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Scientific rationality and evaluative perception on indigenous plant protection practices on coconut (*Cocos nucifera* L.)

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Abstract

This study documented 116 Indigenous Plant Protection Practices (IPPPs) on coconut in Kerala where in more practices were registered in the technology dimension of 'control of rhinoceros beetle' (23.28 %), followed by general plant protection measures (11.21 %) and control techniques of termites (10.34 %). Of the practices, 75 % belonged to pest management practices, while only 25 % were related to disease management. Out of the 116 practices, 47 were selected for further analysis. Of these 47 practices, 39 practices (82.98 %) were found rational; the underlying scientific rationales/operational principles were also analysed in the study, which revealed the strong scientific base of these practices. However, only nine practices out of the 47 practices were known to more than 50 % of the farmers, reflecting the low level of knowledge of farmers on IPPPs on coconut. Similar was the situation, in the case of adoption. Further, out of the 47 selected practices, eight practices were analysed for their perceived effectiveness and found that six practices (75 %) were found rational and effective. Unraveling the indigenous technical knowledge should therefore be a research priority which in turn would enrich our agricultural technology.

Keywords: Coconut, indigenous technical knowledge, perceived effectiveness, rationality

Introduction

Generally, farmer initiated technology does not occur by accident; there is a farmer based method of research, similar to scientific method. It is concrete and relies strongly on intuition, historical experience and directly perceivable evidences. Indigenous knowledge systems have views different from the conventional modern research practices. Its strategies are totally eco-centric, objective as well as intuitive, and they are derived from practical and innovative life of the generations (Rajagopalan, 2003). The indigenous knowledge systems and technologies are readily available, socially desirable, economically affordable and sustainable and involve minimum risk to rural farmers and producers and above all they are widely believed to conserve resources (Grenier, 1998). Thus indigenous agricultural practices are cost-effective, time-tested, eco-friendly and serve to sustain agricultural development. Hence, there is an urgent necessity to systematically document the indigenous practices in agriculture, before they become extinct. This is much more important in the present context of Intellectual Property Rights regime. Along with its documentation, an in-depth analysis of such knowledge would be of high value. A study in this line would be incomplete, if the researcher fails to make attempts to unravel the rationale underlying the indigenous practices. A deliberate effort to find out scientific rationale behind each indigenous knowledge item would be of great significance. Further, it will be quite interesting and enlightening to know the scientific rationale/principles behind various indigenous practices.

Coconut is one of the major crops of Kerala. With coverage of 781,000 ha, coconut occupies 38 per cent of the net cropped area (Government of Kerala, 2009). Majority of the small farmers' livelihood centres around this crop. It is a traditionally grown crop in Kerala having lot of historical back ground and abundance of customary knowledge and indigenous wisdom (Kumar, 2008). Even

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the name of the state, 'Kerala' was originated from 'kera' meaning coconut. Few researchers (Sulaja, 1999; Swapna, 2003; Sreekumar *et al.*, 2006) have made some partial attempts to document indigenous plant protection practices on coconut in Kerala, but this was with limited geographic coverage and without further analysis.

In this backdrop, the present study was undertaken with the objective of collecting and documenting indigenous plant protection practices (IPPPs) on coconut in Kerala, examining the rationality and scientific rationale behind selected IPPPs, and assessing the extent of knowledge, adoption and evaluative perception of selected IPPPs.

Materials and Methods

The study was conducted in the state of Kerala. For the purpose of research, Kerala has been divided into five agro climatic zones under National Agricultural Research Project (NARP) viz. Southern zone, Central zone, Northern zone, High altitude zone and Problem area zone (Kerala Agricultural University, 1989 and Jose, 2004). Excluding the problem area zone, which is scattered in many districts of Kerala, one district each, from these four agro climatic zones was selected based on larger area under coconut cultivation, higher coconut production, higher per cent of total cropped area under coconut and comparatively wide distribution of coconut crop. Thus four districts out of the fourteen districts of Kerala were selected. From each district, two blocks each having predominant area under coconut were selected, and from each block two village panchayats (grama panchayats) were identified in the same manner. Thus, a total of 16 village panchayats spread over the state of Kerala were selected based on stratified sampling.

