# FARMER PARTICIPATORY RESEARCH (FPR) IN CASSAVA THROUGH THE INSTITUTION-VILLAGE LINKAGE PROGRAMME (IVLP) IN INDIA

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**ABSTRACT**

Cassava, upon which millions in the tropics depend for their livelihood and food security, is mostly confined to southern India, with Kerala, Tamil Nadu and Andhra Pradesh states accounting for more than three-fourth of the area planted to cassava. While cassava continues to play an important role as a food crop in the state of Kerala, in the other two states the harvested roots are used mainly as a raw material for the starch and sago factories.

Although the average yield of cassava in India, over 20 t/ha, is the highest in the world, this can still be further increased through the breeding of high yielding varieties supported by sound agronomic management. But it is also clear that varieties need to be developed based on farmers' preferences. Realizing this, CTCRI has initiated during the early nineties farmer participatory research (FPR) in cassava, especially with regard to varietal selection. This culminated in the release of two early-maturing cassava varieties, Sree Jaya and Sree Vijaya, which are now becoming popular in the lowland production system in Kerala.

When the Institution-Village Linkage Programme (IVLP) came into operation on a pilot scale in 1995, the scope of FPR in cassava was widened. IVLP is a novel front-line extension program, the implementation of which begins with the selection of a suitable village; this is followed by a detailed agro-ecosystem analysis of the selected village, diagnozing the problems of each production system and prioritizing these; identification of technological interventions based on problem-cause relationships; the development of action plans and their implementation; and a detailed socio-economic evaluation, including farmers' reaction and perception about the interventions. This is carried out in a short time using various PRA and RRA tools and techniques. The most significant and underlying factor in the entire process is the active participation of farmers from the beginning to end. CTCRI has been implementing IVLP in Chenkal village of Thiruvananthapuram district, Kerala, with cassava as one of the important crops in the production system of the village. This paper, besides detailing the IVLP approach, gives an account of the technological interventions relating to the cassava production system, namely, the performance assessment of high yielding varieties, intercropping technologies and nutrient management. The impact of these interventions in enhancing the productivity and income from cassava is also discussed in this paper.

## INTRODUCTION

Cassava, the third most important food crop after cereals and grain legumes, is a staple food for millions of people in the tropics; it plays an important role as a food security crop. In India, it is the most important root crop, the cultivation of which is mostly concentrated in the southern states of Kerala, Tamil Nadu and Andhra Pradesh, which together account for a little over 90% of the area and production of cassava in the country (Anantharaman *et al.*, 1992). In the major growing state of Kerala, cassava continues to occupy a place as a secondary staple food of the people, however, to a lesser extent as compared to the sixties and early seventies. In contrast, in Tamil Nadu and Andhra Pradesh, a major quantity of the roots harvested is being used as a raw material by the starch and sago industries located there.

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The present yield of cassava in India, 26.32 t/ha, is the highest in the world and more than two and a half times that of world productivity (FAOSTAT, 2002). This is mainly because of the enthusiasm exhibited by the farmers, especially of Tamil Nadu and Andhra Pradesh, to use high-yielding varieties with sound management practices. In a varietal coverage study undertaken by Ramanathan *et al.* (1990), two high-yielding varieties of cassava, namely H-165, and H-226, were found to be grown in about 80% of the cassava area of Salem, Namakkal, South Arcot and Dharmapuri districts of Tamil Nadu. The farmers there harvested on average more than 35 t/ha of roots. The picture in Andhra Pradesh is not much different from Tamil Nadu. In East Godavari, the main cassava district of Andhra Pradesh, over 90% of the cassava area is being occupied by a single variety, H-165 (Balagopalan *et al.*, 1998). Cassava farmers of both Tamil Nadu and Andhra Pradesh were observed to apply a large quantity of chemical fertilizers, more than the recommended dose, to increase yields (CTCRI, 2002a; Srinivas and Ananthraraman, 2000). It may be noted that the Central Tuber Crops Research Institute, responsible for the research and development of cassava in India, has so far released 11 high-yielding cassava varieties for general cultivation by the farmers (Nair *et al.*, 2000) They include three short-duration varieties, one triploid with high starch, one high-carotene variety and two top cross hybrids. In addition, CTCRI, together with the All-India Coordinated Research Project on Tuber Crops, have developed location specific agro-techniques of cassava to get higher production.

With the availability of many high-yielding cassava varieties coupled with efficient management practices, it is possible to increase yields to over 50 t/ha. This process could be enhanced, when varieties are developed with farmers as research partners. Farmer participatory research (FPR) is an effective mechanism to successfully identify varieties preferred by the farmers. Ashby (1990) defined FPR as a set of methods designed to enable the farmers to make an active contribution as decision makers in planning and execution of agricultural technology generation. Participation of farmers in the research process highly facilitates the means of obtaining feedback for the research and extension process, paves the way for the subsequent dissemination and adoption of the technologies and builds up the confidence of farmers in conducting research and in their own innovativeness (Shamebo and Belehu, 1999). Careful selection of new varieties, which show local adaptability and stability as well as good quality characteristics required by the farmers and consumers helps in increasing adoption and cassava yield.

Hence, a methodology based on farmers' participation in the selection of materials could enhance the transfer and adoption of any new technology. Realizing the potential of the FPR approach in the identification of appropriate technologies and their more rapid adoption by farmers, CTCRI has initiated FPR studies in cassava in the mid nineties.

