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Scientific Rationality of Indigenous Plant Protection Practices on Banana *(Musa spp.)* Cultivation

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ABSTRACT

This study documented 75 Indigenous Plant Protection Practices (IPPPs) on banana cultivation in Kerala, India, out of which more practices were reported in the technology dimension of control of pseudostem weevil (29.33%), followed by management of bunchy top (26.67%) and control techniques of rhizome weevil (17.33%). Of the 75 IPPPs, 66.66 per cent belonged to pest management practices, while 33.34 per cent were related to disease management. Of the 19 practices that were selected for in-depth study, 78.95 per cent practices were found rational revealing the strong scientific base of these practices. The scientific rationale/operational principles of these practices elicited from scientists are also explained in this paper. The finding that only two practices (IPPPs-4 and 18) were known to and adopted by 50 per cent or more of the farmers, showed the poor knowledge and adoption levels of farmers regarding IPPPs in banana. The study highlights the significance of documenting and validating indigenous technical knowledge in agriculture, and effectively utilizing this traditional wisdom for enriching sustainable agricultural technologies.

Keywords: Adoption, agricultural practices, banana, indigenous technical knowledge, perceived effectiveness, socio-technical system analysis, traditional.

INTRODUCTION

Indigenous knowledge systems have different views from 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). They are readily available, socially desirable, economically affordable, sustainable, and involve minimum risk to rural farmers and producers. Above all, they are widely believed to conserve resources (Grenier, 1998). These cost-effective, time-tested, and eco-friendly practices sustain agricultural development. Therefore, they should be properly conserved, systematically developed and optimally utilized in order to be handed down to the future generations intact. In the present context of the IPR regime, it is an urgent necessity to systematically document the indigenous practices in agriculture, before they become extinct. Along with its documentation, an in-depth analysis of such knowledge including the rationality and validation studies would also be of high value.

Banana is a traditionally grown major fruit crop of Kerala, with a lot of historical backgrounds, abundance of customary knowledge and traditional wisdom. With an area of 107,816 ha, banana and other plantains occupy the major share of fruit crops cultivated in Kerala (Government of Kerala, 2014). Commercial cultivation of banana has now become common amongst the farmers of the state that many farmers' livelihood is solely dependent on this crop. The earlier attempts to document the Indigenous Technical Knowledge (ITK) on banana cultivation in Kerala (Sulaja, 1999; Bonny, 2001; Swapna, 2003; Husain, 2005; Sreekumar et al. 2006) were either fragmented studies focusing on relatively a small geographical area or didn't attempt to characterize the scientific rationale of the traditional practices. At the same time, Husain and Sundaramari (2011a; 2011b) made comprehensive attempts to analyse the ITKs on coconut cultivation in Kerala. In this line, this study was undertaken with the objectives of collecting and documenting indigenous plant protection practices (IPPPs) on banana cultivation in Kerala. It also analyzed the rationality and scientific logic behind the selected IPPPs and assessed the extent of knowledge, adoption and

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perceived effectiveness of those IPPPs.

METHODOLOGY

One district each from the four major agro-climatic zones of Kerala State viz. Southern zone, Central zone, Northern zone, and High altitude zone, were selected for this study based on the larger area covered under banana. From each of the four districts thus selected, two blocks having banana as the predominant fruit crop were selected. 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 Agricultural Office (Krishi Bhavan), thus forming a total of 160 farmers for identifying the indigenous plant production practices (IPPPs) on banana. The IPPPs were collected through informal interview method. A total of 75 IPPPs on banana were collected. 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.

In the second phase, rationality analysis of the 19 selected IPPPs on banana was done. Here, rationality refers to the degree to which the indigenous practices can be explained or supported with scientific reasons, or established based on long time experience. For assessing the rationality, the selected 19 IPPPs were administered to agricultural scientists, after explaining the purpose and importance of this analysis, 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 followed in this study, which is as follows: Rational based on scientific evidence was given a score of 4, rational based on experience was assigned a score of 3, irrational based on experience and irrational based on scientific evidence were given scores of 2 and 1 respectively.

