also used in rice fields, representing low-cost, eco-friendly solutions that are easy for farmers to adopt. A more localized method includes pulling jute ropes dipped in kerosene across the field to manage rice caseworms (*Nymphula depunctalis*), minimizing pesticide use and supporting the natural balance of the agroecosystem. During Kati Bihu, earthen lamps are lit in rice fields to trap and repel insects, especially during the grain filling stage, while the use of dead frog heads, placed in field corners, attracts and traps Gundhi bugs due to the smell. Weed control is also addressed through traditional means, such as cutting the edges of bunds with spades during rice transplanting, which suppresses weed encroachment. Another integrated method involves allowing ducks to graze in rice fields, which promotes air circulation, controls pest larvae and weeds, and reduces the need for chemical inputs. Scarecrows made from locally available materials like bamboo are set up in fields to deter birds, helping to reduce crop damage. One of the most effective ITK systems is rice-fish farming, where fish are cultivated alongside rice. The fish help control pests and weeds while fertilizing the soil, thereby increasing productivity and providing an additional food and income source. These diverse, low-cost, and eco-friendly indigenous practices reflect the deep-rooted wisdom of Assam's farming communities, contributing significantly to sustainable agriculture and the resilience of agroecosystems in the face of climate change. ITK practices in Major cereal crops their purpose and linkage with climate resilience and sustainable agriculture are tabulated in Table 1.

Farmers in Assam have long utilized a range of Indigenous Technological Knowledge (ITK) practices in vegetable cultivation that not only address crop-specific challenges but also contribute to climate resilience and sustainable agriculture. One widely used method involves the application of wood ash in vegetable crops like brinjal (*Solanum melongena*) to control aphids (*Aphis gossypii*) and other pests. As a natural by-product of firewood, wood ash serves as a readily available and eco-friendly alternative to synthetic pesticides, thus lowering greenhouse gas emissions linked to chemical production. Similarly, pieces of black tobacco (*Nicotiana tabacum*) leaves are applied in cabbage (*Brassica oleracea*) fields to control pests and diseases. This practice recycles crop residues and enhances soil health while avoiding harm to beneficial organisms. Another ITK includes placing a heap of grass in vegetable fields overnight and burning it during the day to kill pests like cutworms (*Spodoptera exigua*). This technique is cost-effective and uses local biomass, reducing dependence on chemical inputs. For storage, potato seed tubers (*Solanum tuberosum*) are preserved by layering them between wild dhekia (*Diplazium esculentum*) leaves to protect against potato tuber moth (*Phthorimaea operculella*) without refrigeration or chemicals, thereby reducing energy consumption. An eco-biological pest control method involves applying red ant nests (*Myrmica rubra* species) to crops like pumpkin (*Cucurbita moschata*) and ridge gourd (*Luffa acutangula*). Red ants act as natural predators, helping maintain ecological balance and reducing the crop's vulnerability to climate-induced pest outbreaks. Similarly, sprinkling powdered tobacco on crops like brinjal and cabbage is used to manage insect pests, offering an organic alternative to commercial pesticides. This approach supports a closed-loop farming system by repurposing agricultural waste and avoiding environmental contamination. To enhance soil health and crop nutrition, farmers often spray fish-washed water around the roots of cucurbit plants. This water, collected after washing fish before cooking, is rich in nutrients and promotes better plant growth. Likewise, the application of vegetable peels and kitchen waste at the base of banana plants enriches the soil with essential nutrients like potassium and phosphorus. As these materials decompose, they improve soil structure and moisture retention, helping crops adapt to irregular rainfall and dry spells. This method also reduces the need for synthetic fertilizers, supporting eco-friendly and sustainable agriculture. Additionally, using crop stubbles of pulse crops after harvest in rice field preparation helps protect the soil from erosion and improve microbial activity by contributing organic matter. This practice enhances soil resilience and fertility between cropping cycles. Lastly, crushed egg shells are used around plants to improve sturdiness by supplying calcium and other micronutrients. This boosts plant resistance to pests and weather-related stress, promoting long-term soil health and reducing dependency on chemical fertilizers. Together, these indigenous practices reflect the wisdom of local farming communities in Assam and their adaptive strategies for maintaining productivity, conserving biodiversity, and building resilient, low-cost, and sustainable agricultural systems in the face of climate change. ITK practices in vegetable crops their purpose and linkage with climate resilience and sustainable agriculture are tabulated in Table 2.