## 1. FARMER PARTICIPATORY RESEARCH IN CASSAVA IN INDIA - A BACKGROUND

Farmer participatory research in cassava in India was started in 1994 for varietal evaluation, since varieties have a major influence on productivity (Anantharaman and Ramanathan, 2001). FPR in cassava is carried out by conducting on-farm trials of promising genotypes in farmers' fields by adopting consultative participation of farmers, which emphasizes researcher-managed and farmer implemented trials (Ashby, 1986). Initially, participatory varietal evaluation was conducted in both upland and lowland cassava production systems of Kerala State and was later extended to Tamil Nadu and Andhra Pradesh. A three-stage evaluation trial was designed by Anantharaman *et al.*, (1999) and implemented; it comprised of "Initial on-farm trial", "Confirmation on-farm trial" and "Validation on-farm trial". The varieties were evaluated both at pre- and at post-harvest stages by the four evaluator groups, i.e. farmers, farm women, traders and scientists, especially formed for this purpose. Under the first stage of the trial, 11 cassava genotypes, three released, four promising, one improved and three local cultivars, were grown under farmers' management. The trials in individual farmers fields served as replications. Based on the evaluation of crop stand, root yield and root characteristics, five promising genotypes were carried forward to the confirmation trial. From that stage, the two genotypes preferred most by the evaluator groups were selected for inclusion in the next stage, for validating their performance. During the course of these trials, various PRA tools, such as key informant interview, matrix ranking, direct observation etc., have been used to elicit information on varietal performance and spread.

### 1.1 Yield performance and varietal selection by farmers

The yield performance of cassava genotypes in three stages of trial under both upland and lowland production systems is shown in **Table 1**. Four pre-released genotypes, CI-664, CI-649, CI-731 and CI-732 were preferred by the farmers, farm women and traders, not only due to their high yield, but also considering the root characteristics such as root shape, size, number, uniformity and cooking quality. In the confirmation trial they continued to exhibit their high yield potential under the two types of production systems. At the final stage of the trial, i.e. the validation trial, two cultivars, CI-649 and CI-732, gave average root yields of more than 30 t/ha at seven months and were most liked by the farmers. At Pallichal village, CI-731 was preferred, in addition to CI-649. The farmers and farm women, besides traders gave weightage to cooking quality and marketability while selecting a cultivar, apart from their yield, as a major portion of the roots produced is going for human consumption in Kerala. Based on the overall performance and farmers' preference, the two genotypes CI-649 and CI-731 have been released for the State of Kerala in the name of "Sree Jaya" and 'Sree Vijaya," respectively (Unnikrishnan *et al.*, 2000). These two varieties are early-maturing, harvestable at 6-7 months, suitable for lowland cultivation as a rotation crop in paddy-based cropping systems.

The two short-duration varieties Sree Jaya and Sree Vijaya have become so popular in the villages where the trials have been conducted, and were found to spread amongst the cassava cultivators. A rapid assessment of the spread effect of these varieties at the end of the three years of evaluation indicated that nearly 53% of the farmers of Anacode village were cultivating the two new varieties in 30% of their cassava area. Similarly, in Pallichal village, these varieties have almost covered 50% of the cassava area by the third year and nearly 70% of cassava farmers of this village cultivated them. In Kodankara village, about 30% of the farmers cultivated these varieties in about 43% of the cassava area. Taking lessons from the FPR on cassava varietal evaluation for successful evolution of varieties that have a greater diffusion effect in the cassava production system, this approach has been extended to evaluate new cassava varieties in Tamil Nadu and Andhra Pradesh. When the

Institution-Village Linkage Programme (IVLP) came into operation during 1996 with CTCRI as one of the implementing centers, the scope of FPR in cassava was widened to include nutrient management, intercropping technologies etc. in addition to varietal evaluation.

**Table 1. Yield performance of cassava genotypes tested under FPR in three villages in Kerala, India.**

| | Average root yield (t/ha) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Lowland production system | | | | | | Upland production system | | |
| | Anacode | | | Pallichal | | | Kodankara | | |
| Cassava genotypes[1)] | IOFT[2)] | COFT | VOFT | IOFT | COFT | VOFT | IOFT | COFT | VOFT |
| 1. Sree Vishakam* | 22 | 29 | - | 32 | 24 | - | 23 | - | - |
| 2. Sree Sahya* | 28 | - | - | 24 | - | - | 17 | - | - |
| 3. Sree Prakash* | 27 | - | - | 27 | - | - | 27 | - | - |
| 4. CI 664** | 20 | 23 | - | 18 | - | - | 28 | 27 | - |
| 5. CI 649** | 55 | 40 | 38 | 32 | 29 | 35 | 22 | 29 | 30 |
| 6. CI 731** | 32 | 35 | - | 33 | 23 | 30 | 18 | 22 | - |
| 7. CI 732** | 29 | 46 | 41 | 33 | 26 | - | 29 | 25 | 27 |
| 8. M4*** | 22 | - | - | 23 | - | - | 13 | - | - |
| 9. Monkozhunthan**** | 31 | - | - | 24 | - | - | 25 | - | - |
| 10. Karukannan**** | 27 | - | - | 27 | - | - | 20 | - | - |
| 11. Kariyilaporiyan**** | 20 | - | - | 21 | - | - | 19 | - | - |

[1)] * Released varieties ** Pre-released genotypes *** Improved variety **** Land races
[2)] IOFT = Initial on-farm trial; COFT = Confirmation on-farm trial; VOFT = Validation on-farm trial
***Source:*** *Anantharaman et al., 1999.*

## 2. INSTITUTION-VILLAGE LINKAGE PROGRAMME

It is an innovative project initiated by the Indian Council of Agricultural Research (ICAR) on a pilot basis from 1995-96, which was later brought under the World Bank funded National Agricultural Technology Project (NATP) in 1999. It is different from the earlier first line extension efforts of ICAR, in the sense that it lays emphasis on the research aspect through the participation of farmers to be carried out by the multidisciplinary team of scientists. Moreover, IVLP is a production system oriented project with agro-ecosystem analysis of the adopted village as the basis to identify problems, prioritize them and find out technological intervention points which are further developed into action plans to overcome the problems through assessment and refinement of technologies. Active participation of the farmers has to be ensured throughout the implementation of this project, and in this regard various PRA tools and techniques are to be employed to study the agro-ecosystem, develop action plans, implement the same and assess their appropriateness to the village.

