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Problem Diagnosis and Research Priority Setting for Cassava in India

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Abstract

Cassava is the most widely cultivated root crop in tropics and continues to be a crop of food security. It is the major tropical tuber crop in India , cultivated in peninsular region and North eastern hill states. Once seen as the food security crop, is now becoming increasingly a multipurpose crop acting as a major raw materials for a range of industrial uses. Cassava area is declining in India and its role in food security and economic growth is diminishing gradually. However, its significance to small and marginal farmers and its growing industrial use could not be ignored and overlooked and maximum advantage of this crop need to be explored through strategic R & D efforts. The funds allocated for cassava R & D should be judiciously used to reap the maximum benefits to the farming community. Research priority setting and monitoring is an effective method to efficiently allot scarce resources. The purpose of this paper is to develop a methodology for setting research priorities for cassava and to delineate the prioritised areas of research. The study suggested to have participatory problem diagnosis, converting problems to researchable issues, using Principle Component analysis for grouping the issues and judges rating and economic assessment for priority setting. The major areas prioritised are development of Cassava Mosaic Disease resistant varieties and its management, lowering the cost of production of cassava, germplasm collection, maintenance, and evaluation of tropical tuber crops (cassava) etc.

Key words: Cassava, problem diagnosis, production system, researchable issues, prioritisation.

Introduction

Cassava *(Manihot esculenta* Crantz) also known commonly as Tapioca in India, is the most widely cultivated root crop in tropics and is grown across a broad range of agro-climatic conditions. It continues to be a crop of food security for the millions of small and marginal farm households especially in the developing countries. Cassava is the major tropical tuber crop of India being cultivated mainly in peninsular region (Tamil Nadu, Kerala and Andhra Pradesh) and North eastern hill states (Nagaland, Meghalaya and Assam). It is cultivated in an area of 1,73,000 ha with a total production of 49,50,000 t (National Horticultural Board, 2019). Once seen as the 'food of the poor', cassava has emerged as a 'multipurpose crop' for the 21st century – one that responds to the priorities of developing countries, to trends in the global economy and to address the challenges of climate change. (Howeler, 2012). Author's analysis indicated that cassava area is declining in India and its role in food security and economic growth is diminishing gradually. Vitality and potentiality of this crop in the food security of small and marginal farmers and its growing industrial use could not be ignored and overlooked and maximum advantage of this crop need to be explored through strategic R & D efforts.

In India, the ICAR-Central Tuber Crops Research Institute (ICAR-CTCRI) provides leadership in research and development of cassava, and over five decades of intensive research has yielded a variety of technologies like high-yielding, disease resistant and industrial quality cassava varieties, profitable cassava production and value addition packages. Despite these efforts, tuber crops are rated low among principal food and industrial crops and receive inadequate resources for research and development. Consequently, the available limited resources should be judiciously allocated and used so as to reap the maximum benefits to the farming community.

Research priority setting and monitoring have been introduced as research management tools to efficiently allot scarce resources to alternate choices (Joshi and Bantilan, 1997). Sandy Oliver (as quoted in Nasser, 2018) defined research priority setting as a collective activity for deciding which uncertainties (e.g. problems, gaps, difficulties, limitations etc) that are most worth trying to resolve through research. During this process, the solutions are identified by rational selection of a specific research priority among alternatives. The aim of priority setting is to make the most effective use of available resources with the objective to select the best portfolio of research activities for a certain research system, institution, or program me (Janssen, 1995).

The purpose of this research is to develop a methodology for setting research priorities for cassava research through a grassroots-level problem diagnosis and research prioritisation approach.

Materials and Methods

The popular methods for research prioritisation are congruence method; domestic resources cost ratio method, checklist method, scoring or weighted criteria method, economic surplus approach, programming models, simulation models and econometric methods (Jha et al., 1995). However, these methods focus largely on economic returns and rely heavily on expert judgement, while ignoring the farmers' preferences and choices. The present study employs a 'Consultative participation' (Biggs, 1989) based methodology, where the research issues are identified at the agro-ecosystem level through a participatory problem-diagnosis approach.

