CASSAVA TECHNOLOGY ASSESSMENT AND TRANSFER THROUGH USERS PARTICIPATION IN INDIA

M. Anantharaman[1] and S. Ramanathan[1]

ABSTRACT

Cassava plays a major role in the food security of a large but weaker sector of the population, operating under complex, diverse and risk-prone farming systems. As the crop generally received low priority in the extension agenda of Government policies, direct intervention in the technology assessment and transfer by CTCRI in India was considered necessary. Over the past three decades the transfer of technology (TOT) program has undergone changes in concept and methodology according to changing farmers' needs and socio-economic conditions, presently culminating in the concern for the users rather than the crop.

CTCRI has implemented a series of "Users Participatory Programmes" in assessing and transferring the cassava technology. The assessment of cassava technology was done in various production systems, including hill agriculture, as well as users' categories, including hill tribes. Agro-ecosystem analyses were conducted prior to the assessment of the cassava technologies; these were carried out in stages involving different categories of users. There were differential preferences observed in the various production systems as well as in the users' categories. Trials conducted in the lowland production system indicated that the cassava varieties CI-649 and CI-731 were preferred, while farmers of upland production systems rated CI-732 and CI-649 as the best ones. Differences were also observed in the varietal preferences by various tribal people. The trials clearly indicate that there is a need to develop location-specific as well as user-specific technologies. The TOT programs excuted by CTCRI during the past three decades, namely the National Demonstrations, the Operational Research Project, and the Lab-to-Land Programme, and the impact of these programs are briefly described in the paper. The technology assessment and refinement through the Institution-Village-Linkage Programme (IVLP), a novel concept using a holistic approach, and the current testing and popularizing of cassava varieties in Tamil Nadu are detailed in the paper. The technology transfer is also enhanced through human resources development in participatory training courses and seminars.

The issue of concern is who makes the choices of technology. Normally those least affected by the choice are the ones responsible for determining that choice, while those who are forced to live with the technology have least say in the matter.

- Hoyzer, N.

INTRODUCTION

Cassava is a secondary crop, extending the primary functions of food security and livelihood to a large majority of the weaker sections of the population, operating under complex, diverse, and risk-prone areas(CDR) in many developing countries. In India, more than 90% of the cassava area is in the states of Kerala, Tamil Nadu and Andhra Pradesh (in order of importance) (Lakshmi *et al*., 2000). Cassava is cultivated in various types of production systems, namely, lowland rainfed, upland rainfed and hill agriculture rainfed (by tribals) in Kerala; under rainfed and irrigated conditions in the plains, and rainfed in hill agriculture (by tribals) in Tamil Nadu; in Andhra Pradesh it is grown under rainfed conditions in the plains as well as hill agriculture (by tribals) – indicating a wide range in

[1] Central Tuber Crops Research Institute, Sreekariyam, Thiruvananthapurum – 695017, Kerala, India.

production systems and thereby in the user systems too. While the end-use of roots are for direct consumption in Kerala (> 75% of the production), cassava occupies a different status in terms of value addition in the form of starch and sago in the neighboring states of Tamil Nadu and Andhra Pradesh (Ghosh *et al*., 1988).

Agricultural technology breakthroughs and the resulting success of the green revolution has been restricted to priority crops and privileged farmers growing them in the more favorable areas with well endowed production systems, but did not benefit the less privileged crops like cassava cultivated by less privileged farmers in peripheral/CDR areas. This clearly shows that agricultural technologies are not neutral to the production systems as well as farmer categories. This situation emerges mainly due to a mismatch between the scientist's assumptions and the farmer's expectations on technology requirements. Rural communities have a vast reservoir of expertise in the management of complex agro-ecologies and their associated agricultural and aquatic systems (Farrington and Martin, 1987). Applied agricultural research cannot begin in isolation on an experimental station, out of touch with farmers' conditions (Rhoades and Booth, 1982).

Similarly, transfer of technologies (TOT) cannot isolate the farmers from the extension system. In fact, crops are not automatically transformed into food unless a series of users, i.e. farmers, laborers, farm women, traders and processors, make the product. In practice, this means obtaining information on the production system's complexities, and achieving an understanding of the user's perception of the value of the technology to be assessed and refined; in other words, emphasizing user participation in research and technology assessment and transfer.

CTCRI provides the leadership in user participatory research in cassava technology generation in India. As a crop not appropriately prioritized in the extension agenda of government polices, cassava also requires the direct intervention in the transfer of technology. This paper describes the CTCRI methodology and some of the salient results in the assessment of cassava technology and transfer.

TECHNOLOGY ASSESSMENT

Technology assessment is carried out both on the production and processing fronts adopting User Participatory Research (UPR). UPR is similar to Farmer Participatory Research (FPR) in the concept and procedures, except that it covers a wide range of persons apart from farmers who are involved in an particular enterprise like cassava. FPR is defined by Ashby (1990) as a set of methods designed to enable the farmers to make an active contribution as decision makers in the planning and execution for agricultural technology generation. As far as the production front is concerned, CTCRI concentrates on varietal evaluation, as crop improvement is considered to be the kingpin of agricultural research, and has a direct bearing on productivity improvement. On the processing front, technologies meant for farm, home and cottage-level industries were subjected to assessment by the users. The methodology followed by CTCRI in assessing cassava technology is shown in **Table 1**. The participatory varietal evaluation is done mainly through on-farm trials (OFT), adopting consultative participation of farmers which emphasizes researcher-managed and farmer-implemented trials (Ashby, 1986). The cassava varietal evaluations are undertaken in Kerala, Tamil Nadu and Andhra Pradesh states, covering all the production systems as indicated in **Table 1**. The utilization technologies which are meant for home, farm and cottage-level industries, comprise value-added products and post-harvest equipment. These technologies are assessed using consumer testing and field testing methods, respectively.

Table. 1. Cassava Technology Assessment - CTCRI Methodology.

I	**Production Technology**		
	a) Varietal evaluation		
	1. Mode: On farm trials - Consultative participation of farmers		
	2. Production systems		
		a. Kerala	1. Lowland, Rainfed
			2. Upland, Rainfed
			3. Hill Agriculture, Rainfed
		b. Tamil Nadu	1. Plains, Irrigated
			2. Hill Agriculture, Rainfed
		c. Andhra Pradesh	1. Plains, Rainfed
			2. Hill Agriculture, Rainfed
II	**Utilization Technology**		
	a) Value-added products		
	Mode: Consumer testing		
	b) Postharvest equipment		
	Mode: Field-testing		

Production Technology

1. User participatory cassava varietal evaluation

The steps followed by CTCRI in the user participatory cassava varietal evaluation are shown schematically in **Figure 1**.

