GOVERNMENT OF KERALA
KERALA STATE PLANNING BOARD

FOURTEENTH FIVE-YEAR PLAN
(2022-2027)

WORKING GROUP ON CONSTRAINTS TO TECHNOLOGY ADOPTION AND THE POTENTIAL TO RAISE PRODUCTIVITY IN KERALA AGRICULTURE

REPORT

AGRICULTURE DIVISION
MARCH 2022

FOREWORD

Kerala is the only State in India to formulate and implement Five-Year Plans. The Government of Kerala believes that the planning process is important for promoting economic growth and ensuring social justice in the State. A significant feature of the process of formulation of Plans in the State is its participatory and inclusive nature.

In September 2021, the State Planning Board initiated a programme of consultation and discussion for the formulation of the 14th Five-Year Plan. The State Planning Board constituted 44 Working Groups, with more than 1200 members in order to gain expert opinion on a range of socio-economic issues pertinent to this Plan. The members of the Working Groups represented a wide spectrum of society and include scholars, administrators, social and political activists and other experts. Members of the Working Groups contributed their specialised knowledge in different sectors, best practices in the field, issues of concern, and future strategies required in these sectors. The Report of each Working Group reflects the collective views of the members of the Group and the content of each Report will contribute to the formulation of the 14th Five-Year Plan. The Report has been finalised after several rounds of discussions and consultations held between September to December 2021.

This document is the Report of the Working Group on "Constraints to Technology Adoption and The Potential to raise Productivity in Kerala Agriculture." The Co-Chairpersons of Working Group were Dr. R. Chandra Babu, Vice Chancellor, Kerala Agricultural University and Dr. K. C. Bansal, Former Director, National Bureau of Plant Genetic Resources, Indian Council of Agricultural Research, New Delhi. Dr. R. Ramakumar, Member of the State Planning Board co-ordinated the activities of the Working Group. Sri.S.S.Nagesh, Chief, Agriculture Division was the Convenor of the Working Group and Smt.G. C. Roshni, Agronomist, Agriculture Division was Co-Convenor. The terms of reference of the Working Group and its members are in Appendix 1 of the Report.

Member Secretary

PREFACE

As part of formulation of the 14th Five Year Plan, the Kerala State Planning Board had constituted working groups of experts in all the major sectors. In Agriculture and Allied Sectors, 6 working groups were constituted viz. Agriculture and Cooperation, Animal Husbandry and Dairy, Inland and Marine Fisheries, Forest and Environment, Water Resources and Regional Packages. To discuss and frame policies in each of these sectors, the working groups were further divided into 28 Expert Sub-Groups (ESG) with specific mandates.

Each Expert Subgroup held at least three meetings beside one focused group meeting before finalising the report. We, the Co-Chairs, place our deep appreciation and gratitude to all the esteemed members of the ESG for their valuable contributions in preparing the report. We are extremely grateful to Dr. V. K. Ramachandran, the Honourable Vice-Chairperson, Kerala State Planning Board, Dr. R. Ramakumar, Member, Kerala State Planning Board and Sri. S. S. Nagesh, Chief, Agriculture Division for their consistent guidance and suggestions in preparing the report. The drafting team put in commendable work in bringing together all the views and opinions of the members. We sincerely hope the recommendations in the report can lead to important changes in the public policy on agricultural development in the State.

Dr. K. C. Bansal
Expert co-chairperson

Dr. R. Chandra Babu
Official co-chairperson

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CONSTRAINTS TO TECHNOLOGY ADOPTION AND THE POTENTIAL TO RAISE PRODUCTIVITY IN KERALA AGRICULTURE

HIGHLIGHTS

- This report highlights the low productivity of crops in Kerala, even within the most suited AEUs
- The current productivity and yield gaps in major crops are identified and the appropriate adoption of technology is discussed.
- A set of observations and suggestions are provided by the expert committee.

ABBREVIATIONS

AEUs	-	Agro Ecological Units
AEZs	-	Agro-Ecological Zones
AI	-	Artificial Intelligence
ANN	-	Artificial Neural Networks
AP	-	Average Productivity
ARYA	-	Attracting and Retaining Youth in Agriculture
ATIC	-	Agricultural Technology Information Centers
ATMA	-	Agricultural Technology Management Agency
BIPM	-	Biointensive Integrated Pest Management
BLAKCs	-	Block Level Agricultural Knowledge Centres
CPCRI	-	Central Plantation Crops Research Institute
CTCRI	-	Central Tuber Crops Research Institute
DoA	-	Department of Agriculture
DSS	-	Decision Support System
ESGs	-	Expert Subgroups
FPO	-	Farmer Producer Organisation
GAP	-	Good Agricultural Practices
GHG	-	Green House Gas
HYV	-	High Yielding Varieties
ICAR	-	Indian Councilof Agricultural Research
ICRISAT	-	International Crops Research Institute for the Semi-Arid Tropics
ICT	-	Information Communication Technology
IDM	-	Integrated Disease Management
IFS	-	Integrated FarmingSystem
IIFSR	-	Indian Institute of Farming System Research
IISR	-	Indian Institute of Spices Research
IoT	-	Internet of Things
IPDM	-	Integrated Pest and Disease Management
IPM	-	Integrated Pest Management
KAU	-	Kerala Agricultural University
KBs	-	KrishiBhavans
KFRI	-	Kerala Forest Research Institute
KUSAT	-	Kochin University of Science and Technology
KVK	-	Krishi Vigyan Kendra
LSG	-	Local Self Government
MGMG	-	Mera Gaon Mera Gaurav
NARS	-	National Agricultural Research System
NBPGR	-	National Bureau of Plant Genetic Resources
OFT	-	On Farm Trials
PP	-	Potential Productivity
PoP	-	Package of Practices
RARS	-	Regional Agricultural Research Station
RATTC	-	Regional Agricultural Technology Training Centre
RGCB	-	Rajiv Gandhi Centre for Biotechnology
RKVY	-	Rashriya Krishi Vikas Yojana

RRI	-	Rubber Research Institute
SAMETI	-	State Agricultural Management and Extension Training Institute
SHG	-	Self Help Group
SKS	-	Swasraya Karshaka Samithi
SOP	-	Standard Operating Protocols
SPB	-	Kerala State Planning Board
SWGs	-	Sectoral Working Groups
ToR	-	Terms of Reference
UPASI	-	United Planters Association of Southern India
VFPCK	-	Vegetable & Fruits Promotion Council of Kerala
WG	-	Working Groups
YG	-	Yield Gaps
YGA	-	Yield Gap Analysis
YGC	-	Yield Gap Coefficient
YP	-	Yield Potential
ZREAC	-	Zonal Research and Extension Advisory Committee

EXECUTIVE SUMMARY

The executive summary of the report of the ESG 4, constituted by State Planning Board (SPB) to address the concern of low productivity of major crops of Kerala and suggest appropriate measures to break the yield barrier through better use of technologies as well as through strengthening research extension linkages is presented herewith.

The report comprises of six parts that examine the current productivity and yield gaps in major crops of the state; identify the relationship between technology and productivity; explore the possibility of enhancing productivity through use of available technologies, assess the future technology needs in agriculture with focus on the XIV five year plan; evaluate how the research extension farmer linkages can be strengthened for better adoption of technologies and finally assess how homestead farming can contribute to sustainable growth of farming sector. The major observations and recommendations of the subgroup are as follows.

OBSERVATIONS

1. The productivity of major crops including that of coconut is low in the state compared to that of other leading states in the country.
2. Even within the state there exists wide variability in the productivity of crops between Agro Ecological Units (AEUs) and also within AEUs.
3. The suboptimal level of technology adoption is identified as one of the principal reasons for low productivity of crops in the state.
4. A range of technologies in the form of improved varieties, integrated nutrient management and integrated pest management techniques, biofertilizers and biopesticides, small farm machinery is already available to the farming community in the state.
5. The feasibility, viability and scalability of the above technologies have also been demonstrated through specific interventions of research institutions in the state.
6. Several factors like non-availability of quality planting materials, high cost of inputs, fluctuating prices, high labour costs and lack of awareness about technologies, however, contribute to the low technology adoption.
7. There is a serious threat of the already low crop productivity being compounded by the negative influence of climate change and an equally pressing need for mitigating the above impact and to reverse the decreasing trends in crop productivity.
8. Addressing the emerging challenges in farming as well as the aspirations of a young, technology savvy farming community in the future would call for new technologies that can help realise the production potential of each crop at minimal costs through improved resource use efficiency.
9. The Research-Extension (R-E) linkage in the state is weak and is impacting the transfer of technologies, thus weakening the efforts in technology development and dissemination.

10. Given the preponderance of small holdings in the state, promoting integrated farming system would be an appropriate strategy for helping farm families meet their food and nutritional security as well as for reinforcing their economic base.

RECOMMENDATIONS

1. Scientifically validated recommendations on the crops and cropping patterns, including the varieties and production packages for each AEU should be developed as a priority.
2. Programmes for achieving targeted productivity should be a major agenda at block and panchayat levels to reduce the yield gaps of major crops.
3. The availability of quality planting materials of the improved varieties needs to be ensured through a multi-pronged strategy of strengthening the farms under Department of Agriculture (DoA), promoting farmer-based collectives like Farmer Producer Organisations (FPOs) and through public-private partnerships involving private nurseries.
4. Interventions are required to double the farm power availability through small farm mechanisation. Measures like custom hiring facilities at affordable costs and development of skilled manpower in every block should be taken upon at war footing.
5. Large scale demonstration of technologies by research institutions like KAU should be strengthened. Participation of DoA and the entire local farming community should be ensured in such demonstrations and On Farm Trials (OFTs).
6. Focused efforts in technology development with very specific agenda is called for in areas such as crop improvement, crop production, crop protection and conservation agriculture.
7. Development of technologies for addressing the emerging challenges in the crop production sector can and need to be accelerated through the application ofadvancements in bio modelling, biotechnology, nano technology, Internet of Things (IoT), robotics etc.
8. Inter institutional and interdisciplinary research with adequate funding and involving all centres of knowledge within the state should be promoted as a policy.
9. R-E linkages in the state should be strengthened through greater involvement of research institutions at the block level Agricultural Knowledge Centres (AKCs), capacity building of main stream micro level extension personnel, through increased interface activities by research institutions and through use of ICT platforms.
10. Developing dynamic models of integrated farming and promoting the same through efforts to support technology adoption and marketing of farm produces through coordinated efforts of DoA, Local Self Government Institutions (LSGI) and research institution should be a major priority.

CHAPTER 1
INTRODUCTION

Kerala State Planning Board (SPB) has constituted Working Groups (WG) in different sectors, sub-sectors and areas for the process of formulation of the XIV Five-Year Plan 2022-2027 and Annual Plan 2022-2023. The Sectoral Working Groups (SWGs) thus formed were divided in to Expert Sub Groups (ESGs), with each ESG work on Terms of Reference (ToR) formulated by the SPB. Accordingly, the WG on `Agriculture and Cooperation sector' was constituted with 11 ESGs under it. This report is prepared by the ESG on `Constraints to Technology Adoption and the Potential to Raise Productivity in Kerala Agriculture'. The ESG was co-chaired by Dr. R. Chandra Babu, Vice Chancellor, Kerala Agricultural University and Dr. K. C. Bansal, Former Director, National Bureau of Plant Genetic Resources, Indian Council of Agricultural Research, New Delhi. The Terms of Reference for the ESG IV were as follows:

ToR 1 To assess the status of productivity of major crops of Kerala and estimated yield gaps
ToR 2 To identify linkages between the adoption and use of modern technology and the gaps in yield in major crops
ToR 3 To explore the potential for raising productivity in major crops with existing technologies
ToR 4 To identify gap in the availability of technology and suggest measures to hasten the development of technologies
ToR 5 To suggest measures to improve research extension linkages in Kerala's Agriculture
ToR 6 To suggest Policy framework to transform homesteads into sustainable units

The ESG had several rounds of discussion for formulation as well as finalisation of the report. The report comprises of six chapters based on the ToRs under discussion.

The first chapter of the report examines the productivity of major crops of Kerala and analyses the yield gap in major crops across the different AEUs delineated in the state. Kerala still lags behind many other states in the productivity of principal crops including rice and coconut despite the introduction of several new and improved technologies. Yield gaps have been estimated as the difference between potential yield and average farmer's yields over a specified spatial and temporal scale of interest. This chapter throws light upon the mean and potential productivity of major crops in different AEUs and also the variation in average productivity from the mean of potential zonal yield of major crops. An attempt to classify these zones into high, medium and low yield gap zones based on Yield Gap Coefficient (YGC) for different crops is also made.

The second chapter analyses the extent of adoption of recommended technologies such as improved varieties, nutrient and pest management etc. by farmers with respect to the major crops in Kerala. That low adoption of technologies has been strongly correlated with low adoption of scientific technologies through case studies where substantial improvements in productivity has been made possible by following recommended practices. The analysis is followed by an attempt to identify the socio-economic and technology wise constraints to adoption of technologies.

The third chapter explores the potential for raising productivity in major crops with existing technologies. Instances of technologies that are available, from varieties to pest management have been showcased. The chapter concludes with various approaches that can be adopted for improving productivity with the existing technologies, followed by an action plan.

The fourth chapter attempts to identify the gap in farming technologies and propose measures to hasten the development of technologies. The chapter recognizes food security concerns, climate change and advent of digital technologies as the technology drivers in the future. The technology need assessment is presented under separate themes like crop improvement, crop production, crop protection and conservation of natural resources. A list of priorities in each of the above areas have been included. Measures are also suggested for hastening the development of technologies including adaptive research, institutional collaborations and participatory technology development. Establishment of Advance Centre for Frontier Technologies and Advance Centre for Infrastructure and Capacity Building have been proposed.

Extension plays a vital role in linking farming communities with research. Yet the experience suggests that the linkage between agricultural research and extension is feeble, in spite of an impressive extension network and an equally impressive presence of research institutions. The currently available platforms for RE linkages are discussed. Suggestions for improvement include need-based research, farmer scientist interfaces, capacity building for extension personnel, and formation of research advisory councils.

The last chapter reiterates the importance for a policy framework to convert homesteads into sustainable units of entrepreneurship. The traditional homesteads ensure food and nutritional security, improve family health and help preserve indigenous knowledge and culture along with assured economic security. The proposed framework of sustainable units emphasises on three pillars, namely, women, marketing and technology. Several state level interventions/policies that are novel and essential are proposed in the report. It is suggested that suitable models be developed based on AEUs, farm holding size and availability of resources through farmer participatory research.

Finally, the report synthesizes the major recommendations that emanated out of the deliberations and proposes multipronged strategy to improve the adoption of technologies and productivity in Kerala's agriculture.

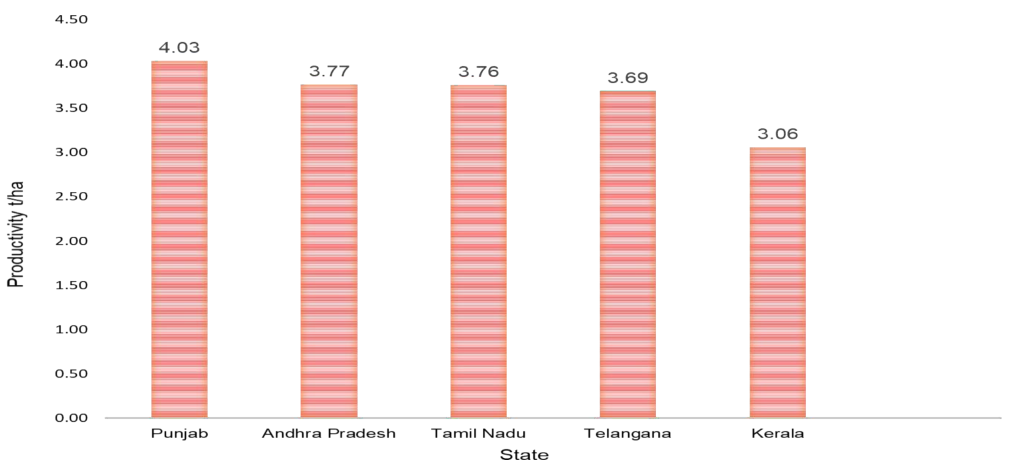
CHAPTER 2
THE STATUS OF PRODUCTIVITY OF MAJOR CROPS OF KERALA AND ESTIMATED YIELD GAPS

Agriculture in Kerala is characterised, by features like extensive biodiversity, predominance of perennial crops, homestead farming and preponderance of highly fragmented land holdings. Almost 97 per cent of agricultural operational holdings in the state are marginal (Department of Economics and Statistics, 2019) and the average size of these holdings has been declining since the 1990s. Considering the limited possibility of extending area under farming, it is evident that the state has to focus on raising the crop productivity by ensuring efficient use of available resources in order to achieve food and nutritional security.