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 and recorded while collecting data regarding the rationality of the IPPPs from the scientists. A scientists' forum with 19 multidisciplinary scientists mainly comprising of Agricultural entomologists and Plant pathologists was conducted to reach consensus on the operational principles and logic behind various practices, after thorough discussion, and their responses were consolidated.

In the third phase, the extent of knowledge and adoption, and perceived effectiveness of the IPPPs were assessed using a structured interview schedule. Five farmers from each of the earlier selected eight blocks, forming a sample size of 40, were randomly contacted 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:

$$\text{Practice wise knowledge Index} = \frac{\text{Number of farmers who knew the IPPP}}{\text{Total number of farmers}} x100$$

The practice wise knowledge was interpreted after checking if the IPPPS were known to $\geq$ 50 % farmers as follows: If the farmers knew > 80 % IPPPs, the knowledge level was rated as 'very good'. If 60 – 80 % IPPPs were known it was rated 'good' and 40 – 60 % IPPPs known was rated 'medium'. If they knew 20- 40 % IPPPs, the rating was 'low' and knowledge of up to 20 % IPPPs got the rating of 'very low'.

In this study, adoption was operationalised as, whether an individual respondent had practiced ever each of the selected IPPPs. The selected practices were explained to the respondents one by one, each time enquiring whether they had adopted the practice in the previous years. A score of one was assigned to the answer, “Yes”, and zero score was given to the answer, “No”. The practice wise adoption was worked out, for which the scores obtained for an IPPP by all the respondents were summed up and the adoption index was worked out using the formula:

$$\text{Practice wise adoption Index} = \frac{\text{Number of farmers adopted}}{\text{Number of farmers having applicability}} x100$$

The practice wise adoption was interpreted in the same way, as in the case of knowledge.

The perceived effectiveness of IPPPs 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 perceived effectiveness of IPPPs in banana was measured using the Perceived Effectiveness Index (PEI) methodology developed and used by Sundaramari and Ranganathan (2005), which consisted of 12 traits. A schedule consisting of the IPPPs and the traits was administered individually to each of the 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:

$$\text{PEI} = \frac{\sum Wi\ Ri}{\sum Ri}$$

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 PEIs obtained from all the respondents for a particular IPPP were summed up and the mean was worked out as the mean perceived effectiveness index (MPEI) for that IPPP. For the most effective IPPP, the MPEI would be 3.00 and for the most ineffective IPPP, the MPEI would be 1.00. Hence, those IPPPs whose MPEIs were greater than 2.00 were considered as effective IPPPs as perceived by the farmers and all other IPPPs as less effective. The IPPPs which secured an MPEI of 2.5 and above were regarded as highly effective. The perceived effectiveness and the PEIs were calculated 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 two IPPPs on banana as perceived by the farmers who had adopted them.

RESULTS AND DISCUSSION

Documentation of IPPPs

The technology dimension wise classification of the IPPPs on banana presented in Table 1 explains the technological dimensions in which more number of IPPPs were available.

Table 1: Technology dimension wise classification of the documented IPPPs on banana

n=?

Technology dimensions	**IPPPs**	
	No.	**%**
Pest management		
General Plant Protection practices	05	06.67
Rhizome weevil control	13	17.33
Pseudostem weevil control	22	29.33
Control of Other pests	10	13.33
Disease Management		
Bunchy top control	20	26.67
Control of Other diseases	05	06.67
Total	**75**	**100.00**

More IPPPs were registered in the technology dimension of 'control of pseudostem weevil' (29.33%), followed by 'bunchy top' (26.67%) and control techniques of 'rhizome weevil' (17.33%). It is clearly in tune with the major plant protection problems of banana farmers of Kerala, the major one being the pseudostem weevil, followed by the other two. Of the IPPPs, exactly two-third belonged to pest management practices, while only 33.33 per cent were related to disease management. These points to the fact that farmers are having more awareness and idea of the pests and their control measures and are ready to experiment more with control measures of the pests than various diseases and their management techniques. This 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 rationale / principles behind the rational IPPPs on banana

The 19 IPPPs selected for in-depth study, four practices were found irrational. The description of the scientific rationale/operational principles of the rest of the 15 rational practices is presented in Table 2.

