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Scientific rationality, adoption and perceived effectiveness of traditional agricultural practices of cassava (*Manihot esculenta* Crantz.) in Kolli Hills, India

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Abstract

The tribal people of the Kolli hills of Namakkal district in Tamil Nadu, India possess rich cultural-heritage and intuitive knowledge of farming that was inherited through generations. Realizing the importance of utilizing the valuable indigenous knowledge, a systematic study was conducted to identify, document, and analyze the rationality of the Traditional Agricultural Practices (TAP) related to cassava cultivation in Kolli Hills, Tamil Nadu, India. About 17 TAPs on cassava cultivation, were collected from 140 farmers of representative seven cluster villages of Kolli hills. After rigorous screening, 11 TAPs on cassava cultivation comprising production and protection aspects were selected for further analysis. Rationality of 11 TAPs was assessed using a specifically constructed questionnaire from 50 subject matter specialists. The adoption and perceived effectiveness of selected TAPs were also collected from farmers. Of the 11 practices evaluated, seven were rational (63.65%) while the remaining four were rejected as irrational (36.35%). The adoption of rational TAPs ranged from 76.67 to 93.33% indicating wide use of these practices. Among them, field planting of 20 cm length setts (93.33%) vertically (93.33%) within three hours after cutting the stem (90 %) were widely adopted and perceived as effective.

Keywords: Cassava, Indigenous Tribal Agricultural Practices, Tribal farmers, Rationality, Adoption, Perceived effectiveness

Introduction

The tribal communities of India have long conquered the challenges of nature by drawing upon inputs from their local environment to reinvent their agricultural practices to sustain their livelihoods. The challenging environment had helped them to harness their creative wisdom that resulted in valuable agricultural techniques and practices that were nurtured through generations.

At the same time indigenous knowledge in India as elsewhere is in danger of extinction due to modernization of agriculture and globalized economy. Traditional Agricultural Practice (TAP) refers to the traditional agriculture practices, which are carrying over from generation to generation by interaction of members of a social system (Suresh, 2010). Such practices were evolved by the early agriculturists over many generations of trial and error under adverse environmental conditions and with little or no chemical inputs. The TAPs are effective, locally available, relatively cheap and less destructive to local environments. Tribal people are protectors of

indigenous agricultural practices who refined and preserved them in functional form for centuries.

The *Malayali* tribes of Tamil Nadu, who reside mostly in the forest of Kolli Hills in Tamil Nadu, (Fig. 1) have rich cultural and agricultural heritage. *Malayali* is one of the 36 scheduled tribes of Tamil Nadu and the population of Malayali tribes' forms around 54% of total schedule tribes in Kolli Hills. These tribes migrated from the plains of Kancheepuram area of Tamil Nadu and settled in this Eastern Ghat hills during 1960s (Vaidyanathan et al., 2013). On migration, these *Malayali* tribes have brought valuable indigenous knowledge into Kolli Hills and utilized various natural resources in a sustainable way for several years. Several studies have documented the wealth of indigenous agricultural knowledge of *Malayali* tribes and few of them proved their scientific rationality (Rengalakshmi et al., 2002; Vaidyanathan et al., 2013)

In Kolli Hills, cassava is a popular cash crop that constitutes 70% of crop production in the region with over 11129 ha area under cultivation (King et al., 2014). Cassava was traditionally found as wild plant in forests or cultivated in homesteads in the Kolli Hills before becoming a cash crop during 1990s (Rengalakshmi et al., 2002; Vaidyanathan et al., 2013). A section of *Malayali* tribes' still follow traditional cultivation of cassava mostly for household consumption, through majority of the tribe shifted to commercial cultivation. Since these traditional practices are believed to posses relatively unknown scientific principles, there is an immense need to document them and assess their scientific rationality. Several studies have assessed the rationality of Indigenous Technical Knowledge (ITK) or TAPs in *Boro* rice cultivation in Assam (Talukdar et al., 2012), marine fisheries in Karnataka (Vipinkumar et al., 2013), fishery management in Maharashtra (Nirmale et al., 2004) and aquaculture in Assam (Devi et al., 2014). A past work by Anantharaman et al. (1999) was the only effort to document indigenous knowledge related to cassava cultivation and assess their scientific rationality in India. Another research study by Ramanathan and Anantharaman (1998) had reported intensive commercial cultivation of cassava in Kolli Hills, but didn't document any TAP. Assessing the adoption of TAP and their perceived effectiveness among tribal farmers will help to understand the reasons for adoption or over-adoption of those practices. Past studies demonstrated the utility of assessing the users' perceived effectiveness of ITKs in *Boro* rice in Assam (Talukdar et al., 2012) and livestock management in Uttar Pradesh (Singh and Chauhan, 2010). Keeping this in view, an investigation was carried out among *Malayali* tribes of Kolli Hills to document TAPs related to cassava and assess their scientific rationality, level of adoption among tribal farmers and the extent to which they are perceived as effective by the tribal farmers.