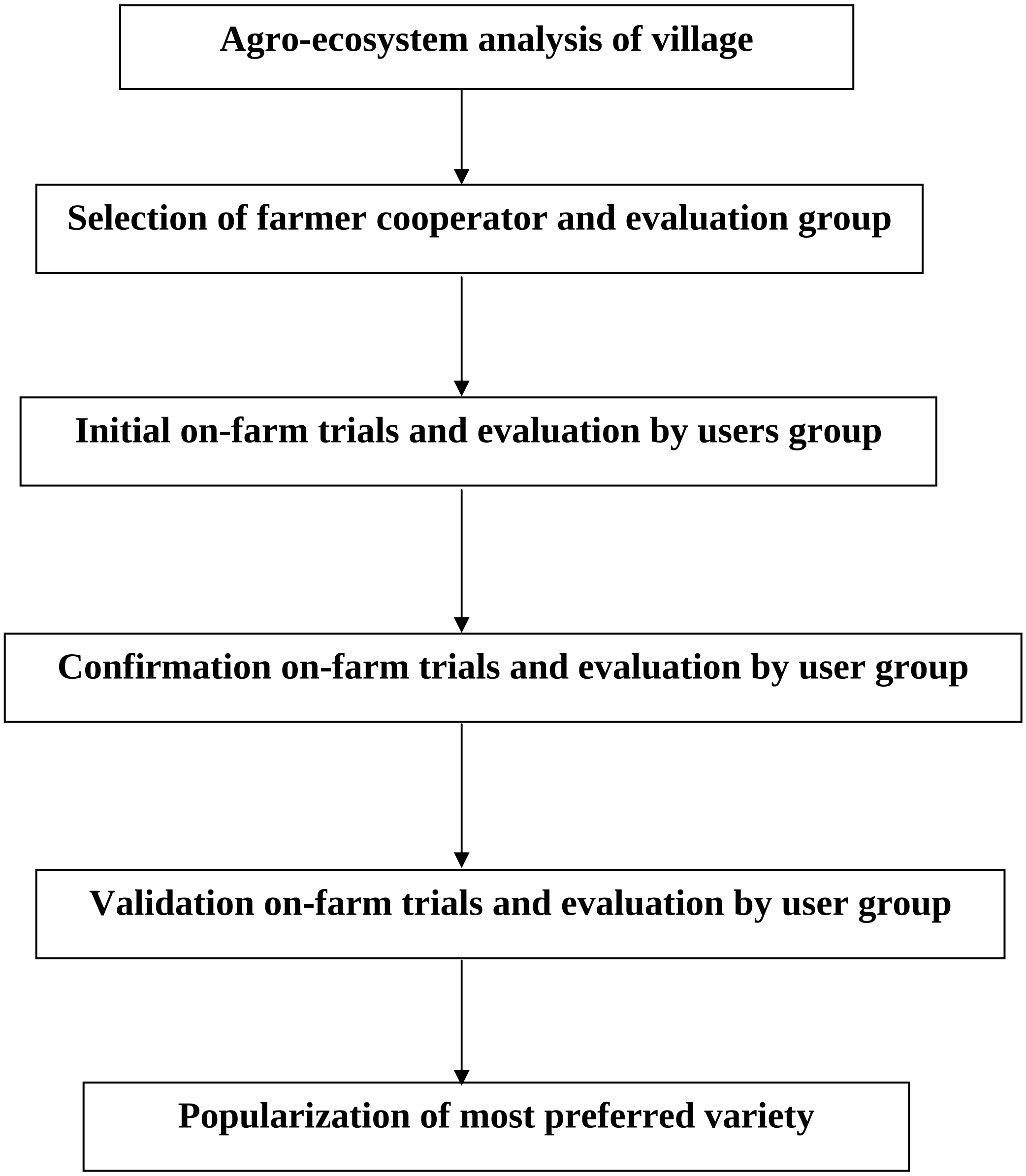


Figure 1. User participatory cassava varietal evaluation.

1.1 Agro-ecosystem analysis

Agro-ecosystem analysis is a technique to analyze an ecological system partially modified by man to produce food, fiber or other agricultural products (Conway *et al*., 1987). Using pattern analysis as a tool, the agro-ecosystem analysis was carried out in a selected village for varietal evaluation. Space, time, flow and decision were considered the major patterns in describing the agro-ecosystem, and were determined using Participatory

Rural Appraisal (PRA) techniques. Results of some of these are presented for the various villages selected in the ensuing pages.

1.2 Selection of cooperator farmers and evaluation groups

One cooperator farmer in each of the villages, selected by the criteria laid out by Ashby (1990), was chosen to conduct an OFT in each of the production systems listed. It was not possible to establish a large number of trials to be used as replications due to the paucity of planting materials and other resources. Instead, groups of various user evaluation categories, such as farmers, farm women and traders, were formed to evaluate a single trial. Each member of the group was considered to be a replication/observation for the purpose of analyzing and interpreting the outcome of the trials.

1.3 Laying out and management of OFT and user's evaluation

Farmer/user evaluation is a subset of these participatory methods. The evaluation methods can be applied at different points (Ashby, 1990). Farmers are involved at three stages of varietal evaluation, namely regional trials, exploratory trials and farmer-managed trials according to Ashby (1987), while Sperling (1995) adopted two stages of evaluation, i.e. on-station and on-farm trials. CTCRI in its varietal evaluation adopted three stages, i.e. initial on-farm trials (IOFT), confirmation on-farm trials (COFT) and validation on-farm trials (VOFT). Considering the ability of the farmers to comprehend as well as their familiarity with the trials, laying out the OFT using a typical design was felt to be difficult under actual field conditions. Hence, a modified completely randomized design was followed to test the cassava varieties in two replications in the IOFT. However, replications were not adopted in hill agriculture production systems in view of the fact that the farmers are tribal, and the terrain highly undulating. The nature and number of varieties in the IOFT were based on the combined decisions of farmers and scientists. The varieties evaluated in the IOFT were screened down to roughly half the number, and carried over to the COFT. The VOFT tested only the best 1 or 2 varieties screened from the COFT. At each stage, the varieties selected and passed on to subsequent trials were left to the discretion of the farmers, based on group consensus. The data were collected using PRA techniques and analyzed using content analysis, ranking, mean scores and analysis of variance.

1.4 Popularization of selected cassava varieties

Both the farmer cooperator and the evaluation group were used for popularizing the varieties based on their own personal experience. They also acted as seed producers *cum* distributors. The spread of the varieties was also studied using PRA techniques.

Following the above-mentioned steps, UPR was undertaken in the various production systems of Kerala, Tamil Nadu and Andhra Pradesh states in India. OFT laid out in Andhra Pradesh are yet to be harvested; hence these results are not presented.

Kerala

1. Lowland rainfed production system

1.1 Agro-ecosystem analysis

Ayanimoodu (Pallichal), a village in the Thiruvananthapuram district, was selected and the agro-ecosystem analysis was conducted. The agro-ecosystem transect of the village is given in **Figure 2**. Cassava is a predominant crop in the lowland production system. The matrix ranking of crops conducted by farmers (**Table 2**) indicates that food security, profitability, risk aversion and marketability are the principal parameters considered by the farmers for crop selection and ranking. It may be observed that cassava was ranked highest for risk aversion and second for food security.

1.2 On-farm trials

The IOFT was conducted on 11 varieties (**Table 3**). The varieties with serial numbers 2, 9 and 10 are landraces, while 1, 4, 8 and 11 are released varieties, and the remaining ones are pre-released ones. The yield performance of the varieties is given in the table. Analysis of variance revealed that there were significant differences in yield among the varieties. The varieties, CI-731, CI-732, CI-649 and H-1687, had significantly higher yields than the other varieties. The roots were evaluated by the users, namely farmers, traders and farm women, and their preferential ranking is also presented in **Table 3**. The Spearman rank correlation indicates that the rank order of varieties between two of the three groups was significant, revealing that there existed concordance among all the three groups. The varieties preferred by the users and selected based on group consensus, namely CI-731, CI-649, CI-732, and CI-664, were forwarded to the COFT. The results of this trial for yield and rank order by the farmers and farm women are presented in **Table 4**. Two varieties, CI-731 and CI-649, clearly emerged as most preferred. It may be noted that CI-731, in spite of its lower yield was preferred because of its other favorable traits like taste, cooking quality and marketability, as is evident from the matrix ranking of varieties by the farmers (**Table 5**). In the VOFT (**Table 6**) which tested two varieties, namely CI-649 and CI-731, the latter was preferred for its root size, shape, uniformity and number.