Productivity of Major Crops in Kerala- An Overview

A comparison with national productivity averages shows that though several innovative policies and improved technologies have been introduced and implemented in Kerala, the state still lags major producers in India with respect to productivity of its principal crops such as rice and coconut. Productivity of rice in the state, for instance, is 3.06 t/ha (2019-20) which is much below the level of major producing states like Punjab (4.03 t/ha), Tamil Nadu and Andhra Pradesh (3.76 t/ha each) (Figure 1).

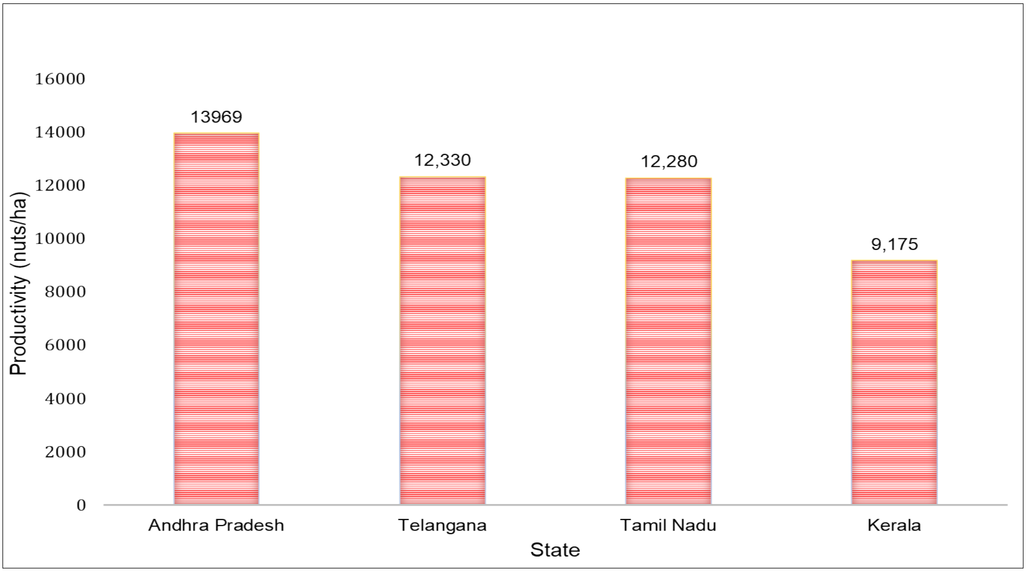
Figure 1. Comparison of rice productivity in Kerala with major producing states 2019-2020



Source: Directorate of Economics & Statistics, MoA & FW, GoI, 2020

Similarly, the state enjoys the status of being the major producer of coconut in the country. However, the productivity of the crop in the state, at 9175 nuts/ha, is much below that of other major producers viz., Andhra Pradesh, Telangana and Tamil Nadu (Figure 2).

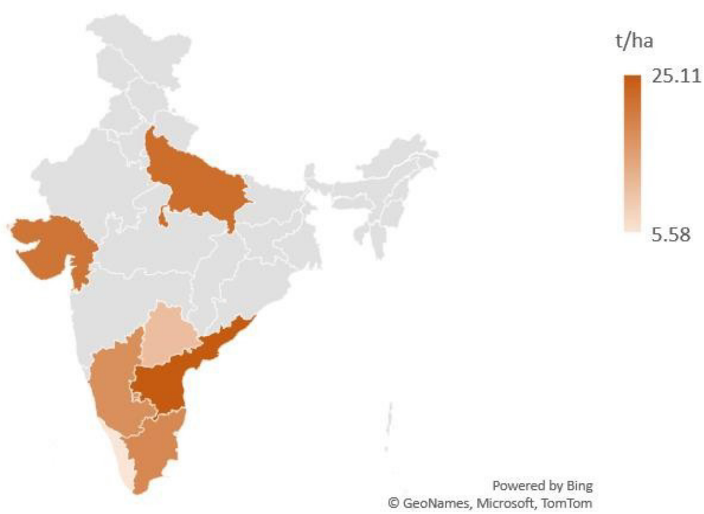
Figure2. Comparison of coconut productivity in Kerala with major producing states (2019-2020)



Source: Coconut Development Board, 2020

Likewise, the average productivity of fruit crops in the state is the lowest among the different states (Figure 3).

Figure 3. Comparison of productivity of fruit crops in Kerala with major producing states (2019-20)



Source: Ministry of Agriculture and Farmer's Welfare, GoI, 2020

Pronounced variations in productivity also exist between different crop ecosystems within the state such as between research stations and farmers' plots as well as between farmers' plots. These variations in productivity or yield gaps are to be considered as significant indicators in agricultural planning. `Yield Gap Analysis' (YGA) helps to identify the constraints in crop production that prevents realisation of the highest possible yield levels. It is also important from a planning perspective, as it can support decision making on research, investments and development policies in the sector. However, such an analysis is a complex exercise, given the high crop diversity and cropping intensity prevalent in the state.

In this context, it needs to be emphasized that, from a crop production perspective, the entire state has been divided into 23 Agro Ecological Units (AEUs), based on altitude, rainfall pattern, soil type and topography (Annexure 1). It would be therefore more appropriate that YGA should be based on the functional data from the AEUs on all parameters. Hence, the AEUs form the basic unit for further elaboration of yield gap in this report.

Estimation of Yield Gap in Major Crops of Kerala

Yield gaps (YG) are estimated as the difference between yield potential and average farmers' yields over some specified spatial and temporal scale of interest. For this report, the YG is estimated as the difference between Yield Potential (YP) as (the highest productivity reported by the farmers) for a particular crop in the given AEU, and the average productivity (AP) of the crop reported in the AEU when grown under field conditions.

Thus, the Yield Gap Coefficient (YGC) is given by the formula,

YGC= [(Best Farmer Productivity - Average Productivity)/Average Productivity]

The average productivity for the major crops i.e., rice, coconut, arecanut, cassava, black pepper and banana are provided in Table 1.

As evident from Table 1, there is pronounced variation in average productivity of major crops across different AEUs. For instance, the average yield of rice is only 2 t/ha in Attappady hills and 2.2 t/ha in Pokkali lands which is only half the mean productivity in Kuttanad (4.2 t/ha). Average yields below the state average of 3.05t/ha is reported in 12 AEUs while only 10 AEUs have mean yields greater than the state average.

In case of coconut, the variation in productivity is as much as three times between Attappady hills (110 nuts/palm) and the AEUs like Southern Coastal Plain, Kuttanad and Southern Laterites. Similar wide variability can be observed in case of other crops such as black pepper, cassava, banana etc., which points to the relevance of developing AEU based cropping patterns. For a better understanding, comparison between average productivity and potential productivity of the major crops is given below (Table 2).

Table 1. The average productivity for some of the major crops in Kerala across various AEUs

Sl. No.	AEU	NameofAEU	Rice (t/ha)	Coconut (nuts/palm)	Arecanut (kg/palm)	Cassava (t/ha)	Pepper (kg/ha)	Banana (t/ha)
1	AEU1	Southern Coastal Plain	2.7	33	8	20	502	11.5
2	AEU2	Northern Coastal Plain	2.6	46	1.1	15	350	16
3	AEU3	Onattukara Sandy Plain	2.4	52	0.7	18	346	18
4	AEU4	Kuttanad	4.2	36	0.7	29	408	26
5	AEU5	Pokkali Land	2.2	26	1.6	12	430	15
6	AEU6	Kole Land	3.3	52	1.6	17	831	14
7	AEU7	Kaipad Land	2.9	41.5	0.9	21	450	15
8	AEU8	Southern Laterites	3.4	33	1	13	600	14
9	AEU9	South Central Laterites	3.3	35	1.4	20	504	11
10	AEU10	North Central Laterites	3.9	50	1.3	12	599	15
11	AEU11	Northern Laterites	2.7	48	1.2	13	461	48
12	AEU12	Southern and Central Foot Hills	3.6	37	1.3	19	530	13
13	AEU13	Northern Foot Hills	2.8	52	1.3	20	434	14
14	AEU14	Southern High Hills	2.4	39	1	16	573	12
15	AEU15	Northern High Hills	2.9	56	1.5	21	482	18
16	AEU16	Kumily Hills	2.4	27	2.6	15	682	20
17	AEU17	Marayur Hills	2.76	45	0.6	22	531	11
18	AEU18	AttapadyHills	2.0	110	2.8	20	217	25
19	AEU19	Attappady Dry Hills*	-	-	-	-	-	-
20	AEU20	Wayanad Central Plateau	3.6	88	1	19	583	13
21	AEU21	Wayanad East ern Plateau	3.2	42	1.6	19	501	30
22	AEU22	Palakkad Central Plain	3.9	61	1.6	13	157	10

23	AEU23	Palakkad Eastern Plain	3.7	63	2.3	17	-	11.5
		Mean	3.04	48.75	1.69	17.77	484.33	17.32

Data is not available *Source:* Author's compilation

It is evident from the Table 2 that when we consider inter AEU comparison, the AP and PP show a wide variation in most of the AEUs. Arguably, the above information is more significant and a concrete indicator when we consider intra AEU comparison of the potential yield that can be attained in a given AEU.

Table 2. AEU wise average productivity (AP) and potential productivity (PP) of major crops

Sl. No.	AEU	Rice(t/ha)		Coconut (nuts/palm)		Arecanut (kg/palm)		Cassava (t/ha)		Pepper(kg/ha)		Banana(t/ha)	
		AP	PP	AP	PP	AP	PP	AP	PP	AP	PP	AP	PP
1	AEU1	2.7	6.3	33	147	2. 8	8	20	55.6	502	1247	11.5	38
2	AEU2	2.6	4.88	46	180	1.1	1.9	15	39	350	1125.75	16	46
3	AEU3	2.4	5.66	52	150	0.7	3.16	18	37	346	2117	18	36
4	AEU4	4.2	8	36	195	0.7	3.8	29	73	408	1876	26	61
5	AEU5	2.2	5.2	26	146	1.6	5.5	12	30.5	430	1247	15	26.5
6	AEU6	3.3	7.7	52	91	1.6	3.3	17	42	831	1571	14	46.5
7	AEU7	2.9	4.75	41.5	152	0.9	2.6	21	37	450	2169	15	41
8	AEU8	3.4	10	33	175	1	5.2	13	40	600	1800	14	45
9	AEU9	3.3	6.7	35	109	1.4	4.3	20	63	504	1760	11	40
10	AEU10	3.9	9	50	160	1.3	3.75	12	35	599	1980	15	38
11	AEU11	2.7	6.5	48	191	1.2	4.7	13	50	461	2242	48	57
12	AEU12	3.6	4.9	37	112	1.3	3.7	19	51.4	530	1800	13	34
13	AEU13	2.8	4.8	52	143	1.3	2.6	20	35	434	1571	14	33
14	AEU14	2.4	3.9	39	76	1	2.5	16	28.8	573	1396	12	29
15	AEU15	2.9	5.8	56	186	1.5	3.8	21	72	482	1700	18	44
16	AEU16	2.4	5	27	100	2.6	2.9	15	40	682	1500	20	40
17	AEU17	2.76	3	45	70	0.6	2.5	22	0	531	643	11	18
18	AEU18	2.0	2.5	110	250	2.8	6.3	20	30	217	600	25	27
19	AEU19*	-	-	-	-	-	-	-	-	-	-	-	
20	AEU20	3.6	7.5	88	250	1	2	19	60	583	3500	13	31
21	AEU21	3.2	3.8	42	200	1.6	3	19	60	501	1000	30	66
22	AEU22	3.9	6.3	61	200	1.6	3.6	13	25	157	500	10	25
23	AEU23	3.7	5.5	63	120	2.3	2.7	17	40	-	-	12	25
	Mean	3.04	5.80	48.75	154.68	1.32	3.72	17.77	42.90	484.30	1587.80	17.33	38.50

*Data not available Source: Author's compilation

While the inter AEU variability in potential productivity underscores the already stated need for AEU based cropping patterns and crop planning, the wide intra AEU yield gaps point to the need for more focused crop wise interventions in implementation of targeted yield enhancement programmes by both Block Level Agricultural Knowledge Centres (BLAKCs) & Krishi Bhavans (KBs) to narrow down the yield gap. This calls for the identification of the critical elements leading to enhanced productivity and replicating them in low productivity areas of each AEU.

The inferences draw further support from the Table 3 on AEU wise YGC. Since YGC is based on achievable higher yield levels reported by farmers, these estimates can provide an index for targeted yield enhancement.

Table 3. AEU wise YGC of major crops across various AEUs

Sl. No.	AEU	Rice	Coconut	Arecanut	Cassava	Pepper	Banana
1	AEU1	1.33	3.45	1.85	1.78	1.48	2.3
2	AEU2	0.87	2.91	0.72	1.6	2.21	1.87
3	AEU3	1.35	1.88	3.51	1.05	5.11	1
4	AEU4	0.9	4.44	4.42	1.51	3.59	1.34
5	AEU5	1.36	4.61	2.43	1.54	1.9	0.76
6	AEU6	1.33	0.75	1.06	1.47	0.89	2.32
7	AEU7	0.63	2.66	1.88	0.76	3.82	1.73
8	AEU8	1.94	4.3	4.2	2.07	2	2.21
9	AEU9	1.03	2.11	2.07	2.15	2.49	2.63
10	AEU10	1.3	2.2	1.88	1.91	2.3	1.53
11	AEU11	1.4	2.97	2.91	2.84	3.86	0.18
12	AEU12	0.36	2.02	1.84	1.7	2.39	1.61
13	AEU13	0.71	1.75	1	0.75	2.61	1.35
14	AEU14	0.62	0.94	1.5	0.8	1.43	1.41
15	AEU15	1	2.32	1.53	2.42	2.52	1.44
16	AEU16	1.08	2.7	0.11	1.66	1.19	1
17	AEU17	0.08	0.55	3.16	1	0.21	0.63
18	AEU18	0.25	1.3	1.25	0.5	1.7	0.08
19	AEU19*	-	-	-	-	-	-
20	AEU20	1.08	1.84	1	2.15	5	1.3
21	AEU21	0.18	3.76	0.87	2.15	0.99	1.2

22	AEU22	1.17	2.3	1.25	0.9	2.2	1.5
23	AEU23	0.48	0.9	0.2	1.3	-	1.2

Data not available *Source*: Author's compilation

The classification of AEU based on YGC into high, medium and low yield gap zones is furnished in Table 4.

Table 4. Classification of AEUs based on categorisation of YGC

Sl. No.	AEU	Rice	Coconut	Arecanut	Cassava	Pepper	Banana
1	AEU1	High	High	Medium	Medium	Low	High
2	AEU2	Low	Medium	Low	Low	Low	High
3	AEU3	High	Low	High	Low	High	Low
4	AEU4	Low	High	High	Low	High	Low
5	AEU5	High	High	Medium	Low	Low	Low
6	AEU6	High	Low	Low	Low	Low	High
7	AEU7	Low	Medium	Medium	Low	High	High
8	AEU8	High	High	High	Medium	Low	High
9	AEU9	Low	Low	Medium	High	Medium	High
10	AEU10	Medium	Low	Medium	Medium	Low	Medium
11	AEU11	High	High	High	High	High	Low
12	AEU12	Low	Low	Low	Medium	Medium	Medium
13	AEU13	Low	Low	Low	Low	Medium	Low
14	AEU14	Low	Low	Low	Low	Low	Low
15	AEU15	Low	Low	Low	High	Medium	Medium
16	AEU16	Medium	Medium	Low	Low	Low	Low
17	AEU17	Low	Low	High	Low	Low	Low
18	AEU18	Low	Low	Low	Low	Low	Low
19	AEU19	-	-	-	-	-	-
20	AEU20	Medium	Low	Low	High	High	Low
21	AEU21	Low	High	Low	High	Low	Low
22	AEU22	Medium	Low	Low	Low	Low	Medium
23	AEU23	Low	Low	Low	Low	-	Low

Source: Author's compilation, details furnished in Annexure 2

It can be seen that approximately 40-56 per cent of all AEUs fall in to the high or medium categories for all the crops listed. The extent is relatively higher for coconut and cassava while is marginally lower in case of paddy and arecanut. Thus, YGC can also be a broad indicator as to the crops that call for greater attention in the quest to narrow the yield gap.

Conclusion

Yield gap assessment is important as a decision support tool which can help targeting for higher productivity. It is complex in nature because it is determined by various factors namely soil characteristics, adoption of technologies, microclimatic variations, genetic potential of crop varieties management practices, agroecology etc. By assigning relative importance to each of these factors, it might be able to provide more valuable insights and suggestions for `bridgeable yield gap' in a given AEU. The present report, however, considered only gross estimates of mean values of productivity of crops, the highest reported productivity by farmers and deviations thereof for yield gap estimates.

Yet, it has brought out clearly the following points with regard to the productivity of some of the major crops of the state.

- The overall productivity of most of the major crops grown in Kerala is very low compared to that of other states in the country.
- Substantial yield gaps exist among the different AEUs which suggest the need for more scientific assessment in the choice of crops to be grown in each AEU.
- The wide variation in average productivity within AEU points to the possibility of enhancing the productivity in each AEU through micro level planning and support programmes aiming at targeted levels of production.