Materials and methods

The Kolli Hills are part of low ranging Eastern Ghats, situated in the Namakkal district of Tamil Nadu, India at 11° 10'-11° 30' N latitude and 75° 15'-75° 30' E longitude (Fig. 1). The elevation ranges between 1000 and 1350 meters MSL and the temperature varies between 14°C to 28°C. The average annual rainfall of Kolli Hills is 1440 mm which is fairly distributed over two seasons in year. Dry deciduous forests occupy 44 % of the total geographic area, while farming activities are performed in the remaining area. The soils are deep to very deep, non-calcareous and developed from weathered genesis.

Each village of the settlement is called '*Oor*' and a group of ten to fifteen '*Oor*' clustered together to form a '*Nadu*'. During the first phase of the study, seven Nadu villages clusters were purposively chosen among the total 14 Nadu villages, based on the geographical area covered in agriculture. In each of the selected villages, twenty elderly (> 50 years) and middle aged farmers (>35 years), totaling 140 for all the Nadu villages, were interviewed for collecting TAPs associated with cassava cultivation. Supplementary information was also collected from secondary sources viz., M. S. Swaminathan Research Foundation, Chennai, Tamil Nadu State Department of Agriculture offices in Salem district. To assess the scientific rationality of TAPs, a specifically-constructed questionnaire was presented to 100 subject matter specialists (Horticulturists – 50; Plant protection specialists – 50). The rationality of indigenous technologies was assessed by using the scoring procedure adopted by Husain (2010) with slight modification as presented below in Table.1.

The subject matter specialist responded to each TAP by assigning a score from one to four based on their assessment of its scientific rationality. Seventy nine questionnaires were returned with a response rate of 79%. To find out the rationality of a TAPs, the total and mean

Table.1. Scoring procedure to assess the rationality of indigenous practices

Sl.No.	Responses	Scores
1.	Rational based on scientific evidence from related studies	4
2.	Rational based on logical thinking derived from experience	3
3.	Irrational based on logical thinking derived from experience	2
4.	Irrational based on scientific evidence from related studies	1

scores given by all the specialists to individual TAP was calculated. Based on the mean score, the TAPs were classified into two categories viz., rational (mean score e" 3) and irrational (mean score <3). In this study, scientific rationality refers to the degree to which TAPs can be explained or supported with scientific reasons, or established based on long time experience. Similarly, irrationality refers to the degree to which TAPs cannot be explained or supported with scientific reasons, or cannot be established based on long time experience. Once the technologies were classified into rational or irrational, their adoption and perceive effectiveness were studies using structured interviews. Thirty farmers were randomly selected as respondents for this work. Based on this data, the adoption quotient for each TAP was randomly then the adoption quotient for each individual was worked out by using the following formula (Sundaramari et al., 2003).

$$\text{Adoption Quotient} = \frac{\text{Number of Indigenous Tribal Agricultural Practices adopted}}{\text{Number of Indigenous Tribal Agricultural Practices applicable}} \times 100$$

Based on the adoption quotient values, respondents were classified into low, medium and high by using percentile method.

The perceived effectiveness of each TAP is important for matching farmers' opinion about the TAP with subject matter specialists' views. Sundaramari (2001) defined that Perceived effectiveness of TAP as the degree to which the farmers perceive that a positive outcome is obtainable by applying the TAP in solving the field problems. The perceived effectiveness of TAP on cassava was measured using the Perceived Effectiveness Index (PEI) methodology developed and used by Sundaramari (2001) with modification. The index consisted of 8 traits, which are given in Table.2, with their relevancy weightage.