Farmers in Assam have developed several Indigenous Technological Knowledge (ITK) practices in fruit cultivation that promote sustainable agriculture and enhance climate resilience. One such practice is smoking under mango (*Mangifera indica*) trees during the flowering stage to deter pests like the stone borer (*Sternochetus mangiferae*) and mango mealy bug (*Rastrococcus invadens*)**.** This method serves as a natural pest repellent that avoids chemical pesticides, offering a low-energy solution to pest management, particularly important as climate change may alter pest behavior and population dynamics. In banana cultivation, the pseudo stem of the plant (*Musa acuminata*) is allowed to decay in the field**,** which not only helps in pest and disease control but also enriches the soil with organic matter. This enhances the soil's capacity to retain moisture and withstand extreme weather events such as drought or heavy rainfall, both of which are becoming more common due to climate variability. Another eco-friendly practice involves placing fish waste at the base of citrus plants to attract fruit-sucking moths (*Othreis fullonia*). This acts as a natural pest trap, reducing the need for synthetic insecticides and thereby lowering environmental and carbon footprints. For fruit ripening, instead of using synthetic chemicals or energy-dependent storage systems, farmers store unripe fruits in airtight containers along with wild Dhekia (*Diplazium esculentum*) leaves, Sonaru tree (*Cassia fistula*) leaves, and straw. This method provides a safe and natural way to ripen fruits, avoiding the harmful effects and emissions associated with chemical ripening agents like ethylene gas. These traditional practices reflect the community's resourcefulness and offer sustainable alternatives to modern input-heavy farming systems, aligning well with climate-resilient and eco-conscious agricultural development. ITK practices in fruit crops their purpose and linkage with climate resilience and sustainable agriculture are tabulated in Table 3.

In Assam, farmers employ several Indigenous Technological Knowledge (ITK) practices to effectively manage storage pests, contributing to both post-harvest food security and climate resilience. One common method involves mixing ash with seeds during storage, which serves as a natural deterrent to pests. This eco-friendly approach reduces the reliance on synthetic chemicals, thereby minimizing environmental pollution and greenhouse gas emissions. By maintaining seed viability, this practice plays a crucial role in ensuring agricultural continuity during unpredictable climatic conditions. Another widely used technique is placing neem (*Azadirachta indica*) leaves in rice storage structures, as neem has strong pest-repelling and growth-inhibiting properties. This chemical-free solution protects stored grains from infestation, ensuring the availability of clean and pest-free food and seed reserves, especially during climate-induced shortages. Additionally, farmers use a sand layer to cover stored potatoes**,** which acts as a physical barrier to pest entry. This method not only prevents damage to stored tubers without using chemicals or refrigeration but also supports low-cost, climate-smart storage options that are accessible to smallholder farmers. Collectively, these practices reduce post-harvest losses, ensure food availability, and align with sustainable and resilient agricultural systems. ITK practices in storage pest control their purpose and linkage with climate resilience and sustainable agriculture are tabulated in Table 4.

The effectiveness of Indigenous Technical Knowledge (ITK) practices in agriculture is demonstrated by their ability to enhance soil health, increase crop yields, and bolster resilience against climatic variability. Farmers consistently affirm the success of traditional methods such as mixed cropping, intercropping, and crop rotation in mitigating pest and disease outbreaks while reducing reliance on external inputs. Recognizing the importance of ITK is crucial for advancing sustainable development, preserving cultural heritage, and strengthening community resilience.