CHAPTER 3
LINKAGES BETWEEN THE ADOPTION AND THE USE OF MODERN TECHNOLOGY AND THE GAPS IN YIELD IN MAJOR CROPS

Introduction

It has been established in the previous section that significant yield gap exists for almost all the major crops across all AEUs in the state. Bridging this gap by enhancing productivity would be possible only through effective utilization of appropriate technologies. Substantial numbers of technologies are available for ensuring higher productivity and income from the agriculture sector. These include high yielding varieties of crops, integrated nutrient management practices, soil and water management technologies, multiple cropping and integrated farming technologies, farm mechanisation and integrated pest and disease management techniques. Technical feasibility and economic viability of these technologies have been demonstrated in farmers' fields. However, the extent of technology adoption in agricultural sector is very low due to various socio-economic and bio-physical constraints which leads to low productivity.

Extent of adoption of technologies

Extent of adoption of recommended technologies in major crops viz., coconut, paddy, vegetables, tapioca, black pepper, cashew, banana, arecanut and coffee in the state are summarised in the following tables.

Table 5. Extent of adoption of recommended technologies in coconut

Sl.No.	Recommended technology	Extent of adoption (%)
1	Improved varieties/ hybrids(≥25%)	8.98
2	Maintenance of optimum plant density	32.59
3	Adoption of pit size	68.34
4	Inter/ mixedcropping	47.49
5	Integrated farming	25.68
6	Soil and water conservation practices	38.36
7	Irrigation	51.83
8	Chemical fertilisers as per recommendation	11.97
9	Integrated pest management(IPM)	29.42
10	Integrated disease management(IDM)	8.80
11	On farm recycling of biomass	31.66

In the case of coconut, 68.34 per cent of the farmers followed the recommended pit size while the extent of adoption of irrigation techniques was 51.83 per cent. However, the adoption rate of new varieties (8.98%) and IDM (8.80%) was very low. Spacing to ensure optimum plant density, on-farm recycling of biomass and IPM practices were adopted by only less than a third of the coconut growers. The relatively poor extent of adoption of recommended cultivation practices could be the major factor leading to low productivity of coconut in the state.

Table 6. Extent of adoption of recommended technologies in paddy

Sl.No.	Recommended technology	Extent of adoption (%)
1	Improved varieties	HYV-60
2	Integrated nutrient management	Organic manure-60.06 Inorganic fertilizers-75.94
3	Integrated pest and disease management (IPDM)	Insecticides-71.36 Fungicides-24.54 Organic management-42.5
4	Value addition through product diversification	Very less

In the case of rice, the adoption of improved varieties and organic manure application was followed by 60 per cent of the rice farmers. As much as 75 per cent of farmers used chemical fertilizers and over 70 per cent used insecticides for pest management.

Table 7 . Extent of adoption of recommended technologies in vegetables

Sl.No.	Recommended technology	Extent of adoption (%)
1	Improved varieties	HYV-67.27
2	Integrated nutrient management	Organic manure-76.00 Inorganic fertilizers-66.91
3	Integrated pest and disease management	Insecticides-54.18 Fungicides-31.09 Organic management-39.33
4	Value addition through product diversification	Nil

Use of organic manures (76%) as well as high yielding varieties (67.27%) were the most adopted technologies by vegetable farmers, followed by use of chemical fertilizers and insecticides with 66.91 and 54.18 per cent respectively.

Technology adoption in tapioca was quite good when we consider variety (42.18), relatively high for spacing (82.44) and organic manuring (75.3), medium for use of inorganic fertilizers as per recommendations (52.76), very low for use of insecticides (10.99) and nil for use of fungicides.

Table 8. Extent of adoption of recommended technologies in cassava

Sl.No.	Recommended technology	Extent of adoption (%)
1	Improved varieties including hybrids	HYV-42.18
2	Spacing	82.44
3	Integrated nutrient management	Organic manure-75.30 Inorganic fertilizers-52.76
4	Integrated pest and disease management	Insecticides-10.99 Fungicides-0
5	Value addition through product diversification	Very less

Table 9. Extent of adoption of recommended technologies in black pepper

Sl.No.	Recommended technology	Extent of adoption (%)
1	Improved varieties including hybrids	HYV-55.90
2	Integrated nutrient management	Organic manure-70.45 Inorganic fertilizers-34.90
3	Integrated pest and disease management	Insecticides-33 Fungicides-19.66 Bio-controlagents-34.5
4	Value addition through product diversification	Nil

The extent of adoption of improved varieties was medium (55.9%) in the case of black pepper. However, adoption of nutrients and plant protection chemicals was very low.

Table 10. Extent of adoption of recommended technologies in cashew

Sl.No.	Recommended technology	Extent of adoption(%)
1	Improved varieties	20%
2	Spacing	60%
3	Integrated nutrient management	Organicmanure-20% Inorganicmanure-30%
4	Integrated pest and disease management	Insecticide-20% Fungicide-0%
5	Irrigation	20%
6	Pruning	20%
7	Value addition through product diversification	Nil

Sixty per cent of the cashew farmers followed recommended spacing in case of cashew while nearly one third of the cashew farmers adopted inorganic chemical application as per recommendations. Organic manure application as per package of practices was followed by 20 per cent of cashew growers.

Table 11. Extent of adoption of recommended technologies in banana

Sl.No	Recommended technology	Extent of adoption (%)
1	Improved varieties	Not available
2	Spacing	71.06
3	Integrated nutrient management	Organic manure-72.05 Inorganic manure-67.11
4	Integrated pest and disease management	Insecticides-35.93 Fungicides-15.55
5	Value addition through product diversification	Very less

In the case of banana, the technology adoption index for organic manure application (72.05%), spacing (71.06%) and inorganic fertilizer application (67.11%) was comparatively high. Though 35.93 per cent farmers adopt insecticides and 15.55 per cent growers adopt fungicide application, the use of plant protection chemicals was not as per recommendations.

Table 12. Extent of adoption of recommended technologies in arecanut

Sl.No	Recommended technology	Extent of adoption(%)
1	Improved varieties	49.74
2	Spacing	69.33
3	Integrated nutrient management	Organic manure-58.28 Inorganic manure-49.5
4	Integrated pest and disease management	Insecticide-29.06 Fungicide-22.40
5	Value addition through product diversification	Nil

Coverage of high yielding varieties in arecanut was 49.74 per cent. About 58.28 percent of arecanut farmers applied organic manure to the areca palms and 49.5 percent growers applied inorganic fertilizers. However, adoption of IPM and IDM was low except for the spraying against mahali (fruit rot) disease.

Table 13. Extent of adoption of recommended technologies in coffee

Sl.No	Recommended technology	Extent of adoption (%)
1	Improved varieties	53.68
2	Spacing	61.64
3	Integrated nutrient management	Organic manure-52.07 Inorganic fertilizer-56.44
4	Integrated pest and disease management	Insecticides-27.23 Fungicides-12.57
5	Irrigation	33.35
6	Shade trees	80.61
7	Pruning	58.49

More than 50 per cent of coffee farmers followed recommendations with respect to application of fertilizers, use of improved varieties and pruning while pest and disease management registered low values for technology adoption. One third (33.35%) of coffee growers adopted irrigation. The recommendation to raise shade trees for the maintenance of congenial microclimate in coffee orchards, though was adopted by 80.61per cent of the growers, pruning was followed by only 58.49 per cent of the coffee growers.

A cursory glance at the summarised information above (Tables 5 to 13, Source: author's compilation) clearly indicates that the extent of technology adoption in the major crops cultivated in the state is far from satisfactory. The low level of technology adoption is a major reason for the huge yield gaps observed in the major crops cultivated in the state.

In general, it can be seen that the rate of adoption of improved varieties and hybrids in the major crops is only low to medium level. Even though majority of the farmers apply organic manure, the same cannot be said about application of inorganic fertilizers. and the rate of adoption of modern irrigation methods such as micro-irrigation is very low. Adoption of multiple cropping and integrated farming systems is also not satisfactory. In most of the crops the extent of adoption of pest management and disease management technologies is quite low.

Constraints to adoption of technologies

Inherent problems in Kerala agriculture like increasing share of non-agricultural area in the total geographical area, the land becoming a highly valued commodity and the subsequent pressure on agricultural land, absentee landlordism and low level of dependence on agriculture as the major source of income, predominance of marginal holdings, lack of availability of labour and high wage rate, lack of irrigation facilities, etc. result in neglect of the agricultural holdings and the resultant low level of adoption of recommended technologies. Further, there is a shift in cropping pattern with a large skew towards commercial crops, where a great degree of uncertainty prevails due to the frequent price fluctuations. This also contributes to the low levels of attention paid to agriculture, resulting in low productivity and income. Finally, lack of appropriate technologies is also a challenge in a few areas like mechanisation. Technology-wise constraints experienced by the farming community are briefly discussed below.

Insufficiency of quality planting material

Lack of availability of quality seeds/planting material continues to be a major problem faced by farmers in adopting the improved varieties and hybrids. In crops like coconut, massive programmes for replacing old and unhealthy palms are necessary to increase productivity. This demands enormous quantity of quality seedlings and there exists a wide gap in supply of the seedlings that the public sector institutions are unable to meet.

Similar shortage also exists in case of fruit crops where there is great demand for quality planting materials like grafts and layers, but availability is extremely limited. Intermediaries have been hugely benefitting from the situation wherein inferior/spurious planting materials are supplied to farmers thus adversely affecting sustainable growth of the sector. The delay in getting the released varieties registered is a major challenge in case of paddy and vegetables since agencies like National Seed Corporation can mass produce only registered seeds.

Sub optimal planting densities

Maintenance of optimum planting density by adopting the recommended spacing is very important in realizing better yields. This is not seen followed by farmers in the case of most crops like coconut, banana etc. Lack of awareness about the recommended spacing and the fragmented size of holdings are the major bottlenecks in this regard. Hence, it is necessary to formulate and implement interventions for restructuring orchards including homesteads which are overcrowded.

Poor irrigation and water management

Lack of irrigation facilities is a major constraint in adopting the recommended practices for irrigation and water management in crops, leading to low productivity in crops. Strengthening the irrigation infrastructure as well as planning and implementing interventions for improving the storage and utilisation of water in the rivers of the state can go a long way in addressing this concern. Promotion of water conserving irrigation methods such as drip irrigation is very relevant for water scarce areas of the state.

Lack of soil and water conservation measures

Even though the state receives one of the highest average annual rainfall in the country (3000 mm), it is often prone to both flood and drought. This indicates inefficient water and soil conservation technologies which in turn leads to low productivity in crops. The extent of adoption of watershed-based interventions for natural resource management as well as production system enhancement in agricultural holdings is not at satisfactory levels due to various factors including lack of awareness, high cost of interventions, lack of labour etc.

Poor soil health management

Soil related constraints such as high acidity and deficiency of primary, secondary and micronutrients in soils across Kerala contribute significantly to the low productivity of crops in the state. AEU based integrated nutrient management, based on the soil test results is therefore inevitable to ensure better productivity of crops. Constraints such as lack of knowledge about the recommended soil health management practices, lack of availability and high cost of fertilizer inputs, lack of labour, lack of adequate incentives for adopting soil test based nutrient management practices, false propaganda against use of chemical fertilizers, etc., adversely affect proper adoption of scientific soil health management practices.

Studies reveal that the proportion of farmers who tested their soils is very low. Again, only half of the farmers who have had their soils tested have resorted to fertilizer application as per the soil test-based recommendations. The widespread deficiency of micronutrients such as boron, zinc, copper, etc in the soils across AEUs, remains largely unaddressed, compounding the productivity problem.

Low prevalence of multiple cropping and integrated farming

The agrarian landscape of state is dominated by small and marginal land holdings. In addition, farmers mostly practice monocropping which compromises the ecological sustainability and economic viability of already disadvantaged holdings. The poor adoption of multiple cropping and integrated farming, which can help farm families cushion themselves against production and market related shocks can force farm families out of agriculture.

Several sustainable models of multiple cropping and integrated farming system models have been developed and demonstrated in farmers' gardens by the research institutions, in spite of which the extent of systematic and scientific adoption of such models in farmers' fields is quite low. Constraints for adopting multiple cropping and integrated farming include lack of labour and high wage rate, lack of availability of planting materials of component crops, lack of sufficient interspace for intercropping due to unsystematic planting of tree components etc.

Low adoption of integrated pest and disease management

Incidence of pests and diseases have always been a major constraint to crop production, irrespective of crops. Though technologies are available for the integrated management of pest and diseases, adoption of recommended IPM/IDM practices is quite low in farmers' field. Pest and disease management is heavily dependent on plant protection chemicals in over ninety per cent of instances, with adoption of IPM being a mere three per cent. Various constraints including lack of awareness/knowledge among farmers about the recommended IPM/IDM technologies, lack of availability of bio-inputs and plant protection chemicals and their high cost, lack of labour, inadequate extension support, etc. have resulted in low level of adoption of plant protection technologies.

Low levels of mechanization

Adoption of mechanisation can enhance productivity and reduce production costs. Yet, for a state where nearly seventy per cent of production cost are wages and there is acute paucity of labour, the extent of mechanisation is extremely low and is mostly limited to paddy. The Factors like poor custom hire facilities for farm machinery, lack of credit facilities, high capital cost of implements, small farm size, high costs of operation, non-availability of suitable implements and spare parts, inadequate service and repair facilities, lack of skilled labour for operating machines etc. are some of the reasons for the poor level of mechanisation in the State.

Conclusion

It can be observed that for most of the major crops grown in the state, the extent of technology adoption by farmers has been low to moderate. The low adoption of improved varieties, which can contribute to productivity to the greatest extent is a case in the point, with paddy and vegetables being exceptions.

Adoption of other key technologies like IPM and INM have also been low. The low adoption of technologies is one of the major reasons for low productivity. This is evident from the substantial improvement in productivity by adoption of recommended technologies in different research institutions.

The major domains where the use of crop production technologies have been low include using improved varieties, soil and water management, nutrient management, IPDM, integrated farming and mechanisation. The reasons for the slow diffusion of technologies include non-availability of quality planting materials, high cost of inputs, fluctuating prices, high labour costs and lack of awareness about technologies.

CHAPTER 4
POTENTIAL FOR RAISING PRODUCTIVITY IN MAJOR CROPS WITH EXISTING TECHNOLOGIES

Introduction

The section three clearly identifies linkages between the adoption and use of modern technology and the gaps in yield of major crops. It has been brought out clearly that while a range of technologies are available for crop improvement, crop production and crop protection, the extent of large-scale adoption of these technologies is very limited, resulting in pronounced yield gap in different crops.

The PoP recommendations released by KAU, provides crop management protocols for all the major crops of Kerala, relying on the scientific inputs from the state and central research organisations. These prescriptions ensure sustainable management through the use of eco-friendly technologies taking into consideration the social, economic and technological aspects.

Improving Productivity With Existing Technology: Approaches

Field level adoption of scientific technologies requires the creation of an enabling environment for effective technology transfer, capacity building, input provision and market support. Targets should be set for reducing the yield gaps. This has to be followed with systematic action plan to achieve the above targets that addresses the major hurdles in technology adoption by redesigning the agricultural extension mechanism, institutional support interventions through social capital development and policy changes.

Presented below are some of the critical areas of crop production where available technologies and approaches can be utilized for enhancing productivity.

Scientific land use and cropping patterns

The state of Kerala is characterised by high level of biodiversity, wherein the ecosystem diversity is markedly clear starting from the high hills to below sea level areas, resulting in wide variability in climate, land and soil. This exemplifies the need for assessing the economic and ecological viability before deciding on the suitability of a crop.

Broad recommendations at AEU level can ideally form the base for more focused micro level cropping patterns that can be formulated by the Block Level Agricultural Knowledge Centres (AKCs) or Krishi Bhavans, in consideration of additional factors like land gradation, water availability, biodiversity and marketability as well. Policy decision to channelize government support to such scientifically vetted production programmes can help to deepen such an approach.

Promoting adoption of improved varieties

Nearly five hundred improved varieties of crops have been released in the state in the past five decades. Yet, the rate of adoption of these varieties by farmers is very low, except in the case of paddy, rubber and vegetables, irrespective of the fact that exploitation of genetic potential by far remains the most critical factor for enhancing productivity. A time bound action plan for enhancing the adoption rates to the 65-70 per cent adoption achieved in case of rice or vegetables need to be adopted and supported in the case of other major crops like coconut, spices and tuber crops. However, a prospective planning for achieving the desired balance and proportion for spread of improved varieties and promoting local varieties is also required. For example, in coconut it is suggested to have a ratio of 60:20:20 for local tall, hybrids and dwarf varieties for the sustainable development of the crop in the state.

Improved supply of quality planting material

A corollary to the above would be ensuring availability of quality seeds and planting material, lack of which is the most important constraint experienced by farmers for cultivating improved varieties. Planting material production by the research institutions in the state as well as the farms and nurseries under the State Department of Agriculture alone cannot meet the demand for seeds and planting material required for new planting and rejuvenation programmes. Hence, the following measures are to be adopted to augment the supply of quality seeds and planting material in the state.

