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Indigenous technical knowledge of Assam for pests management – Exploit potential in organic agriculture

R N Borkakati[a,*], Sinki Barman[b], D K Saikia[a] & Robin Gogoi[c,↓]

[a]AICRP on Biological Control, Department of Entomology, Assam Agricultural University, Jorhat 785 013
[b]KVK, Simaluguri, Assam Agricultural University, Nagaon 782 002
[c]Division of Plant Pathology, ICAR-Indian Agricultural Research Institute, New Delhi 110 012

E-mail: *rnbk.agri@gmail.com; ↓r.gogoiiari@gmail.com

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One neighborhood investigation was conducted amongst 500 farmers of Nagaon, Golaghat, Jorhat and Dibrugarh districts of Central Brahmaputra valley Zone and Upper Brahmaputra valley Zone of Assam. Only 21.8% of farmers completely practiced the indigenous technology knowhow (ITK) for pest management, though 48.4% were aware about ITKs, whereas 41.8% famers apply synthetic chemical driven approaches. A total of 30 different types of ITKs had been collected which weresorted out crop wise and placed in different groups based on their use i.e. rice (20), pulses (1), tuber crops (3), vegetables (2) and fruits (4). It is speculated that a comprehensive study on different ITKs of Assam and their appropriate validation could be the valuable components for organic farming technology.

Keyword: Assam, Fruits, Insect pest management, Pests, Rice, Traditional knowledge, Vegetables

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The state of Assam, India is having total landmass of about 78.43 lakh ha with 40.82 lakh ha gross cropped area and 268.07 lakh rural population[1]. Agriculture is the mainstay and primary source of income for around 70% population of Assam[2]. Most of the Assamese farmers are marginal and they prefer organic means of plant protection especially in case of kitchen gardens. Fortunately, Assam is enriched with different useful traditional knowledge as well as traditional wisdom, developed by farmers through trials and errors[3]. This traditional knowledge, also termed as indigenous technology knowhow or indigenous technical knowledge (ITK), are very much important from organic agriculture point of view. ITKs are nothing but the aggregation of skills, practices and technology of a particular locality or a community and have been conceded on generation after generation in an informal colloquial form with trials and errors[4]. In most cases farmers botheration about preparation of indigenous formulations and slow results of majority of the ITKs were the main reasons of non-adoption of the ITKs by the farming community[5]. In any crop ecosystem co-habitat nature of insect pests and their natural enemies contributes towards maintenance of an equilibrium[6]. But heavy dependence of chemical pesticides can interrupt the balance and pose resistance development in the exposed insects leading to pest outbreak in addition to the damage of environment[7]. Further, these ITKs were not only confined to insect pest management, but also can be useful for animal disease management and seed protection to mitigate the impact of climate change[8].

Government of India (GOI) also emphasized on adoption of organic agriculture technology in a wider way in the North East India, the most productive zone of the country having truly organic land by default. Under such perspective of the country, a new scheme *Paramparagat Krishi Vikas Yojana* (PKVY) was launched by GOI under National Mission on Sustainable Agriculture (NMSA) during 2015-16 under Participatory Guarantee Scheme (PGS) certification for promoting organic farming[9]. Therefore, ITKs may play a vital role for organic farming after thorough screening and scientific analysis of the important aspects *viz.*, standardization of doses, proper time of application, adverse or beneficial effect on crop health, yield, success stories etc. Locally available wild medicinal plants, their by-

*Corresponding author

products, insect's excreta, domestic and stray animal wastes were applied with age old knowledge of farmers for successful management of orchid pests[10] in addition to agricultural pests[11]. Unfortunately, most of the ITKs are neither properly known nor paid proper attention. In addition, ITKs are only colloquial in nature andnot documented in anytext. Not only in Assam, Indian ITKs as a wholehave beenconveyed orally from generation to generation and during this usual practice there is every chance of arising gaps in proper communication at different levels and also misrepresentation of the actual facts. It is often observed that some people try to hide the ITKs practicing in their own communities or do not like to share their ITKs with others. Since theITKs are precious cum value added assets for the resource poor farmers, a systematic investigationand refinement of the ITKs with appropriate documentation are the need of present days so as to execute them in the right direction of organic farming. Therefore, we attempted to bring togethersome of the important traditional knowledge practiced by the farmers of Assam, however, the enlisted ITKs require a relook and standardization.