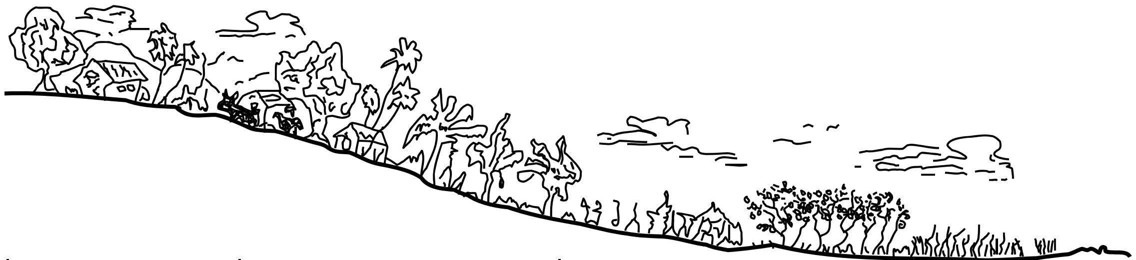
Table 2. Matrix ranking of crops by farmers of Ayanimoodu (Pallichal) village in a lowland rainfed production system in Kerala, India, in 1995.

Character	Paddy	Cassava	Coconut	Banana	Vegetables
Food security	1	2	5	3	4
Profitability	5	4	3	2	1
Risk aversion	4	1	2	3	5
Marketability	4	5	3	2	1

Source: *Anantharaman et al., 1995.*

1.3 Popularization of the most preferred variety

The dissemination effect of the variety CI-731 was assessed in the village. It was estimated from a link source that the variety went from ten farmers after the first year of the IOFT to 30 farmers in the second year. Key informant interviews and direct observation also indicated that nearly 70% of the farmers were cultivating the variety CI-731 in 50% of the area by the third year.



Land type	Upland	Lowland
Soil type	Red laterite	Clayey loam
Trees	Mango, jack fruit, tamarind	-
Crops	Coconut, pepper, cassava, banana	Banana, vegetables (cowpea, bitter gourd, snake gourd, greens, cucumber), paddy, cassava, Colocasia
Irrigation	Rainfed	Tanks, canals
Livestock	Cows, buffaloes, goats, poultry	-
Pests and diseases	CMD, coconut mites	CMD, rice bug, stemboror, aphids, fruit flies, pod-borer, pseudostem weevil, rhizome weevil

Figure 2. Agro-ecosystem transect of Ayanimoodu (Pallichal), village, Thiruvananthapuram district, Kerala, India.

Table 3. Initial on-farm trials on varieties at Ayanimoodu village, Kerala, India, in 1995.

Variety	Yield (t/ha)	User evaluation rank order		
		Farmers	Traders	Farm women
1. H-1687	32.00a	7	8.5	10
2. Karunkannan	26.52b	4.5	7	7
3. CI -664	23.64c	6	4.5	2.5
4. S-856	26.57b	9	10.5	9
5. CI-731	32.73a	1	1.5	1
6. CI-649	32.15a	2	4.5	4.5
7. CI-732	32.51a	3	1.5	2.5
8. M-4	22.65c	10	8.5	4.5
9. Mankozhunthan	23.65c	8	4.5	8
10.Kariyilaporiyan	20.88c	4.5	4.5	6
11.H-2304	17.73d	11	10.5	11
Analysis of variance	**			
F value	108.56	-	-	-
CD	2.55	-	-	-

Degree of agreement: Farmers and Traders 0.86^{**}
Farmers and Farm women 0.76^{**}
Traders and Farm women 0.83^{**}

Varietal yield performance based on CD: values followed by the same better are statistically not significantly different.

Source: *Anantharaman et al., 1995.*

Table.4. Confirmation on-farm trials on varieties at Ayanimoodu village, Kerala, India, in 1996.

Variety	Yield (t/ha)	Rank order	
		Farmers	Farm women
CI-664	24.14	2	3
CI-649	28.93	3.5	2
CI-731	23.14	1	1
CI-732	26.04	3.5	4

Source: *Anantharaman et al., 1996.*

Table. 5. Matrix ranking of varieties by farmers at Ayanimoodu village, Kerala, India, in 1996.

Character	Variety			
	CI-664	CI-649	CI-731	CI-732
Yield	3	1	4	2
Taste	2	3	1	4
Cooking	3	2	1	4
Marketing	3	2	1	4
Starch	3	2	4	4

Source: *Anantharaman et al., 1996.*

Table 6. Validation on-farm trials on two selected varieties at Ayanimoodu village, Kerala, India, in 1997.

Evaluation criterion	Variety	
	CI-649	CI-731
Yield (t/ha)	34.5	29.5
Root size	2	1
Root shape	2	1
Root number uniformity	2	1
Starch content	1	2
Overall preference	2	1

Source: *Anantharaman et al., 1997.*

2. Upland rainfed production system

The farmer participatory cassava varietal evaluation was done in Kodankara village of Thiruvananthapuram district.

Ten varieties were tested in the IOFT. Yields and farmer preferential ranking are presented in **Table 7**. CI-732 gave the highest yield of 28 t/ha. The analysis of variance showed significant differences in yield due to varieties. Varieties CI-732, CI-731, S-856, CI-664, Mankozhunthan, H-1687, and CI-649 were significantly superior in yield to the others. The preferential ranking by the farmers indicate that CI-732 was preferred most, followed by CI-731, CI-649, and CI-664. All the four were carried forward to the COFT. The farmer participatory evaluation of the COFT revealed that CI-732 was again the most preferred variety, followed by CI-664, CI-649 and CI-731 (**Table 8**). However, the highest yield was produced by CI-649 at 28.5 t/ha. Farmers considered eight characters in arriving at the preferential ranking of varieties as is evident from **Table 9**. They are root size, shape, uniformity, number, color, starch content, taste and marketability. CI-732 secured first rank for size, starch and marketability. As there were four varieties, paired ranking was also used to pinpoint the most preferred variety (**Table 10**); CI-732 outranked the remaining varieties. Three varieties, namely CI-732, CI-649 and CI-731, were tested in the

VOFT, and the user evaluation indicated high preference for CI-732 for its starch content and root size (**Table 11**). Key informant sources showed that CI-732 had been adopted by 30% of the farmers in the village.

Table 7. Initial on-farm trials on varieties at Kodankara village in an upland rainfed production system in Kerala, India, in 1996.

Variety no.	Variety	Yield (t/ha)	Farmers' preferential ranking
1	H-1687	23.25abcde	7
2.	Karunkannan	20.15cdefg	9
3.	CI-664	27.90ab	4
4.	S-856	26.67abc	8
5.	CI-731	18.21defg	2
6.	CI-649	22.32abcdef	3
7.	CI-732	29.45a	1
8.	M-4	13.07g	10
9.	Mankozhunthan	24.80abcd	6
10	Kariyilaporiyan	18.60defg	5

F Value: 11.55** CD: 7.39

Varietal performance based on CD: values followed by the same letter are statistically not significantly different

Source: *Anantharaman et al., 1996.*

Table 8. Confirmation on-farm trials on varieties at Kodankara village, Kerala, India, in 1997.

Variety no.	Variety	Yield (t/ha)	Farmers'preferential ranking
1.	CI-664	26.66	2
2.	CI-731	21.70	4
3.	CI-732	24.80	1
4.	CI-649	28.52	3

Source: *Anantharaman et al., 1997.*

Table 9. Matrix ranking of varieties in confirmation on-farm trials at Kodankara village, Kerala, India, in 1997.