Table 2: Scientific rationale behind the rational IPPPs on banana (Musa spp.)

IPPP No.	**Indigenous Practice**	**Rationale**
IPPP-1.	To control rhizome weevil and its grubs, dip suckers for 5 – 6 hrs in running streams or other water sources, 24 hours before planting.	The process washes off the eggs, young grubs and weevils thus reducing the pest load. The weevils might also be killed due to non-availability of oxygen.
IPPP-2	Cool tapioca cooked water and pour it to the base of banana plant intermittently at 2 - 3 leaf stage onwards to control rhizome weevil.	The cooked water of tapioca contains hydrocyanic acid (HCN) which has some insecticidal property. This may have ovicidal action and may be toxic to the grubs and adult weevils too. Furthermore, the starch in cooked tapioca water will form a coating on young grubs.
IPPP-3.	Apply neem cake, coir pith, 'kanjiram' (*Strychnos nux-vomica*) leaves and „ungu/pong?(*Pongamia pinnata*) leaves as basal manure in the banana pit. This will control rhizome weevil.	The leaves of these plants contain insect repellent compounds and alkaloids like strychnine, brucine (in „kanjiram? and karangin, pongamol (in „ungu?), so that subsequent infestation may be prevented.
IPPP-4.	Remove the suckers immediately after harvesting of banana bunches, and apply lime in these pits. This helps to control rhizome weevil.	The practice reduces the chance of secondary infestation and prevents population build up, by preventing breeding of weevils and repels new weevils from oviposition.
IPPP-5.	Putting small pieces of washing soap (bar soap) (50g) into the leaf axils of banana plant helps to control pseudostem weevil during rainy season.	This practice reduces the hiding area for the weevils. Washing soap has germicidal and insecticidal properties and kills the young grubs at pseudostem. It can also deter oviposition.
IPPP-6.	Applying fried fenugreek powder to the leaf axils of banana plant controls pseudostem weevil.	Fenugreek has insecticidal properties and will repel pseudostem weevil. It further acts as a deterrent for oviposition.