In the first step, various cassava production systems were identified through review of secondary data sources like policy and vision documents and published research works. Once the production systems were identified, the list was provided to a group of 10 judges (who had at least 10 years of research/ extension experience in cassava) to rank the systems (Table 1). Based on expert assessment, six cassava production systems such as low land rainfed, upland rainfed, plains irrigated, plains rainfed, hot arid hill mountainous rainfed and homestead systems from three states viz. Tamil Nadu, Kerala and Andhra Pradesh (which cover over 90% of the cassava area), were selected.

Table 1. Ranking of cassava production system by experts

Sl. No.	Production systems	Ranking
1	Low land rainfed	1
2	Upland rainfed	2
3	Plains irrigated	3
4	Plains rainfed	4
5	Hot arid Hill mountainous rainfed	5
6	Homestead systems	6
7	Upland intercropping	7
8	River basin	8
9	Low land irrigated	9
10	Low land intercropping	10
11	Upland irrigated	11
12	Hill and mountainous irrigated	12

The production system based problem diagnosis was carried out through participatory methods such as focus group discussion (Rosario,1990) and key informant interviews (Sandoval, 1990). The data collection was done during 2014-15. Data triangulation and modelling was done from 2017-2019. During the first phase, six focussed group discussions were conducted with 12 cassava farmers in each group, in six selected villages from Thiruvananthapuram, Kollam and Malappuram (Kerala), Salem and Namakkal (Tamil Nadu) and in East Godavari(Andhra Pradesh) districts. In addition, two focus group discussion with 10 cassava processing entrepreneurs one each in Salem district, Tamil Nadu and East Godavari district, Andhra Pradesh were conducted to identify problems of cassava based processing units. During the focus group discussions, the researchers along with farmers and processors identified major problems in cassava production, processing and utilisation. After the focus group discussions, two key informants per village were identified from six selected villages through sociometry approach to collect detailed information of the problems identified through focus group discussion. After identifying major problems faced by cassava farmers, they were converted to researchable issues and were assessed by 220 experts (researchers; extension workers and academicians) on cassava representing research, education and extension system and were asked to judge the issues on five point rating scale (Important = 1 to Very Important = 5). The experts with a minimum five years experience in tuber crops were selected. Based on the mean importance scores, the major issues were selected and subjected to economic assessment.

During the economic analysis, Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) were considered as yard sticks for prioritisation.

The data were subjected to Principal Component Analysis (PCA) to reduce large number of researchable issues into smaller components representing dimensions of research priorities. After extraction, the components were rotated through Varimax rotation. The factors with an eigen value exceeding one were selected for rotation (Field, 2000). Since the sample size exceeds 100, a factor loading of 0.55 was used as a lower cut-off value for selection of variables for each factor (Field, 2000). All the statistical analyses were performed using statistical software SPSS (Ver 15.0).

Results and Discussion

Production system oriented problem diagnosis

From the production system diagnosis, 69 problems were identified which were grouped into 13 areas (Table 2). Of the problems identified, 53.6% were on the issues focused on two aspects such as industrial processing for starch and sago (39.1%) and improved varieties (14.5%) (Table 2). With cassava emerging as a leading industrial crop in India, with diversified uses in food, animal feed, nutraceutical, textile and packaging industries, there is an essential need to meet the industrial needs in terms of providing advanced technology, efficient processes, varieties with processing qualities are need of the hour. In the industry-oriented cassava production systems, technological issues related to industry were identified as key requirements in the past works conducted in Sub-Saharan Africa (Alene et al., 2014) and Mozambique (Costa and Delgado, 2019). Alene et al. (2014) also indicated that cassava varieties with high dry matter, starch and resistant to mosaic disease were ranked high than production constraints. Other key problems identified were soil fertility and nutrition (8.7%), marketing issues (7.2%), extension support (5.8%), farm machinery (5.8%) and pest and disease incidence (5.8%) (Table 2).

Identification of researchable issues

In stage 2, the 69 problems diagnosed were converted to 103 researchable issues which were later rated for their importance by the experts. The Principal Component Analysis of the experts rating extracted 10 components with 65 items, explaining 79.57% of variance (Table 3). During the analysis, 38 research issues explaining poor variance (commonality values < 0.50) or unusual factor loadings (> 1) were deleted.

