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Compiling the wisdom of Kerala's indigenous farmers: A traditional rice pest management calendar

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This study documents traditional pest management practices among rice farmers in Kerala, emphasizing low-cost, ecologically grounded methods rooted in indigenous knowledge. Field surveys and interviews identified techniques including manual removal, sweeping with tools or aromatic plants, cultural practices (e.g., flooding, drainage), light traps, botanical and organic deterrents, cow dung slurry for seed treatment, and bioproducts like *jeevamrutham* and *panchagavya*. Vertebrate pests were managed using physical barriers, sound deterrents, and natural repellents. A seasonal pest management calendar was developed from these observations. The findings indicate that traditional practices can effectively reduce pest incidence and enhance plant health, though further scientific validation is needed for integration into formal Integrated Pest Management (IPM) frameworks.

Keywords: Cultural control, Mechanical control, Rice pest, Traditional knowledge, Traditional pest control, Tribal farmers

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The scientific approach underpins modern agriculture. On the other hand, the traditional farmers use a different strategy based on their knowledge and their interactions with the environment[1,2]. They utilize various plant-based products, such as agricultural waste and animal products, to protect crops and stored products.

Indigenous people carry out farming based on their ethno-science or knowledge[2,3]. These farmers see pests as either a threat to productivity or as fellow beings with a legitimate claim to a fair share[4].

They observe nature through a lens of ideas, knowledge, and purpose, and behave based on their perceptions of nature rather than the natural structure[1]. Therefore, their perceptions of nature determine the interactions between farmers and the environment. These pictures or conceptualizations play a role in determining how farmers assess, decide, and act in their everyday lives when faced with various situations and options. The cognized model represents farmers' perceptions of the world and is essential for Integrated Pest Management (IPM) initiatives. Ethno-agronomy is a subclass of cognized agronomy that considers farmers' indigenous knowledge[3]. The cognized model is always engaged with the operational world in which farmers absorb, dismiss, and refine experiences and perceptions.

Farmer expertise was helpful in the past, but it could not keep up with the rapidly changing rice technologies that came with modern rice. It is found that most farmers still see their knowledge and methods as inferior to those advocated by outsiders. Hence, farmers' knowledge should be included right from the beginning. Because when they feel that their knowledge is being disregarded, it can make new research and projects seem unfamiliar or disconnected to them. That is why it is important to involve them from the very early stages.

Traditional farming, passed down through generations, offers effective, long-lasting pest and disease control. Many modern practices and cultivars have evolved from these traditional systems[5]. As agriculture modernizes, traditional farmers' agricultural systems including pest management measures, are at risk of being lost. Before they disappear, such traditions should be documented, scientifically validated and preserved. Here, we documented the traditional pest management practices employed by the farmers in Kerala and utilized the knowledge to make a pest management calendar to benefit farmers who are unaware of these practices.

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Study area

The study was conducted in Wayanad district, Kerala, South India (11°26′–12°00′ N, 75°75′–76°56′ E), which has the highest Adivasi population in the state (17.43%)[6]. Situated at 700-2100 m above mean sea level, Wayanad is known for its traditional rice cultivation and tropical climate, receiving an average annual rainfall of 2250 mm[7]. Surveys were carried out between 2020 and 2022 in key tribal rice-farming areas including Mananthavady (11.8014° N, 76.0044° E), Edavaka (11.7715° N, 75.9637° E), Panamaram (11.7381° N, 76.0740° E), Pulpally (11.6732° N, 76.1833° E), and Thrissileri (11.8465° N, 76.0227° E). A total of 348 farmers were interviewed, of whom 86 provided details on traditional pest control practices; tribal farmers constituted 70.9% of the respondents.

Materials and Methods

Measuring insect pest incidence after application of traditional plant- and animal-based formulations

The study was conducted during the Kharif seasons (2020-2022) in tribal rice fields of Wayanad district, Kerala. Traditional plant- and animal-based pest control formulations, identified via farmer surveys, were applied once during the vegetative to early flowering stages. For each treatment, three treated plots and one untreated control plot (each 20 m²) were established-totaling 21 treated and 7 control plots.

Pest incidence was recorded seven days post-application and then weekly for three weeks using five random quadrats per plot. Visible pest damage on tillers, panicles, or leaves was noted, and percent pest incidence was calculated as: Pest Incidence (%) = (Infested plant parts / Total observed plant parts) × 100

Treatment efficacy was assessed as: Pest Reduction (%) = (Incidence in control − Incidence in treatment) / Incidence in control) × 100

Results and Discussion

Management of insect pests

Various traditional methods were employed by farmers in the study region to manage major insect pests (Table 1). Sweeping using *muram* (bamboo winnower) or nets, along with handpicking, were commonly used. Immature stages of Lepidopteran pests were removed manually, while sweeping targeted adult insects and larvae. Branches of plants such as *Ficus hispida* L.f. (Fig. 1 a), *Artemisia nilagarica* Clarke, and *Ziziphus oenopolia* L. (Fig. 1 b & c) were swayed to injure concealed defoliators like *Cnaphalocrocis medinalis* Guenée, *Helcystogramma arotraeum* Meyrick, and *Leptispa pigmaea* Baly. The rough texture of *F. hispida* and *A. nilagarica* leaves and thorns of *Z. oenopolia* aided in killing these pests. Leaves of *Cymbopogon citratus* Stapf (lemongrass) were chopped and swung to wound *C. medinalis* caterpillars, with silica and bristles contributing to lethality or making them more susceptible to bird predation. Odours from *Cycas circinalis* flowers (Fig. 1 d & e) and dried sardine fish (Fig. 1 f) served as repellents against rice bugs (*Leptocorisa acuta* Thunberg and *L. oratorius* Fab.). The repellent action of *C. circinalis* was attributed to toxic compounds such as cycasin and β-methylamino-L-alanine (BMAA), which interfere with insect feeding and neural function[8].