Variety	Size	Shape	Uniformity	Root no.	Color	Starch content	Taste	Marketing
1.CI-731	3	1	1	1	2	4	1	2
2.CI-664	4	4	1	1	3	3	3	4
3.CI-732	1	2	3	3	4	1	1	1
4.CI-648	2	3	4	4	1	2	4	3

Source: *Anantharaman et al., 1997.*

Table 10. Paired ranking for varieties in confirmation on-farm trials at Kodankara village, Kerala, India, in 1997.

Varieties paired	Preferred	Rank
731 and 664	731	732 (1)
731 and 732	732	731 (2)
731 and 649	731	649 (3)
664 and 732	732	664 (4)
664 and 649	649	-
732 and 649	732	-

Source: *Anantharaman et al., 1997.*

Table 11. Results on yield and character preference of three varieties by farmers in validation on-farm trials at Kodangara village, Kerala, India in 1998.

Character no.	Evaluation criteria	Variety		
		CI-732	CI-649	CI-731
1.	Yield (t/ha)	27.15	29.76	23.86
2.	Root size	2	1	3
3.	Root shape	1	3	2
4.	Root number	2	3	1
5.	Root uniformity	3	2	1
6.	Starch content	1	2	3
7.	Overall preference	1	2	3

Source: *Anantharaman et al., 1998.*

3. Rainfed hill agriculture production system

Chinnaparakudi, a tribal settlement in Idukki district, known for its tribal population and hill eco-system was selected to assess cassava varieties suitable for hill agriculture. Mannan, the dominant tribe in these hills, is tradition-bound and one of the oldest tribal groups inhabiting this settlement. Even though cassava was introduced to this settlement as recently as four decades ago, it plays a significant role in the livelihood of the tribe. An agro-ecosystem analysis showed that this settlement is rich in cassava varietal diversity. More than ten cultivars were found to be cultivated in this small settlement (**Table 12**).

The IOFT was conducted with ten cassava varieties. High variability was observed in the yield of the different varieties, ranging from 6 to 33 t/ha (**Table 13**). This may be due to the undulating terrain and losses by damage from wild pigs. Preferential ranking of the varieties on root characteristics and taste was made by a group of tribals. There were differences observed in the ranking of varieties in relation to root characteristics and taste. However, S-856, CI-649, CI-731 did not exhibit much difference in rank for these traits. The varieties selected, based on group consensus for forwarding to the COFT, were S-856, H-165, H-97, CI-649 and CI-731. The COFT has yet to be carried out.

Table 12. Special characteristics of local cassava varieties grown by farmers of the tribal settlement of Chinnaparakudi, Kerala under a rainfed hill agriculture production system.

No.	Local name of variety	Special characteristics
1.	Ceylon Kappa	Good taste, non-bitter, suitable for raw consumption
2.	Kanthari Padappan	Non-bitter, suitable for raw consumption
3.	Arimanian	Non-bitter, suitable for raw consumption
4.	Ambakadan	Good yield, suitable for raw consumption
5.	Raman Thalai	Good yield, high starch, suitable for raw consumption and for parboiling
6.	Malabar Kattan	Bitter, high starch, used in large-scale parboiling, less susceptible to wild pig damage
7.	Vella Thundan	Non-bitter
8.	Pathinettu	High starch, suitable for parboiling
9.	Mullan Thalayan	Good taste
10.	Etha Kappa	Non-bitter, good cooking quality

Source: *Anantharaman and Ramanathan, 1996.*

Table 13. Yield, root and taste preference of cassava varieties in initial on-farm trials at Chinnaparakudi tribal settlement, Kerala, India, in 1997.

No.	Variety	Preferential rank		Yield (t/ha)
		Root (yield)	Taste	
1.	H-165	2	8	21
2.	S-856	1	1	33
3.	CI-649	3	6	6
4.	CI731	3	4	9
5.	H-1687	5	2	7
6.	H-226	3	7	13
7.	H-2304	6	5	13
8.	H-97	4	3	6
9.	M-4	4	3	6
10.	Local (Kattan)	3	10	13

Group consensus: S-856>H-165>H-97 >CI-649>CI-731

Source: *Anantharaman and Ramanathan, 1997.*

Tamil Nadu

1. Irrigated production system

Cassava under an irrigated production system is very prevalent in Salem, Namakal, Erode, Dharmapuri and Cuddlore districts of Tamil Nadu. Kalichettipatti village of Namakal district was selected for evaluation under the irrigated production system. Six varieties were tried in the IOFT, of which H-165 and H-226 were found to be most popular in the locality (**Table 14**). H-165 gave the highest yield of 38 t/ha. The farmer evaluators selected all the varieties except H-2304 to evaluate in the COFT which was in progress at the time of this report.

Table 14. Initial on-farm trials on varieties in an irrigated production system at Kalichettipatti village, Tamil Nadu, India, in 1999.

No.	Variety	Yield (t/ha)
1.	H-165	38.0
2.	CI-649	35.5
3.	H-226	28.7
4.	H-2304	16.7
5.	H-97	32.2
6.	CI-731	23.0

Source: *Edison et al., 2000.*

2. Rainfed hill agriculture production system

Kolli hills, also located in Namakal district, are of historical importance and are rich in medicinal herbs and in traditional medical practitioners. It was selected as representative of the rainfed hill agriculture production system in Tamil Nadu. These beautiful hills are situated at an altitude of 1,200 m. The brilliant greenery from its vast stretches of cassava fields on Kolli hills bestows a gratifying experience to any cassava researcher. Cassava, a crop introduced during the early eighties, dominates Kolli hills in terms of cultivated area, and is a major socio-economic determinant in the livelihood of the Malai Gounder tribes (**Figures 3** and **4**). Almost the entire cassava area (of 8,000 ha) in Kolli hills is occupied by a single variety from CTCRI, namely, H-165. Thengottupatti village was selected for the cassava varietal evaluation. The agro-ecosystem transect is given in **Figure 5**. The IOFT was carried out with four varieties, including the popular variety H-165 (**Table 15**). S-856 gave the highest yield, but not much different from that of H-165. Both these varieties were ranked the same by the group of farmers, and were followed by CI-649 and CI-731. The positive and negative aspects of the varieties as evaluated by the tribal farmers are given in **Table 16**. H-165 has many positive traits, whereas S-856 was rated high for starch, yield and shape, but had negative aspects such as knots and fiber in the roots. Farmers selected S-856 and H-165 for inclusion in the COFT.

UTILIZATION TECHNOLOGIES

The UPR on processing technologies was primarily conducted for those technologies to be considered for transfer to the home, farm and cottage-level industries. The technologies assessed may be broadly classified as value-added food products and small pre- and post-harvest equipment.

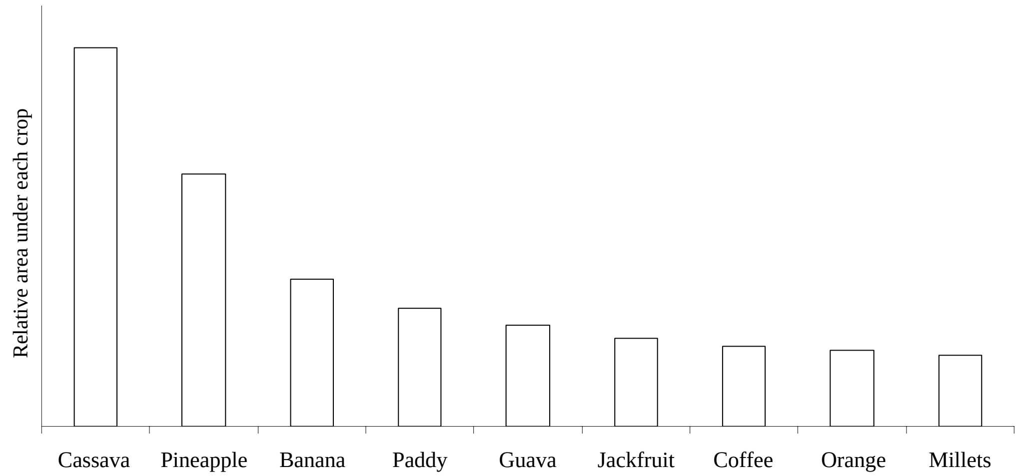


Figure 3. Area under crops (farmers' relative perception diagram) in a rainfed hill agriculture production system at the Thengottupatti village, Kolli Hills, Tamil Nadu, India, in 1997.