### 2.1 Concept of IVLP

The IVLP is conceptualized based on the realization of the fact that the majority of the agricultural technologies are developed and perfected at the research institutes under ideal conditions, which seldom exists among the small and marginal farmers that form the bulk of the farming community in India. The impact analysis of the various transfer of technology (TOT) projects of previous years brought to the limelight that the cause for non-adoption or partial-adoption of agricultural technologies by the farmers operating under complex, diverse, risk-prone (CDR) production systems really did not lay with the farmers or extension system or input supply system as believed generally; rather, it was the technology that was found to be a mismatch to the production system of the farmers. It is against this background, that the need to evaluate agricultural technologies for their appropriateness to the environmental and socio-economic conditions of small and marginal farmers was felt strongly. Hence, a more holistic approach encompassing the detailed analysis of the agro-ecosystem of an adopted village, problem diagnosis, assessment and refinement of identified technological interventions etc., with farmers participation as the underlining principle, was thought of by ICAR and named as Institution-Village Linkage Programme (IVLP), to address the problems of the farming community, particularly of the CDR system.

**2.2 Objectives of IVLP**

The main objectives of the project include

a) To introduce technological interventions with emphasis on stability and sustainability along with productivity and profitability, taking into account environmental issues in well endowed and small production systems.
b) To introduce and integrate appropriate technologies to increase the productivity with marketed surplus in commercial and off-farm production systems.
c) To monitor the socio-economic impact of technological interventions for different production systems, and
d) To identify extrapolation domains for new technology/technology modules based on environmental characterization at meso and mega levels.

The various steps envisaged in the implementation of the IVLP are detailed below, with special emphasis on the cassava production system (Anantharaman *et al.*, 2001).

**2.3 Selection of Operation Site**

The village is the basic unit of operation of IVLP projects. While selecting a village, the factors such as proximity to the implementing Centre, size of the village (800-1000 farm families), contiguity, institutional development, availability of various kinds of production systems, co-operative and willing nature of farmers, etc. should be given due consideration. As regard to CTCRI, care was taken to select a village with cassava as an important crop in the agro-ecosystem of the village, besides giving due weightage to the above criteria. Taking all the above aspects into consideration, Chenkal village in Neyyattinkara Taluk of Thiruvananthapuram district, Kerala, was selected for implementation of IVLP. It is situated about 35 km south of Thiruvananthapuram city. Chenkal village (west) has 600 families, out of which 570 derive their income from agriculture and allied activities.

**2.4 Constitution of Multidisciplinary Team**

The project is to be implemented by a multidisciplinary Core Team of 4-5 scientists drawn from the host institute with one amongst them acting as the Nodal Officer. It is the primary responsibility of the team members to select the village, prepare a project document, implement the action plans contemplated, monitor day-to-day activities and submits reports periodically. Apart from the Core Team, an Optional Team is also constituted with members from disciplines other than those of the Core Team from the host institution as well as from other institutions to render technical guidance as per the need of the project. The core team of CTCRI consisted of 5 members: a plant breeder, an agronomist, a plant protection scientist and two extension specialists, one each acting as a Nodal Officer and Core Team Leader.

## 2.5 Agro-ecosystem Analysis

Agro-ecosystem analysis is a recent concept of multidisciplinary nature and can be used at all levels of hierarchy of agro-ecosystems, from field through farm, village and watershed, to region and nation. It also provides a technique of analysis and packages of technology that focus not only on productivity, but also explicitly on trade-offs between them. The complexity of the system in terms of its dynamic consequences can have four system properties which together describe essential behaviour of agro-ecosystems. These are productivity, stability, sustainability and equitability. To understand the system properties, the pattern analysis is widely used which includes four patterns that reveal the key functional relationship that determine system properties. Three of them, i.e. space, time and flow are known to be important in understanding the system properties and are also neutral with respect to scientific disciplines. The fourth, pattern-decision, reflects the process of human management of agro-ecosystems. The agro-ecosystem analysis was carried out by employing various PRA and RRA tools and techniques such as key informant interview, focused group discussion, village transect, mapping, diagramming, matrix ranking etc.

### *2.5.1 Pattern analysis*

#### *2.5.1.1 Space*

The spatial patterns of the village is better understood by making a village map and village transect. While the village map gives a total picture of the village with regard to domicile pattern, land utilization, availability of various facilities etc., the transect represents the cross section of the village indicating the topography, soil type, crops grown, livestock details, irrigation source, problems etc. of the village. Cassava is an important crop of the upland production system of the adopted village Chenkal, and the crop is grown in red laterite soil, both as a sole crop and in mixed stands with coconut. Cassava is also found cultivated under lowland conditions in clay soil, which is traditionally used for paddy cultivation. Under upland conditions, cassava is grown purely as a rainfed crop whereas the crop may receive canal water under lowland conditions.

#### *2.5.1.2 Time*

The time patterns are best expressed by graphical representations. Historical transect, rainfall pattern, cropping pattern, seasonality of pests and diseases, yield trends, labor availability, fodder availability etc. are some of the key parameters in the analysis of time patterns of the village. This in turn will help in identifying the periods in the year when the timing of operations and the availability of resources is critical for productivity and stability. Long-term changes in production, prices, climate etc. and the stress and perturbation occurring in the agro-ecosystem are also analyzed to reveal productivity trends and to measure the stability/instability of production.