Table 1 — Traditional insect pest management practices involving cultural and mechanical methods as documented in selected rice-growing regions of Wayanad, Kerala

Scientific name of the pest	Local name of the pest		Management practices
	Farmer version	Vernacular name	
Ampittia dioscorides	Pachapuzhu	Ponthachadan	• Hand picking • sweeping
Cnaphalocrocis medinalis	Ilachuruttipuzhu Olappuzhu	Ilachuruttipuzhu	• Swaying branches of plants such as “Paarakam” (*Ficus hispida*) or “Kattukarpooram” (*Artemisia nilagarica*) or “Churi Mullu or Kottamullu” (*Ziziphus oenopolia*) to injure the larvae as well as insects in the field • Bund shaving • Swaying with lemongrass oil leaves (*Cymbopogon citratus*) • Light trap to capture adults
Dicladispa armigera	Vandu	Kaaravandu	• Sweeping using sweep net
Helcystogramma arotraeum	Ilachuruttipuzhu	Ilachuruttipuzhu	• Swaying branches of plants such as “Paarakam” (*Ficus hispida*) or “Kattukarpooram” (*Artemisia nilagarica*) or “Churi Mullu or Kottamullu” (*Ziziphus oenopolia*) to injure the larvae

… *Contd*.

Table 1 — Traditional insect pest management practices involving cultural and mechanical methods as documented in selected rice-growing regions of Wayanad, Kerala (Contd.)

Scientific name of the pest	Local name of the pest		Management practices
	Farmer version	Vernacular name	
Hieroglyphus banian	Pachathullan Pulchaadi Pachakuthira	Pachathullan Pulchaadi Pachakuthira	• Sweeping using sweep net • Bund shaving
Leptispa pygmaea	Ilachuruttipuzhu	Elachuruttivandu	• Swaying branches of plants such as "Paarakam" (*Ficus hispida*) or "Kattukarpooram" (*Artemisia nilagarica*) or "Churi Mullu or Kottamullu" (*Ziziphus oenopolia*)
Leptocorisa oratorius	Chaazhi Munja	Chaazhi	• Flowers of "Eenth" (*Cycas circinalis*) are used as a deterrent • Swaying with "muram" • Hanging a fish in a cloth attached to a stick erected in the field • Keep the field and bunds free of weeds and grasses • Spraying of diluted buttermilk in the field • Light trap to capture adults
Melanitis leda ismene	Pachapuzhu	Pachakombanpuzhu	• Hand picking, sweeping using muram
Mythimna separata	Pattalapuzhu	Pattalapuzhu	• Flood the field as soon as the caterpillars are noticed
Naranga aenescence	Pachapuzhu	Pachapuzhu	• Hand picking, sweeping using muram
Nilaparvata lugens	Chaazhi Munja	Munja	• Draining the field
Oxya hyla	Pachathullan Pulchaadi Pachakuthira	Pachathullan Pulchaadi Pachakuthira	• Sweeping using sweep net, bund shaving
Orsotriaena medus	Vellapuzhu	Vellakkarumban	• Hand picking • Sweeping using muram
Parapoynx stagnalis	Kuzhalpuzhu Ilachurutti Muzhipanni	Kuzhalpuzhu	• Drain away the water from the fields • Light trap to capture adults
Parnara bada	Ilachurutti Pachapuzhu	Ilamadakki	• Hand picking • Sweeping using muram
Pelopidas agna	Ilachurutti Pachapuzhu	Ilamadakki	• Hand picking • Sweeping using muram
Pelopidas mathias	Ilachurutti Pachapuzhu	Ilamadakki	• Hand picking • Sweeping using muram
Scirpophaga incertulas	Thanduthurappan Chaazhi	Thanduthurappan	• Uprooting the affected parts (rouging) • Burn rice stubble • Handpicking of egg masses. • Light trap to capture adults • Cut the leaf top
Scirpophaga innotata	Thanduthurappan Chaazhi	Thanduthurappan	• Uprooting the affected parts (rouging) • Burn rice stubble • Handpicking of egg masses. • Light trap to capture adults • Cut the leaf top
Spodoptera litura	Pattalapuzhu Karuthapuzhu	Pattalapuzhu	• Sweeping using muram • Planting and maintaining *Colocasia* near the rice field as a trap crop.
Spodoptera mauritia	Pattalapuzhu	Pattalapuzhu	• Flood the field as soon as the caterpillars are noticed.
Tetrix subulata	Thavitt Pulchadi	Pulchadi	• Sweeping using sweep net