Table 15. Preferential ranking and yield of varieties in initial on-farm trials at Thengottupatti village, Tamil Nadu, India, in 1997.

Variety	Rank	Yield t/ha
H-165	1.5	30.0
S-856	1.5	31.0
CI-649	3	27.0
CI-731	4	24.0

Source: *Anantharaman and Ramanathan, 1997.*

Table 16. Positive and negative aspects of varieties as perceived by tribal farmers at Thengottupatti village, Tamil Nadu, India, in 1997.

Variety	Positive characters	Negative characters
H-165	Size, Shape, Starch, Uniformity, Number, Market value, Yield, Non- fibrous, Hardy stems	Nil
H-856	Starch, Yield, Shape, Size, Color	Knots, Fiber
CI-649	Size, Starch, Color	Yield, Number, Fiber, Short
CI-731	Size, Shape	Yield, Color, Knots, Fiber, Less market

Source: *Anantharaman and Ramanathan, 1997.*

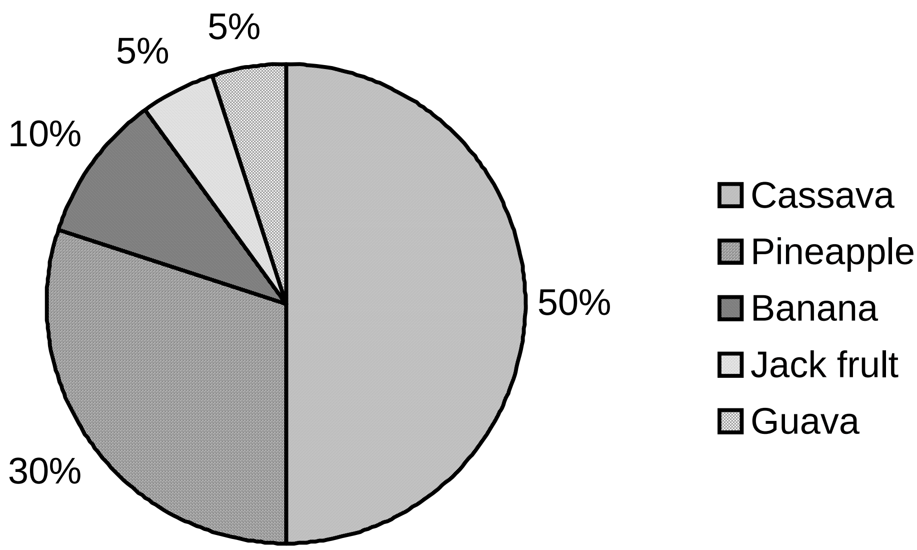


Figure 4. Livelihood income from various crop enterprises in Thengottupatti village, Kolli Hills, Tamil Nadu, India. (farmers' perception)

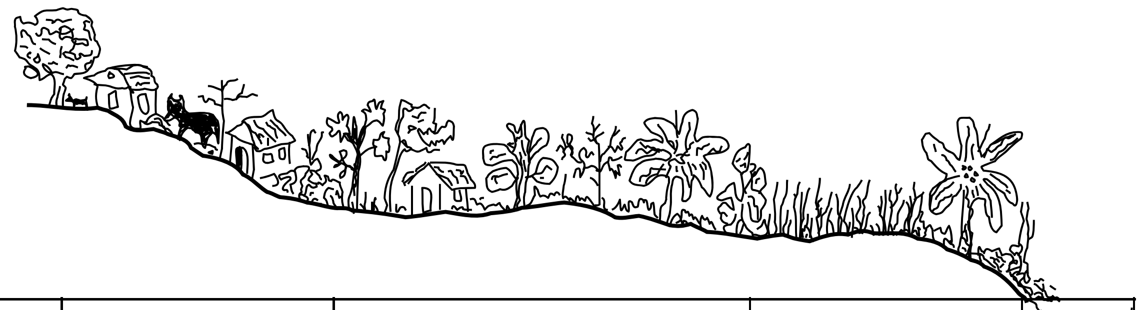
Value-added Products

1. Cassava semolina

Consumer testing was done with randomly selected respondents from among consumers who purchased cassava semolina from the CTCRI exhibition stalls. Data were collected by means of a structured mailed questionnaire on selected testing criteria using a Hedonic scale. The method of preparation of the recipes from semolina was demonstrated at the stall as well as described on the packets and distributed printed folders (Anantharaman and Balagopalan, 1996). Results are presented in **Table 17**. The majority of the consumers expressed an overall satisfaction with the product, showing their acceptance of such parameters as color, consistency, ease in cooking and taste. As far as inclination to purchase was concerned, 53% of the consumers expressed an interest to buy the product in the open market. The step-wise regression carried out indicated that comparative assessment, consistency and taste significantly explained the variation in the overall satisfaction, whereas comparative assessment, taste and ease in cooking influenced the purchase inclination of the consumers. Marketing depends very much on a competitive price of this product.

2. Cassava porridge

The method of consumer testing followed was that of cassava semolina. Ease in cooking, color, comparative assessment and aroma of the cassava porridge were rated



Land type	High uplands	Mid uplands	Lowlands	River
Soil type	Red, Rocky	Red, loamy	Black, clayey	
Water resources	Springs	Rainfed	Rainfed, flood depressions	River
Crops	Coffee, citrus, pepper, guava, pineapple	Cassava, pineapple, banana, millet, sweetpotato	Paddy, banana	-
Trees	Jackfruit, mango, orange, silver oak, konnai	Jackfruit, mango	-	-
Livestock	Sheep, cows, buffaloes, poultry	Sheep, cows, buffaloes, poultry	-	-
Pest and diseases	-	Wilt, bunchy top	Hoppers, rice bug	-
Problems	-	Lack of irrigation, middle man problem in cassava, yield decrease in cassava	-	-

Figure 5. Agro-ecosystem transect of Thengottupatti village, Kolli Hills, Tamil Nadu, India.

higher than the other parameters, and it was observed that more than 80% of the consumers expressed their satisfaction over the product (**Table 17**). However, a relatively lower proportion (56%) had an inclination to purchase the product.

Table 17. Distribution of consumers for acceptance/satisfaction (%) and purchase orientation in consumer testing of value-added products (cassava semolina and cassava porridge).

Parameter	Semolina			Porridge		
	Acceptance/ satisfaction	MS*	Rank	Acceptance/ satisfaction	MS	Rank
1. Color	89.04	3.98	1	84.21	4.05	2
2. Taste	72.73	3.78	4	84.21	3.73	5
3. Aroma	49.09	3.47	5	78.17	3.80	4
4. Consistency	86.45	3.94	2	72.53	3.58	7
5. Ease in cooking	81.82	3.90	3	100.00	4.47	1
6. Fuel consumption	10.91	3.05	7	51.12	3.63	6
7. Comparative assessment	50.90	3.27	6	76.38	3.92	3
Overall satisfaction	54.55	3.43	-	82.97	3.89	-
Purchase orientation	52.73	2.41	-	56.00	3.25	-

*MS = Mean Score

Source: *Anantharaman and Balagopalan, 1996.*

Pre- and Post-harvest Small Equipment

1. Hand-operated chipping machine

The machine was field tested in five villages in Kerala and Tamil Nadu where cassava roots are converted to chips. Evaluation of the machine was done by keeping the machine in each village to allow the users to operate it. Responses were collected on 17 characters categorized under four factors, namely, operation, productivity, cost and maintenance (Nanda, 1987). The machine was well received by the farmers with an average rate of adaptability of 81.2%. The characters found favorable to acceptance were overall skill required for operation, convenience in loading, operating cost and method of removal and refitting of blades, whereas the characters initial cost, broken produce and inclination to purchase were deemed unfavorable. It may be noted that this technology, although a mechanical contrivance, was kept simple to transfer and easy to manage.