As regard to the cassava crop, the high yielding varieties were introduced into Chenkal village after 1975. During the period 1988-90, the Lab-to-Land Programme (LLP) of CTCRI was in operation in this village and under this progaramme, the high-yielding cassava varieties Sree Vishakam and Sree Sahya have been introduced by setting up demonstrations in farmers' fields. Except for cassava mosaic disease and rat damage during the root bulking stage, no other serious pests/diseases have been noticed. The present root yield of cassava **(Figure 1)** of 20 t/ha is a little higher than the district yield (18.8 t/ha) and block yield (16.43 t/ha). A gradual and steady increase in cassava yields was observed in the adopted village **(Figure 2);** it was below 10 t/ha in 1950, increased to 10 t/ha in the sixties and increased further to the present level of 20 t/ha. The yield level has more or less stabilized over the years.

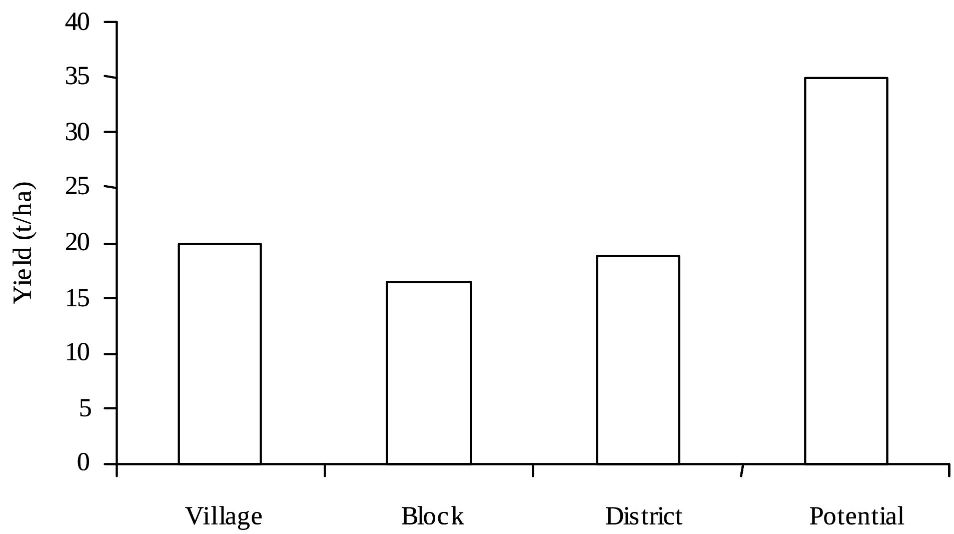


*Figure 1. Yield of cassava in the village, block and district, and the potential yield.*

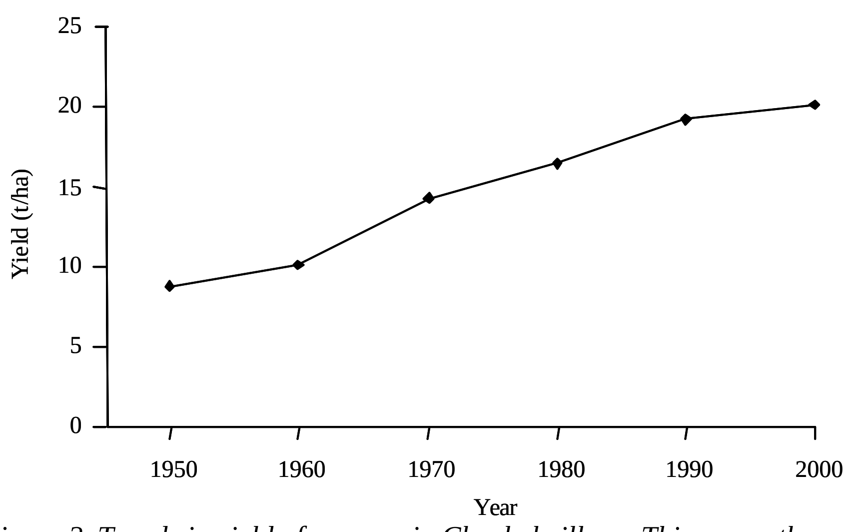


*Figure 2. Trends in yield of cassava in Chenkal village, Thiruvananthapuram district of Kerala, India from 1950 to 2000.*

*2.5.1.3 Flow*

The patterns of flow represent the transformations of energy, materials, money, information etc. in the agro-ecosystem. Flow diagrams are used to depict the interrelationship between the various elements. The resource flow diagram of the adopted village revealed that 90% of the cassava produced is going out of the village through sales and only 10% is consumed within the village. The mobility map and livelihood analysis are the other important flow patterns used to get an idea about the behaviour of the farmers and their allocation of resources towards income and expenditure patterns.

*2.5.1.4 Decisions*

This refers to the individual farmer's choice in the selection of enterprises, crops and crop varieties as well as management practices, such as what to grow, where to grow, how and from where to purchase inputs etc., which occur at all levels in the hierarchy of agro-ecosystems. They are mainly represented in the form of matrices and they help in identifying the priorities given by the farmers as well as the selection criteria used by them in arriving at such priorities. The matrix ranking of crops and cassava varieties ranking are presented in **Tables 2 and 3,** respectively, which has relevance to the cassava production system of the village. In **Table 2** a score of 1 was awarded for the most preferred crop with respect to a particular character, and the scores of 2, 3, 4 and 5 were given for the crops in the order of preference with 5 indicating the least preferred. The crops' ranking indicate that cassava is most preferred for its food security, profitability and low pest and disease incidence. With respect to low input requirement and marketability, it is ranked fourth. In respect to **Table 3**, a score of 5 represented the highest and most preferred variety for a particular attribute and the rank 1 is the lowest score given for the least preferred variety. The varietal preferences of cassava varied with the varietal characteristics, as evidenced from the varieties ranking matrix. The farmers preferred Ullichuvala most owing to its yield, duration, root shape, market preference, cooking quality and suitability to lowland cultivation. It is followed by Vellanoorumuttan, M4, Mankozhunthan, Kariyilaporiyan and Narukku in that order.