1. Modernising the farms under the Department of Agriculture by training and infrastructure development to produce improved planting materials like tissue culture plantlets, micro propagules, grafts and layers of varieties which are in great demand, instead of seeds and seedlings alone. With a vast network of nearly 64 seed farms and nurseries across the state, such a measure alone can help achieve a quantum jump in improving uptake of improved varieties.
2. Accreditation of private nurseries, as followed by the Rubber Board of India. The Rubber Board, through a hugely successful programme of providing training and supporting private nurseries has been making available over 55 lakh rubber grafts every year across the country through nearly 275 certified private nurseries, even as its own six nurseries produce only 3 lakhs grafts every year.

Box1. Uma–the rice variety that made a mark :

Rice variety MO16 (Uma) was released by Rice Research Station, Moncompu, KAU, for the Kuttanad rice ecosystems. The variety has proved to be superior to the other leading variety(Jyothi) and other local varieties with respect to many attributes such as high yield, high tolerance against pest and diseases, high grain weight, high tillering capacity and high seed dormancy. There was an income advantage of Rs. 38000/- per ha over Jyothi and Rs. 95000/-per ha over local varieties, equivalent to adding Rs. 104.30 to Rs. 260.75 crore per annum to the economy of Kerala. The variety has continued to be one of the most popular varieties for more than15years.The indirect social impacts of Uma included increased social participation, better information seeking behaviour and decreased labour use.

Source: Neshwa.2015. Impact of the rice Variety Uma (MO16) on farmers. M.Sc. (Ag) Thesessubmittedto KAU. Unpublished. 89p

3. Providing support to FPOs and other collectives like Kudumbasree units for insitu production and distribution of quality planting material of improved varieties through decentralised community nurseries. Utilisation of local elite germplasm of crops

should be ensured in such interventions which help in nurturing agro-biodiversity. A recently implemented project covering 12 districts in Kerala involving ICAR-CPCRI and State Department of Agriculture has amply demonstrated the effectiveness of such interventions. (See Box 2)

Box2. Facilitating decentralized coconut nurseries managed by Farmer Producer Organisations

Rejuvenation of coconut orchards by replanting with quality seedlings of improved varieties is an important strategy for making coconutfarming profitable in the state.Successful experiences under the novel initiative implemented by ICAR-CPCRI with the support of State Department of Agriculture and Farmers'Welfare, Government of Kerala, clearly indicate that FPOs in coconut sector can be empowered to establish and manage decentralized coconut nurseries so that availability of seedlings canbe augmented locally. More than 30 decentralized coconut nurseries were established in different districts under the project. As part of the project Kunnamangalam Federation is maintaining about 400 mother palms in farmer's field for seed nut collection and during the period 2018-20, they collected 13600 and 4302 seed nuts of tall and dwarf varieties respectively.During 2019 the Federation distributed 4600 WCT seedlings, 1551 Chowghat Orange Dwarf (COD) seedlings and 621 Chowghat Green Dwarf (CGD) seedlings to the farmers. They could collect 10,000 seed nuts of WCT,3,000 seed nuts of COD and 2,500 seed nuts of CGD varieties of coconut for production and distribution of seedlings during 2021.

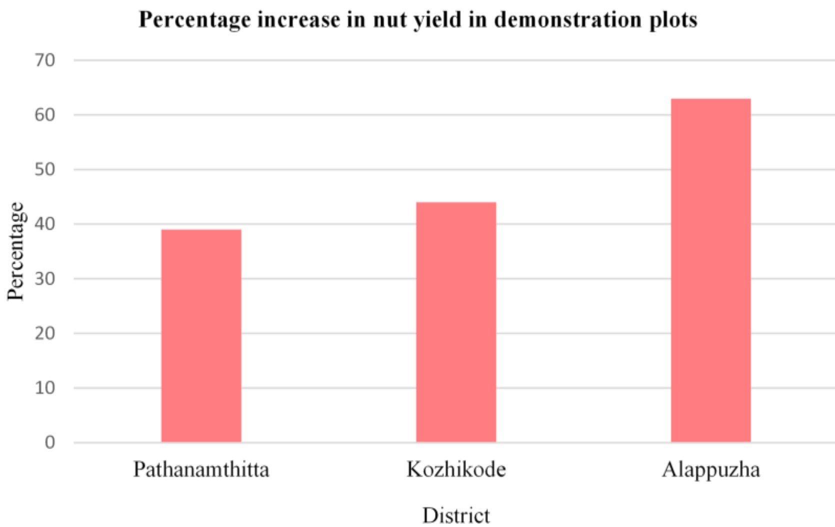
The public sector research institutions will have to take the lead role in decentralising planting material production. Considerable attention will have to be paid to capacity building through sharing of germplasm and training as well as to regular monitoring of the production programme. Robust, rigorous certification protocols also need to be established and followed to ensure maintenance of quality. Along with that, proposed nursery act should facilitate decentralised production of certified quality planting material.

Enhancing adoption of scientific soil health management practices

The health of the soil in which the plant grows is paramount in realising the yield potential of a variety. As a medium for crop growth, the soils of Kerala, in general, are highly acidic and are low in organic matter, as well as Potassium, Calcium, Magnesium and Boron while they have high levels of Phosphorus (see Box 3). Hence, soil test-based integrated nutrient management needs to be adopted as a policy and need to be implemented in the state to help enhance productivity. For this, the existing soil testing facilities will need to be utilized to their full potential. Likewise, analysis and dissemination procedures also need to be streamlined so that farmers receive the results more quickly

Box 3. Enhancing coconut productivity through scientific soil health management

A consortium of ICAR institutes carried out a project during the period 2015 to 2019 with the primary objective of enhancing the palm productivity in major coconut- growing regions of the state through mitigation of soil related constraints to the palm.The majorsoil related constraints were strong surface and subsoil acidity, toxicity of aluminium and deficiencies of major, secondary and micro nutrients. Best Management Practices (BMP) were formulated,which involved discontinuing with the annual opening of basins around the palm, returning palm residues to the base of palms, application of liming materials to address soil acidity and aluminium toxicity and use of chemical fertilizers to meet the palm's nutrient requirements.Within three years, the nut yield registered a substantial increase, with average increase in nut yield being 48 per cent in the demonstration plots in northern Kerala, 32 per cent at Central Kerala and 49 per cent in the southern Kerala.



A very powerful tool in this regard can be the Mobile application on Mannu (MAM) by the Department of Soil Survey and Soil Conservation, Kerala (see Box 4).

Box4. Mobile application on Mannu(MAM)

Mobile application on Mannu (MAM) is an app which provides the general status of the soil fertility in crop ecosystems to the farmers at their fingertips.It incorporates the soil test results of all the soil samples tested across the state on a GIS platform. The app provides information on macro, secondary and micronutrients, provide fertilizer recommendations and also helps calculate the quantity of fertilizers required for a given area. This is complimented by the Microlevel Information Systems for Soils of Kerala, a web GIS portal by the Department of Soil Survey and Soil Conservation. It provides cadastral level information on soils in the state.

The above support can and need to be continuously updated and validated by cross referencing with soil sample analysis conducted by other agencies in the state, like KAU and Department of Agriculture.

Plant Health Management:

Plant protection is a critical area that helps protect the yield produced. Integrated pest and disease management packages are available for paddy and coconut, which have been demonstrated to be effective at scale (Box 5.). Similar eco- friendly plant protection technologies are available for all economically important crops. However, the widespread adoption of these technologies is constrained by several factors which include information gaps, access and availability of technologies, farm level constraints and inadequate efforts to effect behavioural changes among the farming community.

Box 5. IPM in Paddy-the Alathur experience

The All-India Co-ordinated Research Projecton Biological Control has been conducting large scale demonstration on rice IPM in Palakkad district during the second crop season for the last five years. Starting with 5 ha, the demonstration has expanded to 200 ha. The major components include seed and seedling treatment with *Pseudomonas flourescens,* use of *Trichogramma* egg cards for management of stemborer and leaf folder as well as use of KAU strain of *Beauveria bassiana* against rice bug. The trials have consistently recorded over 20 percent increase in yield along with an average 10 percent reduction in plant protection costs without use of synthetic pesticides.Alathur Grama Panchayat, where the demonstrations are organized supported the establishment of a tricho card production unit in 2020, being run by members of a Kudumbasree

The following measures can help strengthen adoption of eco-friendly pest management.

1. As in the case of integrated nutrient management, IPM should also be declared as part of the official policy on agriculture.
2. Implementing IPM programmes based on an Area Wide Community Approach since IPM strategies often are more effective with the use of such a strategy. Moreover, certain pests and diseases can be managed only through collective efforts across large area.
3. Ensuring rational use of synthetic pesticides through strict enforcement of the prevailing rules and regulations. Stocking, sale and use of synthetic insecticides should be only with prior permission of Agricultural Officers.
4. Ensuring availability of eco-friendly botanicals and bio agents for biotic stress management. A major hurdle in this context is the obstacle in getting bio pesticides developed by public sector institutions registered with CIB RC, which needs to be addressed at the highest level.
5. As in the case of planting material, the services of collectives like FPOs and Kudumbasree can be made use of in the production of bioagents like trichogramma egg parasitoids, entomopathogenic microbes, etc through the plant health clinics in Krishi Bhavans and by taking the help of research institutions.
6. Quality control mechanism for ensuring the quality of commercially available bio inputs with more powers to states.

Ensuring Labour Availability In Agriculture:

In Kerala, agricultural labour resource is considered as a critical input due to the constraints associated with its availability as well as its high cost. As per 2011 Census, there are 13.2 lakh agricultural labourers (main and marginal workers) and 6.5 lakh cultivators in Kerala (Agricultural Statistics at a glance, 2018). Agricultural labourers constitute only 11.2 per cent of total work force in the state while it is around 30 per cent at all India level.

Paddy, coconut, arecanut, banana and tapioca constitute almost 45 per cent of Kerala's gross cropped area and these crops are also regarded as the major labour-intensive crops grown in the state. Among these crops, coconut and paddy are considered to be the most labour-intensive, with their share of labour requirement going up to 48 per cent and 31 per cent respectively (Table 14). It can be seen that a relatively skewed distribution of the labour resource use exists in the state with regard to the cropping pattern. This can have an indirect negative effect on the productivity of the other principal crops grown in the state, especially when a declining trend is observed in the agricultural labour supply.

Table 14. Annual labour use in major crops in Kerala (for 2018-19)

Sl.No.	Crops	Man days/ ha/ year	Total labour requirement/ year (Mandays)	Share of labour use among the major crops
1	Paddy (Autumn, Winter and Summer)	150	29607847	31%
2	Coconut*	60	45437905	48%
3	Arecanut*	74	7115120	7%
4	Banana	140	7379478	8%
5	Tapioca	91	5628672	6%

Note: Methodology for calculating crop wise labour requirement (Indira, 2012). The imputed family labour is not considered in the calculation for the ease of comparison with agriculture labour supply.

**In coconut and arecanut 65% of the labour cost (particularly male labour cost) is assumed to be associated with harvesting. The wage rate for harvesting is assumed to be equivalent to skilled labour wage rate of Rs. 900/- (as available for Kozhikode district - major coconut producing district). A weighted average of the normal wage rates with a skilled wage rate comes to Rs. 820.55/-.*

***Agriculture labour population in Kerala as per Census 2011 is 1322850. We have not considered the cultivators in this group.*

To address the above situation, labour banks and labour collectives must be established at panchayat level for executing and implementing crop calendar-based activities for scientific crop management.

An emerging alternative that is gathering strength is mechanisation of agriculture. Mechanisation can lead to increased efficiency of manpower by 15-20 per cent, reduction in input cost by 20 per cent. In addition, it can lead to timely farm operation, improving the quality of cultivation and increasing farm output. The social benefits include reduction in workloads and drudgery (especially for women workers), improving safety and also attracting and retaining youth in farming. (See Box 6).

In order to accelerate the agricultural mechanization in Kerala, the following major points

Box 6 : Unmanned Aerial Vehicles for Bio control agent Application

The KVK at Ambalavayal under KAU has started execution of modern rice technology protocol using unmanned aerial vehicles (UAV). Field level demonstration of application of biocontrol agents with UAV has been conducted on paddy fields at Kuppadithathara with the support of Padinjarethara KB. The main objective of the demonstration was sensitising the farming community for achieving maximum production from small limited area with judicious use of resources. The initiative envisaged to enhance precise farming techniques in small and medium holdings. Moreover, it helped the farmers to see and experience the benefits of technology,i.e in saving time, effort, money and dearth of training workers. This in turn direct farmers to act collectively and get involved with the scientific community in testing and analysing the impact of innovations.

are to be taken up on a priority basis.

a. Measures to increase the farm power availability to a level of 2kW/ha of cultivable land.
b. Establishment of custom hiring and agro-service centers for agricultural machines in every block under public or private ownership or in cooperative sector.
c. Forming mechanized labour force consisting at least ten members in each Grama Panchayath who are trained in operation, repair and maintenance of farm machinery.
d. Setting up of Govt. approved farm machinery workshop specifically for repair and maintenance in each block/panchayath level.
e. Establishment of district level mobile workshop, mobile information unit and machinery

information kiosks with online booking facilities of agricultural machines for custom hiring.

Rationalising Organic Farming Policy And Interventions

Organic farming, riding on increasing health awareness and purchasing power, has been growing at the rate of about ten per cent across the world. Kerala had formulated its organic farming policy in 2010 with a very laudable vision to make Kerala's farming sustainable, rewarding and competitive while ensuring poison-free water, soil and food to every citizen. The approach suggested was to convert Kerala into an organic State in a phased manner. It was also proposed that the impact be reviewed comprehensively after three years of implementation and the drawbacks be corrected before implementing in the rest of the areas. Unfortunately, neither a systematic implementation nor an impact assessment has been undertaken till date. The only study conducted on the impact of organic farming interventions in Kasaragod district has brought out light on the inadequacies of the policy and the interventions.

Reports on the implementation of organic farming policy in Sikkim in India and more recently in Sri Lanka also have clearly indicated the adverse impact of a total conversion to organic farming on crop production. Sri Lanka's overnight flip to total organic farming has been already rated as an economic disaster and has been wisely abandoned. It is widely accepted that a food grain deficient state like Kerala can't afford a total conversion to organic agriculture, given the attendant fall in on crop productivity. A more rational approach would be to identify crops and ecosystems where sustainable alternatives to external input driven production protocols are called for, to identify or develop such alternatives and evaluate them.

Concurrently, the use of chemical inputs can be limited to situations where they are absolutely essential. Organic farming can be promoted in crops with high market potential for such produces. For major crops like paddy fruits and vegetables, aiming for "safe to eat" farm produce would be more advisable lest food and nutritional security be compromised.

Even the selective transition to organic farming suggested above would call for efforts to validate the current package of practices recommendations for organic farming, development, standardization and testing of new bio-inputs including bio-agents, interventions to ensure quality control of organic inputs distributed to farmers, market support for organic produce, support for branding organic produce and hassle-free organic certification.

Conclusion

Improving productivity through greater adoption of technologies call for greater promotion of available technologies such as the improved varieties of different crops. Over 400 varieties of improved varieties are available in crops such as rice, coconut, vegetables, spices, tubers etc. However, the availability of good quality planting materials of the improved varieties is a challenge that needs to be addressed through a multi-pronged strategy which includes strengthening of the planting material production facilities under DoA, production by farmer-based collectives like FPOs, registration and capacity building of nurseries etc. Similarly, a range of technologies demonstrated to be effective by research institutions in the state are available in case of nutrient management as well as pest and disease management.

Measures like improving availability of quality bio inputs, popularisation of technologies etc are called for better spread of the above technologies. Addressing labour issues like high wages and labour shortage through mechanisation drive is also recommended.

CHAPTER 5
IDENTIFY GAP IN THE AVAILABILITY OF TECHNOLOGY AND SUGGEST MEASURES TO HASTEN THE DEVELOPMENT OF TECHNOLOGIES

Reports predict 2050 to be a critical year for agriculture globally, as human population will see a 50 percent increase compared to present levels (Future Farms, 2021). India is predicted to be the most populous nation of the world with a population of 1.6 billion people by middle of the century. This would call for a seventy per cent increase in food production. This suggests that the current emphasis on food security is likely to remain the major agenda for agriculture research in the coming decades as well. For a state that imports much of its requirements in rice, fruits and vegetables, enhancing production and productivity in case of the major crops will be vital to absorb any extraneous shocks in production or demand of the above crops.

The above challenge will be even more daunting given the need to conserve and optimize the use of natural resources. Studies point out that average ground water recharging has fell by 6.93 per cent in the state over the last decade. Similarly, the increasing pressure to convert agricultural land for non-farming uses is likely to persist. Decline in the size of land holdings and climate vagaries would make it hard for the state to find the right balance between the conflicting objectives of enhancing productivity and sustaining agro eco systems. This warrants a transdisciplinary approach in agricultural research, which, in addition to conventional disciplines, will have to embrace as diverse fields as ecology, geology, biotechnology and nanotechnology, to state a few.

In this background, the contours of farming technologies of the future will be set by the following factors.