From each of the 16 selected village panchayats, 10 aged and experienced farmers were identified through judgement sampling, in consultation with the agricultural extensionists of the concerned local agricultural extension office (Krishi bhavan), thus forming a total of 160 farmers for identifying the indigenous plant protection practices (IPPPs) on coconut.

The IPPPs were collected through informal interview method. Eight PRA sessions were also conducted i.e. two in each of the above agro climatic zones to cross check and refine the collected IPPPs. The main tool adopted was Focused Group Interview, using a semi-structured interview guide. A total of 153 farmers had attended in the eight PRA sessions. Thus a total of 116 indigenous plant protection practices of coconut were collected and documented as part of the study.

In the second phase, rationality analysis of the 47 selected indigenous plant protection practices on coconut was done. Here, rationality refers to the degree to which indigenous plant protection practices can be explained or supported with scientific reasons, or established based on long term experience. Similarly, irrationality refers to the degree to which indigenous plant protection practices can not be explained or supported with scientific reasons, or cannot be established based on long term experience.

For assessing the rationality, the 47 selected IPPPs were administered to scientists, and were asked to state the rationality/irrationality of each of the IPPPs, by rating them on a four point continuum ranging from 4 to 1. The scoring procedure enunciated by Somasundaram (1995) and followed by Rambabu (1997) and Sundaramari (2001) was employed in this study, which is as follows:

Response	Score
Rational based on scientific evidence	4
Rational based on experience	3
Irrational based on experience	2
Irrational based on scientific evidence	1

For the purpose of rationality study, the questionnaires were referred to the scientists of Kerala Agricultural University, Gandhigram Rural University and some ICAR institutes. Except in five cases, the questionnaires were handed over in person explaining the purpose and importance of the analysis, and in five cases, mailed questionnaires were used. A total of 52 plant protection experts (Agricultural entomologists and Plant pathologists) were approached from which 42 questionnaires were received back and finally considered for analysing the rationality. Mean scores were calculated for each of the IPPPs, and those practices having a mean score of 2.5 and above were identified as rational and those below 2.5 were identified as irrational. The IPPPs which secured a score of 3.5 and above were considered highly rational practices.

The operational principles behind the 'IPPPs having rationale' were identified with the help of the scientists while collecting data regarding the rationality. After collecting the information, responses of the scientists were consolidated. Consensus on the scientific principles and logic behind various practices was reached after thorough discussion of the consolidated responses of the scientists in a Scientists' Forum where 19 multidisciplinary scientists mainly comprising of Agricultural entomologists and Plant pathologists participated and deliberated.

In the third phase, the extent of knowledge, extent of adoption and evaluative perception of the IPPPs were assessed using a structured interview schedule. It was proposed to contact randomly five farmers from each of the earlier selected eight blocks in turn forming a sample size of 40 for this phase of the study.

For assessing the extent of knowledge, the farmers were asked appropriate questions in respect of each IPPP so as to identify whether they know each one of the IPPPs. A score of 'one' was assigned if they knew the IPPP and 'zero' if they did not know the IPPP. The practice wise knowledge of farmers was worked out to identify the popular IPPPs as shown below:

$$\text{Practice wise knowledge index} = \frac{\text{Number of farmers who knew the IPPP}}{\text{Total number of farmers}} \times 100$$

Then the IPPPs were categorized, in terms knowledge among farmers, as follows.

Category	Description
Low	IPPPs known to d"33% farmers
Medium	IPPPs known to 34 to 66% farmers
High	IPPPs known to e"67% farmers

Adoption was operationalised, in this study, as whether an individual respondent had practiced ever each of the selected indigenous plant protection practices. The selected IPPPs were explained to the respondents one by one, each time enquiring whether they had adopted the practice in the previous years. If the answer was "Yes", a score of one was assigned and if the answer was "No", zero score was given. The practice wise adoption was worked out so as to identify the adoption level of each IPPP. For this, the scores obtained for an IPPP by all the respondents were summed up and the adoption index was worked out by using the following formula.

$$\text{Practice wise adoption index} = \frac{\text{Number of farmers adopted}}{\text{Number of farmers having applicability}} \times 100$$

The categorization of IPPPs based on adoption was made in the same way, as in the case of knowledge.