**Table 2. Matrix ranking of crops by farmers in Chenkal village of Thiruvananthapuram district of Kerala, India in 1999.**

| Characters | Rice | Coconut | Cassava | Banana | Vegetables |
|---|---|---|---|---|---|
| Food Security | 5 | 4 | 1 | 4 | 3 |
| Profitability | 2 | 3 | 1 | 5 | 5 |
| Low pest and disease incidence | 1 | 3 | 1 | 5 | 5 |
| Drought tolerance | 1 | 3 | 5 | 4 | 2 |
| Low input requirement | 1 | 5 | 4 | 3 | 2 |
| Marketability | 1 | 5 | 4 | 3 | 3 |

Note: 1 = highest rank = best
***Source:*** *Anantharaman et al., 2001.*

**Table 3. Matrix ranking of six cassava genotypes by farmers in Chenkal village of Thiruvananthapuram district of Kerala, India in 1999.**

| Characters | Kariyila-poriyan | Narukku | M4 | Ullichu-vala | Vellanooru-muttan | Mankozhun-than |
|---|---|---|---|---|---|---|
| High yield | 3 | 3 | 2 | 5 | 4 | 2 |
| Short duration | 5 | 2 | 2 | 5 | 3 | 3 |
| Good root shape | 5 | 2 | 3 | 5 | 3 | 2 |
| High starch content | 2 | 5 | 4 | 3 | 4 | 5 |
| Good market preference | 4 | 3 | 5 | 5 | 4 | 3 |
| Excellent cooking quality | 5 | 3 | 5 | 5 | 4 | 3 |
| Suitability to grow under lowland condition | 5 | 1 | 2 | 5 | 3 | 1 |
| Suitability to grow under upland condition | 2 | 4 | 4 | 3 | 5 | 5 |

Note: 5 = highest score = best
***Source:*** *Anantharaman et al., 2001.*

***2.5.2 Analysis of system properties***

*2.5.2.1 Productivity*

The yield of cassava (20 t/ha) in Chenkal village, though higher than the productivity of the respective block and district, is much below the realizable potential as opined by the scientists **(Figure 1)**. This means that farmers can probably achieve the potential yield by replacing the existing land races with high-yielding varieties. Hence, the cassava yield of the village may be regarded as medium.

*2.5.2.2 Stability*

Contrary to many of the other crops like paddy, banana, coconut, vegetables etc. which showed variability in production, cassava exhibited consistency with steady increase in yield from a low 9 t/ha during the 1950s to the present level of 20 t/ha **(Figure 2).**

*2.5.2.3 Sustainability*

Owing to the steady increase in cassava yield during the past five decades, the sustainability of this crop in the adopted village can be considered as high.

*2.5.2.4 Equitability*

Equitability is estimated using wealth ranking and it was observed that there is no equal distribution of wealth among the villagers, with agricultural laborers accounting for more than 65% of farm families. However, as far as cassava cultivation is concerned, there is high equitability, since it is grown uniformly by all the sections of the farmers cutting across land holding size, resource availability, caste etc.

***2.5.3 Problem diagnosis and prioritization***

By effectively utilizing the technique of key informant interview, focused group discussion and direct observation, the various problems confronting the production of crops and other enterprises are diagnosed. The root causes for problems are also listed and grouped into bio-physical and socio-economical. In consultation with the farmers and concerned experts in the field, the causes are prioritized for possible technological interventions. This entire exercise is depicted in the form of a problem-cause relationship diagram with respect to low cassava yields, and represented in **Figure 3.** It is clear from the diagram that non-availability of planting material of improved varieties is the primary cause for low yield. High incidence of cassava mosaic disease, rat damage and non-availability of seeds of suitable intercrops are also identified as other causes for low productivity and income from cassava production systems. Among the different socio-economic factors limiting the productivity, poor knowledge about production and processing was selected for suitable technological intervention.

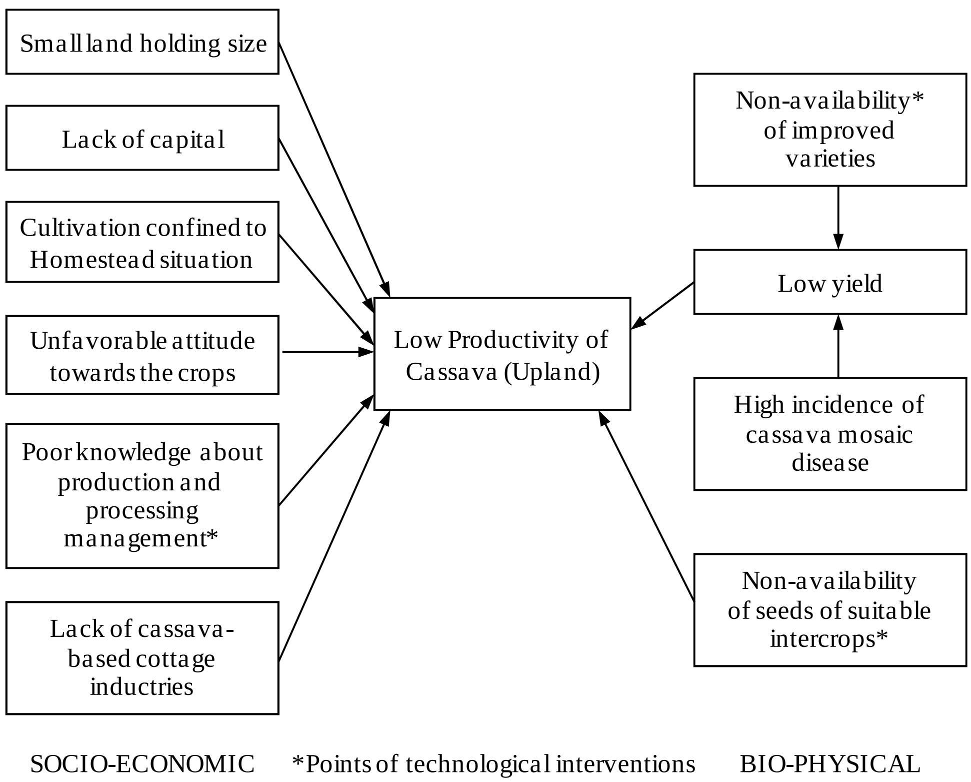


*Figure 3. Problem-cause relationships for low productivity of cassava.*

### *2.5.4 Legitimization of problems and solutions*

Legitimization is a process by which problems and solutions are presented and discussed with the villagers in order to get their concurrence; this is done through focused group discussion, in which farmers, Core Team members and experts take part. This forms the basis for developing appropriate action plans to be implemented to overcome the problems identified.