Food security

The shift from food crops to cash crops and the resultant sharp fall in the area under paddy cultivation has been having implications on economic, ecological and social development of the state. The gap between the demand and production of rice has increased from 50 per cent in 1960s to more than 85 per cent at present, severely undermining the State's ability to ensure food and nutritional security to its people. A similar situation prevails with respect to fruits and vegetables as well. This has also enhanced the state's dependence on other states considerably. Given the high population density and increased pressure on land, feeding the three crore plus people in the coming decades is a formidable challenge for the state. It is highly imperative to bridge the gap between demand and production through enhanced production and productivity using the innovative and advanced technologies.

Climate change

Contradicting roles of agriculture in greenhouse gas (GHG) emissions and its capacity to serve as a natural sink for carbon stock positions agriculture at the centre stage of climate change discourses. Violent and increasingly frequent disturbances as well as less obvious but equally significant changes in that the state is bound to experience in the coming years will need be addressed. Changing to commodities which have lower GHG footprints and changing the way agricultural crops are managed so that the GHG efficiency of production is increased will remain the cardinal principles in farming.

Changing farming systems

The growing scarcity of natural resources such as land, water and bio resources would lead to degradation and overexploitation of the same. This calls for efficient farming systems based on complementarity of components in terms of resource use. Cropping plans based on data on the hydrology, topography, climate, soil profiles and crop yields need to be tested and evolved. Significant attention will have to be devoted to the testing and demonstrating the benefits of alternative management systems in the homestead gardens of Kerala.

Use of digital technologies

Future agriculture will use sophisticated technologies such as robots, temperature and moisture sensors, aerial imaging and GPS technology. Agrobots guided by artificial intelligence and expert systems are expected to control farming activities and technology dissemination protocols in 2050. These advanced devices and precision agriculture systems will allow farms to be more profitable, efficient, safe, and environmentally friendly. Better informed decisions and efficient allocation of resources can reduce quantity of inputs such as synthetic fertilizers, chemical pesticides and plant growth regulators. These would entail increased need for farm specialists with expertise in data analysis and information technology

Technology Needs In Agriculture

The projected research trajectory to be pursued by the agricultural research institutions in the state, encompassing the above factors, are presented under the following five major themes.

1. Crop improvement

Plant breeding for enhanced productivity in major crops of Kerala will always remain a priority for agricultural research. A quantum leap in the productivity of major crops such as rice, coconut, cashew, banana, pineapple, vegetables, tuber crops and spices will be central to ensuring food and nutritional security, profitability, and competitiveness of the above crops to which end, breeding efforts will have to be continued for the above crops.

Instances of abiotic stresses like drought, inundation, acidity and salinity are expected to increase in terms of extent, intensity and frequency in the state in the coming years. Breeding for resistance to abiotic stresses, particularly in rice and vegetables therefore would be another thrust area for crop improvement (Box 7.)

Box7.KAU Manu Ratna

It is a short duration, non-lodging rice variety with a total duration of 95-99 days.It has an average grain yield of 4.5-5.7 t/ha with red kernel and is tolerant to stem borer, leaf folder, whorl maggot and blast. The short duration enables farmers in the lower reaches of Kole lands of Thrissur to raise it as a second crop during January and harvest it before onset of peak summer.

This in turn would require development of rapid and reliable techniques for screening and evaluation of germplasm and breeding lines against major abiotic stresses.

Identification, characterization, evaluation and conservation of native genotypes, especially in rice and tuber crops will call for more intense efforts, given the significance of these crops to food and nutritional security.

Genomics, aided by bioinformatic tools can support speed up such initiatives.

Breeding objectives for future would also include metabolic profiling or screening genotypes for non-nutrient bio actives that confer health advantages, development of varieties with specific and novel traits such as increased nutritional and pharmacological traits and biofortification of popular varieties.

Equally significant would be screening and identification of suitable varieties of small cereals or millets for marginalised crop production systems or in summer fallows. The hardy nature of the above group of crops, the low production costs and the perceived health benefits as low glycaemic index foods are increasing their significance even in a non-traditional tract like Kerala.

Conventional breeding will need to be supported by modern biotechnological tools in the above quest. Mapping and introgression of novel genes associated with yield and stress tolerance can bring down the time and resources required for realisation of breeding objectives (Box 8.)

Box2. KAU Jyotsna

It is a rice variety released by KAU in 2017. It was developed by introgressing the popular variety Jyothi with saltolgene. Jyotsna possesses remarkable tolerance to salinity and is ideal for the Pokkali tracts of central Kerala. It yields up to 6.5 tons/ha

Recent tools like speed breeding and gene editing offer exciting possibilities in hastening development of varieties. Techniques for the vegetative and micropropagation will also need be developed for more crops, including spices, forest trees and non-traditional crops. More specific objectives in the area of crop improvement for the next five years would include

1. Short duration varieties in rice for summer crop, without compromising on yield levels. Such varieties can be used for raising additional crop of rice in areas like the low-lying fields of Kole lands, irrigated areas of Palakkad districts etc. where critical irrigation can be ensured.
2. Breeding rice varieties with tolerance to abiotic stresses like high temperature, low moisture, salinity, etc.
3. Developing hybrids in vegetables with greater yield potential. Exploitation of heterosis would be imperative to break the yield barrier and achieve self-sufficiency in vegetable production. Moreover, this can ensure availability of quality planting material at affordable costs to farmers.
4. Evolving dwarf varieties in coconut without compromising on quality is an important requirement for popularisation of the palm, especially as a component of homesteads.
5. Screening of germplasm and varietal development in tubers, millets and pulses would require attention given their potential to offer food and nutritional security in an affordable manner to the vast sections of people.
6. Spices form yet another economically important group of fruits where crop improvement efforts will have to be sustained so that the state's superiority in the global markets is consolidated.
7. Development of protocols for tissue culture in coconut is a much-needed technology that can help replacement of the senile and unproductive palms with quality seedlings, especially in case of hybrid and dwarf varieties.

2. Crop Production

Crop production is a complex amalgamation of diverse disciplines, approaches, and practices, aimed at the realisation of the genetic potential of the crop. It is also the most challenging aspect in crop husbandry, given the multitude of interactions the plant is subjected to, involving both biotic and abiotic components. The practices involved aim to provide the crop with the resources required for production.

With Agro ecological units (AEU) being the basis for crop planning in Kerala, the most pressing agenda in crop management would be to develop separate package of practices for different crops for each AEU. This would involve fine tuning available technologies as well as filling the gaps, notably in terms of suitable varieties and soil health management, in an AEU context.

Increasing international trade in crops like pineapple, banana and spices demand assurance on the part of farmers in terms of quantity and quality of produce that can be supplied in given time. This calls for standard operating protocols (SOPs) and good agriculture practices (GAP) protocols in case of the above crops.

Water and nutrient management are the two major concerns in crop production, since any deficiency of the above inputs at critical stages in crop phenology is bound to seriously impede crop productivity. Profiling of the entire state based on nutrient and water availability has to be a priority, as it can be vital to AEU based planning that is expected to gather momentum in future.

Exciting possibilities in soil amelioration exist through the recycling of the unutilized plant biomass. It would help resolve the twin challenges of organic waste disposal and the acute shortage of manures in one stroke. Novel products like biochar, fortified manures and compact products like blocks and briquettes suited for urban households will be relevant. A related area will be exploitation of soil microflora through rhizosphere engineering for improving soil health as the soil microbes have been long known to make available nutrients, confer tolerance to abiotic stress and subjugate pathogens. Technologies would also be called for minimising the use of plastics in agriculture. Eco-friendly, biodegradable or plant-based options such as rubber-based products, plant fibre fabrics for mulches etc will need to be developed.

One of the most noticeable features of Kerala agriculture is the extensive fragmentation of farm lands. With the average land holding size of 0.12 ha, small farm mechanisation will be a critical factor in the progress of the sector. Versatile, multipurpose instruments with flexibility of operation across holdings of different sizes will need be developed and popularized, especially in view of the preponderance of homesteads in the state. Such machines will need to be designed so that they can be operated by women as well.

Technologies for early detection of biotic and abiotic stresses will be key to successful farming in the coming years. Plant and soil based nano sensors need to be developed that can help monitor real time status of soil moisture and nutrient levels accurately and reliably, for timely interventions as well as for enhancing resource use efficiency. Studies on stress physiologies of various crops and physiological approaches to combat water stress will also be called for.

Sensor based technologies that rely on the minute changes in the physiology of plants following pest and disease incidence would assist early detection of biotic stresses and adoption of pest management measures sufficiently early so that losses can be avoided and cost of plant protection minimized.

Farm mechanisation could be revolutionizing agriculture which will be playing an increasing role in farming. Automation can lead to more efficient means for planting, input delivery, harvest and storage (Box 9.).

Box 9. Farm mechanisation-the next revolution

Studies have consistently shown that farm productivity is linked to farm energy in put. Mechanisation however, has not progressed much beyond tractors in India since 70s. But, strides in IT are all set to revolutionize farm mechanization beyond recognition and agriculture could see a great degree of automation in the coming decades. Automation will be driven by advances in Artificial Neural Networks (ANN) and robotics. Technologies like solar power-based pump sets, sensor equipped seed cum fertilizer drills, spectral reflectance/NDVI basedfertilizer applicator, uniform rate sprayer, real time soil moisture-based sprinkler irrigationsystem, automatic irrigation system for rice, automatic yield monitor for indigenous combine harvesters, drones for surveillance and spraying etc have already been developed. Future developments would include unmanned ground vehicles for operations like transplantation, weeding and harvesting, agrobots for harvesting tree crops like coconut, arecanut etc., ground and aerial sprayers equipped with image analysers, automated storage and packing systems etc.

Smart agriculture refers to farming that extensively uses the frontier technologies based on IOT, robotics, big data analysis, bioinformatics, nanoscience, remote sensing etc., to plan and execute farming operations so that resource use efficiency, productivity and quality are maximised. It has been projected as the future of farming. Some of the key components of smart agriculture are given below.

Crop weather relationship models in conjunction with accurate weather forecasting will be increasingly needed to advice farmers about undertaking farm operations in time as well as impending weather events like inundation and extended periods of dryness, so that farmers can adopt timely remedial measures (Box 10.).

Box 10. Sowing goes smart

Microsoft in collaboration with ICRISAT recently developed an AI Sowing App. The app sends sowing advisories to participating farmers on the optimal date to sow. The advantage of the app is that the farmers don't need to install any sensors in their fields or incur any capital expenditure. All they need is a feature phone capable of receiving text messages. The advisories contained essential information including the optimal sowing date and sowing depth, soil test based fertilizer application, farm yard manure application, seed treatment etc., In 2017, the program was expanded to touch more than 3,000 farmers across the states of Andhra Pradesh and Karnataka for a host of crops including groundnut, ragi, maize, rice and cotton. The reported increase in yield ranged from10% to 30% across crops.AI in agriculture a step further by developing a pest risk prediction app in collaboration with United Phosphorous Ltd (UPL)as well as another app on price forecasting in collaboration with the Government of Karnataka. Commodity prices for items such as tur, of which Karnataka is the second largest producer, will be predicted three months in advance for major markets in the state.

Nano science is expected to revolutionize crop production and protection in more than one way. Nano formulations of nutrients and chemical pesticides can help lower the requirement of inputs to a fraction of current levels, thereby significantly reducing cost as well as environmental contamination. A second possibility is to use nanoparticles as carriers of microbial bioagents and pheromones, which will lead to enhanced efficiency.

Artificial intelligence can find application in a range of areas from identifying optimal sowing to pest and disease surveillance, targeted delivery of inputs, grading, price forecasting and systems like `see and spray' that can change the dynamics of crop protection will need to be developed.

Specific research goals for the next five years in crop production would include the following:

1. Mapping of Kerala soils for fertility status, including that of micronutrients. Soils of the state have undergone major physical changes following the recent floods and an accurate assessment is called for in order to develop site specific nutrient and irrigation regimes. Developing devices for rapid assessment of nutrient levels and the pesticide residues in plants.

2. Developing AEU wise package of practices for major crops within the next two years. Validation of the current recommendations will be required mostly in identifying most suitable variety for each AEU as well as in refining the nutrient and irrigation management.
3. Developing SOPs for targeted yield levels in case of rice, coconut, banana, vegetables, pineapple and pepper.
4. Developing IOT based nutrient and water management solutions for precision farming in major crops, especially banana and vegetables.
5. Assessing suitability of exotic fruits and vegetables being imported into the state and developing package of practices for the same.
6. Developing and evaluating nano formulations of synthetic as well as bio fertilizers.
7. Designing and developing smart and affordable AI powered machines.

3. Crop Protection

Pest management has always been a central concern in crop production, as pests and diseases account for 20-30 per cent of crop loss. Pest management solutions in future will be assessed as much by their safety to other organisms as their efficacy in regulating pest populations. The concept of integrated pest management, riding on ecological compulsions on one hand and technological advances on the other, will assume the centre stage of plant protection.

Host plant resistance is ideally the corner stone of any IPM package and in fact the only viable approach against viral and phytoplasmic diseases. Yet, efforts at breeding for resistance are very scanty due to the negative correlation between yield and resistance levels. In the context of ecological sustainability and increasing plant protection costs, developing varieties resistant to major pests and diseases, especially against virus diseases in vegetables assume great significance.

A sound IPM strategy relies heavily on the multitude of interactions among the different trophic levels and also between the biotic and abiotic components of the ecosystem for deriving management measures. Such studies on interactions are very complex but crucial for effective pest management. Advances in modelling and computing ought to be therefore be exploited to further our understanding on interactions between different components of the crop ecosystem, leading to pest management options through disruption of crop pest phenological synchronisation. Studies on the effect of weather and plant nutrition on pest and disease incidence will be the key to development of short-term forecasting and forewarning of pest incidences.

Detection of pests and diseases sufficiently early, enabling farmers to adopt timely management measures will be another area of interest. Efforts in molecular diagnostics and nanotechnology can lead to the development of diagnostic kits for early field level detection of plant disorders and pathogens.

Bioprospecting for potential biocontrol agents and antagonistic organisms will always be a research priority, given the rich biodiversity in the state. Survey, collection, characterisation and evaluation of novel organisms from within the state can lead to effective biocontrol

Box 11. Microbial Encapsulation Technology

ICAR-Indian Institute of Spices Research, Kozhikode has successfully patented and commercialized encapsulation technology for smart delivery of agriculturally important microorganisms such as biofertilizers or biocontrol agents. The contents of a single capsule can be used to prepare 200 litres of spray fluid. The product combines cost effectiveness with ease of transport, extended shelf life and reduced environmental pollution.

solutions since such organisms are more likely to be better adapted to local environment. An equally important area would be development of cost effective, convenient and eco-friendly formulations of biopesticides and biofertilizers (Box 11).

Increase in trade has led to an alarming increase in the introduction of invasive alien pests, diseases and weeds. Programmes for constant surveillance, early detection and quick containment will be called for to manage such pests before they become established. A related aspect will be identification and notification of pest free areas for export-oriented production and procurement. Similarly, development of traceability systems in exported commodities would be a key to gain and retain access to international markets, especially in export-oriented crops like cardamom.

Researchable issues in plant protection would be

1. Developing biointensive integrated pest management (BIPM) packages for major vegetables, banana, pepper, cardamom, pineapple and coconut.
2. Developing and operationalizing traceability system in cardamom and honey.
3. Bioprospecting, characterisation and evaluation of potential bioagents.
4. Development of nano formulations of botanicals and biopesticides.
5. Validation of nano pesticides available for plant protection.
6. Development of digital decision support systems (DSS) that connects farmers with extension personnel and plant protection experts.
7. Breeding for resistance to pests and diseases in major crops like paddy, vegetables, tapioca, spices etc.

4. Conservation Of Natural Resources

Scientific management of available water, soil, energy and other natural resources in a sustainable manner will be one of the critical components for adaptation to climate change in near future, as already stated. Soil organic carbon and C/N dynamics in the soil will be the basic determinants of soil management strategies in future. This in turn would call for maintenance strategies to improve soil cover and organic carbon recycling along with use of chemical fertilizers and interplay of microbial inoculants. Water productivity will have to be enhanced through fine tuning of efficient agronomic practices, tapping the synergistic effect of water and nutrient interaction and utilization of bio molecules to reduce water loss. An integrated approach is required to be created for optimizing resource use and enhancing productivity. Conservation agriculture practices like direct sowing, laser levelling, retention of residues and minimum tillage hold promise in conserving moisture, nutrients and energy and thereby reducing the cost of cultivation apart from maintaining and improving carbon stock in the soil. There is potential to convert ecologically fragile lands in Western ghat region under conservation agriculture. Long-term studies are, however, required for adapting different crop production systems, under conservation agriculture. Suitable varieties of different crops for conservation agriculture also need to be evolved.

Traditional soil and water conservation measures will need to be supported by outputs of modern technologies. Automation of irrigation systems at macro and micro levels, development of precision farming techniques with control over nutrient and water supply to crops etc will have to be strengthened further through research.