Methodology

Data of the present investigation were gathered through survey at the time of field visit, farmers-scientist interactions as well as conducting Front Line Demonstration (FLD) and On Farm Trials (OFT) at different localities. The investigation was carried out in twenty villages of four districts of Assam *viz.*, Nagaon, Dibrugarh, Golaghat and Jorhat (Table 1 & Fig. 1) and interrogated five hundred farmers (above

Table 1 — Geographical information regarding surveyed locations of four different districts of Assam, India

Name of location	District	Approximate coordinates (Latitude, longitude)	No of participant farmers with their gender
Alengmora	Jorhat	$26^0$80' N $94^0$12'E	11M,20F
Rajabahar	Jorhat	27.24 N 94.79 E	15M,16F
Kaliapani	Jorhat	26.83 N 94.41E	20M,8F
Madhapur	Jorhat	26.31N94.06E	20M,15F
Badulipaar	Golaghat	26.95N94.16E	7M,16F
Furkating	Golaghat	26.46N94.01E	14M,19F
Jamuguri	Golaghat	26.38N 93.96E	17M,8F
Naojan	Golaghat	26.12N 93.84E	27M,17F
Chetiagaon	Dibrugarh	27.48N95.17E	21M,11F
Bachapothar	Dibrugarh	27.28N95.21E	14M,17F
KhaniaGaon	Dibrugarh	26.87N94.33E	18M,10F
Khowang	Dibrugarh	27.27N94.87E	15M,19F
Bengenaati	Nagaon	26.48N92.96E	12M,14F
Barapujia	Nagaon	26.23N92.51E	18M,17F
Borkola	Nagaon	27.54N94.72E	9M,20F
Dhing	Nagaon	26.46N92.47E	10M,25F

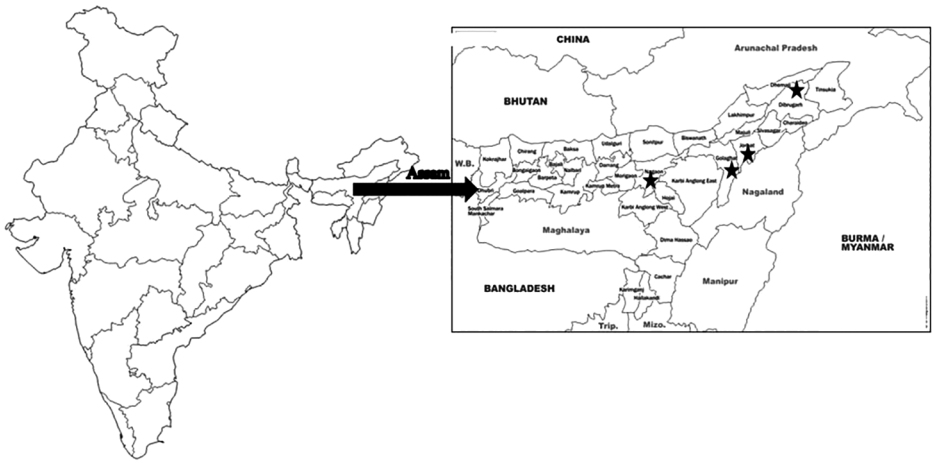

Fig. 1 — Map of four districts of Assam indicating location of surveyed areas (Courtesy: https://d-maps.com/)

55 yrs age group) during 2016-2019 by providing following schedule:

1. What type of pest management strategy did you have practiced in your farm?
   a. Only Indigenous Technical Knowledge (ITK)
   b. Only chemical control
   c. Both ITKs and chemical control
   d. None of the above
2. Do you feel that the ITKs are enough for pest management?
3. Do you feel ITKsare useful for pest management in organic farming?
4. Do you know that tobacco leaves are excluded in organic farming?
5. Enlist the crop wise ITKs followed by you in your farm.