The evaluative perception of indigenous plant protection practice was operationalised as the degree of positive outcome obtainable, as perceived by the farmers, by applying the practice, in solving their problems faced in farming. The evaluative perception of indigenous plant protection practices in coconut was measured using the Perceived Effectiveness Index (PEI) methodology developed and used by Sundaramari (2001). The index consisted of 12 traits.

A schedule consisting of the IPPPs and the traits was administered individually to each of the farmer respondents and they were asked to rate the effectiveness of each of the IPPPs, adopted by them in selected crops, against each of the traits on a three point continuum, the points being agree, undecided and disagree with scores of 3, 2 and 1 respectively.

Perceived Effectiveness Index (PEI) was calculated as follows:

$$\text{PEI} = \frac{\sum W_i R_i}{\sum R_i}$$

Where, W_i is the score obtained for the i^{th} trait for an IPPP from a respondent, and R_i is the relevancy weightage for the i^{th} trait.

The PEI computed as above was actually the PEI for a particular IPPP as expressed by an individual respondent. Hence, the PEIs obtained from all the respondents for a particular IPPP were summed up and the mean was worked out. That mean PEI was taken as the Mean perceived effectiveness index (MPEI) for that IPPP.

For the most effective IPPP, the MPEI would be 3 and for the most ineffective IPPP, the MPEI would be 1. An averagely effective IPPP would get a MPEI of 2. Hence, those IPPPs whose MPEIs were greater than 2.00 were considered as effective IPPPs as perceived by the farmers and all others as less effective IPPPs. The IPPPs which secured an MPEI of 2.5 and above were regarded as highly effective.

It could not be expected that the entire sample of respondents would have adopted all the IPPPs selected for this study. At the same time, an IPPP which was adopted by a very few respondents could not be termed as effective even had it been perceived as effective by them. Hence, it was decided to analyze the evaluative perception and to calculate the PEIs only for those IPPPs, which were known to at least 50 per cent of the respondents and adopted by not less than 50 per cent of them having knowledge of the respective IPPPs. Thus, PEIs were worked out only for eight practices as perceived by the farmers who had adopted them.

Results and Discussion

Documentation of IPPPs

In coconut, 116 IPPPs were documented as part of the study. Since it will be elaborate to list all the collected IPPPs here, the technology dimension wise classification of the same is presented in Table 1.

Table 1. Technology dimension wise classification of the documented Indigenous Plant Protection Practices (IPPPs) on coconut

Sl. No.	Technology dimensions	IPPPs No.	%
	Pest management		
1.	PP- General	13	11.21
2.	Rhinoceros beetle	27	23.28
3.	Red palm weevil	11	9.48
4.	Coconut mite	08	6.90
5.	Termites	12	10.34
6.	Rodents	09	07.76
7.	Root grubs	04	03.45
8.	Leaf eating caterpillar	03	02.59
	Disease Management		
10.	Bud rot	08	06.90
11.	Stem bleeding	05	04.31
12.	Root (wilt)	05	04.31
13.	Button shedding	09	07.76
14.	Yellowing	02	01.72
	Total	116	100.00

Table 1 explains the technological dimensions in which more number of IPPPs was available. More IPPPs were registered in the technology dimension of 'control of rhinoceros beetle' (23.28 %), followed by general plant protection measures (11.21 %) and control techniques of termites (10.34 %). Of the IPPPs, 75 % belonged to pest management practices, while only 25 % were related to disease management. This points to the fact that farmers are having more awareness and idea of the pests and their control measures rather than various diseases and their management techniques, may be because of the visibility of majority of the pests to the naked eye while it is not the case of disease causing pathogens.

Scientific rationality of IPPPs on coconut

Forty seven indigenous plant protection practices (IPPPs) were selected for analyzing the rationality. Of these, eight practices were found irrational. The rest 39 practices were adjudged by the scientists as rational. The rationality scores of the practices are presented in Table 2.