In the above quest, considerable research efforts will have to be undertaken to fine tune alternative farming systems like organic farming, integrated farming systems, silviculture systems etc so as to make them more economically productive without essentially undermining their potential ecological benefits.

Researchable issues from a conservation point of view would include

1. Developing soil and water conservation technologies like conservation tillage and residue mulching for each AEU
2. Developing locally relevant crop rotation practices combining sustainability with productivity
3. Identifying suitable inter and mixed crop components for perennial crops.
4. Vulnerability mapping in the coastal and hill regions and identifying scientific crop husbandry
5. Developing rhizosbiome engineering practices for major cropping systems.

Measures to hasten the development of technologies

Fast tracking technology development would require a multipronged strategy that is outlined below.

Fast tracking the development of technologies can be achieved through adaptive research wherein technologies of significance, developed by national and international agencies can be sourced, validated and recommended. This would help produce quicker results and save on time and resources. For instance, developing AEU based Package of Practices need not reinvent the whole package but can be limited to unit wise refinement of select technologies like varieties, nutrient and irrigation management. The OFT platforms of KVKs can be utilized in a more focused manner for such validations. Elaborate, well designed research programmes should be attempted in those areas that require such investments of resources and manpower.

Given the scarcity of resources in public sector research organisations, greater convergence and collaboration in all possible areas need to be explored for the development of technologies. Research organisations like RGCB, NBPGR, KFRI, UPASI, etc also should be brought into the network as well. A co-ordinating mechanism involving agricultural research institutions in the state might be called for to make this a reality.

There is a large pool of expertise in digital technology that exists outside the walls of R&D institutions in agriculture sector. This group of young professionals in IT sector, IITs, engineering colleges, CUSAT etc are already developing creative solutions to challenges in farming such as apps, but are hampered by lack of basic knowledge about the scientific aspects of crop production. Establishing a dynamic interface between institutions under NARS and other educational institutions/ private institutions with such hugely talented, innovative human resource base can help bridge the digital divide in research and integrate technology driven options into formal research right from planning and formulation of research projects.

As stated, field level utilization of technologies is not satisfactory in Kerala in spite of strong presence of agricultural research institutions and vast network of extension system. Hence, it is essential that factors responsible for low level of technology uptake in farming are delineated through systematic research so as to streamline appropriate policies and programmes for enhancing technology adoption. It is also worthwhile to assess the nature, extent and impact of integration of improved farm technologies in the agricultural development interventions. Social science research focusing on multidimensional analysis of technology generation, transfer and utilization in crop sector of Kerala state, identification of space for greater synergy of functional linkages among research, development and extension institutions in agriculture sector and value chain analysis of major crops in Kerala in perspective of technology integration also need be strengthened.

Speedier development of technologies would also call for greater investment in agricultural R and D and newer frontiers of science. Public investment in agricultural R and D should be given more emphasis to evolve suitable agricultural technologies. More investment has to be made in capacity building such as establishing centres of excellence in frontier technologies in nanotechnology, artificial intelligence, genomics and big data analytics etc, which would bring about feasible solutions to many long-standing problems.

Conclusion

Crop production technology in future is going to be dominated by a confluence of three factors, namely, the need to enhance productivity, the need to mitigate the effects of climate change and the evolution of technologies with far reaching impact. This would call for cutting edge research and development in crop improvement, crop production and crop protection.

Crop improvement will have to judiciously combine traditional methods of plant breeding with modern tools like gene editing to fast track development of varieties with high yield and stress tolerance. Crop specific agenda would include developing hybrid varieties in vegetables as well as developing tissue culture protocol for propagation in coconut.

Resource use efficiency will have to be integral to crop production technologies in future. Optimisation in terms of time, space and quantities through use of crop simulation models, weather data, sensor-based technologies, nano formulations of fertilizers will be the need of the hour. Similarly, small farm mechanisation with focus on machine learning based automation will be called for.

Crop protection will strive for early detection of biotic stresses. In depth understanding on pest population dynamics and the ecological interactions at different tropic levels will be guiding pet management technologies of the future. Specific objectives would include breeding for resistance to major pests and diseases, especially in vegetables against viral diseases as well as developing traceability systems in cardamom and honey.

Hastening the development of technologies would require collaboration between the research institutions in the state. Another area worth exploring would be utilizing the technologies available with different institutions such as engineering colleges under Kerala Technical University, Cochin University of Science and Technology etc. Strengthening social science research focusing on different aspects of technology generation, transfer and utilization in crop sector also need to be strengthened.

CHAPTER 6
STRENGTHENING RESEARCH EXTENSION LINKAGES

The previous chapters of this report have already pointed out that the extent of adoption of technologies recommended for higher yield and income from farming is low due to various socio-economic, technological, managerial, and operational constraints. Lack of coordination among the pluralistic actors and minimal functional linkages is cited as one of the main challenges in this regard.

A well-established agricultural extension system has evolved in the state over the years with the engagement of multifarious actors from agricultural research and extension domains. Yet, the efficacy of the existing `Research-Extension' linkage is not up to the desired level to meet the needs of farming community, despite a robust network of research institutes for development of technologies in agriculture. The role of the extension personnel as knowledge providers, connecting the farmers with latest technological know- how has been acknowledged as limited in reach and scope. In this context, the larger domain of engagement between research and extension systems needs to be revisited in order to address the concerns regarding scope and effectiveness of such interactions.

The agricultural research system in Kerala mainly comprises of research stations of Kerala Agricultural University (KAU), research institutes under Indian Council of Agricultural Research (ICAR) namely, Indian Institute of Spices Research (IISR), Central Plantation Crop Research Institute (CPCRI) and Central Tuber Crop Research Institute (CTCRI). Besides, there are dedicated research stations set up for various crops under the Commodity Boards. These include Rubber Research Institute (RRI) under the Rubber Board, Regional Coffee Research Station (CRS) under Coffee Board and Tea Research Foundation under United Planters Association of South India (UPASI).

The agricultural extension system of Kerala is mainly represented by the network of Krishi Bhavans (KBs) functioning at the Grama Panchayath level. Besides, there are Krishi Vigyan Kendras (KVKs) in all the 14 districts of the state for promotion and dissemination of agricultural technologies.

The Agricultural Technology Management Agency (ATMA) is yet another mechanism of the agricultural department to facilitate technology dissemination with the involvement of multi stakeholders. In addition, organizations like the Vegetable and Fruit Promotion Council Kerala (VFPCK) have carved out their own unique space in the arena of extension service delivery. Moreover, the state has recently formed the block level Agricultural Knowledge Centers (AKC) to ensure better linkage between research and extension actors. Of late, Farmer Producer Organizations (FPOs) are also gradually taking up service delivery as demanded by commodity-based farmer groups. Lastly, the role of many Non-Governmental Organizations (NGOs) in this regard cannot be overlooked, especially in the high range zone of the state.

Though the ratio of extension staff to farmer ratio of the state is the highest in the country (1: 300) as indicated in the NSSO report, the same is not reflected in terms of number and extent of their engagement with researchers. Hence this chapter puts forward a few suggestions for strengthening the research-extension (R-E) linkages in the state.

AKC Based Activities

The state Department of Agriculture (DoA) along with KAU has initiated AKCs at the block level to aid planning and implementation of locally relevant initiatives as well as to offer solutions to farmers' felt problems. Each AKC had a scientist from KAU precisely as part of strengthening the R-E linkage at grassroots. Though this mechanism has led to improvement, there is immense scope for further improvement. A team of trained subject matter specialists should be attached to AKCs under the leadership of nodal officers to assess problems, fetch weather related information and crop calendar-based activities, and thus propose participatory solutions. The provisions for hand holding in formulation of projects by LSGIs, ATMA and their vetting by the nodal officer and team should be utilized fully. Regular meetings at AKC level can be organized by including researchers, farmers, and various stakeholders to discuss the problems and needs of the farming community.

Box 12. Participatory Technology Development (PTD)

Elavanchery was the best VFPCK of Palakkad district in 2018-19 with bumper yield of peas, bittergourd, bottle gourd etc.There were around 200 farmers grouped into16 Self Help Groups (SHGs) in the area and the activities were coordinated by Swasraya Karshaka Samithi (SKS) under VFPCK. The activities of VFPCK were carried out by these SHGs (15-20members) with one master farmer who carries out extension activities. Novel approach of PTD for technology development and refinement with farmer participation was adopted by VFPCK in Elavanchery. PTD programmes were conducted by comparison of indigenous Ash gourd KAU local and Thara, testing suitability for growing in a particular locality. Innovative technologies developed by farmers were tested by these SKS and farmers were given Rs. 10,000 as an incentive for motivating other farmers.It helped in enhancing experimental capacities of the farmers through participatory approach and thus the farmers were trained in solving problems by themselves.

KB Based R-E Activities

A proactive approach to facilitate the linkage between the farmers and researchers could be facilitated at panchayat/KB level as well, in addition to the AKC at block level. Rashriya Krishi Vikas Yojana (RKVY) project could be further extended to research activities in collaboration with the farming community with emphasis on Participatory Technology Development (PTD) (Box 1). The researchers may adopt panchayats and it is suggested that they should arrange monthly visits to the farmer's field, interact with them, identify their problems, and suggest solutions in consultation with extension personnel and farmers.

Based on demand for seeds, a specific procurement plan for the required varieties may be prepared by the Directorate of Agriculture in consultation with research organisations well in advance. Meeting of representatives of research stations and DoA officials need to be convened to facilitate the preparation of realistic procurement of seeds of improved varieties of important crops and ensure its timely availability before the cropping season. Another suggestion is that outlets for supply of inputs such as seeds, micronutrients, biopesticides etc., may be established in conjunction with eco-shops.

Capacity Building For R-E Linkage

At present, capacity building activities for DoA functionaries as well as farmers are facilitated by Regional Agricultural Technology Training Centre (RATTC), State Agricultural Management And Extension Training Institute (SAMETI) and Training Service Scheme of KAU. Different stations of KAU, ICAR institutes, KVKs, VFPCK etc are also actively engaged in this area. A mechanism for greater co-ordination between the above agencies is called for, for better utilization of these platforms as well as for creating greater impact on ground. SAMETI would be an ideal platform to undertake such an initiative.

In addition to this, concentrated and deliberate efforts may be undertaken to include youth and young farmers in the research demonstration trials, problem analysis and social media networks. Skill development of rural youth for entrepreneurial activities through Attracting and Retaining Youth in Agriculture (ARYA) model could be replicated at state level. To facilitate this, strengthening the capacities of staff of RATTCs with the help of ICAR research stations, KAU and SAMETI can be considered.

R-E Linkages of KAU Institutions

One option for strengthening the R-E linkages would be to ensure the active involvement of different stakeholders like the Krishi Bhavans, AKCs and ATMA in front line demonstration programmes conducted by RARS and KVKs.

The Zonal Research and Extension Advisory Committee (ZREAC) Organized by Regional Agricultural Research Stations (RARS) annually with the participation of multi stakeholders is another established platform to strengthen R-E linkage. It can be made more purposeful by ensuring the participation of central institutes in the deliberations as well. However, there should include a strong review mechanism to ensure that the recommendations of the ZREAC are reflected in the schemes of DoA and LSGDs as well as in the research projects by research institutions in the zone.

Another point for intervention could be in supporting projects that involve scaling up of successful models/approaches for better technology integration evolved by research institutions and KVKs through SHM, RKVY etc.

Agricultural Technology Information Centers (ATIC) is a single window delivery system of KAU and it should be strengthened and modernized with ICT technologies in developing an e- platform for delivery of inputs and services and also in reaching out to farmers through social media platforms.

The package of practices (PoP) recommendations should be updated by convening workshops and integrating latest technology preferably once in two years.

Strengthening ICAR Institution's R-E Linkage

ICAR convenes zonal regional committee meetings once in two years. The frequency of the meetings should be enhanced with assured participation from concerned KAU and RARS representatives. Likewise, care should be taken in aligning the research priorities of IRC recommendations with that of the ZREAC so that there is greater complementarity between the two. Another intervention could be expansion of Mera Gaon Mera Gaurav programme (MGMG) to provide farmers with required information, knowledge, and advisories on a regular basis by adopting villages on various researchable issues with the help of a multidisciplinary team. This would support and ensure participation of farmers in research activities. Moreover, farmer participatory breeding trials may be initiated in major crops with the support of RARS/KVK to ensure acceptability of the released varieties.

To usher, develop and support entrepreneurial ecosystem in agriculture, Intellectual Property and Technology Management Units of ICAR and KAU should promote incubation centers for conducting routine training programmes especially on value addition and thus play crucial role in strengthening linkage between R-E-Farmer (R-E-F) linkages.

Information Communication Technology (ICT) Based Activities

ICT is an efficient tool which can be effectively utilized to manage agricultural knowledge systems. The application of ICTs in agriculture has been low with only around 15 per cent of the farming community regularly depending on ICT applications of any kind to retrieve information on agriculture for their daily farming operations. However, recently the number of farmers using ICT tools for sourcing information from around the world has increased tremendously. Yet, making full use of the advances in IT would require greater rural connectivity and also upgrading the KBs to `Smart KBs' by providing video conferencing facility, net connectivity, computers etc. to have better linkage with research stations. This is essential for online interactions, accessing information on weather, market, pest and disease etc and sharing the relevant information with concerned target groups.

Farm Information Bureau can act as the nodal center for linking the knowledge on ICT interventions developed by research stations with KBs. The cloud storage facility of the research institutes also needs strengthening for the better use of ICT in Agriculture. A Hub and Spokes model for ICT led extension would be a better solution i.e Research Station as the hub and KBs in that locality as spokes. Again, farmer leaders can be made as mini spokes.

Online platforms offer seamless opportunities for knowledge transfer, and this could be utilized through regular problem-oriented interactions and conversations over online platforms. This will enable the farmers to get quick response to the field problem as well as ensure credibility on the research system. Moreover, it will help better realization by the R-E system about expectations of various stakeholders. This could be facilitated by the Agricultural Officer in association with the Information Technology Department of Govt. of Kerala even in developing various applications for disease diagnosis, reporting farmers problems, introducing new Govt. schemes etc. Social media platforms offer powerful tools that can be utilized for creating a dynamic interface between researchers, extension agents and farmers that can overcome the constraints like time, distance and resources that more conventional, physical interactions suffer from.

The remote villages where ICT facilities do not exist need to be given preference. The ICAR institutes and KAU have already developed several mobile apps for the better dissemination of technology. ICAR-CTCRI has developed two mobile apps TOMS and HOMS. Many mobile apps like Sree Poshini from ICAR-CTCRI, for integrated nutrient management of different crops have been developed by research Institutes. Social media could be better utilized through linking farmer representatives of social groups in the R-E linkage committee.

Artificial Intelligence & Strengthening Of Startups

Learning the activities of few start-ups like Simplify Agri, Moolya farms agri research, etc have given great hope in the use of Data Science like Artificial Intelligence (AI), machine learning, Natural language processing, to be used in automation and mechanisation for agriculture. The above-mentioned start-ups are continuously involved with farmers in the region trying to understand their grassroot level problems, gaps and use of the latest technologies in software, electronics, instrumentation, mechanics and use data science for bringing up with smart solutions suitable for small land holdings in the state. These initiatives include smart mobile applications to manage day to day activities of farmers, farming and resource planning, accounts, inventory and use the solution to improve their process, timing, application of inputs etc. The above collected information can readily be made available for research bodies, government, government offices and institutions responsible to provide services to the farming community and agriculture.

Live information and analysis reports will help policy makers, research organisations, government departments for agriculture, farmers, and service providers to work as a single unit. In addition to this, Internet of Things devices simulate the crop growth real-time in the field, collect weather data from the field and generate agro advisory for the crop which is planted in the field using the simulation model and the generated advisory will be sent to the mobile of the concerned farmer in the form of SMS automatically.

Conclusion

The agricultural extension system of the state lacks coordination and linkages of multiple actors. Even though the technologies are evolving at research stations, the transfer of technology and feedback from the extension and research system is very limited. Concerted efforts to strengthen the R-E linkage is essential for enhancing the technology adoption and productivity in Kerala's agriculture. The R-E linkage could be strengthened by coordinating the activities of KAU institutions, ICAR research stations, KVKs and DoA through decentralized activities at AKC and KB level with emphasis on capacity building, ICT interventions and AI and machine learning. Periodical Scientist-Extension agent and Scientist-Farmer interfaces could pave way to problem oriented and need based research and transfer of technologies through grass root level organizations.

CHAPTER 7
POLICY FRAMEWORK TO TRANSFORM HOMESTEADS INTO SUSTAINABLE UNITS

Nationally, sustainable means of stabilizing and maximizing profit through multiple enterprises in the farm are being promoted. Kerala has a unique feature of the presence of home gardens or homesteads, which have evolved in response to the pressure of shrinking land resource base coupled with high population density. The traditional homestead cultivation contributes to enhancing food and nutritional security, improving family health and preserving indigenous knowledge and culture along with ensuring economic security. According to the Tenth Agricultural Census of Kerala, the average size of an operational holding has shrunk to 0.18 ha in 2015-16 from 0.22 ha in 2010-11.