Table 2. The inventory of 8 traits with their relevancy weightage

Sl. No.	Traits of TAPs	Relevancy Weights
1.	Yields effective results sustainable over a long period	0.86
2.	Satisfies farmers' needs	0.76
3.	Produce easily observable results	0.80
4.	Yields higher cost-benefit ratio	0.88
5.	Acts as an effective alternative to the modern technology/ practice	0.84
6.	Helps to reduce the cost of cultivation	0.85
7.	Easy to understand by other farmers	0.81
8.	Faster adoption	0.72

The farmers were asked to rate each TAP based on these traits, on a three point scale (Agree – 3, Undecided – 2, Disagree – 1). If R1, R2, R3…. R12 were to be the relevancy weights of the twelve traits, then the Perceived Effectiveness Index (PEI) was defined as follows

$$\text{PEI} = \frac{\text{WIR2} + \text{W2R2} + \text{W3R3} + \ldots\ldots\ldots\ldots\ldots + \text{W8R8}}{\text{R1+R2+R3+}\ldots\ldots\ldots\ldots\ldots\text{+R8}}$$

Where, W1, W2……W8 were the scores obtained for the traits for a TAP for a respondent.

To obtain the Mean Perceived Effectiveness Index (MPEI) for a particular TAP, the mean score of PEIs obtained from all the respondents for a particular TAP was calculated. Hence, those TAPs, the MPEIs greater than 2 were considered as effective TAPs and MPEI of 2.5 and above were regarded as highly effective.

Results and Discussion

Documentation of TAPs

A total of 11 TAPs on cassava were collected and classified systematically based two technological dimensions i.e. crop production and protection (Table 3). Among the TAP categories, harvesting (95.3%), processing and storage (93%), planting (87%), intercropping (86%) and crop protection (81.5%) were frequently mentioned by the respondents.

All the TAPs were screened by the research team with the help of subject matter specialists. During the screening, the TAPs that are recommended practice of University/ Research Institution, known facts, less frequently mentioned by the respondents, and perceived as scientifically irrational were removed. A final list of 11 TAPs selected for further assessment is displayed in Table 4.

Rationality analysis

The rationale behind the use of TAPs gathered during investigation was purely based on the respondent's opinion and no attempt was made to influence their view points through

Table 3. Classification of the documented Traditional Agricultural Practices of cassava in Kolli Hills

TAP Categories	Practices under each category	Frequency (%)
Soil and season	2	76.5
Selection of planting material	3	51.5
Planting	3	87
After cultivation practices	1	54
Intercropping	1	86
Manuring	1	73
Crop protection	2	81.5
Harvesting	3	95.3
Processing and storage	1	93
Total	17	

scientific explanation. Therefore, some rationale may be devoid of any scientific background and explanation while some others may be strongly backed by scientific view points and principle. During the rationality analysis, the experts either declared the TAP as rational by supplementing them with scientific facts or declared irrational based on their logical thinking and experience. The TAP-wise rationality scores and underlying scientific rationale behind them as declared by the farmers / explained by experts are presented in Table 4.

Of the 11 practices evaluated, seven were rational (63.65%) while the remaining four were rejected as irrational (36.35%). The experts rated the TAPs rated the selection of healthy setts and planting high (> 3.5) among others. The criteria followed by farmers to select disease free setts were rated high (R=4), followed by vertical planting (R=3.74), using 20 cm sett (R=3.61) and applying neem oil for pest and disease management (R=3.53) were rated high. Cultivating cassava in bench terraces, using shorter internodes setts, storing tubers at 16% moisture and using latex of mango, *Calotropis* and *Jatroph*a as pest repellants were declared irrational by the experts.

Adoption and perceived effectiveness

Data on adoption of TAPs among tribal farmers displayed in Table 5 indicate that all the practices were widely used (>70%).

The adoption of rational TAPs ranged from 76.67 to 93.33% indicating wide use of these practices. Among them, field planting of 20 cm length setts (93.33%) vertically (93.33%) within three hours after cutting the stem (90 %) were widely adopted. All the rational TAPs were perceived effective by the farmers (Range: 2.46 to 2.67) indicating their strong belief in their practice and trustworthiness of the practice. Among them, field planting of 20 cm length setts (MPEI- 2.67) vertically (MPEI - 2.64) within three hours after cutting the stem (MPEI - 2.59) were rated high for their perceived effectiveness. It indicates that these time-tested TAPs are products of intelligent reasoning and practical applications that are evolved through trial and error method that lead to wide acceptance and use (Hunn, 1993).

Though TAP related to planting material and method of planting was practiced traditionally, their rationality has already been established by past studies. Cassava is propagated through stem cuttings and the sprouting capacity depends on the stem age, thickness, number of nodes per cutting, and its size (Lozano et al., 1977). The farmers' practice of using 6-8 cuttings of 20 cm obtained from mature stem, leaving the top tender shoot and woody bottom is an established practice in India (Ravindran et al., 2013) and abroad (Carvahlo et al., 1993). The farmers practice of discarding tender stem is rational as they have high water content and dehydrate rapidly when cut for use as planting material, while the wooden base has lower sprouting capacity (Wargiono et al., 2001). Using longer cuttings produced a fast growing canopy and yielded high than shorter cuttings. Vertical planting was found effective than horizontal planting as it resulted in higher sprouting percentage (88.8%) (Oguzor, 2007), high leaf area index (Abdullahi et al., 2014), yielded more tubers (Breuninge et al., 2009) and produced deeper but compactly arranged tubers (Gurnah, 1974). Compact arrangement helps in easy harvesting and processing. As majority of the *Malayali* tribes cultivate cassava as a cash crop, compact tubers will help to save labor.