From the first question, it was easy to derive an idea about rate of use of ITK and depth of chemo-centric agriculture. Some participants expressed their knowledge about pest management with traditional practices and/or application of synthetic chemical, while a few of them were not aware about any practice with detail concept. This unaware group is mostly resource poor, land less, illiterate and casual worker who performed agricultural activities on other's field on daily wage basis. Regarding the last question, there were three observations +++, ++ and + made based on frequency of their uses by number of participants *viz*., >100, 100-50 and <50, respectively for a particular traditional practice out of the total 500 participants.

Results and Discussion

During present study, data were collected from farmers by various extension activities like training, OFT and FLD etc. from Alengmora, Rajabahar, Kaliapani and Madhapur areas of Jorhat district; Badulipaar, Furkating, Jamuguri and Naojan areas of Golaghat district; Chetiagaon, Bachapothar, Khaniagaon and Khowang areas of Dibrugarh district; and Bengenaati, Barapujia, Borkola and Dhing areas of Nagaon district. Total 500 numbers of farmers of above the age of 55 years were selected and asked the questions regarding use of ITK and application of synthetic chemical pesticides. Most of the educated farmers rely on chemical dependent agriculture rather organic practices, though they know about all the ill-effect of chemicals but to harvest more yield. In addition to this, 100% farmers were unaware about prohibition on the use of tobacco in organic farming, even though it is advisable under eco-friendly category pesticides. The results revealed that out of the total 500 farmers, 242 (48.4%) farmers were aware of various traditional knowledge, of which 109 (21.8%) farmers relied solely on ITKs for pest management, whereas 209 (41.8%) farmers were completely dependent on chemicals (Table 2). Interestingly, 133 (26.6%) farmers applied both ITKs and chemical methods, whereas 49 (9.8%) farmers totally avoided both types of practices due to lack of resource to procure chemical pesticides. Besides, they believed that organic agriculture does not require any inputs, more especially in plant protection.

Total 30 ITKs (Table 3) could be collected from 500 farmers of all four districts of Assam. Most of the ITKs were common in all places. These ITKs were divided into different groups based on the utility in different crops, i.e., rice (20), pulse (1), tuber crop (3), vegetables (2) and fruits (4). Depending on frequency of use by the farmers, these ITKs were rated with +, ++ and +++ used based on <10%, 10-20% &>20% farmers, respectively. Due to quick knockdown effect of synthetic chemical pesticides most of the farmers were now diverted to application of inorganic pesticides rather than theuse of ITKs[12]. Most likely a considerable number of the farmers of Assam even today adopted ITKs and also advise others to follow those eco-friendly approaches[4,11]. It is mention worthy

Table 2 — District wise distribution of indigenous technical knowledge (ITK) awareness and rate of exploitation for insect pest management

Particulars	Districts of Assam				Total
	Jorhat	Golaghat	Dibrugarh	Nagaon	
ITK	11 (8.8%)	13 (10.4%)	64 (51.2%)	21 (16.8%)	109 (21.8%)
Chemical	74 (59.2%)	78 (62.4%)	28 (22.4%)	29 (23.2%)	209 (41.8%)
Both ITK and chemical	26 (20.8%)	22 (17.6%)	21 (16.8%)	64 (51.2%)	133 (26.6%)
None	14 (11.2%)	12 (9.6%)	12 (9.6%)	11 (8.8%)	49 (9.8%)
Total	125	125	125	125	500

Number of individual respondent about their Insect management practices/ data within parenthesis indicate the per cent adoption by respondent out of total participants (i.e., 500)

Table 3 — List of indigenous technical knowledge (ITKs) adopted by the farmers of Assam for insect pest management