2. Pedal-operated chipping machine

The machine was assessed in six villages in Kerala and Tamil Nadu, by using a structured interview schedule with a five-point rating scale for 30 characters (Sheriff and Kurup, 1997). The field-testing indicated that the items favorable were convenience in loading, thickness, shape and uniformity of chips and trimming facility. The characters which were not favored by the farmers were initial cost, broken produce and inclination to purchase.

3. Cassava harvesting tool

The harvesting tool was field evaluated in six villages in Kerala and Tamil Nadu with a five-point rating scale for 20 characters. The results showed that the characters appropriateness to socio-economic status and superiority over traditional pulling were highly correlated with overall performance, farmers' liking and willingness to purchase (Sheriff and Kurup, 1997). Effort in lifting the tool, breakdown of the tool and cost of purchase were negatively associated with willingness to purchase. The mean values of quality of the roots and quantity left in the soil were rated favorable for the harvester.

TECHNOLOGY TRANSFER

TOT is a process by which viable technologies developed and perfected at research institutes are transmitted to the farming community and other users through strategic programs and appropriate methods. CTCRI has taken the lead in formulating and implementing TOT strategies for cassava in India. The TOT model followed by CTCRI is depicted in **Figure 6**. CTCRI transfers technologies directly to the user system through on-farm research mainly on cassava varieties, field-oriented outreach programs, and by various extension methods, such as training, exhibitions, demonstrations, etc., and indirectly through close liaison with the Departments of Agriculture/Horticulture of various states, and with NGOs. The linkage with the various departments and NGOs are through training programs organized for extension personnel, seminars, workshops and seed multiplication programs. The department in turn transfers the technologies through training programs for the farmers, demonstrations, mass media, etc. to the user system.

Outreach Programs of CTCRI

CTCRI has adopted various field-oriented outreach programs to transfer cassava technologies (**Table 18**).

1. National demonstrations (ND)

National demonstration (ND) on cassava was the pioneering attempt to transfer cassava technologies on a specific program basis during the early seventies (1970-74). The main concept under ND was unless scientists demonstrate the technologies in the farmers' fields their advice may not be accepted by the farmers. Also, the demonstration plot should be sufficiently large so that the feasibility of raising a good crop can be strikingly and unquestionably demonstrated. In total, 27 NDs were conducted on high-yielding varieties of cassava, i.e. H-97, H-165 and H-226, by scientists in cooperation with local extension agents and farmers in four states, Kerala (23 NDs), Tamil Nadu (2), Andhra Pradesh (1) and Karnataka (1). The demonstrations have convinced farmers that high-yielding cassava varieties were able to produce as much as 40 t/ha. As a result of the proven potentialities, there was a great demand for planting material, especially in Tamil Nadu. A beginning on the dissemination of high-yielding cassava varieties was made due to ND.

2. Operational research projects (ORP)

This program was in operation during 1976-1980 in a village called Vattiyoorkavu in Thiruvananthapuram district of Kerala. The main theme of the program was to

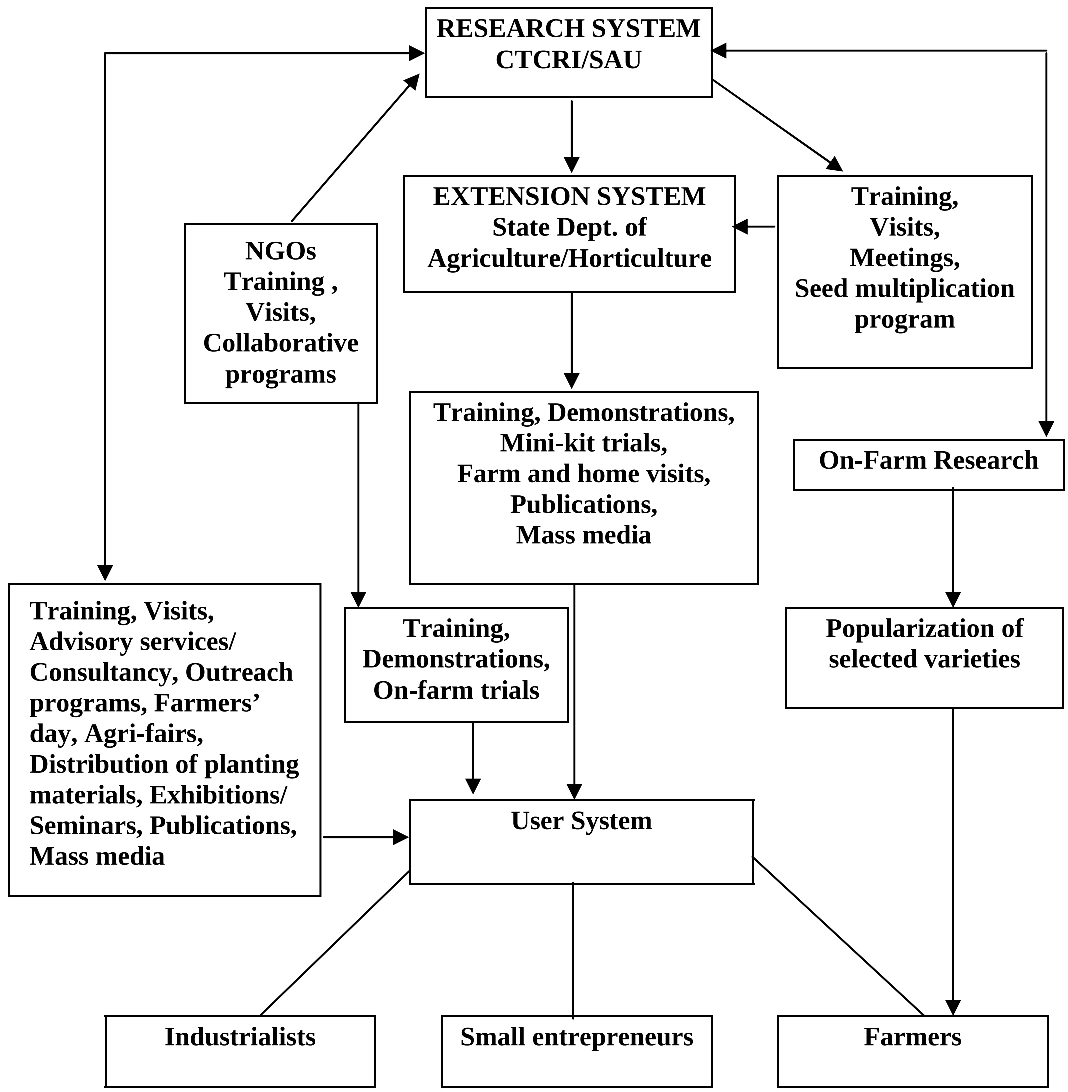


Figure 6. Technology transfer system for cassava in India.

Table 18. Types of outreach programs in India since 1970.