The *Malayali* tribes indicated that the cassava setts should be planted within three hours after cutting. In general, the sett viability is directly proportional to its moisture content, hormone content and type. If the setts are stored under high temperatures and low relative humidity, it leads to 20% to 50% reduction in moisture content causing about 50% reduction in viability (Seesahai and Persad, 2011.). Thus, it can be concluded that TAP on sett cutting and planting is rational based on past research work. The farmers' criteria for selecting disease-free planting materials ~~was~~ were found rational and perceived as

Table 4. Scientific rationale of the Traditional Agricultural Practices of cassava in Kolli Hills

S. No	TAPs on Cassava cultivation	Rationality score	Scientific rationale of farmers and experts
A. Crop production			
TAP 1	Cassava is cultivated in bench terrace.	2.45 IR	The farmers used bench terraces in steep slopes, at high altitude areas 1100-1200 m, to prevent soil erosion. But, experts declared it as irrational.
TAP 2	Selection of setts with shorter internodes for planting.	1.97 IR	Farmers prefer 15-20 cm length setts with 5-6 internodes outside, to mitigate drought stress. But, experts declared it as irrational.
TAP 3	Selection of disease-free stems for propagation	4 R	Farmers have rejected the immature and diseased stems/ setts. Stems having leaves with lesions and brown spots are not selected. The experts judged this practice as rational.
TAP 4	The setts should be planted within three hours after cutting.	3.37 R	The farmers believed that if the setts are planted late (three hours after cutting), the germination percentage will be reduced. The experts judged this practice as rational.
TAP 5	About 6-8 cuttings of 20 cm is obtained from mature stem, leaving the top tender shoot and woody bottom	3.61 R	While tender shoots and woody base do not sprout into new plants, a sett size of 20 cm will withstand drought. The experts judged this practice as rational.
TAP 6	The setts are planted vertically at one inch depth in the soil.	3.74 R	Farmers indicated that it facilitates root establishment at the early stages. The experts judged this practice as rational.
TAP 7	The farmers cultivate *Dolichos sp*. as a smoother/cover crop in between the rows as an inter-crop.	3.26 R	It helps in weed control, prevents lodging of crop during heavy winds, and prevents soil erosion by water and augmenting the fertility through N fixation. The experts judged this practice as rational.
TAP 8	Application of pig manure for large tuber size.	2.78 R	Pig manure is rich in potassium which results in faster tuber bulking. The experts judged this practice as rational.
TAP 9	Storage roots are cut and sun dried for a week and stored with 16% of moisture content.	2.13 IR	As the moisture level increases, the roots get spoiled. Since the moisture content exceeds the recommended level of 13%, experts declared it as irrational.
B. Crop protection			
TAP 10	Spraying neem oil mixed with soap solution to control pest and diseases	3.53 R	Neem has pesticidal property. The experts judged this practice as rational.
TAP 11	Using latex of Mango, *Calotropis* and *Jatropha* mixed with hot water (100° C) is used to control aphids and white flies in cassava.	2.29 IR	Farmers believed that *Calotropis* and *Jatropha* have repellent action over sucking pests. But the experts declared this practice as irrational.

Table.4. Farmers rationality, adoption and practice wise perceived effectiveness of TAPs on cassava cultivation as perceived by the farmers (n=30)