	Technology	Purpose	Remarks	Relative adoption*
Crop: Paddy				
1	Burning the rice straw after harvesting (Air pollution issues is being there in some north Indian states)	To control all kinds of insects	It can destroy pupa of the pests and other soil arthropod pests	++
2	Deep ploughing during March-April	To control all kinds of insects	It can destroy pupa of the pests and other soil arthropod pests	+
3	Leaves of *Sonboriyal* (*Sida rhombifolia* L.) vines chopped into small pieces and applied to rice field during final land preparation	Management of nematode and soil arthropod	*Sonboriyal* is a medicinal herb having bitter taste of root, stem and leaves which prevents the growth of the soil dwelling pests	+
4	Chopped leaves of *Sonboriyal* (*S. rhombifolia*) vines applied to rice field during tillering stage	To control stem borer (*Scirpophaga incertulas* Walker*, S. innotata* Walker, *Chilo suppressalis* Walker, *C. polychrysus* Meyrick and *Sesamia inferens* Walker.) and rice hispa (*Dicladispa armigera* Oliv.)	Medicinal property of the herb can repel insect pests	+
5	Clipping off tip of rice seedling, before transplanting to the main field	To control stem borer (*S. incertulas* Walker*, S. innotata* Walker, *C. suppressalis* Walker, *C. polychrysus* Meyrick and *S. inferens* Walker.), leaf folder (*Cnaphalocrocis medinalis* Guenée) and rice hispa (*D. armigera* Oliv.)	Most of the insect (stem borer, leaf folder, hispa etc.) prefers tip portion of leaves for egg laying	+++
6	Application of chopped piece of citrus fruits like grape fruit (*Citrus paradise* Macfad.) after transplanting in rice field	Repels insect pests	Volatile oil present in grape fruit repels insect pests	++
7	Erection of bamboo branches in rice field after transplanting and removal before panicle initiation to protect the grains from herbivore birds. However, installation of wooden structure for burn owl also had been observed in some field to control rodent.	It provides space for predatory birds to take rest and prey upon larvae and adult stages of insect pests	Sap of tender bamboo contains hydrocyanic acid which can destroy moth/larvae of insects	+++
8	Application of chopped pieces of stem of Phutuka or Indian rhododendron (*Melastoma malabathricum* Linn.) after transplanting in rice field	Scent of *Phutuka* stem repels insect	It emits strong scent which drive away the insect pests from field	+++
9	Application *Biholongoni* [*Sphaerostephnos unitus* (L.) Holtt.] leaves during growing stage of paddy	To control rice stem borer (*Scirpophaga incertulas, S. innotata*, *C. suppressalis*, *C. polychrysus* and *S. inferens*)	*Biholongoni* leaves contains natural chemicals which can hamper insect growth & development	+++
10	Application of grounded bark of *Sojina* or drumstick (*Moringa oleifera* Lam.) in the main field	To control rice stem borer (*S. incertulas, S. innotata*, *C. suppressalis*, *C. polychrysus* and *S. inferens*)	Bark of *Sojina* or drumstick plant has medicinal properties	+
11	Application of chopped pieces of *Kola Kochu* or taro [*Colocasia esculenta* (L.) Schott] mixed with cow dung into stagnant water in the rice filed	To control case worm (*Nymphula depunctalis* Guen).	*Kola Kochu* or taro contains crystal of calcium oxalate and hydrocyanic acid which can control insect pests	++

(*Contd*.)

Table 3 — List of indigenous technical knowledge (ITKs) adopted by the farmers of Assam for insect pest management (*Contd*.)