Table 2. Scientific rationality of Indigenous Plant Protection Practices (IPPPs) on coconut

IPPP No. and the indigenous plant protection practice	Rationality score(n = 42)
IPPP-1. If we put fire in the field during dusk using dried trashes, fronds and spathes, the pests of coconut palms in the field will be attracted to the fire. So put fire at different locations in the coconut plantation in the interspaces of the palms or in the border region without the heat affecting it.	2.95 (R)
IPPP-2. Putting 'erukku" (*Calotropis gigantea*) leaves & 'ungu' (*Pongamia pinnata*) leaves in coconut basin will reduce pests and diseases.	2.89 (R)
IPPP-3. Coconut husk or spathe is burnt in the pits taken for planting coconut seedlings, once or twice to char the sides of the pit, which prevents termites attack and reduces other pests and diseases.	3.35 (R)
IPPP-4. A method to plug the holes in the trunk of coconut palm naturally – Make small balls using a mixture of coal and sand. On the very next day deposit the balls in the holes tightly, fully covering the holes. Wood inside the hole portion starts to grow, slowly forcing out the coal-sand mixture. The hole will be completely covered with wood within six months period by expelling the coal-sand mixture.	2.00 (IR)
IPPP-5. Leaves of 'karinochi' (*Vitex negundo)* in the Farm yard manure pit destroy grubs of rhinoceros beetle.	3.56 (R)
IPPP-6. While putting cow dung in the Farm yard manure pit, apply salt in between layers, to destroy the grubs of Rhinoceros beetle.	2.93 (R)
IPPP-7. To destroy the grubs of rhinoceros beetle put leaves of 'peruvalam' (*Clerodendrum infortunatum*) in Farm yard manure pits.	3.69 (R)
IPPP-8. Applying the leaves of 'perumaram' (*Ailanthus triphysa*) in Farm yard manure pits keeps away young ones of rhinoceros beetle.	2.89 (R)
IPPP-9. Rhinoceros beetle and Red palm weevil can be effectively managed by a mixture of castor oil cake (250 g) and rice gruel ($^3/_4$ of pot) in 1:8 proportion. They are mixed in a mud pot, and the pot is buried in the soil with its mouth open at the soil level. It is kept in the field for one week, while it gets fermented; it develops a smell which attracts the beetles to the pots, resulting in death of the beetles.	3.15 (R)
IPPP-10. Prepare baits by putting five 'marotti' (jungli badam / *Hydnocarpus pentandra)* seeds in 1 litre of rice gruel and tie it to the lower part of coconut trunk in a container. Adult beetles/weevils will be attracted to the bait and killed or inactivated by the toxin.	3.39 (R)
IPPP11. Applying the mixture of 'marotti' (jungli badam / *Hydnocarpus pentandra)* oil cake and sand in the leaf axils of coconut palm prevents infestation of rhinoceros beetle.	3.20 (R)
IPPP-12. Keeping balls made up of long human hairs in leaf axils of coconut will inactivate the beetles, thus controlling them.	2.56 (R)
IPPP-13. Mix sand with 'chenninayakam' (a product of *Aloe vera*) and dry it. Apply this mixture in the leaf axils of coconut to control beetle/weevil	2.74 (R)
IPPP-14. Application of sand and salt in equal proportion in the leaf axils of coconut during Aug-Sep prevents attack of rhinoceros beetle.	3.02 (R)
IPPP-15. Make a mixture of mud and water and plaster it on the wounds/cut surfaces on the stem to control red palm weevil.	2.58 (R)
IPPP-16. Planting 'maruthu' (*Terminalia cuneata*) in coconut garden reduces infestation of the grubs of red palm weevil and root eating grubs.	2.61 (R)