In rainfed rice-growing regions, water management is traditionally employed as a pest control strategy[9,10]. In the study area, farmers reported flooding fields during severe armyworm outbreaks[11], noting a significant reduction in damage following submergence. Specific water management practices were also adopted to control pests such as brown plant hoppers (BPH) (*Nilaparvata lugens* Stål) and rice

caseworms (*Parapoynx stagnalis* Zeller). To manage BPH, fields were typically flooded for several days during the early to mid-tillering stage. In contrast, rice caseworms, which float in silken leaf cases, were controlled by draining fields for 2-3 days during the early vegetative phase. This practice exposed larvae to desiccation and natural enemies, as the pest thrives in waterlogged conditions[12]. Draining was also believed to harden plant tissues, enhancing resistance to insect attack, possibly due to increased calcium uptake under drained conditions[13]. Although farmer responses varied, studies have reported a negative correlation between excess water and BPH populations[10]. One report suggested that higher water levels could destroy BPH eggs laid within leaf sheaths[14]. Additionally, field drainage has been used to suppress *Dicladispa armigera*[10,15] and mole crickets[16].

Stemborers were primarily managed by burning rice stubble, handpicking egg masses, cutting the leaf top (Fig. 1 g), removing the damaged parts of the rice plant (Fig. 1 h), and using light traps. The most common method of eliminating stemborers was rouging, *i.e.*, cutting and removing the injured tillers of the rice plant. Rouging should be done extensively

Fig. 1(a-h) — Pest management methods used by the traditional farmers in Wayanad, (a) swaying the branch of *Ficus hispida* against the concealed defoliators, (b & c) *Ziziphus oenopolia* L. branch, (d & e) *Cycas circinalis* L. flower to repel rice bugs, (f) dried sardine fish in a cloth bag, (g) cutting the leaf tip, (h) uprooting the affected plant parts

over a vast region and several years to prevent the rice stem borer[16]. Another practice for managing stemborers is to cut the dead heart with a knife[17]. However, removing dead hearts or whiteheads fails to remove all stem borer larvae. A second step that works best on immature rice plants is to remove the whole plant when dead hearts are seen[11]. In order to manage rice stem borers, a different approach is thus required. When a crop is harvested, lingering stem borer larvae and pupae remain in the stubble and straw. Rice straw is usually burned soon after harvest. In addition, stubble is ploughed during land preparation for the following crop. Both activities kill the residual stemborer populations[17].

In our field study, light traps were used by farmers to attract nocturnal moths of rice pests, relying on the insects' positive phototaxis[17]. Several farmers also reported lighting bonfires at night to attract and kill rice bugs and moths, a traditional practice still observed in some regions. However, we noted that the effectiveness of light traps varied, and farmers expressed dissatisfaction due to risk of theft, inconsistent moth attraction, and accidental killing of beneficial insects. These observations are consistent with earlier reports[14,16,18].

Many rice insect pests are known to survive on common rice field weeds, especially grasses found in fallow fields, field borders, and near rice crops[19]. In the study area, increased pest incidence was observed in weedy fields. To manage pests such as armyworms, mole crickets, and field crickets, weeds were piled to attract and collect them. If not regularly removed, these pests caused significant crop damage. Traditional weed and rodent control methods such as mowing and shaving rice bunds (Fig. 2 a) also disrupted the habitat of soil-dwelling pests, including armyworm pupae,

Fig. 2(a-d) — Pest management methods used by the traditional farmers of wayanad, (a) bund shaving, (b-d) growing wild varieties of *Colocasia* along field margins as a trap crop for *Spodoptera litura*.

mole cricket tunnels[15], and grasshopper eggs[14]. To drown pest eggs and pupae, soil from bunds was relocated into floodwater. Fresh mud was sometimes applied to bund sides to trap mole crickets. A traditional technique involved growing wild varieties of *Colocasia* along field margins, acting as a trap crop for *Spodoptera litura* (Fab.) (Fig. 2 b & c). Larvae showed a clear preference for feeding on *Colocasia* leaves, reducing damage to rice. The broad, moisture-retaining foliage of *Colocasia esculenta*[19] attracted *S. litura*, while its allelopathic compounds possibly influenced insect feeding and deterred further spread[20,21]. As *S. litura* is polyphagous, its preference for *Colocasia* (Fig. 2 d) helped protect adjacent rice crops (Table 1).

Traditional farmers in Kerala used mainly four animal products-diluted buttermilk, *jeevamrutham* (Fig. 3 a & b), and *panchagavya* (Fig. 3 c-e), fish amino acids (Fig. 3 f)- as well as three plant products-