	Technology	Purpose	Remarks	Relative adoption*
Crop: Paddy				
12	Hanging of dead toad/ frogs/flesh of snail on stick and placed in the rice field during milky stage of grain	To control rice gundhi bug [*Leptocorisa varicornis* Thumb,. *acuta* Thunberg].	Smell of dead animals attracts gundhi bug towards it which can help to protect grains	++
13	*Akashbonti* (lamp or *Dia* fixed at the top of one stick) are placed in the rice field at the time of *Kati Bihu* (October -November) during grain filling stage of rice	To attract some phototrophic insects for killing	Flying insects move to the light and burnt in the flame	+++
14	Holding of a rope pre-soaked in kerosene oil by two persons and dragging from one side of the rice field to the other end	To control rice hispa (*D. armigera*) and case worm (*N. depunctalis*)	Smell of kerosene act as repellant for rice hispa and affected insects fall down on stagnant water	++
15	Placing dried neem (*Azadirachta indica* A. Juss.) and curry leaf or *Narasingho* [*Murraya koenigii* (L.) Spreng] leaves in rice store (room, container)	To control storage pest [Rice moth (*Corcyra cephalonica* St.) and rice weevil (*Sitophilus oryzae* L.)]	Leaves of neem and curry leaf trees possess medicinal properties which can suppress insect pests, check their population build up in the stored grain	+++
16	Application of raw goat dung in rice field	To control rice hispa (*D. armigera*)	Bad acrid odour of goat dung respells the insects	++
17	Brushing of the rice plants with branches of Indian Jujube (*Ziziphus jujuba* Mill.) and application of 1% kerosene oil in the standing water	To control case worm (*Nymphula depunctalis*)	Mechanical removal of insects from the plants using thorny branches. Insects fallen on the surface water die in contact with the droplets of kerosene oil	+
18	Application of raw cow dung @40 kg /bigha in low land situation	To control crab or potamonids (non insect arthropod) in field	Raw cow dung contains some chemicals which can check problems caused by crab during interculture operations	++
19	Spraying of grounded mixture of neem seed (soaked in water over night)	To control case worm (*N. depunctalis*) and stem borer (*S. incertulas, S. innotata*, *C. suppressalis*, *C. polychrysus* and *S. inferens*)	Botanical azadirachtin present in neem has insecticidal properties which can prevent insect damage	+++
20	Beating an empty drum and tying the reel of tape recorder cassette across the rice field	To control bird damage in rice field during ripening stage	Sound of empty drum and dazzling reel made the birds scary and it helps get rid of the birds	+++
Pulse:				
21	Mixing of 10 mL mustard oil per kg of pulse grain (after removal of cotyledons of edible pulse) before storage	To control from bruchid (*Callosobruchus* spp.)	Preference by bruchids reduces after removal of cotyledon. Mustard oil prevents moisture absorption from humid air. It is very effective in the humid situation of Assam.	+++
Potato tubers				
22	Mixing of mustard cake with well grind soil after final land preparation	To control red ant (*Dorylus orientalis* Westwood)	Chemical present in mustard cake can directly control the red ant	+++
23	Placing of pieces of *Vim* (*Musa balbisiana* Colla) banana randomly at different ridges of potato field	To control red ant (*D. orientalis)*	Sweetness of banana can attract red ant	+
24	*Phoot chai* (Fly ash) applied to canopy of potato plant and at the base. Same practice useful for brinjal too	To control epilachna beetle (*Henosepilachna vigintioctopunctata* Fab.) and red ant (*D. orientalis)*	Ash can repel the epilachna beetle and can increase plant tolerance to pest by providing potash nutrient.	+++

(*Contd*.)

Table 3 — List of indigenous technical knowledge (ITKs) adopted by the farmers of Assam for insect pest management (*Contd.*)

	Technology	Purpose	Remarks	Relative adoption*
Vagetables				
25	Overnight soaking of tobacco (Nicotiana tabacum L.) leaves water and application of diluted solution on vegetable crops.	To control soft bodied insects	Nicotine of tobacco possess insecticidal property	++
26	Smoking under hendali (a quadrangle bamboo structure erected to facilitate creeping of gourds vines) by burning rice straw and dry chilli.	To control attack of fruitfly (*Bactrocera cucurbitae* Coquillett)	Smoke can debar female fruitfly from oviposition in the fruits	+++
Fruits				
27	Tying mango tree trunks above the ground with the ropes made of rice straw on the day of Magh Bihu (First day of Makar Sankranti)	To control of mealybug (*Drosicha mangiferae* Stebbins)	Mealy bug and other soil dwelling insects cannot crawl up on the mango tree	+++
28	Painting of the trunk of citrus trees with lime solution up to about 1.5 m height from the base and also sealing the insect holes with mud	To control of citrus trunk borer [Anoplophora versteegi (Ritsema)]	Lime can repel the citrus trunk borer and mud plaster can kill growing grubs inside the holes	+++
29	Smoking during the flowering period of mango	To control of mealybug (*D. mangiferae*)	Smoke repels insects and does not allow laying eggs in the inflorescence	++
30	Pouring milk at the central leaf of coconut palm	To control of rhinoceros beetle [*Oryctes rhinoceros* (L.)]	Milk can invite entomopathogenicbioagents, which can control beetles	+

*(+, ++ and +++ used based on relative adoption of ITKs by <10%, 10-20% &>20% farmers)

that some of the traditional knowledges has been incorporated in the package of practice (PoP) of AAU, Jorhat[13]. From the perspectives of plant protection, some plants are very much useful and among those valued plants neem[14] (*Azadirachta indica* A. Juss.) and pumalo[15] (*Citrus grandis* Osbeck) are most useful. Different parts of the neem plant especially leave, bark and seeds are utilized to protect crops from insect attack; whereas essential oil present in pumalo rind can repel insect pests from rice field during ear head emergence stage.