IPPP-17. Keep flowers of 'chempakam' (*Michelia champaca*) in the bored holes of weevil on the coconut palm to repel their adults.	2.41 (IR)
IPPP-18. Planting 'panikoorkka' (*Pelctranthus amboinicus)* as intercrop in coconut garden will repel rhinoceros beetle and red palm weevil.	2.65 (R)
IPPP-19. Close all the boreholes of red palm weevil, make a new hole above these holes, insert cotton soaked in eucalyptus oil in the new hole and close it with cement. The young ones of the weevil inside the trunk will be destroyed.	2.87 (R)
IPPP-20. Smoke the palms by firing dry leaves, coconut leaves and organic wastes at the base of the palm to control mites.	2.85 (R)
IPPP-21. Apply garlic solution (Grind 20- 30 g of garlic and take the extract in one litre of water) at the bottom of the crown to prevent mites.	2.69 (R)
IPPP-22. To avoid termite attack, sow the seed nuts by exposing its tip portion above the soil.	2.50 (R)
IPPP-23. Application of a handful of crushed fenugreek seeds in the pits at the time of planting will reduce termite infestation.	2.56 (R)
IPPP-24. Swabbing of cashew nut shell liquid at the base of coconut seedlings and leaf base will control termites.	3.60(R)
IPPP-25. Application of salt and ash in the basin will control termites.	2.87 (R)
IPPP-26. Application of leaves of 'karingotta' (*Quassia indica*) and 'kanjiram' (*Strychnos nuxvomica*) in coconut basins will reduce the attack of termites.	2.99 (R)
IPPP-27. Wild arrowroot is planted in coconut garden for preventing /controlling termites.	2.70 (R)
IPPP-28. Spray lime solution on the seedlings so as to prevent termites.	2.63 (R)
IPPP-29. Lime solution is painted on the tree trunk to about 1m from the base to reduce the attack of white ants on the trunk.	3.09 (R)
IPPP-30. Coil the trunk of coconut palm with coconut leaves and bamboo thorn to control problems created by rats and thieves.	3.50 (R)
IPPP-31. At the time of planting coconut seedlings, plant 1-2 tubers of arrowroot in the pit. This will keep away the root grubs and termites.	2.50 (R)
IPPP-32. Planting turmeric along with coconut seedlings will prevent the attack of root grubs and termites.	2.85 (R)
IPPP-33. Plant 'maruthu' (*Terminalia cuneata)* in coconut garden or Use 'maruthu' leaves in coconut basin. This will yield green leaf manure and at the same time will control the attack of root grubs.	2.73 (R)
IPPP-34. Keep a handful of calcium carbonate shell in a fired hearth/chulah, for a day. On the next day, collect the calcium carbonate shell and the ash from the chulah and put the same in the basin of coconut palm. This will control bud rot.	1.81 (IR)
IPPP-35. Put a mixture of salt and ash in the spindle leaf base against bud rot of coconut.	2.56 (R)
IPPP-36. Burning dry coconut leaves near the base of palm helps to control bud rot disease and increase the yield of the palms.	2.10 (IR)
IPPP-37. To control bud rot in coconut, remove the decayed portions (chisel out the rotted portion) in the crown, and apply a mixture of ash and salt in equal proportions.	2.64 (R)
IPPP-38. Applying a mixture of ash, salt and indigo blue (Royal brand blue) in equal quantities is very effective to control bud rot. Liquid blue and salt can also be mixed and applied at the crown for controlling bud rot.	2.56 (R)
IPPP-39. Apply cashew nut shell liquid on the trunk, after cleaning the affected parts, to control stem bleeding.	2.87 (R)
IPPP-40. Apply on the trunk a paste of fresh cow dung and neem cake for stem bleeding of coconut.	2.50 (R)
IPPP-41. Application of neem cake and salt in the basin of coconut palm reduces root (wilt).	2.53 (R)
IPPP-42. Application of 'kanjiram' (*Strychnos nuxvomica*) leaves in coconut basin will control root (wilt).	1.95 (IR)
IPPP-43. Apply crushed small onion (1 kg) and salt (2 kg) in the basin of coconut trees per year to control root (wilt) and nut fall.	1.89 (IR)
IPPP-44. Spray fresh cow urine diluted with 10 times of water in the crown to control button shedding.	2.56 (R)
IPPP-45. Cow urine, if applied in the basin of coconut tree, prevents button shedding.	2.55 (R)
IPPP-46. Basin application of old battery powder mixed with neem cake reduces abnormal nut fall.	1.60 (IR)
IPPP-47. Incorporate chopped banana pseudo stem in coconut basin to reduce button shedding.	2.20 (IR)