1.	National Demonstrations	1970-1974
2.	Operational Research Project	1976-1981
3.	Lab to Land Program	1978-1996
4.	Institution-Village Linkage Program	since 1996
5.	Testing and popularization of cassava varieties in Tamil Nadu	since 1998

demonstrate the proven technology, and concurrently to study the constraints in adoption. The major technologies promoted in ORP were: 1) two high-yielding cassava varieties, H-2304 and H-1687, together with improved management, and 2) cassava mosaic disease (CMD) eradication. In total, 268 demonstrations were laid out in the selected village. Eradication of CMD in an area of 200 ha was achieved through method demonstration and campaigns. The experience on the ORP revealed that the root quality of introduced cultivars was not comparable to that of landraces, there was poor market demand for high-yielding cassava varieties, and that farmers were reluctant to adopt recommended practices in view of the required additional expenditure.

3. Lab-to-land program (LLP)

The lab-to-land program (LLP) is a massive TOT program initiated by the Indian Council of Agricultural Research (ICAR) targeting small and marginal farmers for socio-economic upliftment. The program emphasized direct participation of a multidisciplinary team of scientists and a multi-mix extension approach. The technologies transferred with respect to cassava were: 1) high-yielding cassava varieties, i.e. H-226, H-2304 and H-1687; 2) improved methods of cultivation; and 3) intercropping cassava with groundnut and cowpea. The CTCRI LLP has passed through eight phases from 1978 till 1996, during which sixteen villages from three states, i.e. Kerala, Tamil Nadu and Orissa, were adopted, benefiting directly more than 1700 families (**Table 19**).

Table 19. Lab-to-Land Program on cassava. (1978-1996)

State	No. of villages covered	No. of beneficiaries
Kerala	12	1600
Tamil Nadu	4	165
Orissa	1	25

Source: *Balagopalan and Anantharaman, 1995.*

An impact study conducted clearly indicates that the technologies introduced could double farmer income from high-yielding cassava varieties, apart from additional income from the intercrop (Balagopalan and Anantharaman, 1995). The adoption behavior of the beneficiary farmers significantly improved due to the program, especially for high-yielding cassava varieties and fertilizer adoption (Anantharaman *et al*., 1993). The impact of the program was also felt in the spread of technologies to non-beneficiaries.

4. Institution-village linkage program (IVLP)

Over the years, TOT has focused on those technologies which have been standardized based on the criterion of increasing productivity. Initially, non-adoption of technologies by resource-poor farmers was attributed to inadequate support systems like extension, and then attributed to attitudinal constraints. This perception is largely the product of the basic assumption that technologies are good and are resource- and scale-neutral. This perception is untrue as is evident from the failure of technologies in many complex, diverse and risk-prone (CDR) systems. This has led to the thinking that technologies must be evaluated in terms of both its technical performance under the environmental conditions prevailing on small farms and also in conformity to the goals and socio-economic organization of a small-farm production system. A more holistic approach through the process of diagnosis of problems, identification of technologies based on farmers' knowledge and from the research institute system, and assessment of these identified technologies for suiting various production systems of a social system is envisaged in IVLP. The operation of IVLP has the following steps: 1) selection of the operation area; 2) forming a multidisciplinary team; 3) characterizing the agro-ecosystems of the selected village; 4) problem diagnosis; 5) identification of alternative technologies for solving problem(s); 6) drawing up an action plan; 7) technology assessment; and 8) extrapolation.

The IVLP includes as many as six production systems. In the cassava production system, three types of interventions have been made, namely, on-farm trials on new high-yielding cassava varieties, on nutrient management in cassava, and on intercropping in cassava. The treatments and replication parameters for assessment, and the results of each intervention are presented in **Table 20**.

5. Testing and popularizing of cassava varieties in Tamil Nadu

Tamil Nadu, known for its irrigated cassava production system, high cassava yields and cassava-based starch factories, is the largest producer of cassava in India, although it ranks second in area. H-226 and H-165 have been the predominant varieties for two decades. There has been a long-pending agenda of identifying new high-yielding cassava varieties and popularizing them. With this concept in mind, cassava varietal evaluation was undertaken in an irrigated production system. The varieties were evaluated by district, and the results are given in **Table 21**. It was observed that varieties seldom exhibited consistency in yield: some of the varieties (TCH-1 and TCH-3) had poor establishment and growth, while CI-649 and CI-731 were susceptible to CMD. The trials are being continued for a second year for confirmation. From the experience on yield variability among varieties, it was concluded that instead of trying only a few new varieties which had been evaluated and released elsewhere, it is better to evaluate a large number of varieties of both released and non-released status to select for varieties appropriate for the test region.

Table 20. Institution-village linkage program implemented in an upland cassava-based production system in Chengal village, Thiruvanthapuram district, Kerala.

Technology intervention	Variety	Yield (t/ha)	Parameter	Result
1. On-farm trials on new high-yielding cassava varieties(6 replications)	M-4	24.96	Root number	TCH-1 and TCH-2 were accepted due to high yield and good culinary characters
	Sree Visakham	25.92	Root weight	
	Sree Jaya	26.09	Cooking quality	
	Sree Vijaya	28.25	Taste	
	TCH-1	46.74	Incidence of CMD	
	TCH-2	45.92	Marketability	
	TCH-3	29.63		
	TCH-4	39.20		
	Local	24.44		
2. On-field trials on nutrient management (10 replications)	1. Farmers practice 40 N: 40 P_2O_5: 40 K_2O (kg/ha)	25.50	Yield Incidence of CMD	VAM[1)] increased yield slightly, and could replace 25 kg of P_2O_5
	2. Recommended practice 100 N: 50 P_2O_5: 100 K_2O (kg/ha)	30.20		
	3. VAM* + 100 N: 25 P_2O_5: 100 K_2O (kg/ha)	32.80		
3. Intercropping in cassava	Peanut varieties:		Yield	Peanut variety JL-24 found to be suitable as an intercrop. Crop loss of cowpea due to mosaic.
	TMV-2	0.650	Pest and disease incidence	
	JL-24	0.827		
	Cowpea, variety C-252	0.300	Marketability	

[1)] VAM = mycorrhizal inoculation

Source: *CTCRI, 1999.*

Table 21. Cassava fresh root yields (t/ha) from the testing and popularizing of cassava varieties in on-farm trials in various districts of Tamil Nadu, India, in 1999/2000.

Variety	District				
	Salem*		Namakkal*	Erode*	Tirunelveli**
	Village-1	Village-2			
H-97	24.0	40.9	33.4	15.0	26.7
H-165	31.0	37.5	37.0	29.5	34.0
H-226	28.0	48.3	29.7	20.8	-
H-2304	41.0	44.0	14.8	27.7	17.0
CI-649	27.7	40.0	39.5	8.6	17.0
CI-731	20.0	44.0	26.0	32.0	34.0
TCH-1	-	29	-	6.9	-
TCH-2	-	37	-	24.3	-
TCH-3	-	40.9	-	8.6	-
TCH-4	-	33.4	-	29.5	-
H-1687	-	-	-	-	19.0
S-856	-	-	-	-	37.0
M-4	-	-	-	-	29.7
Local	H-226 Popular variety	H-226 Popular variety	H-165 Popular variety	Mulluvadi 35.0	Narukku 19.3

* irrigated ** rainfed

Observations:
1. Varieties do not exhibit stability in yield over locations
2. TCH varieties have generally poor growth/establishment
3. CI-649 and CI-731 showed CMD infection.

Source: *Edison et al., 2000.*

Consultancy

CTCRI offers consultancies to large-scale farmers and entrepreneurs, thereby transferring both production and processing technologies. Project UPTECH is one by which CTCRI gives consultancy on a contract basis.