Conclusion

The utilization of Indigenous Technical Knowledge (ITK) in agriculture by farmers in Assam underscores the profound connection between culture, environment, and livelihoods. These traditional knowledge systems provide invaluable insights and practical solutions to modern agricultural challenges, laying a robust foundation for sustainable development and climate resilience. To safeguard and promote ITKs, future efforts must be anchored in principles of equity, inclusivity, and respect for indigenous rights. By valuing the diversity of knowledge systems and fostering collaborative partnerships among stakeholders, we can establish resilient agricultural systems that ensure food security, environmental sustainability, and the preservation of cultural heritage for generations to come. Integrating ITKs into agricultural extension programs, research efforts, and policy frameworks can greatly enhance the inclusivity and efficacy of agricultural interventions. The documented ITKs serve as a ready reference for the agricultural scientists for further study to determine their scientific rationality and effectiveness. This will also be helpful in technology blending programme to generate eco-friendly, location specific, economically viable and socially acceptable technology (Barman *et al.*, 2012). Moreover, empowering local communities to document, revitalize, and share their traditional knowledge not only conserves biodiversity but also promotes agroecological principles and supports climate change adaptation. By embracing the collective wisdom of indigenous peoples, policymakers, researchers, and practitioners can collaboratively design innovative solutions to tackle the multifaceted challenges confronting agricultural systems. Documented ITKs will serve as a vital resource for agricultural applications, aiding in the design of technology-blending programs. These initiatives will focus on generating low-cost, eco-friendly, and location-specific technologies by adapting and enhancing existing methods, ultimately delivering significant benefits to farmers and promoting sustainable agricultural practices. Although ITKs are relevant to farmers of Assam, but due to the lack of interest and promotion measures, many individuals do not prefer and follow the available technical know-how. So, efforts must be integrated with modern sustainable practices to preserve and conserve the best practices of ITKs for future.

Table 1: Indigenous Technological Knowledge (ITK) practices in major cereal crops in Assam.

Sl. No	Practiced ITKs	Purpose	Contribution to Climate resilience and sustainable agriculture
1	A flame is put on in the rice field in the milky stage of rice (*Oryza sativa*)	For controlling Gundhi bug (*Leptocorisa acuta*) when population build up is more during the milky stage of rice.	This technique uses a simple, non-chemical method to manage pests, reducing dependency on synthetic pesticides. By reducing pesticide usage, this practice supports soil health, water quality, and biodiversity, essential for sustainable farming.
2	Solid excreta of goats are applied to the field.	Manure as well as plant protection measure.	Goat manure improves soil organic matter and enhances the soil's water retention capacity, which is critical in coping with irregular rainfall and drought conditions. It enriches the soil with nutrients, promotes healthy microbial activity, and reduces reliance on synthetic fertilizers, lowering greenhouse gas emissions from fertilizer production.
3	Neem (*Azadirachta indica*) seeds are powdered and then tied in a piece of cloth. Then this is to be dipped in water for 24 hours. Later, that water can be used for spraying crops.	Acts as insect repellent.	Neem-based solutions are biodegradable and leave no toxic residues, ensuring environmental safety and maintaining ecosystem services. They reduce the chances of pest resistance, making pest control more adaptable to climate changes.
4	Clipping off tip of seedlings before transplanting of rice	Control rice hispa (*Discladispa armigera*)	Encourages labour-intensive yet sustainable practices, promoting a circular approach where the pest problem is managed without harming the soil or water.
5	Pumelo peels are cut into small pieces and applied	Control Leaf folder, case worm	Utilizing organic waste as a pest control agent helps manage pests effectively without affecting non-target species, ensuring the stability of the agro ecosystem.
6	Application of Germany bon and Posotia leaves in	Act as insect repellent	Promotes agro ecological practices that are inexpensive, eco-friendly, and easy to adopt, fostering