S. No	TAPs on cassava cultivation	Rationality	Adoption		Mean MPEI
			No.	%	
A. Crop production					
TAP 1	Cassava is cultivated in bench terrace.	Irrational	24	80.00	2.47 E
TAP 2	Selection of setts with shorter internodes for planting.	Irrational	23	76.67	2.45 E
TAP 3	Selection of disease-free stems for propagation	Rational	25	83.33	2.54 E
TAP 4	The setts should be planted within three hours after cutting.	Rational	27	90.00	2.59 E
TAP 5	About 6-8 cuttings of 20 cm is obtained from mature stem, leaving the top tender shoot and woody bottom	Rational	28	93.33	2.67 E
TAP 6	The setts are planted vertically at one inch depth in the soil.	Rational	28	93.33	2.64 E
TAP 7	The farmers cultivate *Dolichos sp*. as a border crop or intercrop between the rows.	Rational	25	83.33	2.58 E
TAP 8	Application of pig manure for increased storage root size.	Rational	23	76.67	2.46 E
TAP 9	Cassava storage roots are cut and sun dried for a week and stored with 16% of moisture content.	Irrational	26	86.67	2.58 E
B. Crop protection					
TAP 10	Spraying neem oil mixed with soap solution to control pest and diseases	Rational	26	86.67	2.61 E
TAP 11	Using latex of Mango, *Calotropis* and *Jatropha* mixed with hot water (100°C) is used to control aphids and white flies in cassava.	Irrational	22	73.33	2.39 E

effective by fellow farmers. The leaf lesions are developed by leaf spot diseases (Misra, 2008), which result in significant yield loss. The black residues on stem may be sooty mould which indicates a secondary infection. Planting diseased stems reduces the sprouting percentage, which result in significant reduction in tuber yield.

Though intercropping cassava with *Dolichos sp*. as a border crop or intercrop was not researched, it is assumed to increase the soil fertility. As the cassava grows slowly at the initial stages, more field area is exposed to sunlight leading to indiscriminant weed growth. Intercropping of *Dolicos* spp. not only reduces the weed infestation, but also protect soil erosion. Besides, it helps in soil nutrient recycling. A Kenyan field experiment (Karuma et al., 2011) demonstrated that intercropping *Dolichos sp*. with maize has significantly increased maize yield. The soil physical and chemical properties namely the soil moisture content, organic carbon, total nitrogen, penetration resistance and the bulk density were changed to enhance the unit area productivity of the crops.

The soil fertility in Kolli Hills is declining due to continuous monocropping of cash crops, unbalanced cropping systems etc. A survey by MS Swaminathan Research Foundation (Rengalakshmi et al., 2002) has indicated

deficiency of only 3 main macro ingredients – organic carbon, nitrogen and potash. Over the years, the farmers indiscriminately used complex fertilizers, resulting in high phosphorous levels, which suppress other nutrients from reaching the plants (The Hindu, 2012). Since potash is essential for tuber bulking of cassava, the farmers apply pig excreta into cassava crops, which enhance tuber bulking. The *Malayali* farmers grow pigs for meat that are sold mostly in the local or nearby markets (Meghanathan et al., 2010). Applying pig excreta into cassava has not only increased the soil fertility, but also enhanced the productivity.

Neem oil is a widely used bio-pesticide and has antiviral, bactericidal and antifungal action that manages pests and diseases without leaving any residual toxicity. Neem oil based biopesticide was found effective in controlling grasshoppers in Nigeria (Olifa and Adanuga, 1988), spider mites (Gopalakrishnan and Peter, 2007) and mealy bugs (Jayaprakas, 2008) in India.

Interestingly, all TAPs that were declared irrational by the experts like bench terrace cultivation (80 %), using shorter internode setts (76.67%), storing tubers with 16% moisture (86.67%) and using *Calotropis* and *Jatropha* (73.33%) were adopted extensively by the tribal farmers and majority of them were perceived as effective (MPEI >2) (Table 4). This finding shows the widespread ignorance among *Malayali* farmers on specific aspects of scientific cassava cultivation. Therefore, it is necessary to conduct extension campaigns or awareness programmes to explain the scientific irrationality of these TAPs and pursue the farmers to discontinue the TAPs which were irrational.

Limitations of the study

Though this research investigation has several strengths, it has few limitations. Firstly, the TAPs were collected from farmers based on their criteria. Though few practices were perceived as traditional and transmitted over generations, they are already tested through empirical studies. There is a need to follow rigorous screening procedures to collect and assess TAPs. Secondly, this study was conducted on a small sample of cassava farmers among *Malayali* tribes. There is a need to conduct robust surveys on a large sample size to collect TAPs and also assess their adoption and perceived effectiveness in an objective way.

Conclusion

The present study has documented 11 traditional agricultural practices on cassava cultivation from the *Malayali* tribes of Kolli Hills. Majority of the TAPs were adjusted rational by the subject matter specialist, while few of them were rejected as irrational. Though all the rational practices were adopted extensively and perceived as effective, few irrational practices were also followed in a considerable population. Conducting extension campaigns or awareness programmes on irrational TAPs can help the farmers to discontinue these practices and follow more scientific cultivation. Despite the limitations of small sample size and subjective screening, this study has brought few significant TAPs on cassava production which need to be tested and refined.

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