Following traditional practices were highly adopted by most of the farmers of different districts

a. Clipping off tip of seedling, before transplanting of rice

Before transplanting the seedlings in the main field, clipping off the tips of rice seedlings (Fig. 2) was carried out to control stem borer, leaf folder and rice hispa. Most of the insects prefer tips of the leaves for oviposition. Rice is an important cereal crop of Assam and most of the farming community engaged in rice cultivation as tea is regarded as rich man's business. However, the terms like "rice grower" and "farmer" are synonymous. Interestingly, farmers of Assam also evolved a number of traditional practices for pest management through the long processes with trials and errors. Fascinatingly, some of the traditional practices (clipping and removal of the affected leaves up to about 6 inches from the tip should be done as such leaves bear eggs, larvae and pupae) developed

Fig. 2 — Clipping off tip of rice seedling, before transplanting to the main field

by farmers also incorporated in the Package of Practice (published jointly by Assam Agricultural University, Jorhat and Department of Agriculture, Govt. of Assam) of some crops in Assam. Notably, hispa (*Dicladispa armigera* Olivier) is a major pest of rice and for management of this chlorophyll feeding Coleopteran beetle a similar tactic adopted by the farmers also got a place in the PoP of rice crop[16].

b. **Erection of bamboo branches**

Installation of bamboo branch (Fig. 3) or T-perch in rice field after transplantation and removal before panicle initiation to protect the grains from herbivore birds is routinely used. Nonetheless, installation of wooden structure near rice field for providing living space for owl also had been observed in some fields to control rodent pests. Bamboo branches provide space for predatory birds to take rest and prey upon larvae and adult stages of insect pests. In addition, exudates of tender bamboo contain some chemicals like hydrocyanic acid (HCN) which is capable of eliminating the immature stages (i.e., moth/larvae) of lepidopteran pests.

c. **Application of Indian rhododendron**

Use of chopped pieces of stem of *Phutuka* (Fig. 4) or Indian rhododendron (*Melastoma malabathricum* Linn.) after transplanting the rice seedling to main field. Strong scent emitted by *Phutuka* stem possesses repelling characters against insect pests from field.

Fig. 3 — Bamboo perch helps management of insect pests by providing sitting sites to the predacious birds

d. **Use of *Biholongoni* [Sphaerostephnos unitus (L.) Holtt.] leaves**

Application of *Biholongoni* [*Sphaerostephnos unitus* (L.) Holtt.] leaves (Fig. 5) during growing stage of paddy are very much effective for management of rice stem borer (*Scirpophaga incertulas*, *S. innotata, C. suppressalis, C. polychrysus* and *S. inferens*). The chemical composition present in herbs may interfere the normal growth and development of the insect pest.

Fig. 4 — Application of chopped pieces of stem of *Phutuka* or Indian rhododendron (*Melastoma malabathricum* Linn.)

Fig. 5 — *Biholongoni* [*Sphaerostephnos unitus* (L.) Holtt.]

e. **Storage pest management**

Placing of dried leaves of neem (Fig. 6) and curry leaf (Fig. 7) or *Narasingho* in rice stores (containers, godowns) for suppression of storage pests like rice moth (*Corcyra cephalonica* St.) and rice weevil[17,18] (*Sitophilus oryzae* L.). Actually, the leaves of neem and curry leaves possess medicinal properties which can destroy the insect pests of granaries and check their population builds up in the storage.

f. **Spraying of botanical solutions**

Application of grounded mixture of neem seeds (pre-soaked in water for overnight) in rice fields for the management of insect pests *viz*., case worm, leaf folder and stem borer are a common practice. The chemical compound "azadirachtin" present in neem has insecticidal properties which can prevent the multiplication of insect population. Earlier workers had also mentioned about successful useof neem extract in the management of soft bodied insect like aphid[19].

Fig. 6 — Neem (*Azadirachta indica* A. Juss.)