Fig. 3(a-f) — Plant and animal products used by the traditional farmers of Wayanad, (a&b) *jeevamritham*, (c-e) *panchagavya*, (f) fish amino acid

neem oil emulsion, neem seed extract, and tobacco emulsion-to control rice insect pests (Table 2). *Jeevamrutham* is one of them, strengthening the rice plant's defenses against pest invasion, while the others act as insect repellents. In the preparation of *jeevamrutham*, each ingredient plays a vital role in enriching soil microbial activity and promoting plant health through natural means. Cow dung and cow urine are rich in beneficial microorganisms and nutrients, acting as biofertilizers that stimulate microbial populations essential for nutrient cycling. The jaggery (a sugar source) acts as an energy substrate, enhancing the multiplication of microbes. Pulse powder provides protein and amino acids, supporting microbial growth and enzymatic activity. The soil acts as a microbial inoculum, introducing native microflora into the solution. Stirring in both clockwise and anti-clockwise directions ensures uniform aeration and distribution of microbes. Fermenting the mixture in a shaded area for 14 days allows the microbial colonies to mature. When applied twice a month, the diluted *jeevamrutham* improves soil fertility, strengthens plant immunity, and reduces dependency on chemical fertilizers, thus supporting sustainable rice cultivation. *Azadirachta indica* L., the neem tree seed, contains extracts with numerous insect pest management benefits[22]. Repulsion, oviposition deterrence, insect growth regulation, low mammalian toxicity, and minimum environmental persistence are a few of them[22-24]. Spraying of diluted buttermilk is traditionally employed for its sour odor, beneficial microbial activity, and film-forming ability on panicles, which together act as a deterrent to insect pests and protects grains from infestation. Buttermilk has a population of bacteria such *Lactobacillus* sp., which may help slow the spread of various bacterial and fungal infections and insect infestation[25]. Insect pests were successfully suppressed and repelled by *panchagavya*[26]. A natural fertilizer called *jeevamrutham* helps to guard against bacterial and fungal plant diseases[27].

The traditional plant and animal-based treatments significantly reduced pest incidence in rice fields compared to untreated controls in the present study. Pest incidence in control plots ranged from 33.7% to 41.5%, which decreased to 14.2%-18.5% after treatment. Percent reduction in pest incidence varied

Table 2 — Plant and Animal products used to prepare the pesticide formulations to control rice insect pests in Kerala

Plant/ Animal product	Mode of preparation	Target pest
Diluted butter milk	Spraying of diluted butter milk in the field	*Leptocorisa oratorius, Leptocorisa acuta*
Fish amino acid	One kilogram of chopped fish was mixed with one kilogram of jaggery and fermented in a sealed container for ten days. The liquid formed was stored airtight for up to 21 months. For use, 1 mL of the extract was diluted in 1 L of water and sprayed on the crop.	*Leptocorisa oratorius, Leptocorisa acuta*
Jeevamrutham	A mixture was prepared with 200 L of water to treat 1 acre, using 3 kg soil, 2 kg jaggery solution, 2 kg pulse flour, 10 kg cow dung, and 4 L cow urine. Cow urine and cow dung were combined and stirred, followed by the addition of soil, jaggery solution, and pulse flour. The mixture was transferred to a barrel, filled with water, stirred in both directions, sealed, and kept in shade. It was stirred daily for 14 days and diluted before use. The formulation was applied twice monthly for pest control.	Against all insect pests
Neem oil emulsion	Sixty grams of bar soap were dissolved in 0.5 L of water and mixed with 1 L of neem oil. The mixture was diluted with 40 parts water and sprayed uniformly in the rice field.	Grasshoppers, thrips, and rice bugs
Neem seed extract	A poultice of 30-80 g powdered neem seeds was soaked in 1 L of water for 12 h. The resulting extract was diluted and applied against insect pests.	Lepidopteran caterpillars, grasshoppers, and stemborers
Panchagavya	It was prepared using milk, curd, ghee, cow dung, and urine. Initially, 4 kg of cow dung was mixed with 500 g of ghee. Separately, 4 kg of cow urine was combined with 500 g each of milk and curd, 50 g of palm sugar, and appropriate amounts of salt and yeast. The mixture was kept in a shaded area and stirred daily to encourage microbial activity. It remained effective for up to six months with regular mixing and water added as needed to prevent drying. The formulation was used to enhance plant resistance to pests.	Against all insect pests
Tobacco emulsion	To prepare the tobacco emulsion, 500 g of dried tobacco leaves were chopped and boiled in 4 L of water, then left to stand for 24 h for extraction of active compounds. The extract was filtered to remove residues. A 12 g bar of soap was dissolved in water and added to the filtered solution. The mixture was then diluted with 12-15 L of water. The emulsion was applied after irrigation, preferably during early morning or late evening, using a hand or knapsack sprayer to ensure even coverage on both leaf surfaces. A single batch was found sufficient to treat one acre of field.	Lepidopteran caterpillars, mealy bug, scale insects etc. (against soft bodied pests)

from 53.75% to 62.50%, with *jeevamrutham* showing the highest overall efficacy (62.5%) against all insect pests. Neem-based products and tobacco emulsion also demonstrated strong control against specific pests like caterpillars, stem borers, and soft-bodied insects (Table 3).

Management of non-insect pests

Agricultural damage from elephants, ungulates, wild pigs, and monkeys is the most common human-wildlife conflict in India[28]. In Kerala, farmers used various methods to deter vertebrate pests (Table 4). Due to religious beliefs and the peacock's protected status as India's national bird, few measures were taken against them, despite their impact on grain yield[29]. Physical barriers were commonly used to keep them out. Firecrackers were widely used to scare monkeys, though some farmers viewed relocation as a more permanent solution[30].