Also, out of the total holdings, the size of the group below one ha (marginal farmers) accounts for 96.7 per cent of the total number of holdings and the average size of the group is 0.12 ha (Department of Economics and Statistics, 2019). It is for these populous marginal and small homestead farmers that intensive land use practices like multitier cropping and integrated farming are becoming increasingly important. Home garden/homestead can be defined as a functional and self-sustaining farm unit which consists of a conglomeration of crops and multipurpose trees, planted arbitrarily, with or without animals/ poultry / apiculture, owned and primarily managed by the dwelling farm family, with the objectives of satisfying the basic family needs (food, fuel, timber) and producing marketable surplus for the purchase of non-producible items (John, 1997).

At present, the farmers concentrate mainly on crop production which is subjected to a high degree of uncertainty in income and employment to the farmers. The COVID-19 pandemic has necessitated and reiterated the revival of homestead cultivation in the State. In this context, it is imperative to evolve suitable strategies for augmenting the income from a farm. Kerala has faced two devastating floods in the recent years, which have caused huge damage to the agriculture sector and particularly to large number of homesteads in all districts. Gearing up for a massive rehabilitation and rebuilding programme for the affected population and their homesteads is critical.

Based on the existing facts and identified gaps, a few major issues that need to be addressed in homesteads through appropriate interventions include viz. regenerative agriculture (biodiversity, soil, water, energy) & ecological sustainability, promotion of organic farming particularly through integrated farming, in situ waste management, achieving food security for the farm family and also the livestock, nutritional security, enhancing income of the farmer/profitability of homestead and ensuring livelihood security (Box 13).

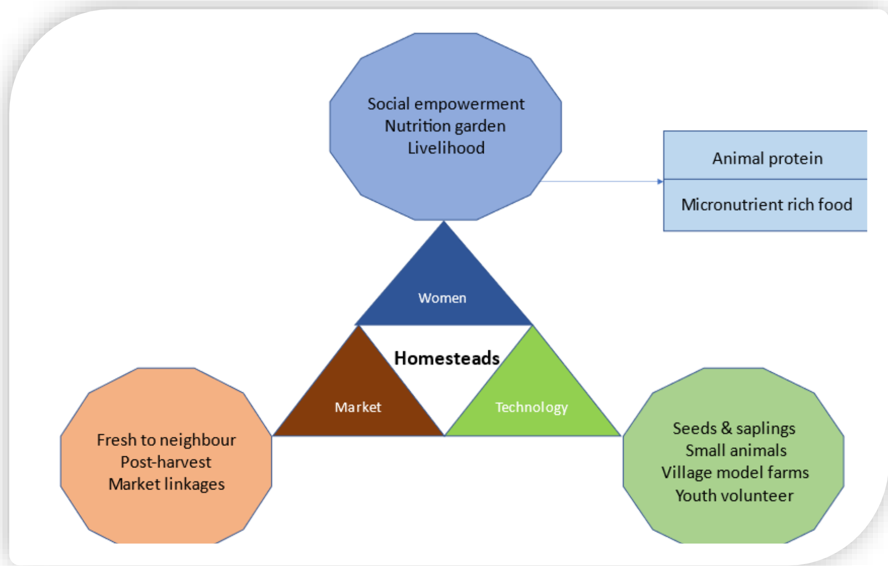
Box13. Housewife in Wayanad makes wonders in her10 cent homestead : A success story

What could be done in 10 cents of land for meeting livelihood is meticulously proved by Mrs. Sabi, from Kaniyanbattta panchayath of Kalpetta Block in Wayanad. She was the recipient of KarshakaThilak Award constituted by Thodupuzha Gandhi Study Centre with a price money of Rs. 1,50,000/-. The magic of meeting the entire family subsistence is emulable. Spatial planning was the highlight, taking the house to a corner of the land and creating maximum space for agricultural activities. She started with kitchen garden and goat rearing (single). Milk was used for domestic consumption while the dung and other green leaf manure was used to enrich the nutrient status of the soil. Later, she constructed a shed for rearing 1000quails, which was the major revenue generating component. Besides, she has a collection of unique high value birds like 'porukozhi, frillkozhi,Italian white hen, etc. that contribute to additional profit generation. She cultivates papaya, dragon fruit, banana, tomato, green chillies, brinjal, okra and other vegetables enabling her to market around 20-25kg vegetables per week. From quail alone, she makes a profit of Rs.800 per day. Other components also fetch her modest profit and provide live lihood security. On an average, with the said components, she derives a net return of Rs.3-4 lakh per yearand that too from 10cents of land, which is a model to be popularised

The Proposed Framework

Due to rapid urbanization and fragmentation of holdings in Kerala, homestead cultivation is considered as the most suitable form of cultivation as it offers self- sufficiency. This self-sufficiency could be converted to profit maximization through three main pillars viz. women empowerment, market and technology (Figure 4). There are many success stories of women centered agriculture which enhanced the income of the household and welfare of the family as a whole. Women are the key caretakers of the health of children and elderly at home. Empowering women and ensuring their pro-active involvement in the homestead nutrition garden concept will facilitate safeguarding of the nutritional requirement of future generations. Proper care should also be taken to include animal protein, vitamin and micronutrient food sources in the homesteads. The next pillar in the framework is the market, and for strengthening marketing and tapping market opportunities, online marketing/software options should be explored. Another intervention could be `fresh to neighbour' i.e delivery of vegetables to the houses in nearby locality, with online payment options. The third pillar i.e. technology and its adoption/scaling up concerns could be resolved through the research institutions and the Department of Agriculture (DoA). The availability of quality inputs (crops/subsidiary enterprises) should be ensured through decentralized mechanisms under a convergent supervisory system. Village level model farms and youth volunteers may be formed for helping the homesteads to get used to the latest technologies.

Figure 4. Proposed policy framework to transform homesteads into sustainable business models



State Level Intervention/Policy

Given the declining holding size, rather than sole cropping, practices to promote multitier cropping/integrated farming and achieve the primary objectives of food and nutritional security are inevitable. In regions where average holding size is <30 cents, it is desirable to go for a food and nutritional security targeted approach with some marketable surplus. For larger homesteads eg. in Wayanad, Idukki etc., a commercial and profit- oriented approach can be adopted. Here, in selected crops (perennial spices, beverage crops etc.) scientific organic farming practices can be practiced provided they are assured of a premium price, which is realizable. Also, the possibility of providing incentive for such specialized farm-homesteads should be examined. Besides, the export market for select crops/produce from homesteads (especially large homesteads) should also be certainly tapped. Support mechanisms for this need to be put into force, including online transactions, for which software solutions are inevitable. It would be prudent, to identify efficient production zones/pockets (spatial database) for selected crops so as to intensifyproduction and prevent conversion to other crops (if necessary, legislation as in case of wetland). Focusing on the farm family, every attempt to increase profit from the homestead should be, indisputably, achieved without compromising the basic objectives of food and nutritional security.

For developing, homestead farming, the major farming system of Kerala, it is crucial to reorient schemes of the State DoA for a systems-based approach, rather than crop based approach. Schemes on homestead farming as a priority for food, nutritional and livelihood security need to be invariably included in the planning of schemes of the DoA and Local Self Government (LSG) institutions. Scaling up of Integrated Farming System (IFS) and

Box 14.Jaivagriham : A Novel Government Scheme

The Jaivagriham project of the Kerala Government being implemented through the State DoA as part of Rebuild Kerala Initiative and Subhiksha Keralam project aims at enhancing livelihood security through maximizing the yield of all component enterprises to provide-steady and stable income to the farmers. The project envisaged establishing a minimum of 14,000homesteads based integrated farming units in the State. The estimated cost of the project is Rs.50 crore. The basic premise is that integrated farming in homesteads opens a new vista of opportunities for a family to use its man power, collective wisdom and leveraging Government support to make every household healthy and productive. Besides Kerala, scaling up of integrated farming models suited to homesteads through the schemes of the department ofagriculture has been implemented by Tamil Nadu, Jammu and Telangana on a large scale. As per the national policy of initiatives for doubling farmers' income, several other states are also on the anvil of implementing such schemes. The pioneering initiative of Kerala should be intensified in future. Continuing such projects with technical support of research institutions would be more beneficial to Kerala

high-tech models evolved by the Kerala Agricultural University (KAU), research institutes suited to homesteads and specific to AEUs should form a part of projects of the State department of agriculture and also LSG institutions. In this context, a commendable initiative of the Government is the `Jaivagriham' project being implemented by the State DoA (Box 14)

It is to be assessed meticulously, if farming is for home consumption or market oriented. Accordingly, the incentive structure of government schemes is to be decided, rather than a homogeneous incentive to all. Also, incentives via government schemes for full time homestead farmers, who depend entirely on their farming income for livelihood, should certainly be higher than those who engage in farming activities, over and above their regular employment/source of income. Beneficiary selection under schemes should also be unquestionably prioritized in this regard.

Existing watershed development-based projects need to be reoriented with homestead as the basic unit of development in a micro water watershed, observing natural resource management principles. For effective implementation of such schemes, it is vital to constitute a mechanism at Panchayat level for convergence of departments. The agricultural officer can be coordinator as in case of watershed committee. It is also desirable to bring out flexibility in working guidelines for implementing schemes related to homestead farming/ IFS which are quite different from the routine field based schemes. The post Covid-19 scenario is characterized by a rising interest among the public towards agriculture for production of safe-to-eat vegetables, fish etc. and as a plausible means of livelihood. People have initiated farming in the homesteads with diverse crops and enterprises and are in dire need of technical support in maintaining the production units sustainably. However, there is a gap in the availability of production inputs (crops & subsidiary enterprises). Thus, the new found emphasis on farming could be effectively utilized only if there are adequate support mechanisms which include capacity building of farmers to establish and maintain integrated farming in homesteads, training rural youth on the technologies that can be employed in such production systems and establishing specialized workforce with skills in managing IFS by organizing trained youth. Furthermore, evolving appropriate IFS models in selected grama panchayats across the state through farmer participatory approach and providing technical support to farmer and women collectives to establish IFS through functional linkages among various development agencies may also be included. In this regard, a decentralized microlevel support system involving LSG Department, cooperative sector, and government agencies should be exercised for input, technical and post production support, including primary processing at the farm level.

Some suggested initiatives are: online sales platforms like Amazon, online mechanisms in government institutions eg: online seed portal of Indian Institute of Horticultural Research, Bengaluru [https://www.iihr.res.in/online-seed-portal]; decentralized input production to support IFS with quality control at Ward/Panchayat/Block level involving unemployed youth/Kudumbashree. Inputs include seeds/planting material, organic inputs, biocontrol agents, livestock components (poultry chicks, fish fingerlings); improving convergence/ collaboration with other government agencies eg. Suchitwa mission for biodigesters, Horticorp for stingless bee units; garnering support of Farmer Producer Organizations for coordinating such efforts. Service support through decentralized level Karma Senas, acquiring the support of the local educated nemployed youth, especially for small scale mechanized operations like tilling, pruning, harvesting etc. for homesteads, is a strategy to be seriously considered in Local Self Government Institution projects.

Such projects should focus on a mission mode approach during the coming plan period.

A decentralized procurement system for homestead produce (vegetables, minor fruits, spices etc.) like the MILMA model needs to be instituted by the Government, for which utilizing block chain technology software could open up new vistas. Marketing is, without doubt, very fundamental in a system like homestead farming, where it is at present lacking or highly disorganized. Certain ground-breaking introductions are the need of the hour. They include viz. enhancing home garden produce range in the market, integrating with cooperative sector, linking home garden produce with online facilitation eg. apps like Subhiksha F2C, Subhiksha KSD etc. Services similar to fresh to home, farmers fresh zone, farm fresh, Swiggy, and Zomato (with online payment options) can also be effectively utilized (Box 15).

Box15.An innovative intervention from the Cooperative sector

During the past years, there have been several initiatives from the cooperative sector in Kerala to support Agriculture. However,the venture of Palliackal Service Cooperative Bank in Ezhikkara Panchayat of Paravoor, Ernakulam to support integrated farming stands out and needs special mention. With a modest beginning in 2000, on a pilot basis, in the agricultural sector, their pro active intervention resulted in generating more employment andincome for the farmers in their jurisdiction. They formed Self Help Groups affiliated to the bank and involved in the production of fruits, vegetables, Pokkali cultivation, milk production, duck rearing and related egg production, fisheries and floriculture. They were instrumental in providing a labour force (army) who supported the farmers technically and by way of modern technological services as part of the agro-service centre established. Besides,they provided planting materials of ten different crops. The procurement of the produce of all enterprises supported by the society, especially Pokkali rice, at a reasonable price, was a big solace to the farmers. Over and above all, the farmers were also given interest free loans for undertaking the farming activities. Such initiatives ought to be replicated in the State.

Research Institutions & Krishi Vigyan Kendras

Though homestead farming can be described as a system comprising several mutually cohesive and complementary agro-based enterprises, no standard model will be suitable under all the situations. Suitable models have to be developed based on agro- ecological situations, holding size and availability of resources, undeniably through farmers' participatory approach. In urban homesteads, integrated terrace garden, low-cost vertical farming, successful, easily adoptable aquaponics, stingless bee etc. can be prioritized and implemented. It would be beneficial to explore possibilities of collaborativeventures between research (govt)-development departments-private online platform developers (IT) for providing consultancies related to IFS, establishing, new homesteads with integrated farming. It would be very prudent to monitor land use changes using Geographic Information System/drones/advanced technology (research institutions) in homesteads (Box 16)

Box 16. Scalable Homestead Models from Research Institutions

Different models suited to homesteads have been developed by the research institutions in Kerala. In KAU, the homesteads-based model (0.20 ha) registered an annual gross return of Rs.2,15,338. Sustainable value index (based on previous five-year data) was the highest for coconut-based model (0.78) suited to homesteads in lowlands.Efficient recycling of the organic biomass generated in the model resulted in 46 per cent increase in soil organic carbon when compared to the initial benchmark.

Central Plantation Crops Research Institute (CPCRI), Kasaragod has developed profitable-coconut-based models which can be scaled up in homesteads. CTCRI and Indian Institute for Spices Research, Calicut have evolved tuber and spice-based models respectively. All these models, though cannot be replicated as such in famers' field, need to be modified/ restructured and scaled up, suiting to the AEU through a farmer participatory approach.

The National level (ICAR) recommendation of practices evolved by KAU (ICAR-IIFSR, 2021) suited to Urban Agriculture are listed below:

Technology/ IFS Model	Current status	Recommended package/ technology
Integrated Terrace Garden	Limited cultivation under terrace garden	Vegetables/Crops+azolla+ poultry+vermicompost
Vertical farming Structures	Inadequate floor space inhome steads	Vertical farming structures with provision for drip /wickirrigtion

Conclusion

Homesteads are the future self-sufficient units of sustainable agriculture and food security. To strengthen the proposed pillars of sustainable homesteads i.e. women empowerment, market and technology, Government, LSGD and various research institution activities should be integrated and thus, pave the way to a resilient system of livelihood to achieve the targets of Sustainable Development Goal.

CHAPTER 8

CONCLUSION

The Fourteenth Five Year Plan in Kerala envisages enhancement of productivity, profitability and sustainability in the era of food security concerns, climate change, changing farming systems and use of digital technology. To this end, Kerala State Planning Board (SPB) had constituted Working Groups (WG) as well as expert sub groups (ESGs) in different sectors, sub-sectors and areas for the formulation of the XIV Five-Year Plan 2022-2027 and Annual Plan 2022-2023. The WG report on `ESG: Constraints to technology adoption and the potential to raise productivity in Kerala Agriculture' was made possible through the concerted efforts of the WG members under the leadership of Dr. R. Chandra Babu, Vice Chancellor, Kerala Agricultural University & Dr. K. C. Bansal, Former Director, National Bureau of Plant Genetic Resources, Indian Council of Agricultural Research, New Delhi.

The ESG report, divided into six chapters, comprehensively analyses the low productivity of major crops of Kerala through yield gap analysis across different AEZs of the state at the outset. The striking inter AEU variations in each crop reinforces the need to adopt AEU based cropping patterns across the state. The GAP analysis also brings out the intra AEU variation which can help prioritisation at the micro level with programmes aimed at targeted production in select crops.

The yield gap analysis leads to an assessment of the impact of technology adoption on productivity. The level of technology in crop production remains low in almost all crops. For instance, adoption of improved varieties and hybrids in the major crops is only low to medium level and this has been a major reason for the low productivity. There are several constraints to adoption of technologies such as insufficiency of quality planting material, sub optimal planting densities and lack of soil and water conservation measures that need be addressed.

Establishing the significance of recommended technologies brings the focus on to the possibility of enhancing productivity with currently available crop production technologies. Some of the critical areas where better adoption of technologies can lead to improved productivity could be greater availability of improved varieties, soil and plant health management and mechanisation. That there is no dearth of technology options is discernible in the light of success cases where significantly higher production levels have been achieved by farmers through adoption of the recommended technologies.