### *2.5.5 Action plan and implementation*

Keeping the problem-cause relationship as the basis, action plans are prepared for each technological intervention, with the active participation of farmers and facilitated by

IVLP Core Team members. The action plans prepared for cassava based interventions, such as assessment of the performance of high-yielding varieties, assessment of the effect of nutrient management practices in cassava, and the assessment of the performance of intercropping technologies, are given in **Tables 4, 5 and 6**, respectively. The action plan gives an account of the micro-farming situation, the problems and their causes, intervention points, potential solutions, nature of intervention, treatments, critical inputs etc. The technological interventions contemplated under the action plans are implemented in the selected farmers' fields, either as on-farm trials or verification trials. At each and every stage of the trial, the participating farmers are involved in assessing the interventions, using various performance indicators such as technical observations, economic observations, farmers' reaction etc.

**Table 4. On-farm trial on new high-yielding varieties of cassava to be conducted by farmers in Chenkal village.**

| Name of the intervention | Assessment of the performance of new high-yielding varieties of cassava |
|---|---|
| Micro farming situation | Cassava-based cropping system under upland rainfed condition |
| Problem and its causes | Non-availability of planting materials of new high-yielding varieties of cassava. All the local varieties are low yielding (20 t/ha) and infected with cassava mosaic disease, and disease-free planting materials are not locally available |
| Intervention points | Non-availability of planting materials of high-yielding varieties of cassava |
| Potential solutions | There will be an increase in yield and income from cassava plots by planting disease-free planting materials of high-yielding varieties of cassava |
| Nature of intervention | On-farm trials |
| Treatments | 1. Sree Jaya<br>2. Sree Vijaya<br>3. M-4,<br>4. Sree Vishakam<br>5. Sree Prabha<br>6. Sree Rekha<br>7. TCH-3<br>8. TCH-4<br>9. Local (Ullichuvala) |
| No. of replications | 20 |
| Critical inputs | Planting materials of high-yielding cassava varieties |

***Source:*** *Anantharaman et al., 2001.*

## 2.6. Assessment of Cassava-based Technological Interventions

### *2.6.1 Assessment of the performance of high yielding cassava varieties*

Non-availability of planting material of new high-yielding varieties of cassava was identified as the major limitation in increasing cassava yields in the adopted village. To combat this problem, an action plan has been developed to evaluate new high-yielding cassava varieties developed and released from CTCRI, along with local varieties in selected farmers' fields in the form of on-farm trials. The trials were conducted under upland production system conditions during the rainy seasons of 1998, 2000 and 2001. The yield performance of the varieties are shown in **Table 7.** Of the 12 varieties evaluated for their

**Table 5. On-farm trial on nutrient management practices in cassava to be conducted by farmers in Chenkal village.**

| Name of the intervention | Assessment of the effect of nutrient management practices in cassava |
|---|---|
| Micro farming situation | Cassava-based cropping system under upland rainfed conditions |
| Problem and its causes | The farmers generally have a poor knowledge about production and processing management of this crop. The low productivity of cassava (20 t/ha) in this area is due to inadequate and imbalanced nutrient use. Poor economic base of the farmers prevents them from practicing balanced nutrient management |
| Intervention points | Non-availability of phosphate fertilizers and lack of knowledge regarding judicious application of fertilizers |
| Potential solutions | There will be a yield increase due to timely and balanced application of a combination of organic, inorganic and bio-fertilizers |
| Nature of intervention | On-farm trials |
| Treatments | 1. Farmers practice (40 kg N+40 kg $P_2O_5$ +30 $K_2O$/ha)<br>2. Recommended nutrient management (100 kg N+ 50 $P_2O_5$ +100 kg $K_2O$/ha); half N, full P and half K as basal and half N and half K one month after planting<br>3). Use of VAM[1)] + 100 kg N + 25 $P_2O_5$ + 100 $K_2O$/ha (VAM + half N, full P, half K as basal and half N and K one month after planting |
| No. of replications | 10 |
| Critical inputs | Fertilizers and VAM |

[1)]VAM = vesicular-arbuscular mycorrhiza
***Source:*** *Anantharaman et al., 2001.*

**Table 6. On-farm trial on intercropping in cassava to be conducted by farmers in Chenkal village.**

| Name of the intervention | Assessment of the performance of leguminous intercrops in cassava |
|---|---|
| Micro farming situation | Cassava-based cropping system under upland rainfed condition |
| Problem and its causes | Non-availability of seeds of suitable intercrops |
| Potential solutions | There will be an increase in yield and income from cassava plots due to intercropping and the more effective utilization of interspaces by growing suitable intercrops |
| Nature of intervention | On-farm trial |
| Treatments | 1. Farmer's practice (no intercrop)<br>2. Intercropping with peanut, var. TMV 2 and JL-24<br>3. Intercropping with French bean, var. Contender<br>4. Intercropping with cowpea, var. C-152 and Arka Garima |
| No. of replications | 31 |
| Critical inputs | Seeds of intercrops |