1. Project UPTECH

Project UPTECH, set up by the State Bank of India in 1988, is an extension of the management of consultancy services for supporting a client's efforts in modernization. Its mission is to catalyze technology upgrading in selected industries, following a cluster of industries approach. UPTECH, for the first time, has entered into the improvement of agriculture and processing of resultant produce, by selecting cassava as the crop and cassava-based sago industries in Samalkot of the East Godavari district in Andhra Pradesh. Through a memorandum of understanding, CTCRI offers technical support on production and processing by providing consultancies since 1998.

CTCRI transfers technology by providing consultancies on:

- refinement of agro-techniques to improve yield and quality,
- evaluation of high-starch medium-duration genotypes,
- preservation of planting materials,
- soil fertility management, and
- modernization of sago industries to increase starch recovery and quality, and to reduce the cost of production,

CTCRI also participates in training courses, seminars, exhibitions and farmers' days organized under UPTECH.

2. Training programs and other TOT activities

Apart from outreach programs, cassava technologies are transferred by organizing training programs for extension personnel, farmers and students. Other TOT activities undertaken by CTCRI are participation in mass media, both electronic and print, exhibitions, popular articles, video production and presentation, and distribution of planting materials.

CONCLUSIONS

FPR, which had a humble beginning in the form of pilot projects by international research institutes, has taken up the magnitude of a movement in many national agricultural research systems, especially for privileged crops. Cassava also needs to be addressed in the form of an intensified UPR. The relevancy of UPR is felt more in cassava, in view of the gravity of micro-niche influences. While FPR has been attempted on a extensive scale, care needs to be given to the main concept of FPR and its procedures, without much dilution, to encourage the participation of users in a real sense. In view of the high variability observed in cassava, the area of on-farm trials has to be large, but then this faces problems of resources in terms of planting material availability and limited land holding of cassava farmers. It may be necessary to develop suitable farmer-friendly field designs, especially for hill agriculture systems. UPR is mostly attempted in the area of varietal evaluation in India, and the time is ripe to intensify FPR in production practices with special reference to soil conservation, nutrient and water management and cropping systems. Cassava is cultivated in a wide range of production systems, and by different categories of farmers. This calls for documentation of farmer practices by region, production system and farmer category. Hitherto, UPR in the case of processed product development and transfer has been passive. UPR methodology for processed products demands a different approach from that of production. Action research is more wanting in this aspect. The low priority of cassava in policy making, as well as inadequate extension programs and information systems, have been the weaknesses of cassava TOT. Linkage and coordination with state development departments need to be strengthened. Development of an appropriate information system also becomes the need of the hour for effective TOT.

REFERENCES

Anantharaman, M. and C. Balagopalan. 1996. Consumer testing of cassava processed product (rava) - methodological aspects. J. Root Crops 22(1): 35-39.

Anantharaman, M. and S. Ramanathan 1996. Cultivation and Utilization Pattern and Popularization of Tuber Crops Technologies among Tribal Farmers. RPF II 1996, CTCRI, Trivandrum

Anantharaman, M. and S. Ramanathan 1997. Cultivation and Utilization Pattern and Popularization of Tuber Crops Technologies among Tribal Farmers. RPF II 1997, CTCRI, Trivandrum

Anantharaman, M., S. Ramanathan, K.R. Lakshmi and A.U. Gadewar. 1993. Impact of a cassava technology transfer programme on adoption level by small farmers. Trop. Agric. 70(4): 359-362.

Anantharaman, M. , S. Ramanathan, S.G.Nair and T.V.R. Nair 1995. Farmers Participation in Cassava Varieties Evaluation. RPF II 1995 CTCRI, Trivandrum

Anantharaman, M. , S. Ramanathan, S.G.Nair and T.V.R. Nair 1996. Farmers Participation in Cassava Varieties Evaluation. RPF II 1996 CTCRI, Trivandrum

Anantharaman, M. , S. Ramanathan, S.G.Nair and T.V.R. Nair 1997. Farmers Participation in Cassava Varieties Evaluation. RPF II 1997, CTCRI, Trivandrum

Anantharaman, M. , S. Ramanathan, S.G.Nair and T.V.R. Nair 1998. Farmers Participation in Cassava Varieties Evaluation. RPF II 1998, CTCRI, Trivandrum

Ashby, J.A. 1986. Methodology for the participation of small farmers in the design of on-farm trials. Agricultural Administration 22: 19.

Ashby, J.A. 1987. Farmer participation in on-farm varietal trials. Agricultural Administration (Research and Extension) Network, Discussion paper 22. Overseas Development Institute, London. 30 p.

Ashby, J.A. 1990. Evaluating technology with farmers. *In:* A Hand Book of IPRA Projects**.** CIAT and the Kellogg Foundation, CIAT, Colombia. 93 p.

Balagopalan, C. and M. Anantharaman. 1995. Cassava technology transfer and utilization in India. *In:* R.H. Howeler (Ed.) Cassava Breeding, Agronomy and Technology Transfer in Asia, Proc. 4th Regional Workshop, held in Trivandrum, India. Nov. 2-6, 1993. CIAT, Thailand. pp. 97-109.

Conway, R.C., J.A. McCracken and J.N. Pretty. 1987. Training Notes for Agro-ecosystem Analysis and Rapid Rural Appraisal, Sustainable Agriculture Programme, Intern. Inst. for Environment and Development, London, England. 60 p.

Central Tuber Crops Research Institute (CTCRI). 1999. Progress Report . Technology Assessment and Refinement through Institution Village Linkage Programme. CTCRI, Trivandrum.

Edison, S., C.R. Mohankumar, S.G. Nair, M. Unnikrishnan, C.S. Raveendran, M. Anantharaman, T. Makeshkumar, D. Vimala, and V. Ravi. 2000. Production, evaluation, multiplication, popularization and distribution of quality planting materials of tropical tuber crops *In:* CTCRI Annual Report 1998-1999, CTCRI, Trivandrum, India.

Farrington, J. and A. Martin. 1987. Farmers participatory research: a review of concepts and practices. Discussion 19, Agricultural Administration (Research and Extension), Overseas Development Institute, Regents College, London, UK.

Ghosh, S.P, T. Ramanujam, J.S. Jos, S.N. Moorthy and R.G. Nair. 1988. Tuber Crops. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India. 403 p.

Lakshmi, K.R., T. Srinivas, and S. Mitra. 2000. Long-term trends in production of tuber crops. Technical Bulletin Series 32. CTCRI, Thiruvananthapuram, India. 82 p.

Nanda, S.K. 1987. Field evaluation of hand-operated cassava chipping machine. *In:* T. Ramanujam, P.G. Rajendran, M. Thankappan, C. Balagopalan and R.B. Nair (Eds.). Tropical Tuber Crops: Production and Utilization, Proc. National Symp. on Production and Utilisation of Tropical Tuber Crops, held in Trivandrum, India. Nov. 27-29, 1995. Indian Society for Root Crops, Trivandrum, India. pp. 225-228.

Rhoades, R.E. and R.H. Booth. 1982. Farmer-back- to farmer: A model for generating acceptable agricultural technology. Agricultural Administration 11: 127-137.

Sheriff, J.T. and G.T. Kurup. 1997. Performance evaluation of cassava production and processing equipments. *In:* CTCRI Annual Report 1996-97. CTCRI, Trivandrum, India. 22 p.

Sperling, L. 1995. Generating appropriate technologies to users: The research perspective. *In:* R.H. Howeler (Ed.). Cassava Breeding, Agronomy and Technology Transfer in Asia, Proc. 4th Regional Workshop, held in Trivandrum, India. Nov. 2-6, 1993. CIAT, Thailand. pp. 23-29.