IPPP-7	Filling the leaf axils of banana plant with a mixture of salt and ash (1:1) or salt alone or ash alone controls the infestation of pseudostem weevil.	The mixture acts as physical poison reduces the hiding area for the weevils. The salt moving down into the fronds and pseudostem may control the grubs by ex-osmosis. Besides, it may deter egg laying and damage by the weevil.
IPPP-8.	At three months stage, clean the banana plant and paste a mixture of mud and ash (or mud alone) on the pseudostem and close the bored holes, if any, with the same paste to control pseudostem weevil.	The paste of mud and ash acts as a physical barrier and prevents oviposition by weevils.
IPPP-9	Put salt crystals in the bored holes of the pseudostem, after cleaning the banana plant, so as to control pseudostem weevil. After that the boreholes may be closed with clay.	In the initial stages, grubs are confined to outer leaf sheath. Salt may kill the grubs by exosmosis. Furthermore, it deters the weevil from entering and laying eggs in the pseudostem.
IPPP-10.	Growing „thakara?(*Cassia tora*) around the plants will control nematodes attacking banana.	The scientists put forth two different views on this. (a) It acts as a trap crop and attracts nematodes from banana plant. (b) It is known to have anti- nematode properties. It contains a glycoside „emodin?and fragrant oil, which may prevent the infestation by nematodes. The exact reason is yet to be found out.
IPPP-11.	Planting turmeric as an intercrop to plantain helps to prevent pests.	Active principles in turmeric are general pest repellents.
IPPP-12.	Cut the bunchy top affected banana at half height, and apply curd at the cut end in the beginning stage itself. This will arrest the disease.	Irrational
IPPP-13	Applying dry fried fenugreek 5 gms each in the leaf axils is good against bunchy top.	Fenugreek acts as repellent to banana aphids (*Pentalonia nigronervosa*), which spreads the disease, thereby preventing the disease.
IPPP-14	Application of ash on the leaf axils, and pasting ash on the pseudostem of banana will control bunchy top.	Ash acts as physical poison and repellent against aphids, the insect vector of bunchy top disease.
IPPP-15.	Pour diluted cow urine (10 % dilution) in the leaf axil of banana affected with bunchy top; it will rejuvenate.	Irrational
IPPP-16.	Cut away the top half of the bunchy top affected banana plant, before bunch emergence. Make a vertical cut of one „muzham?(approximately 15 cm) through the centre of the cut end of the bottom half. The plant may rejuvenate.	Irrational
IPPP-17.	Apply 1 kg lime/sucker at the time of planting banana to prevent „kokkan? disease (Banana bract mosaic virus).	Irrational
IPPP-18.	For controlling yellowing and to get good bunch weight, application of cow dung solution at the base is good. This may be done from 2 - 3 leaf stage onwards at an interval of one month.	Cow dung solution provides nutrients and enhances microbial activity. The growth factors and nutrients are helpful in improving the general conditions and correcting deficiencies thereby enhancing bunch weight.
IPPP-19.	Grow lemon grass near banana pits to reduce pests and diseases. Alternately, lemon grass is incorporated into the pits used for planting banana as a control measure against pests and diseases. But the suckers are planted only after 3 - 4 days of incorporation.	The essential oil in lemongrass repels pests and reduces diseases since the essential oils have insecticidal and fungicidal properties.

It could be observed from Table 2 that IPPPs-12, 15, 16 and 17 were irrational. IPPP-12 was adjudged irrational because systemic viral diseases cannot be disinfected, and virus affected plants cannot be recovered. But few scientists pointed towards the anti-viral properties of curd, which is yet to be proved and validated. IPPP-15 reduces the population of banana aphid thereby controlling the spread of disease and may give some temporary relief, but the argument that the plant will rejuvenate is unscientific.

The IPPP-16 was also unfounded, and it would only result in disease affected bunch. IPPP-17 is tenuous, since lime does not have proven anti-viral properties. But the practice ameliorates soil conditions, favouring growth of banana plants. Among the rational IPPPs, IPPP-1 enables to reduce the pest load mainly that of the adults, but the grubs may remain inside. Besides, the suckers will become soft by this practice and it may lead to attack of rotting fungi/bacteria. In the case of IPPP-13 and 14, though they were found rational due to the repellent action of fenugreek/ash against the insect vector of bunchy top, bunchy top cannot be cured once the plant is affected.

Practice wise rationality, knowledge and adoption of IPPPs on banana

The rationality, knowledge among farmers, and adoption by farmers of each of the 19 IPPPs selected for further analysis are presented in Table 3. The IPPPs are denoted here by their respective code numbers.

Table 3: Practice wise rationality, knowledge and adoption of IPPPs on banana

IPPP No.	Rationality score (n = 42)	Knowledge in % (n = 40)	Adoption in % (n =40)	Adoption out of farmers having knowledge of the IPPP
IPPP-1	2.76 (R)	17.50	15.00	85.71
IPPP-2	2.59 (R)	17.50	15.00	85.71
IPPP-3	3.08 (R)	27.50	17.50	63.64
IPPP-4	2.98 (R)	60.00	52.50	87.50
IPPP-5	2.59 (R)	27.50	17.50	63.64
IPPP-6	2.53 (R)	25.00	7.50	30.00
IPPP-7	2.63 (R)	35.00	25.00	71.43
IPPP-8	3.06 (R)	25.00	17.50	70.00
IPPP-9	2.58 (R)	27.50	17.50	63.64
IPPP-10	2.77 (R)	10.00	10.00	100.00
IPPP-11	2.73 (R)	40.00	25.00	62.50
IPPP-12	1.73 (IR)	7.50	2.50	33.33
IPPP-13	2.53 (R)	10.00	7.50	75.00
IPPP-14	2.78 (R)	17.50	10.00	57.14
IPPP-15	1.48 (IR)	15.00	7.50	50.00
IPPP-16	1.64 (IR)	7.50	7.50	100.00
IPPP-17	1.74 (IR)	27.50	25.00	90.91
IPPP-18	3.45 (R)	57.50	50.00	86.96
IPPP-19	2.70 (R)	40.00	15.00	37.50