***Source:*** *Anantharaman et al. 2001*.

suitability to the village conditions during the past three years, the new top-cross hybrid cassava varieties "Sree Prabha" and "Sree Rekha", had consistently high root yields of more than 35 t/ha and the yield was as high as 53 t/ha in 2001. They outyielded other varieties and resulted in a net income of Rs.57,000-139,700/ha during different years depending upon the price of the roots. The preference for these two varieties became very clear by the matrix ranking **(Table 8),** as well as the farmers' evaluation of the positive and negative aspects of the varieties **(Table 9).** In **Table 8**, the scoring pattern similar to the one followed in **Table 2** was adopted with a score of 1 indicating the most preferred variety and 5 for the leased preferred one. Farmers preferred Sree Prabha and Sree Rekha because of high yield, good root size and shape, excellent cooking quality (Sree Rekha), low mosaic incidence and intermediate starch content. The beneficiary farmers who took part in the assessment of cassava varieties became the source of planting material for other farmers who have shown a keen interest in growing these varieties. These two varieties are now spreading gradually in the IVLP village, Chenkal.

**Table 7. Assessment of the performance of high-yielding cassava varieties under upland production systems in Chenkal village, Kerala, India from 1998 to 2001.**

| | 1998 rainy season[2)] | | 2000 rainy season[3)] | | 2001 rainy season[4)] | |
|---|---|---|---|---|---|---|
| Cassava genotypes[1)] | Root yield (t/ha) | Net income (Rs/ha) | Root yield (t/ha) | Net income (Rs/ha) | Root yield (t/ha) | Net income (Rs/ha) |
| 1. Sree Vishakam* | 25.92 | 32,400 | - | - | - | - |
| 2. Sree Jaya* | 26.09 | 32,610 | 27.80 | 65,600 | 15.43 | 28,490 |
| 3. Sree Vijaya* | 28.15 | 35,190 | - | - | 20.40 | 43,400 |
| 4. Sree Prabha* | 46.74 | 58,430 | 34.60 | 86,000 | 52.50 | 139,700 |
| 5. Sree Rekha* | 45.92 | 57,400 | 36.20 | 90,800 | 51.90 | 137,900 |
| 6. M4** | 24.96 | 31,200 | - | - | - | - |
| 7. TCH-3*** | 29.63 | 37,040 | - | - | - | - |
| 8. TCH-4*** | 39.20 | 49,000 | - | - | - | - |
| 9. Manjanoorumuttan**** | 24.44 | 30,550 | - | - | - | - |
| 10. Kaliyanmanja**** | - | - | 25.60 | 59,600 | - | - |
| 11. Narayanakappa**** | - | - | 16.40 | 31,400 | - | - |
| 12. Ullichuvala**** | - | - | - | - | 22.20 | 48,800 |

1) *Released varieties; ** Improved variety; *** Pre-released genotypes**** Land races; planted in early rainy season (June)

2) 6 replications 3) 10 replications 4) 20 replications

***Source:*** CTCRI, 1999; CTCRI, 2001; CTCRI, 2002b.

**Table 8. Matrix ranking of seven cassava genotypes by farmers in Chenkal village.**

| Root characters | Sree Jaya | Sree Vijaya | Sree Prabha | Sree Rekha | Kaliyanmanja | Narayanakappa | Ullichuvala |
|---|---|---|---|---|---|---|---|
| High root yield | 3 | 4 | 1 | 2 | 3 | 5 | 4 |
| Good root shape | 2 | 2 | 3 | 1 | 4 | 5 | 2 |
| Optimum root size | 3 | 3 | 2 | 1 | 3 | 3 | 2 |
| Excellent cooking quality | 1 | 4 | 5 | 1 | 5 | 4 | 2 |
| Good taste | 1 | 3 | 2 | 3 | 5 | 4 | 1 |
| Low mosaic incidence | 5 | 3 | 1 | 2 | 4 | 3 | 3 |
| High starch content | 5 | 5 | 2 | 3 | 4 | 1 | 2 |

Note: 1 = highest ranking = best

***Source:** CTCRI, 2001; and CTCRI, 2002b.*

**Table 9. Farmers evaluation of seven cassava genotypes: positive and negative aspects.**

| Cassava genotypes | Positive aspects | Negative aspects |
|---|---|---|
| Sree Jaya | Moderate yield<br>Excellent cooking quality and taste | High mosaic incidence<br>Low starch content |
| Sree Vijaya | Moderate yield<br>Good root shape | Low starch content<br>Poor cooking quality |
| Sree Prabha | High yield<br>Good root size<br>Low mosaic incidence<br>Moderate starch content | Poor cooking quality |
| Sree Rekha | High yield<br>Good root shape & size<br>Excellent cooking quality<br>Low mosaic incidence<br>Moderate starch content | - |
| Kaliyanmanja | Moderate yield | Poor cooking quality & taste<br>High mosaic incidence<br>Low starch content |
| Narayanakappa | High starch content | Poor yield<br>Poor cooking quality & taste<br>High mosaic incidence |
| Ullichuvala | Moderate yield<br>Excellent taste<br>Moderate starch content | Moderate mosaic incidence |

***Source:*** *CTCRI, 2001; CTCRI, 2002b.*

### *2.6.2 Assessment of the performance of leguminous intercrops in cassava*

To increase the income of farmers from the cassava production system, intercropping was thought to be a viable proposition. The agro-ecosystem analysis showed that intercropping was not used much in the adopted village. Hence, an action plan was developed to conduct on-farm trials in selected farmers' plots with various intercrops such as peanut, cowpea, French beans etc. in cassava over a period of four years. The performance assessment of various intercrops and the farmers' reaction are shown in **Tables 10 and 11,** respectively. While peanut and vegetable cowpea were found to be very suitable to the village conditions, French beans was found totally unsuitable. Both varieties of peanut, TMV-2 and JL-24, gave an average pod yield of over 0.8 t/ha with a additional net income of Rs.15,000-22,000/ha, depending on the yield levels. Similarly, vegetable cowpea (var. Arka Garima) was also assessed to be an ideal intercrop of cassava. In contrast, there was a total failure of French beans, which did not flower at all. Likewise, the grain cowpea (var. C-152) did not have a high yield due to a severe aphid attack and mosaic incidence. Besides additional yield and income, peanut and cowpea were found to have good marketability and an alternate use as green manure or cattle food. There is enthusiasm amongst the IVLP farmers to adopt intercropping of peanut or/vegetable cowpea whenever cassava is grown under upland conditions.