R = Rational IR = Irrational

As seen from Table 2, majority (82.98%) of the practices were rational. Of these, IPPP-5, IPPP-7, IPPP-24 and IPPP-30 were found highly rational. At the same time eight practices (IPPP-4, 17, 34, 36, 42, 43, 46 and 47) were found irrational. Putting fire as in IPPP-1 is found rational as the infrared radiation attracts insects especially the newly emerged adults. Fire acts as light trap, and the insects get attracted to fire due to light/ infrared radiation and fall into the fire. Thus, the pests can be controlled to some extent. Rhinoceros beetle, one of the major pests of coconut is attracted to the light especially during rainy season, and hence, this pest can be controlled by adopting this practice during rainy season. Use of 'erukku" (*Calotropis gigantea*) leaves and 'ungu' (*Pongamia pinnata*) leaves in coconut basin will reduce pests and diseases (IPPP-2) as both the plants have antimicrobial and insecticidal properties. They are rich in tannin and phenols inhibitory to grubs and pathogens in soil. *Pongamia* has insecticidal properties and the oil from leaves is a growth inhibitor. *Pongamia* contains alkaloids- karangin, pongamol etc. known to be nematicidal. *Calotropis* contains insect repellent substance- calotropin, an active poison of digitalis type (yellow bitter resin). IPPP-3 is a rational practice as it disinfests the soil borne insect stages, destroys the inoculum of soil borne diseases, and destroys termite galleries if any; while ash acts as a physical poison against termites. Termites, in general, will not cause damage for one year after burning.

Use of leaves of 'karinochi' (*Vitex negundo)* in Farm yard manure (FYM) pit to destroy grubs of rhinoceros beetle (IPPP-5) was rated as rational by the scientists since the leaves and plant parts contain principles /constituents such as eastian, isoerieutin, chrysophenol.D, lutcolin, p-hydroxybenzoic acid and D-fructose which may act as antifeedent and deterrent. Furthermore, the leaves of the plant contain toxic principles *viz.*, terpinyl acetate and diterpene alcohol. Thus, the alkaloids/constituents of the plant give antifeedent, deterrent and repellent effect to the beetles. Application of salt in FYM pit as mentioned in IPPP-6 affects the osmotic balance of grubs of rhinoceros beetle. The principle of exosmosis leads to plasmolysis of the grubs due to highly concentrated salt solution resulting in rupture of skin, loss of water and death of the grubs. But, salt may deteriorate the nutrient status of cow dung.

Keeping a mixture of castor oil cake and rice gruel to control rhinoceros beetle and red palm weevil (IPPP-9) was also found rational. Any fermentation product attracts beetles due to the presence of ethyl alcohol in fermented materials. The attracted beetles are killed due to the toxic principles (mainly ricinin) in castor. The same rationale is applicable to IPPP-10, where 'marotti' seed contains fixed oil containing hydnocarpic acid and chaulmoogric acid. The seed also contains non oxygenated alkaloid wightine and conessine. Altogether this is toxic.

Filling sand mixed with 'chenninayakam' (a product of *Aloe vera*) as in IPPP-13 was also judged as rational. *Aloe vera* solution is gummy and increases aberration property of sand causing severe injuries on the body of beetle/weevil. Filling sand salt mixture to control rhinoceros beetle (IPPP-14) was judged as rational as sand provides a physical barrier and causes aberrations in the neck of rhinoceros beetle, while salt acts as feeding deterrent and causes exosmosis. IPPP-15 acts as a physical barrier to the weevils for oviposition. The weevils are attracted only to the wounds/cut surface on the stem. Regarding IPPP-18, it was stated that 'panikoorkka' (*Pelctranthus amboinicus)* contains insect repellent essential oil- Norcitrate known to be a mosquito repellent (Methoxy 1-4-naphthoquinone).

Cashew nut shell liquid is a rich source of tannins with some anti termite/ repellent/ deterrent property, and hence, its application is good to control termites (IPPP-24). The liquid is vicious and gives a protective coating. It prevents contact of termites with the bark / plant part due to external coating thus acting as a physical barrier. But the practice controls termite only in the applied area. IPPP-26 suggests application of leaves of 'karingotta' (*Quassia indica*) and 'kanjiram' (*Strychnos nuxvomica*) to reduce attack of termites. Both the plants are known to have insecticidal action. Both contain glucosides/ alkaloids toxic to termites. *Quassia* contains quassinoid alkaloids which are insecticidal where as the toxic principle in *Strychnos* is the alkaloid, strychnine. So the practice definitely reduces termite infestation.