R = Rational; IR= Irrational

Table 3 reveals that, none of the practice was highly rational by registering a score of 3.5 and above. Further, only three IPPPs (IPPP- 18, 3 and 8) could score more than '3'. Thus the IPPPs in general are found less rational. This might be because of the fact that the farmers tried many techniques so as to manage various pests and diseases, which need not be rational in all aspects.

Some of these practices, found as reasonably rational to some extent, might have been transferred to other farmers. This does not mean that these practices are illogical. It is interesting to note that all the irrational IPPPs are related to viral disease control, and these practices were rated as irrational since viral diseases did not have any curative measures according to the scientists. Hence the practices related to control of viral diseases need to be validated through scientific experimentation, as there are no proven measures to cure viral diseases once affected.

Regarding knowledge, 42.10 per cent of the IPPPs in banana were not known to more than 80 per cent of the farmers, and only two IPPPs (IPPPs-4 and 18) were known to more than 50 per cent of the farmers, which shows the poor knowledge level of farmers on indigenous crop protection practices. IPPP-4 deals with control of rhizome weevil, which is a major problem in majority of the banana growing tracts of Kerala. Moreover, this practice is considered by farmers as very effective, and hence the knowledge of this practice has increased. IPPP-18 is a highly rational practice with a rationality score of 3.45, and by applying cow dung as mentioned in the practice, the farmers were obtaining good results, which in turn would have contributed to the higher knowledge level of this practice.

Regarding adoption, only 10.53 per cent of the practices were adopted by more than 50 per cent of the farmers. It is to be noted that the adoption of IPPPs is very less as 73.68 per cent of the IPPPs had not been adopted by more than 80 per cent of the farmers.

However, the adoption level of farmers who were knowledgeable about these IPPPs was found to be comparatively higher. Except two IPPPs, all the other practices recorded 50 per cent or more adoption. There were two practices (IPPP-10 and 16) which registered 100 per cent adoption among knowledgeable farmers.

Practice wise effectiveness of IPPPs on banana

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. Out of the total 19 IPPPs selected, two IPPPs were found to be known to 50 per cent or more of the farmers and adopted by at least 50 per cent of them. The details regarding the effectiveness of these IPPPs are furnished in Table 4.

Table 4: Rationality score (R) and Perceived effectiveness index (PEI) of selected IPPPs on Banana

IPPP No.	Rationality	Mean PEI	Remarks
IPPP-4	2.98	2.66	R E
IPPP-18	3.45	2.22	R E

RE = Rational and effective

As pronounced by Table 4, both of the IPPPs on banana were found effective. This result was supported by the good rationality scores assigned to these practices by the scientists. Hence, these rational and effective practices may be taken for recommendation by the agricultural extensionists.

CONCLUSION

Indigenous plant protection practices do not involve hazardous chemicals as they utilize locally available bioresources. Hence, such practices have to be documented before they become extinct, validated for their effectiveness, propagated and promoted among the end users not only for the benefit of the people but also for maintaining agricultural sustainability and ecological balance. In the present study, majority (78.95%) of the indigenous plant protection practices on banana are found to be rational. Those IPPPs found as rational and effective 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 were found to be 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 that sustain agricultural development. Planners and policy makers have to think of providing support to farmers for adopting selected indigenous technical practices. Further, concerted efforts should be made to collect and document indigenous knowledge/practices in the field of agriculture, before they become extinct.

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