	rice		self-reliance among farmers.
7	Jute (*Corchorus capsularis*) ropes are dipped in kerosene and pulled across the paddy crop field.	To control rice caseworm (*Nymphula depunctalis*)	A simple and localized technique that minimizes chemical usage, reducing the carbon footprint associated with the production and transport of pesticides. Encourages the use of traditional, cost-effective methods that do not disturb the natural predator-prey relationships in the ecosystem, ensuring long-term pest management.
8	Lighting of earthen light during Kati Bihu in rice field	To control Gundhi bug and related insects	It works as an insect trap and prevents the attacks to the rice cultivation during grain filling stage.
9.	Use of dead frog head in the rice field	To control insects like Gandhi bug, which gets attracted to the dead smell of the frog head.	The head of a dead frog is hanged in the corner of the rice, mostly during the milky stage.
10.	Cutting the edge of the bund in rice field	To suppresses weed growth and prevent weed encroachment	Use of tools like spade to trim the edges of bund during rice transplanting to control weed.
11.	Letting the ducks graze in the rice fields	To promote air circulation, reduce pests and control weeds.	Ducks are allowed to graze to eat the larva of pests present in the tillers of rice, also to control the weed growth.
12.	Use of scarecrows to ward off birds from the rice fields.	To distract birds from field.	Farmers made scarecrows with locally available materials like bamboo, busket etc and established in the middle of the field to reduce bird attack.
13.	Rice-Fish Farming	Integrated farming for Enhanced productivity.	Cultivating fish in rice paddies, where fish help control pests and fertilize the fields while providing an additional food source.

Table 2: Indigenous Technological Knowledge (ITK) practices in vegetables.

Sl. No	Practiced ITKs	Purpose	Linkage with Climate resilience
1	Application of wood ash in vegetables like brinjal (*Solanum melongena*).	To control aphid (*Aphis gossypii*) and other insects.	Wood ash is a by-product of natural processes like burning firewood, making it a readily available, low-impact resource. It reduces dependence on synthetic pesticides, minimizing greenhouse gas emissions from their production and transport.
2	Application of black tobacco (*Nicotiana tabacum*) leaf pieces in the cabbage (*Brassica oleracea*) field	To prevent occurrence of diseases and to control insect	Utilizing crop residues like tobacco leaves promotes a circular farming system. The organic nature of this method prevents harm to beneficial organisms and enhances soil health.
3	A heap of grass is kept in the vegetable fields at night time and burnt at day time.	Killing pests like cutworm (*Spodoptera exigua*).	This practice is energy-efficient and uses locally available biomass, reducing reliance on chemical pest control methods. It helps manage pest outbreaks exacerbated by changing climate patterns.
4	Storage of potato (*Solanum tuberosum*) seed tubers in between the layers of wild dhekia (*Diplazium esculentum*) leaves	To protect seed tuber from potato tuber moth (*Phthorimaea operculella*) infestation.	This method ensures the safe storage of seed tubers without refrigeration or synthetic chemicals, reducing energy consumption and carbon emissions.
5	The nest of red ants (Myrmicarubra group of species) is applied to crops.	To control specific pests in crops like Pumpkin (*Cucurbita moschta*), Ridge gourd (*Luffa acutangula*).	By promoting the use of natural predators, this practice maintains ecological balance and supports natural pest regulation, reducing the vulnerability of crops to pest outbreaks linked to climate variability.