Planting wild arrow root in coconut garden (IPPP-27 and 31) is good as its exudates would repel termites and other soil fauna. Lime (IPPP-28 and 29) is also a good repellent of termites. Regarding IPPP-35, ash and salt have some fungicidal properties. It would prevent the growth of the causal organism of bud rot, *Phytophthora palmivora*. The osmotic action of salt would also prevent mycelial growth of the fungus.

IPPP-44 and 45 (Cow urine to prevent button shedding) is again rational with scientific base, as cow urine contains certain growth factors like auxins and micro nutrients. It contains benzoic acid, oxilisic acid, fuluric acid, phenyl acetic acid, p-oxesol and many other constituents. Thus it provides nutrients and plant growth substances, and prevents drop of buttons. But there are many reasons for button shedding other than nutrient deficiency/ imbalance, and hence, the practice may not be effective in all cases.

The IPPP-12 is a good mechanical control measure. Though found rational, it is not practicable for commercial cultivation of coconut. IPPP-20 was also found rational and supported by vast majority of scientists, but some pointed out that there was no evidence of acaricidal effect for smoke. Further, the mites located inside the perianth are not exposed to smoke which may hinder the effectiveness of the practice. IPPP-22 prevents contact of the tender portion of nuts with soil and hence, is a rational practice to control termites. But scientists were of the view that this practice alone is not effective in termite prone areas.

Among IPPPs on coconut, IPPP-4 was stated as irrational since depositing coal sand mixture in the holes was unlikely to stimulate tissue growth in coconut, especially when coconut is a monocot and would not have secondary thickening. IPPP-17 was also rated irrational. Though 'chempakam' (*Michelia champaca*) flowers are having pungent smell and can repel adult insects, it can not repel the grubs inside the bark that is causing damage to the trunk of the palm. IPPP-36 was found to be irrational, since the bud rot pathogen infects the palm at the crown region. However, the practice leads to destruction of resting spores of the pathogen in soil. But it is not practicable during monsoon season, when the chance of infection is more.

Knowledge and adoption of IPPPs on coconut

Indigenous Plant Protection Practices (IPPPs) on coconut were categorized based on the knowledge and adoption of these practices by farmers and the results are presented in Table 3.

Table 3. Categorisation of Indigenous Plant Protection Practices (IPPPs) based on knowledge and adoption

Category	Knowledge	Adoption	Adoption of an IPPP out of farmers having knowledge of the IPPP
Low	29 (61.70)	37 (78.72)	11 (23.40)
Medium	13 (27.66)	10 (21.28)	17 (36.17)
High	05 (10.64)	00 (00.00)	19 (40.43)
Total	47 (100.00)	47 (100.00)	47 (100.00)

Figure in paranthesis is percentage

As evident from Table 3, majority of the practices (61.70 %) were in the low category in respect of knowledge of farmers. Only five practices out of the total 47 IPPPs were known to more than 66 % of the farmers. More than half of the practices (29 items) were known only to less than 33 % of the farmers. This reflects the low level of knowledge of farmers on IPPPs on coconut. This might be because of the dominance of chemical pesticides in use and limited availability of various locally available bio-inputs, and this could have prevented the diffusion of such practices to other locations entailing lesser knowledge of crop protection practices of coconut. Similar is the case of adoption level also. Here also, majority of the practices (78.72 %) were in the low category. None of the practices were in the high category i.e. adopted by more than 66 %. Further analysis of the data collected revealed that only four practices (IPPP-20, 29, 41 and 14) were adopted by more than 50 % of the farmers, while there were 32 practices adopted only by less than 25 % of farmer respondents, of which 15 practices were adopted by 5 % or less of the farmers. There were four practices which were not adopted by even a single farmer though some of them were aware of these practices. Thus, the adoption of IPPPs on coconut was also found low. This might be due to the fact that to put the IPPPs into use various locally available inputs are required, and hence, cannot be practiced in other places where such inputs are not adequately available. The farmers of various locations might have tried different plant protection practices using locally available inputs, say leaves of certain plants that are available in very limited quantities in other locations, and this might have prevented the diffusion and adoption of such practices in other locations.

However, 19 practices were adopted by more than 66 % of the farmers having knowledge about those practices, out of which 8 practices (IPPPs- 17, 41, 31, 25, 32, 20, 6 and 22) were adopted by more than 80 % of the farmers having knowledge of the practices concerned. The practices which are found rational with high knowledge and adoption among farmers are presented in Table 4.