Table 2. Field problems identified through production system oriented problem diagnosis

Sl. No.	Problems	Frequency	Percentage	Rank
1	Issues in industrial processing for starch and sago	27	39.1	1
2	Improved varieties	10	14.5	2
3	Soil fertility management	6	8.7	3
4	Marketing problems	5	7.2	4
5	Extension support	4	5.8	5
6	Farm machinery	4	5.8	5
7	Pest and disease issues and their management	4	5.8	5
8	Food quality related issues	3	4.3	8
9	Poor shelf life of tubers	2	2.9	9
10	Planting materials - availability and access	1	1.4	10
11	Climate variations	1	1.4	10
12	Weed management	1	1.4	10
13	Technology for animal feed	1	1.4	10
	Total	69		

Table 3. Principal components extracted with their loading range and variance explained

Sl. No.	Principal components	Factor loading	No. of items	Eigen value	Variance explained (%)
1	PC1: Technologies for sago and starch based industrial cassava production systems	0.564-0.872	21	22.62	27.92
2	PC2:Technologies for postharvest management and entrepreneurship development	0.591-0.846	10	9.23	11.39
3	PC3: Technologies for effective management of production, utilization and technology transfer	0.571-0.787	13	7.95	9.81
4	PC4: Labour saving technologies and novel products	0.576-0.795	6	5.45	6.73
5	PC5: Cutting-edge technologies for value chain improvement	0.573-0.737	6	4.90	6.05
6	PC6: Basic studies on postharvest management	0.613-0.714	4	3.894	4.808
7	PC7: Basic studies on CMD	0.617-0.783	2	3.082	3.805
8	PC8: Basic studies on water management	0.795	1	2.580	3.185
9	PC9: Basic studies on quality planting material production	0.607	1	2.509	3.098
10	PC10: Basic studies on genetic transformation of cassava	0.658	1	2.243	2.769

Based on the nature of research issues the Principal Component 1 (PC1) was named as ‘Technologies for sago and starch based industrial cassava production systems’, which had 21 items explaining 22.62% variance. While the principal component 2 (PC2) had ten items representing ‘Technologies for postharvest management and entrepreneurship development’ which explained 11.39% variance in the data, the principal component 3 (PC3) comprised 13 items of ‘Technologies for effective management of production, utilization and technology transfer’ and explained 9.81% variance. Principal Component 4 (PC4) explained 6.73% variance and comprised six items related to labour saving technologies and novel products. While Principal Component 5 (PC5) comprised six items of ‘Cutting-edge technologies for value chain improvement’ explained 6.05% of variance. Other components PC6 to PC10 together explained the basic studies in genetic transformation, quality planting material production, water management, Cassava Mosaic Disease resistance, and post harvest management which together explained 17.66% variance (Table 3).

From the analysis, it is evident that over 34% of the research issues were focused on technological needs of the industry as well as creating and sustaining tuber crops based entrepreneurship. Among them, the research priorities focusing improving performance of value chain in the starch and sago industries in Tamil Nadu was identified as highest priority area. These findings clearly established the emerging role of cassava as an industrial crop and also highlighted the need to reorient the tuber crops research programmes towards the industrial processing. The labour-saving technologies along with technologies for effective management of tuber crops production (PC 3 & 4) explained 16.54% variance in the data. As the tuber crops are considered as ‘less intensive management systems’ (Muimba-Kankolongo, 2018), they offer effective alternative to ‘high labour-demanding’ vegetable crops. Low priority for the basic research on genetic transformation, disease resistance and post harvest management indicates that tuber crops stakeholders demanded solutions for field-level problems ahead of fundamental research.

Final prioritisation based on economic assessment

Based on expert judgement scores, only 15 issues which had minimum rating of 4 were selected for economic assessment (Table 4). Among them, development of cassava mosaic disease resistant varieties and its management and lowering the cost of production of cassava were rated high (>4.5 rating) indicating stakeholders propensity towards profitable and commercial production of tubers in the industrial system