According to the farmers surveyed, the glass bottles dangling in the air and the steel rod (Fig. 4 a) moving in the wind make a noise that deters deer. In both the pre-harvest and post-harvest phases of cultivation, rodents provide a significant challenge to rice production[32]. Bund shaving, which makes it simpler to detect rats in rice fields where they reside in bunds, was done after the rat tunnels had been excavated. Rodents are also reduced by installing owl perches on coconut fronds or dried tree branches in rice fields (Fig. 4 b).

To deter wild boars, farmers hung steel plates, metal sheets (Fig. 4 c), white cloths and plastic sheets (Fig. 4 d & e), and bags filled with castor leaf paste (Fig. 4 f). The sound produced by steel plates and metallic sheets during wind blowing might keep wild boars at bay.

In this study, some farmers reported that placing white cloths and plastic sheets in the field helped deter wild boars. Although wild boars do not have strong vision and primarily rely on hearing and smell to navigate[31], the sudden fluttering movement and unusual appearance of these materials created a visual and auditory disturbance. These unfamiliar cues were perceived by the animals as potential threats or barriers, making them hesitant to enter the fields. Such methods were locally developed and used as non-lethal deterrents to reduce crop damage. The castor leaf paste bag effectively deters wild boars due to its strong odor, which disrupts their keen sense of smell. Combined with visual and sound barriers, it creates a multi-sensory deterrent that keeps boars away from fields.

Scarecrows and bird tape were used to terrify the birds and reduce grain loss during the ripening phases of the paddy. Using human bird scarers, scarecrows, flash tapes, and various traditional noise-making devices are all examples of direct protection[33]. The farmers used different methods to reduce the prevalence of avian pests. Jackfruit (*Artocarpus heterophyllus* Lam.) latex is used as a

Table 3 — Percent pest incidence in control and after treatment with traditional plant and animal-based formulations in rice fields

Plant/Animal product	Target [est	Percent pest incidence in control (Mean ± SE)	Percent pest incidence after treatment (Mean ± SE)	% Reduction in pest incidence
Diluted buttermilk	*Leptocorisa oratorius*	40.0±2.5	18.5±1.8	53.75
Fish Amino Acid	*Leptocorisa acuta*	38.5±3.0	17.2±2.0	55.32
Neem seed extract	Lepidopteran caterpillars	36.8±2.7	15.5±1.5	57.93
Neem seed extract	Stem borers	37.2±3.1	16.8±1.9	54.84
Tobacco emulsion	Mealy bugs	35.5±2.9	14.2±1.4	60.00
Tobacco emulsion	Scale insects	34.8±3.3	14.8±1.6	57.47
Neem oil emulsion	Grasshoppers	35.0±2.8	16.0±1.7	54.29
Neem oil emulsion	Thrips	33.7±2.4	14.5±1.3	57.00
Jeevamrutham	All insect pests	41.5±3.2	15.6±1.5	62.50

Table 4 — Existing cultural and mechanical management practices of vertebrate pests in traditional rice fields of Kerala

Name of the pest	Management practices
Deer	Electric fencing, hanging glass bottle along with metallic rode in a tap
Elephant	Electric fencing, fire crackers
Monkey	Fire crackers
Peacock	Physical barriers
Rodents	Bund shaving, placing bird (for owl) perches in paddy field
Small Birds	Bird tape, jack fruit latex, fig latex, catapult, human effigy
Wild boar	Electric fencing, wood fencing, hanging steel plates along with metallic sheets, placing white cloths and plastic sheets in the field, hanging castor leaf paste in a cloth bag

Fig. 4(a-f) — Vertebrate rice pest management methods used by the traditional farmers, (a) hanging glass bottle with metallic rod and X-ray sheet, (b) placing owl perches, (c) hanging steel plates along with metallic sheets, (d) placing white cloths, (e) placing white plastic sheets, (f) hanging castor leaf paste in a cloth bag

bird lime or to attract and catch birds[29]. Tribal farmers in Kerala also suggested using fig latex to capture bird pests.

Since traditional pest management practices were employed primarily by tribal farmers[34], these indigenous groups carry out several rituals according to their religious beliefs to reduce the insect infestation in rice fields (Table 5). The knowledge, practice, and belief systems of the custodians of rich indigenous knowledge systems were formed over a long period of time and handed down via cultural processes through the generations[35].

Construction of rice pest management calendar

A traditional rice pest management calendar was developed based on survey data for indigenous rice varieties (Fig. 5). The agricultural year was divided into stages including field preparation, seed selection,

Table 5 — Rice pest management belief/ceremony of tribal farmers in the High hill region of Kerala

Tribal group	Belief/ceremony	Target pests
Kuruchiyar	Charcoal, turmeric, and lime are mixed in a coconut shell with mantras recited, then placed at the field edge. The black-yellow contrast is believed to repel pests.	Birds
Most tribal communities	An erect post called "vavu" is created by bundling twigs collected from common nearby forest trees.	Against all pests and diseases
Wayanadanchetti	A black fowl and fried rice are offered to God during Uthradamnakshatra in March-April, in a ritual known as Vaikattu, Vaipoottal, or Panchakacham.	Birds, cattle, wild boar and other pests