Table 4. Popularity of rational Indigenous Plant Protection Practices (IPPPs) on coconut among farmers

Categories	IPPP No.
Rational with high knowledge	14, 20, 29, 30
Rational with high adoption	NIL
Rational with high adoption among farmers who know the practice	6, 8, 14, 15, 18, 20, 22, 25, 29, 31, 32, 35, 37, 38, 39, 41
Rational with high knowledge, and high adoption among farmers who know the practice	14, 20, 29

As can be seen from Table 4, four practices were rational with high knowledge among farmers, but none of the rational practices were found with high adoption. However, 16 practices were rational with high adoption by the farmers having knowledge of those practices. Of them, IPPP-14, 20 and 29 were found rational with high knowledge and high adoption among farmers who knew the practice. Thus, it can be interpreted that majority of the IPPPs are rational in nature, but with low level of knowledge and adoption amongst the farmers. It is noted here that one IPPP (IPPP- 17) was adopted by 100 % of the farmers having knowledge of the practice, which shows the worth of that practice, but unfortunately this IPPP had been known only to 5 % of the total farmers. It is also to be noted that this IPPP was rated as irrational, and therefore, the said IPPP needs to be subjected to scientific experimentation.

Effectiveness of IPPPs on coconut

It would be illogical to validate many of the indigenous knowledge items in terms of their materialistic effect alone. At the same time, testing the indigenous practices at field level with many variables, some of which are unquantifiable would produce results that would be extremely difficult to interpret and justify. Hence, the effectiveness of the IPPPs, in this study, was analyzed based on their perceived effectiveness index and the rationality score.

The details regarding the practice wise effectiveness of the selected eight practices are furnished in Table 5.

Table 5. Rationality score (R) and Perceived effectiveness index (PEI) of selected Indigenous Plant Protection Practices (IPPPs) on coconut

Sl. No.	IPPP No.	Rationality score	Mean PEI	Remarks
1	IPPP-31	2.95	2.43	R E
2	IPPP-33	3.35	2.10	R E
3	IPPP-44	3.02	2.64	R E
4	IPPP-50	2.85	2.34	R E
5	IPPP-58	2.63	2.08	R E
6	IPPP-59	3.09	2.12	R E
7	IPPP-71	2.53	1.85	R LE
8	IPPP-77	2.20	1.89	IR LE

RE = Rational and effective; R LE = Rational but less effective; IR LE = Irrational and less effective

Table 5 enunciates that out of the eight IPPPs on coconut, one was irrational and less effective practice and another one was rational and less effective, while the rest of the six practices were rational and effective. Of these, high mean PEI value was obtained by IPPP-44. This was rated as a highly effective practice to prevent the attack of rhinoceros beetles, and this practice has now-a-days been recommended by the extension system, which adds validity to this practice. It may be noted that the IPPP-71 which was found rational was perceived to be less effective, as application of neem cake and salt or any soil ameliorant hardly controls root (wilt). However, majority (75%) of the IPPPs analysed were found rational and effective.

Conclusion

Unlike modern technologies, indigenous plant protection practices do not involve hazardous chemicals as they utilize locally available bio resources. Hence, indigenous plant protection practices may be propagated and promoted not only for the benefit of the people but also for maintaining agricultural sustainability and ecological balance. In the present study, majority of the indigenous plant protection practices on coconut are found to be rational and effective and such practices will definitely be valuable, and may be directly recommended for adoption in order to ensure sustainable farming. Such IPPPs could also be taken up for experimentation to integrate them with modern technologies. Though majority of the IPPPs are rational in nature with strong scientific base, farmers' knowledge and adoption of these practices was found very low. The low level of knowledge of indigenous practices points to the fact that the treasure of indigenous knowledge is slowly getting eroded from the minds of the farmers. Hence, efforts to improve the knowledge and adoption of indigenous practices by the farmers may be undertaken which would act as an impetus for promotion of indigenous practices which are eco friendly and conserving natural resources. Further, concerted efforts should be made to collect and document various indigenous knowledge/practices in the field of agriculture, before they become extinct.

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