Fig. 7 — Curry leaf or *Narasingho* [*Murraya koenigii* (L.) Spreng]

g. **Management of herbivore birds**

Beating an empty drum and tying the reel of tape recorder cassette across the rice field is a common practice in most of the rural areas adopted to control bird damage in rice fields during ripening stage. Sound of empty drum and dazzling reel made the birds scary and it helps get rid of the birds. Traditional practices for birds' repellent by a plate hanging from the top of bamboo stick[20] was practiced by Chandel and Chandanpokpi village of Manipur.

h. **Bruchid management**

Mixing of 10 mL mustard oil per kg of pulse grain after removal of cotyledons before storage is helpful in management of bruchid (*Callosobruchus* spp.). This practice reduces preference of the bruchids to the treated seeds. Further, air moistureabsorption does not take place in the oil coated seeds. It is found very effective in the humid situation of Assam.

i. **Red ant management**

Mixing of mustard cake with well grind soil after final land preparation was practiced for the management of red ant (*Dorylusorientalis* Westwood). The chemicals present in mustard cake can directly affect the red ants.

j. **Use of *Phoot chai* (Fly ash) for insect management**

Phoot chai or fly ash (Fig. 8) is applied on the potato plants and also at the plant bases to control epilachna beetle (*Henosepilachna vigintioctopunctata* Fab.) and red ant (*D. orientalis*). This practice is very common in brinjal pest management. Ash can repel the *Epilachna* beetle as well as nourish the plants with potash, thereby boosting tolerance to the pests.

Fig. 8 — *Phoot chai* (Fly ash) applied on brinjal leaves

Fig. 9 — Smoking under *hendali* (climber support with bamboo sticks) by burning rice straw and dry chilli

Similar practice has also been following by the farmers of Sihai Khullen and Lunghar village of Ukhrul district of Manipur[20].

k. Use of smoke against fruitfly

Smoking (Fig. 9) under *hendali* (a quadrangle bamboo structure erected to facilitate creeping of gourds vines) by burning rice straw and dry chilli is a common practice in Assam to repell gravid female of fruitfly (*Bactrocera cucurbitae* Coquillett) for egg laying inside newly developed fruit of cucurbitaceous vegetables.

l. **Painting of citrus tree trunks with lime**

Smearing of citrus trunk with lime paste (lime: water at 1: 25) up to about 1.5 m height from the base and also sealing the insect holes with mud for the management of citrus trunk borer are very old practices. Lime can repel the citrus trunk borer and mud plaster can kill growing grubs inside the holes. This most usual prophylactic measure is followed in Khasi Mandarin or orange (*Citrus reticulata* Blanco) during March/April which prevents the adults of trunk borer from laying egg and included in the Package of Practice for Horticultural Crops of Assam, 2021[21].

m. **Binding of mango tree trunk with rice straw**

Tying mango tree trunks (Fig. 10) above the ground with the ropes made of rice straw is a unique traditional activity of the Assamese people performed on the day of *Magh/Bhogali Bihu* (*Makar Sankranti*)

Fig. 10 — Tying mango tree trunks above the ground with the rice straw ropes

in mid-January. The rice straw barrier deters mealy bug and other soil dwelling insects from crawling up on the mango tree. Nearly similar to this practice of Assam, the farmers of Lahual-Spiti district of Himachal Pradesh also use to tie the tender branches of young apple treeswith the help of cloth pieces or ropes with the main stem to protect them from breakage during heavy snowfall[22].

Conclusion

Of late the importance and eco-supportive role of the age old indigenous technical knowledge are realized to some extent. Creation of awareness towards ITKs in the farming communities is necessitated for their conservation and to solve the risk of extinction. To achieve these, ITKs are to be brought to the regular applicationas an integral component of organic farming. Prior to their recommendation in organic farming practice, pre-requisite information like appropriate doses and time of application are needed to be worked out and standardized through scientific analysis of the more potent ITKs. Further, ITK's being economically viable in naturemay be judiciously exploited for sustainable agriculture combating hidden hunger and nutritional deficiency of each and every undernourished citizen of India[10,14].

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Conflict of Interest

The authors declare that there is no conflict of interest for this study.

Author's Contributions

RNBK and SB collected data by various extension activities conducted at Jorhat, Golaghat, Dibrugarh and Nagaon District. DKS and RG provided critical feedback and helped in preparation of manuscript. All the authors read and approved the final manuscript.

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