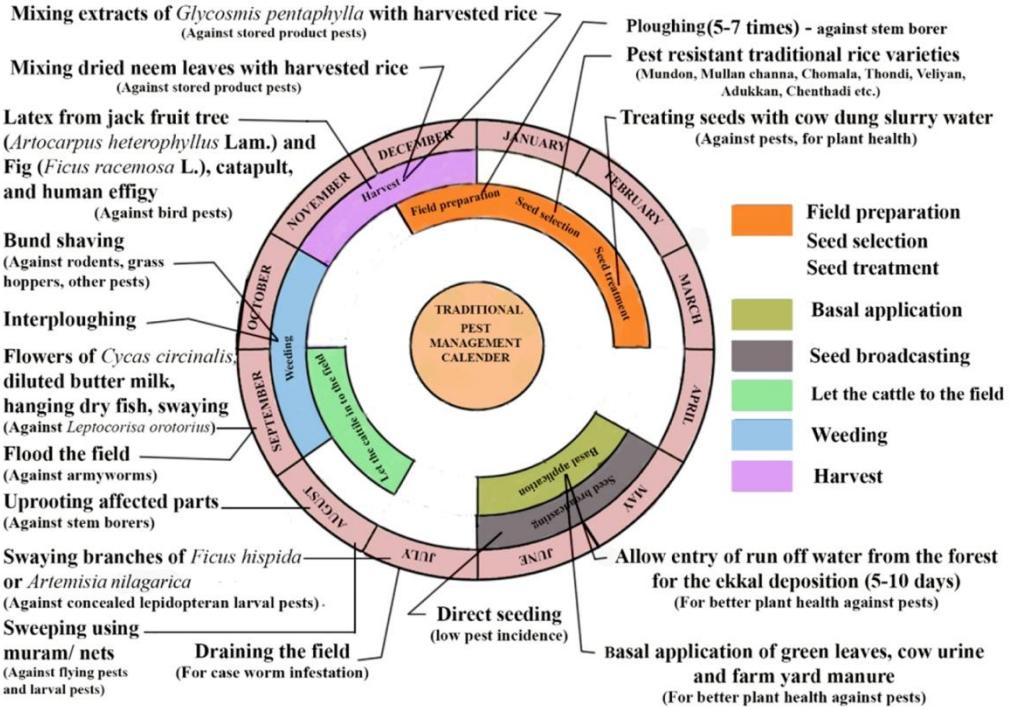

Fig. 5 — Traditional pest management calendar for traditional rice varieties in the High hill region (Wayanad district) of Kerala

seed treatment, basal application, seed broadcasting, cattle entry, weeding, and harvesting. Traditional pest control and plant-strengthening practices were reported during each stage to improve yield. Seed treatment was practiced by 63% of farmers, primarily by soaking seeds in cow dung slurry to enhance seedling vigor and protect against early pest and disease attacks. Post-harvest, dried neem leaves and *Glycosmis pentaphylla* (Retz.) extracts were mixed with rice seeds to deter storage pests.The basal application of green leaves, cow urine, and farmyard manure reflects traditional knowledge aimed at enhancing plant vigor and pest resilience. Neem (*Azadirachta indica*) leaves contribute organic matter while exerting insect-repellent and allelopathic effects that suppress pests and weeds[36,37]. Cow urine, as used in formulations like *Panchagavya*, acts as a bio-enhancer due to its nutrient content (N, P, K) and antimicrobial properties[38,39]. Farmyard manure improves soil structure, moisture retention, and microbial activity, promoting plant health and reducing pest susceptibility[39].

In addition, direct seeding was reported by traditional farmers to reduce pest incidence. This observation aligns with earlier studies suggesting that direct seeding minimizes transplant shock and shortens vulnerable crop stages, thereby limiting pest colonization and supporting uniform crop establishment[40]. Collectively, such traditional practices contribute to sustainable pest management and help maintain ecological balance within the rice agro-ecosystem (Fig. 5).

While earlier studies, such as one from Assam[41], have assessed the efficacy and rationale of indigenous rice pest management practices, the present study is the first to compile these into a calendar format. This time-based framework, grounded in farmers' knowledge, offers a structured guide for sustainable pest control and supports the integration of traditional methods into formal IPM strategies.

Conclusions

Farmers in the study region continue to use diverse traditional methods to manage insect and non-insect pests in rice fields. These include handpicking, sweeping, and thorny branches as barriers. Natural deterrents like neem and lemongrass, along with water management such as flooding and drainage, are also common. Cultural practices like removing infested plants, burning stubble, and using light traps help limit pest buildup. For vertebrate pests such as wild boars, monkeys, and birds, farmers employ metal sheets, white cloths, castor leaf paste bags, and owl perches for rodent control. Biological formulations like *jeevamrutham*, *panchagavya*, and neem emulsions are widely used. Seed treatment with cow dung slurry, application of cow urine, green leaves (especially neem), and direct seeding support ecological resilience. Despite their effectiveness, scientific validation of these methods, including their mechanisms, consistency, and environmental impact remains limited. Their integration into modern strategies like (IPM) also needs exploration. Collaborative research that values indigenous knowledge is essential to refining and adopting these eco-friendly practices in sustainable agriculture.

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Conflict of Interest

The authors have no conflict of interest to disclose.