6	Powdered tobacco (*Nicotiana tabacum*) is sprinkled on the foliage of crops like brinjal (*Solanum melongena*), cabbage (*Brassica oleracea*).	To control insect pests.	Tobacco powder provides an organic alternative to chemical pesticides, reducing carbon emissions from industrial pesticide production and usage. The practice repurposes agricultural by-products and does not harm the environment, promoting a closed-loop farming system while effectively managing pests.
7	Spraying of Fish washed water in the roots of cucurbits	It provides nutrition and enhances soil health.	After washing the fish before cooking, the fish washed water is collected and used for watering over the roots and leaves of cucurbits
8	Use of vegetable peels and waste materials in the roots of banana plant	Improving soil fertility and plant nutrition	These biodegradable materials decompose slowly, releasing essential nutrients like potassium and phosphorus, which are crucial for banana growth. This ITK reduces the need for synthetic fertilizers, thereby lowering input costs and minimizing environmental pollution. By enhancing soil organic matter and microbial activity, it improves soil structure and moisture retention, helping plants better withstand drought and irregular rainfall. As a result, this practice contributes to climate resilience and promotes sustainable agriculture by recycling farm and kitchen waste into valuable plant nutrients in an eco-friendly and cost-effective manner.
9	Use of the crop stubbles of pulse crop after harvesting in the preparation of rice field	It helps to protect the soil from erosion until next cultivation and also improves microbial activity by adding organic matter	After harvesting the pulse crops, the crop stubbles are left to dry out and mix with the soil before next cropping, usually rice cultivation.
10.	Using egg shell	To make the plant healthy and sturdy.	The use of egg shells in farming, a traditional practice, helps make plants healthy and sturdy by enriching the soil with calcium and other essential minerals. This contributes to climate resilience by improving soil health, reducing dependence on chemical fertilizers, and strengthening plants against pests and climate-related stress. As a low-cost and eco-friendly method, it supports sustainable farming by promoting better nutrient recycling and enhancing the crop's ability to withstand adverse weather conditions.

Table 3: Indigenous Technological Knowledge (ITK) practices in fruit crops and others.

Sl. No	Practiced ITKs	Purpose	Linkage with Climate resilience
1	Smoking under mango (*Mangifera indica*) tree at the time of flowering.	To repel insects like stone borer (*Sternochetus mangiferae*), mango mealy bug (*Rastrococcus invadens*) etc	This low-energy practice uses smoke as a natural deterrent, reducing dependence on chemical pesticides. It helps control pest outbreaks that might increase due to climate-induced shifts in pest populations.
2	Pseudo stem of banana (*Musa acuminata*) is allowed to decay in the field.	Pest and disease management.	Decaying banana pseudo stems enhance soil organic matter, improving water retention and resilience to drought or heavy rains caused by climate variability.
3	Wastes of fish are placed below citrus plants	To attract fruits sucking moths (*Othreis fullonia*)	This practice uses natural baits to manage pests, reducing reliance on chemical pesticides. It also limits the environmental and carbon footprint associated with synthetic pest control methods.

4	Keeping unripe fruit in an air tight container with Wild Dhekia (*Diplazium esculentum*), leaves of sonaru tree(*Cassia fistula*) and straw	For ripening of fruit	This natural ripening method eliminates the need for energy-intensive technologies or synthetic ripening agents like ethylene gas, which contribute to greenhouse gas emissions.

Table 4: Indigenous Technological Knowledge (ITK) practices in storage pest control.

Sl. no	Practiced ITKs	Purpose	Linkage with Climate resilience
1	Storage of seeds mixed with ash	Controls storage pests.	Ash acts as a natural pest deterrent, reducing the need for synthetic chemical treatments that contribute to environmental pollution and greenhouse gas emissions. It ensures seed viability during storage, which is crucial for resilience in unpredictable climatic conditions.
2	Neem (*Azadirachta indica*) leaf is kept in the rice storage structures.	Effective against storage pests.	Neem leaves naturally repel pests and inhibit their growth, providing a chemical-free solution for grain storage. This ensures the availability of pest-free seeds and grains during climate-induced shortages
3	Sand cover over the stored potatoes	To control pest	Sand acts as a physical barrier, preventing pests from reaching stored potatoes. This low-tech method reduces the dependency on energy-intensive cold storage or chemical treatments, supporting climate-smart storage practices. Sand is a natural and inexpensive material, making it accessible to smallholder farmers. It ensures the safe and chemical-free preservation of potatoes, reducing post-harvest losses

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