**Table 10. Assessment of the performance of leguminous intercrops in cassava under upland production systems in Chinkal village. Kerala, India from 1996 to 2000.**

| Intercrops | 1996 rainy season[1] | | 1997 rainy season[2] | | 1998 rainy season[3] | | 2000 rainy season[4] | |
|---|---|---|---|---|---|---|---|---|
| | Yield (t/ha) | Net income (Rs/ha) | Yield (t/ha) | Net income (Rs/ha) | Yield (t/ha) | Net income (Rs/ha) | Yield (t/ha) | Net income (Rs/ha) |
| **Peanut** | | | | | | | | |
| TMV 2 | 0.650 | 13,000 | 0.975 | 22,000 | - | - | 0.750 | 15,000 |
| JL 24 | - | - | - | - | 0.827 | 20,540 | 0.900 | 18,000 |
| **Cowpea** | | | | | | | | |
| C-152 | - | - | 0.200 | 2,000 | 0.300 | 3,000 | - | - |
| Arka Garima | - | - | - | - | - | - | 2,000 | 12,000 |
| **French beans** | | | | | | | | |
| Contender | - | - | Crop loss | | - | - | - | - |

[1] 41 replications [3] 31 replications
[2] 31 replications [4] 79 replications; early rainy season (June) planting
***Source:*** *CTCRI, 1999; CTCRI, 2002b.*

**Table 11. Farmers evaluation of three intercropping systems: positive and negative aspects.**

| Intercrops | Positive aspects | Negative aspects |
|---|---|---|
| Groundnut | Additional yield<br>Improvement in soil fertility<br>Haulms used as green manure & cattle feed<br>High marketability<br>Nutritious food for children | Attracts rats |
| Cowpea | High yield<br>Most preferred as vegetable<br>Attractive dark green color<br>High marketability | Severe aphid and mosaic attack in grain type<br>Several harvests needed in vegetable type |
| French beans | - | Flowering not occurred<br>Highly sensitive to rainfall<br>Not suited to adopted village |

***Source:*** *CTCRI, 1999; CTCRI, 2002b.*

### *2.6.3 Assessment of the effect of nutrient management in cassava*

To overcome the problem of imbalanced nutrition in cassava, various nutrient management practices, including the use of organic manure were assessed for their effectiveness. As compared to the farmers' practice, the recommended nutrient management practice increased the root yield from 25 t/ha to 30 t/ha, and further increased to 33 t/ha by the use of VAM and half the recommended dose of $P_2O_5$ with full dose of N and $K_2O$ **(Table 12).** Accordingly, there was an increase in the net income too, from Rs.31,000/ha under farmers practice to Rs.38,000/ha under recommended practice, and to Rs.41,000/ha with the use of VAM. Farmers were convinced of the benefits of using VAM which reduced the cost of cultivation while increasing the yield of cassava. However, lack of availability of VAM culture at the village or nearby villages was experienced as the most serious impediment to the spread of this technology. Excepting CTCRI, where VAM is produced mostly for research purposes, no other agency is engaged in the large-scale multiplication and distribution of VAM inoculum.

**Table 12. Assessment of various nutrient management systems in cassava under upland production systems in Chenkal village, Kerala, India in 1996.**

| Nutrient management practices[1] | Root yield (t/ha) | Net income (Rs/ha) |
|---|---|---|
| Farmers practice: 40kg N+ 40 $P_2O_5$+40 $K_2O$/ha | 25.50 | 31,035 |
| Recommended: 100 kg N+50 $P_2O_5$ + 100 $K_2O$/ha | 30.20 | 38,180 |
| VAM[2] +100 kg N+ 25 $P_2O_5$+100 $K_2O$/ha | 32.60 | 41,215 [3] |

[1] 10 replications
[2] VAM = Mycorrhizal inoculation
[3] Even though the use of VAM increased the yield of cassava and net income, the technology could not be adopted on a large scale due to non-availability of VAM inoculum at the village or nearby.
***Source:*** *CTCRI, 1999.*

## CONCLUSIONS

The use of FPR in cassava in India is of recent origin, when CTCRI started using this approach for varietal evaluation of cassava in 1994. It is only through the FPR approach, that the two short-duration cassava varieties "Sree Jaya" and "Sree Vijaya" were selected by farmers and released for the state of Kerala. As these varieties were developed with the farmers as partners in the varietal evaluation process, their acceptance was found to be of crucial importance for the spread of these varieties in the lowland production systems, where they suit ideally as a sequence crop after the harvest of paddy rice. When IVLP came into operation in 1996, FPR was used as an integral part of this programme, and this methodology is being used as an effective tool to assess the various cassava production technologies amongst the farmers of the IVLP village, Chenkal. New cassava varieties, intercropping technologies and nutrient management practices have been assessed for their appropriateness to the village. The new top cross cassava varieties "Sree Prabha" and "Sree Rekha", as well as intercropping with peanut and vegetable cowpea have been accepted by farmers, and are now gradually being adopted by the IVLP farmers. In contrast, the unavailability of VAM is a major limiting factor for the acceptance of improved nutrient management practices. Realizing the potential of IVLP as a vehicle for FPR in cassava, more and more new production and processing technologies of cassava developed at CTCRI are being assessed for their field application and acceptability by the farmers.

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