Author Contributions

The first author collected data and drafted the manuscript with inputs from the second and third authors.

Ethics Approval

Traditional knowledge was documented respectfully, ensuring accurate representation without revealing sacred or proprietary details.

Prior Informed Consent

Prior informed consent was obtained after clearly explaining the study's purpose; participation was voluntary, and personal information was anonymized.

Data Availability

Data supporting this study's findings are available from the corresponding author upon reasonable request.

References

1 Brosius P, Lovelace G & Martin G, Ethnoecology: An approach to understanding traditional agricultural knowledge, In: *Traditional Agriculture in Southeast Asia*; Martin GG, Ed., (Westview Press, Boulder, Colorado), (1986) 187-198.

2 Nazarea-Sandoval V D & Rhoades R E, Rice, reason, and resistance: A comparative study of farmers' vs. scientists' perception and strategies, In: *Rice Blast Disease*, Zeigler RS, Leong SA & Ten PS, Eds., (CAB International, Wallingford, UK), (1994) 559-575.

3 Nazarea-Sandoval V D, Ethnoagronomy and ethnogastronomy: On indigenous typology and use of biological resources, *Agric Hum Values*, 8 (1991) 121-131. DOI: 10.1007/BF01579665.

4 Brown B J & Marten G G, The ecology of traditional pest management in Southeast Asia, In: *Traditional Agriculture in Southeast Asia*; Martin GG, Ed., (Westview Press, Boulder, Colorado), (1986) 241-272.

5 Fujisaka S, Kirk G, Litsinger J A, Moody K, Hosen N, *et al*., Wild pigs, poor soils, and upland rice: A diagnostic survey of Sitiung, Sumatra, Indonesia, (IRRI Research Paper Series), (1991) 155.

6 Chathukulam J & John M S, Issues in tribal development: The recent experiences of Kerala, In: *Tribal Development in India: The Contemporary Debate*, Rath GC, Ed., (SAGE Publications Pvt. Ltd, New Delhi), (2006) 182-202.

7 Kumar D & Srinath P, Climate trends in Wayanad: Voices from the Community, In: *UGC-sponsored Conference on Recent Trends in Climate & Impact of Climate Change on South-West India*, (St. Joseph's College, Devagiri, Kozhikode, Kerala), 2011.

8 Whitaker M R L, Banack S A, Mescher M C, Cox P A & De Moraes C M, BMAA in cycad-feeding Lepidoptera: defensive sequestration or bioaccumulation?, *Front Ecol Evol*, 11 (2023) 1114636. DOI: 10.3389/fevo.2023.1114636.

9 Fujisaka S, Rainfed lowland rice: Building research on farmer practice and technical knowledge, *Agric Ecosyst Environ*, 33 (1) (1990) 57-74. DOI: 10.1016/0167-8809(90)90144-3.

10 Roshan D R & Raju S V S, Influence of abiotic and biotic factors on population dynamics of BPH (*Nilaparvata lugens* Stål) and GLH (*Nephotettix virescens* Distant), *Crop Res*, 52 (1-3) (2017) 67-73.

11 Lorenz G N, Bateman N, Hardke J & Cato A, Insect management in rice, In: *Arkansas Rice Production Handbook*, Hardke JT, Ed., (University of Arkansas Cooperative Extension Service, Fayetteville, Arkansas, USA), (2018) 145-168.

12 Vromant N, Rothuis A J, Cuc NTT & Ollevier F, The effect of fish on the abundance of the rice caseworm *Nymphula depunctalis* (Guenée) (Lepidoptera: Pyralidae) in direct-seeded, concurrent rice-fish fields, *Biocontrol Sci Technol*, 8 (4) (1998) 539-546. DOI: 10.1080/09583159830054.

13 Barrion A T & Litsinger J A, Taxonomy of rice insect pests and their arthropod parasites and predators, In: *Biology and Management of Rice Insects*, Heinrichs EA, Ed.,(Wiley Eastern Ltd., India & IRRI, Manila, Philippines), (1994) 13-362.

14 Litsinger J A, Cultural, mechanical, and physical control of rice insects, In: *Biology and Management of Rice Insects*, Heinrichs E A, Ed., (IRRI, Philippines), (1994) 549-584.

15 Watson G A & Willis M, Farmers' local and traditional rice crop protection techniques: Some examples from coastal swamplands, Kalimantan, Indonesia, *Indones Agric Res Dev J*, 7 (1-2) (1985) 25-30.

16 Litsinger J A, Cultural, mechanical, and physical control of rice insects, In: *Biology and Management of Rice Insects*; (IRRI, Philippines), (1994) 549-584.

17 Litsinger J A, Alviola A L, Dela Cruz C G, Canapi B L, Batay-An E H III, *et al*., Rice white stemborer *Scirpophaga innotata* (Walker) in southern Mindanao, Philippines. I. Supplantation of yellow stemborer *S. incertulas* (Walker) and pest status, *Int J Pest Manag*, 52 (1) (2006) 11-21. DOI: 10.1080/09670870600552497.

18 Li-Ying L, Integrated rice insect pest control in the Guangdong Province of China, *Entomophaga*, 27 (Suppl 1) (1982) 81-88. DOI: 10.1007/BF02371858.