Selected research issues were subject to economic analysis of Net Present Value (NPV), Benefit cost ratio (BCR) and Internal Rate of Returns (IRR), which are presented in Table 5. The ranking was based on Net Present Value. It showed the priority in the order of development of CMD resistant varieties and its management, lowering the cost of production of cassava tubers, germplasm collection, maintenance and evaluation of tropical tuber crops, high starchy drought tolerant varieties in cassava, technology transfer studies and programme for tuber crops. However, it may be noted that among the researchable priorities identified, technology transfer studies and programme for cassava had highest Internal Rate of Return (IRR = 4636) indicating the investment in technology transfer fetches high profits. The technology transfer is the key driver of adoption of improved technologies, which maximises the yield while generating additional income for the farmers. Past studies on returns to investment in agricultural extension estimated that 8–49% in Uganda (Benin et al., 2011), 0.69 – 38.34% in India with an IRR of 18-84% (Joshi et al., 2015). The quality seed production and distribution and seed system studies along with research on lowering the cost of production of cassava tubers, which directly impact the cost of reduction, had reasonable IRR (134-136). In commercial production systems, the farmers often procure planting material from other sources, which escalate the cost of production. An ICAR-CTCRI study (Srinivas, 2009) demonstrated that investment in high yielding variety as quality planting material contributed 30.58% of total returns from cassava research investment. The resource allocation as perceived by the judges for cassava is 33%, of the total budget of research for all tropical tuber crops.The limited resources available for cassava research can be allocated for these researchable issues.

Table 4. Mean and standard deviation of experts' importance rating of researchable issues of cassava

Sl. No.	Researchable Issues	Mean	SD
1	Development of Cassava Mosaic Disease resistant varieties and its management	4.54	0.81
2	Lowering the cost of production of cassava tubers	4.53	0.89
3	Germplasm collection, maintenance and evaluation of tropical tuber crops	4.44	0.94
4	High starchy drought tolerant varieties in cassava	4.35	0.78
5	Technology transfer studies and programme for tuber crops	4.26	1.07
6	Reducing soil erosion in hilly tracts	4.24	1.01
7	Quality seed production and distribution and seed system studies	4.24	0.95
8	Agro-techniques for improving the yield reducing the cost	4.21	0.85
9	Exploring exclusive value added products from cassava	4.18	0.66
10	Modified starches for food and industrial application	4.12	0.91
11	Lowering the water usage and power consumption in starch factories	4.09	0.83
12	Creation of new business opportunities through cassava technologies	4.09	0.81
13	Improving marketing system and entrepreneurship development in cassava value addition	4.06	0.80
14	Development of effective gadgets for estimating starch content in cassava tubers	4.06	1.01
15	Biofuel from cassava	4.06	0.78

Table 5. Researchable issues prioritised based on economic analysis

Sl. No.	Researchable Issues	NPV	BCR	IRR (%)	Final Rank
1.	Development of CMD resistant varieties and its management	16472	658	73.00	1
2.	Lowering the cost of production of cassava tubers	4627	1002	134	2
3.	Germplasm collection, maintenance and evaluation of tropical tuber crops	3886	39	43	3
4.	High starchy drought tolerant varieties in cassava	3018	80	45	4
5.	Technology transfer studies and programme for tuber crops	1507	38	4636	5
6.	Management of soil erosion and depletion change in hilly tracts	1317	530	98	6
7	Quality seed production and distribution and seed system studies	1184	3.68	136	7
8	Agro-techniques for improving the yield reducing the cost	251	70.50	78	8
9	Exploring exclusive value added products from cassava	223	24.01	39	9
10	Modified starches for food and industrial application	78	21.45	59	10
11	Lowering the water usage and power consumption in starch factories	64	7.72	30	11
12	Entrepreneurial development for cassava	41	12.66	63	12
13	Improving marketing system and entrepreneurship development in cassava value addition	13	2.38	12	13
14	Development of effective gadgets for estimating starch content in cassava tubers	11	2.96	12	14
15	Biofuel from cassava	5	1.57	4	15

Conclusion

This paper proposed a methodology for assessing research priorities following a grass root and participatory approach clubbed with converting problems to researchable issues for judges rating followed by Principal Component analysis for meaningful categorization of issues and supported by economic analysis. Development of CMD resistant varieties and its management, lowering the cost of production of cassava tubers stood as major prioritised areas as per Net present value. The shifting of focus of research priorities towards meeting industry requirements, development of low cost technologies along with quality planting materials demonstrate the transition of cassava from staple food to industrial crop. Investment in these priorities was found worthy with high IRR. Since the current system is focusing on quantitative and secondary data to set research priorities, the farmers' preferences can be built into the technologies to maximize their utility to stakeholders and therefore resulting in wide adoption.

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