19 Jepson W F, *A critical review of the world literature on the lepidopterous stalk borers of tropical graminaceous crops*, (Commonwealth Institute of Entomology, London), (1954) 127.

20 Abaza A M, Ahmed Y M, Abbas M G, Soliman H A & Ashour H K, Chemical constituents of *Colocasia esculenta* leaves extract in relation to its self defense against the cotton leafworm, *Spodoptera littoralis* (Boisd.), *Catrina Int J Environ Sci*, 13 (1) (2015) 1-7.

21 Velu G, Rajogopal A & Palaniappan S P, Allelopathic impact of *Colocasia* on crop plants, *Madras Agric J*, 81 (1994) 580-583. DOI: 10.29321/maj.10.a01586.

22 Schmutterer H, Properties and potential of natural pesticides from the neem tree, *Azadirachta indica*, *Annu Rev Entomol*, 35 (1) (1990) 271-297. DOI: 10.1146/annurev.en.35.010190.001415.

23 Koul O & Isman M B, Effects of azadirachtin on the dietary utilization and development of the variegated cutworm, *J Insect Physiol*, 37 (8) (1991) 591-598. DOI: 10.1016/0022-1910(91)90036-Y.

24 Mordue A J & Blackwell A, Azadirachtin: An update, *J Insect Physiol*, 39 (11) (1993) 903-924. DOI: 10.1016/0022-1910(93)90001-8.

25 Jaffar N S, Jawan R & Chong K P, The potential of lactic acid bacteria in mediating the control of plant diseases and plant growth stimulation in crop production – A mini review, *Front Plant Sci*, 13 (2023) 1047945.

26 Swaminathan C, Swaminathan V & Vijaylakshmi K, *Panchagavya: Boon to Organic Farming*, (IBDC Publishers, Mumbai), 2007.

27 Sreeni K R, Sarvathobhadram – Organic initiative: Cooperative model for resilient agriculture by adopting system of rice intensification, *J Rice Res*, 10 (12) (2022) 337. DOI: 10.4172/2375-4338.1000337.

28 Choudhury A, Human– elephant conflicts in Northeast India, *Hum Dimens Wildl*, 9 (4) (2004) 261-270. DOI: 10.1080/10871200490505693.

29 Sridhara S, An overview of vertebrate pests in India, In: *Proceedings of the Vertebrate Pest Conference*, 22 (22) (2006) 1-8. DOI: 10.5070/V422110078.

30 Imam E, Yahya H S A & Malik I, A successful mass translocation of commensal rhesus monkeys *Macacamulatta* in Vrindaban, India, *Oryx*, 36 (1) (2002) 87-93. DOI: 10.1017/S0030605301000011

31 Taklis C, Wild boar responses to red-white tape: A field study, *Int J Sci Res*, 12 (3) (2023) 76-78. DOI: 10.21275/SR23301032233.

32 Palis F G, Singleton G, Sumalde Z & Hossain M, Social and cultural dimensions of rodent pest management, *Integr Zool*, 2 (3) (2007) 174-183. DOI: 10.1111/j.1749-4877.2007.00057.x.

33 Ejiogu A & Okoli V, Bird scaring technologies in rice production: The need for policies prohibiting participation of women and children, *J Food Sci Technol*, 1 (3) (2012) 31-38.

34 Firake D M, Lytan D, Thubru D P, Behere G T, Firake P D, *et al*., Traditional pest management practices and beliefs of different ethnic tribes of Meghalaya, North Eastern Himalaya, *Indian J Hill Farm*, 26 (1) (2013) 58-61.

35 Sachana P C & Bonny B P, Farming among the Attappady tribes of Kerala: A livelihood analysis, PhD Thesis, Department of Agriculture Extension, College of Horticulture, Vellanikkara, Kerala, 2020. Available online: http://hdl.handle.net/123456789/10407 (accessed on 01 March 2024).

36 Hummel H E, Langner S S, Hein D F, Sanguanpong U & Schmutterer H, Unusually versatile plant genus *Azadirachta* with many useful and so far incompletely exploited properties for agriculture, medicine and industry, *Acta Fytotech Zootech*, 18 (5) (2015) 169-175.

37 Usharani K V, Naik D & Manjunatha R L, Neem as an organic plant protectant in agriculture, *J Pharmacogn Phytochem*, 8 (3) (2019) 4176-4184.

38 Devasena M & Sangeetha V, Cow urine: Potential resource for sustainable agriculture, In: *Emerging Issues in Climate Smart Livestock Production*, (Academic Press, London), (2022) 247-262.

39 Patra D & Bharti N, Revitalizing agriculture: Role of cow dung and urine in promoting sustainability, *Bharatiya Krishi Anusandhan Patrika*, 39 (1) (2024) 32-38. DOI: 10.18805/bkap696.

40 Pradhan SS, Verma S, Kumari S & Singh Y, Bio-efficacy of cow urine on crop production: A review, *Int J Chem Stud*, 6 (3) (2018) 298-301.

41 Barman I, Sarma A K & Bora B, Indigenous pest management practices in rice ecosystem of Assam, India, *Indian J Tradit Know*, 23 (12) (2024) 1154-1160. DOI: 10.56042/ijtk.v23i12.15584.