Enhancing productivity would be a concern not only from the current context of food and nutritional security but climate change related events are increasingly impinging upon crop production directly and indirectly, threatening to pull down crop production in the coming decades to address which, the present options might not be adequate. The requirement of technologies in future, when a delicate balance will have to be achieved between increasing production and conserving the sustainability of production systems will be a formidable challenge in crop improvement, crop production and crop protection. Specific, focused agenda is called for in each of the above areas to make a sustained breakthrough in crop productivity during the next five years. In addition, agricultural research will have to draw a lot upon the emerging, frontier technologies such as genomics, nanotechnology, IoT, block chain, big data analysis and robotics. Small farm mechanisation would be yet another area that would require resources and efforts to make farming profitable.

Kerala has a strong research system comprising of the KAU and ICAR institutes and a matching extension system made up of state DoA, VFPCK, commodity boards, NGOs and farmers organizations. However, farmers are not able to derive the full benefit of the above support mechanism due to the weaknesses in the research extension linkages. Mainstream extension services can be strengthened through the block level AKCs which have been envisaged to support micro level planning and formulation of development initiatives that pan beyond the limits of a Krishi Bhavan (KB). The KB level activities also need be streamlined and better coordinated, especially with regard to procurement and supply of planting materials. Capacity building of the extension personnel through frequent interfaces, trainings and refresher programmes also need be revitalized. The extension services of the KAU also need to engage more closely with the KBs while organizing farm trials and demonstrations so that better involvement of a greater number of farmers can be ensured. The interface programmes of national research institutions also need to be more frequent and should provide greater space for farmers in voicing their technology needs. The wide reach and scope of social media, while being used to some extent to pass on information, out to be tapped more creatively by sharing videos, FAQs and online interaction sessions.

The homesteads are the future self-sufficient units of sustainable agriculture and food security. Given their functional commonalities but regional variabilities, evolving dynamic models for homesteads that takes into consideration the newer challenges that farmers face and newer opportunities that technology offers should always be a priority.

Such models should address the food and nutritional concerns of the family in case of small holdings. In case of larger holdings, there should also be interventions to support the marketing of farm produces. Timely supply of inputs at reasonable rates, ensuring on site delivery of technology through trained man force, providing marketing channels and empowering women who are the primary stakeholders are some key areas to focus on. Above initiatives should necessarily incorporate lessons from success cases already available in the state and elsewhere. A mechanism to coordinate and monitor the interventions of the DoA, LSGIs and research institutions can be institutionalized to pave the way for creating resilient system of livelihoods through homesteads.

Annexure 1

Table 1. District wise AEU in terms of total geographic area

Sl. No.	Agro-Ecological Unit	Area (km^2)	AEU area as percentage to total area
1	**Thiruvananthapuram**		
	AEU 1: Southern Coastal Plain	204.77	9.34
	AEU 8: Southern Laterites	544.00	24.82
	AEU 9: South Central Laterites	568.59	25.94
	AEU12: Southern and Central Foot Hills	294.21	13.42
	AEU 14: Southern High Hills	580.43	26.48
	Total	2192.00	100.00
2	**Kollam**		
	AEU 1: Southern Coastal Plain	331.74	13.32
	AEU 3: Onattukara Sandy Plain	251.76	10.11
	AEU 9: South Central Laterites	476.20	19.12
	AEU 12: Southern and Central Foot Hills	650.33	26.11
	AEU 14: Southern High Hills	781.05	31.35
	Total	2491.08	100.00
3	**Pathanamthitta**		
	AEU 4: Kuttanad	96.60	3.57
	AEU 9: Southern Central Laterites	696.00	25.69
	AEU 12: Southern and Central Foot Hills	532.74	19.66
	AEU 14: Southern High Hills	1383.99	51.08
	Total	2709.33	100.00
4	**Alappuzha**		
	AEU 4: Kuttanad	96.60	3.57
	AEU 9: Southern Central Laterites	696.00	25.69
	AEU 12: Southern Central Foot Hills	532.74	19.66
	AEU 14: Southern High Hills	1383.99	51.08
	Total	2709.33	100.00
5	**Kottayam**		
	AEU 4: Kuttanad	646.48	30.32

	AEU 9: South Central Laterites	765.89	35.92
	AEU 12: Southern and Central Foot Hills	719.89	33.76
	Total	2132.26	100.00
6	**Ernakulam**		
	AEU 5: Pokkali Lands	417.03	15.23
	AEU 9: South Central Laterites	1111.64	40.59
	AEU 12: Southern and Central Foothills	623.03	22.75
	AEU 14: Southern High Hills	586.95	21.43
	Total	2738.65	100.00
7	**Idukki**		
	AEU 12: Southern and Central Foot Hills	321.02	7.14
	AEU 14: Southern High Hills	2331.84	51.84
	AEU 16: Kumily Hills	1553.53	34.53
	AEU 17: Marayur Hills	292.11	6.49
	Total	4498.50	100
8	**Malappuram**		
	AEU 2: Northern Coastal Plain	211.17	5.99
	AEU 6: Kole lands	157.41	4.46
	AEU 11: Northern Laterites	1577.38	44.73
	AEU 13: Northern Foot Hills	340.73	9.66
	AEU 15: Northern High hills	1239.66	35.15
	Total	3526.35	100.00
9	**Thrissur**		
	AEU 2: Northern Coastal Plain	224.38	7.45
	AEU 5: Pokkali Lands	125.99	4.18
	AEU 6: Kole Lands	711.52	23.62
	AEU 10: Northern Central Laterites	881.31	29.26
	AEU 14: Southern High Hills	582.90	19.36
	AEU 15: Northern High Hills	485.74	16.13
	Total	3011.84	100
10	**Palakkad**		
	AEU 2.3: North Central laterites	846.24	18.90
	AEU 3.2: Northern Foot hills	482.35	10.78
	AEU 4.1: Southern High hills	576.54	12.88

	AEU (1) 4.2 Northern high hills, (2) 4.5 Attappady dry hills and (3) 4.6 Attappady extremely dry hills	703.23	15.71
	AEU 5.1: Palakkad Central Plains	1333.62	29.79
	AEU 5.2: Palakkad Eastern Plains	534.32	11.94
	AEU 2.3: North Central Laterites	846.24	18.90
	AEU 3.2: Northern Foot Hills	482.35	10.78
	Total	4476.3**	100.00
11	**Kannur**		
	AEU 2: Northern Coastal Plain	302.17	10.18
	AEU 7: Kaipad Land	117.10	3.95
	AEU 11: Northern Laterites	1150.62	38.77
	AEU 13: Northern Foot Hills	337.24	11.36
	AEU 15: Northern High Hills	1060.83	35.74
	Total	2967.96	100.00
12	**Kozhikode**		
	AEU 2: Northern Coastal Plains	343.39	14.66
	AEU 7: Kaipad Land	59.41	2.54
	AEU 11: Northern laterites	1174.70	50.15
	AEU 15: Northern High Hills	764.80	32.65
	Total	2342.30	100.00
13	**Kasargod**		
	AEU 2: Northern Coastal Plain	305.19	15.56
	AEU 7: Kaipad Land	120.93	6.17
	AEU 11: Northern Laterites	980.95	50.02
	AEU 13: Northern Foot Hills	77.45	3.95
	AEU 15: Northern High Hills	476.78	24.31
	Total	1961.30	100.00
14	**Wayanad**		
	AEU 15: Northern High Hills	709.43	33.28
	AEU 20: Wayanad Central Plateau	643.07	30.16
	AEU 21: Wayanad Eastern Plateau	779.49	36.56
	Total	**2131.99**	**100**

Annexure 2

YGA-Quartile range of values for classification in to low, medium and high

Sl. No.	Crop	Quartile	Classification
1	Paddy	Q1 0.67 Q2 1.03 Q3 1.32	>Q3 - high >Q2 - medium otherwise - low
2	Coconut	Q1 1.86 Q2 2.32 Q3 2.96	>Q3-high >Q2-medium otherwise - low
3	Arecanut	Q1 1.03 Q2 1.85 Q3 2.79	>Q3-high >Q2-medium otherwise- low
4	Cassava	Q1 1.26 Q2 1.66 Q3 2.13	>Q3-high >Q2-medium otherwise- low
5	Pepper	Q1 1.46 Q2 2.30 Q3 3.35	>Q3 - high >Q2 - medium otherwise- low
6	Banana	Q1 1.10 Q2 1.41 Q3 1.70	>Q3 - high >Q2 - medium otherwise -low

Annexure 3. Crop Varieties released for Kerala

A. Rice Varieties for major rice growing tracts of Kerala

1. Pokkali Lands

Name	Duration	Characters	Potential yield(t/ha)	Av. farmer yield(t/ha)
VTL 4	115-120	Tolerant to acidity, salinity and submergence	3.50	2.5 to 3
VTL 6	105-110	Tolerant to acidity, salinity and submergence	4.0	3.50
VTL 8	115-120	Tolerant to acidity, salinity and submergence	4.0	4.0
VTL 9	115-120	Tolerant to acidity, salinity and submergence	4.0	3.50
VTL 10	110-115	Tolerant to acidity, salinity and submergence	4.20	4.0
VTL 11	105-110	Tolerant to acidity, salinity and submergence	5.0	3.0

2. Kole Lands

Name	Duration	Grain character	Special characters	Potential yield(t/ha)	Farmer yield(t/ha)
Hraswa	75-80	Red, medium bold	Ideal as a contingent variety for areas where there is crop loss. Susceptible to leaf folder. Raised only as direct sown crop	4.0	3.5
Ahalya	90-100	Red, good cooking quality	Tolerant to leaf folder and moisture stress in the early growth phase	4.0-4.5	Not cultivated (NC)
Manupriya	105-110	Red, long	Suitable for Kole lands. Tolerant to sheath bold blight, brown spot, blast, stem borer and gall midge. Suitable for all seasons	4.0-4.5	NC
Manu Ratna	95-99 days	Red bold Good cooking quality	Suitable for low land and Kole cultivation tolerant to stem borer, leaf folder, whorl maggot and blast.	5.7	5.2
Manu Varna	128-138	Red bold good cooking quality	Tolerant to leaf folder and stem borer, non-shattering, suitable for 2 seasons in lowlands and for Kole lands	7.2	6.5

3. Kuttanad

Variety name	Duration	Characters	Potential Yield (t/ha)	Farmer Yield (t/ha)
Bhadra	125-135	Red, short bold. Suitable for *puncha* season in Kuttanad. Low susceptibility to pests and diseases. Tolerant to BPH. Weakly photosensitive	5.0 – 5.5	4.5 – 5.00
Asha	115-120	Red, medium bold. Suitable for both seasons of Kuttanad, moderately resistant to pests and diseases. Tolerant to BPH	5.0 – 6.0	-

Pavizham	115-120	Red, short bold. Easy to thresh. Fairly resistant to BPH. Moderately resistant to stack burn and sheath rot and fairly resistant to sheath blight	5.0 – 6.0	-
Karthika	105-110	Red, bold long. Suitable for growing in all the three seasons. Moderate resistance to sheath blight, sheath rot and BPH. A good first crop component in koottumundakan	5.0 – 6.0	-
Aruna	100-110	Red bold, medium tolerant to BPH and stem borer, moderately resistant to gall midge, sheath rot. Dormancy up to one month. Specifically suited to wet season	5.0 – 6.0	-
Makom	100-110	Red bold, short moderately resistant to pests like BPH, stem borer, gall midge, leaf folder and diseases like sheath blight and sheath rot. Dormancy up to one month. Specifically suited for wet season. Can be cultivated in all the three seasons	6.5- 7.0	5.0 -5.5
Remya	110-120	Red, long bold, moderately resistant to BPH, gall midge, sheath blight and sheath rot, semi-tall variety. Suitable for all the three seasons. Seed dormancy up to one month	6.5 -7.0	-
Kanakom	120-125	Red, medium bold resistant to BPH and moderately resistant to stem borer. Resistant to diseases like rice tungro virus and blast. Moderately resistant to bacterial blight. Semi-tall variety suitable for all the three seasons	5.5 – 6.0	-
Renjini	115-120	Red, medium bold dwarf, resistant to blast and BPH	6.0 – 6.5	-
Pavithra	115-120	Red, medium bold dwarf, medium tillering, resistant to BPH and GM Biotype-5	6.0 – 7.0	-
Panchami	115-120	Red bold, medium dwarf, medium tillering, resistant to BPH and GM Biotype-5	6.0 – 7.0	-
Remanika	100-105	Red bold, short dwarf, medium tillering, resistant to BPH and moderately resistant to gall midge	5.0 – 5.5	-
Uma	115-120	Red, medium bold non lodging, resistant to BPH and Biotype-5. Dormancy up to 3 weeks. Suited to	6.5- 7.0	6.5 – 7.5

		three seasons especially to *virippu* crop season of Kuttanad		
Revathy	105-110	Red, medium bold dwarf, medium tillering, resistant to BPH and moderately resistant to gall midge. Dormancy up to 3 weeks. Suited to all the three seasons especially to additional crop of Kuttanad	5.0 – 5.5	-
Karishma	115-120	Red, medium bold dwarf, medium tillering, resistant to BPH and medium resistant to GM. Suited to three seasons especially to Kari lands of Kuttanad; tolerant to iron toxicity	5.0 – 5.5	-
Krishnanjana	105-110	Red, medium bold medium tillering, resistant to BPH and dormancy up to 3 weeks, suited to all seasons especially to Kari lands of Kuttanad, tolerant to iron toxicity	5.0 – 5.5	-
Gouri	115-120	Red, medium bold Medium tall, non-lodging, moderately resistant to sheath blight. Suitable for p*unja* and additional crop seasons of Kuttanad, m*undakan* season of Kole lands, first and second crop seasons in double cropped wet lands	5.0 – 5.5	-
Prathyasa	100-110.	Red, long bold non-lodging, photo insensitive, semi-tall variety, suitable for Kuttanad. Moderately resistant to gall midge, BPH, sheath blight and sheath rot	5.0 – 5.5	5.0 – 5.5
Shreyas	115-120	Red moderately resistant to sheath blight, sheath rot, BLB and false smut	7.0	6.0 – 6.5
Pournami	-	-	7.0 – 7.5	6.5 – 7.5

4. *Kaipad*

Name	Duration	Grain character	Characters	Potential Yield t/ha	Farmer Yield (t/ha)
Ezhome-1	135-145	Red, bold	Suitable for *virippu* season in the saline medium coastal Kaipad areas of North Kerala. Non lodging with base. Non shattering awn-less grains with purple	7.5	3.5

			coloured apiculus. Good cooking qualities. There is no pest and disease incidence at Kaipad field condition		
Ezhome -2	125-130	Red bold	Medium suitable for *virippu* season in the saline coastal Kaipad areas of North Kerala. Nonlodging with medium height, non-shattering awn-less grains with good cooking qualities. No pest and disease incidence at Kaipad field condition	6.8	3.2
Ezhome -3	120-125	Red bold	Medium duration. Variety tolerant to medium salinity suited to Kaipad and Pokkali soils during Kharif and Rabi seasons	5.7	4.0
Ezhome- 4	135-140	White	HY long duration paddy suitable for Kaipad lands and non-saline flooded tracts	6.4	5.1
Jaiva	130-135	White	HY photo insensitive rice variety developed for organic farming in ordinary non-saline wet lands	6.6	5.2
Mithila	125-130	-	A high yielding saline and flood tolerant non lodging, photo insensitive, organic rice variety resistant to sheath blight, leaf folder and gall midge, good grain yield and straw yield.	6.8	5.2

5. Palakkad

Name	**duration**	**Grain characters**	**Special characters**	**Potential Yield (t/ha)**	**Farmer av. Yield (t/ha)**
Karutha Modan (PTB 29)	105-110	Red, long bold	Tall		

Chuvanna Modan (PTB 30)	105-110	Red, long bold -	Tall	2.2	1.50
Annapoorna, (PTB 35)	95-100	Red short bold	Suitable for direct seeding. Susceptible to blast, sheath blight and BPH. Suited for I and III crop season	5.0	4.0
Rohini. (PTB 36)	85-105	White, long bold	Performs well during *virippu* season Not recommended for *mundakan* season. Suitable for direct seeding	5.0	3.5
Triveni (PTB 38)	100-105	White, long bold	Tolerant to BPH. Susceptible to blast and sheath blight	5.0	3.75
Jyothi (PTB 39)	110-115	Red, long bold	Moderately tolerant to BPH and blast; susceptible to sheath blight; suitable for direct seeding, transplanting and special systems of Kole and Kuttanad	6.0	5.2
PTB 40 (Sabari)			Susceptible to sheath blight	5.0-6.0	5.0
PTB 43 (Swarnaprabha)			Semi-tall variety suitable for upland cultivation also. High photosynthetic efficiency under low light conditions.	5.0	4.0
Rashmi (PTB 44)	150-160	Red	Suitable for growing in the second crop as the *mundakan* for koottumundakan		

			system. Resistant to leaf folder and tolerant to gall midge		
PTB 45 (Matta triveni)	-	-	High volume weight. High grain yield potential especially during summer.	5.5	4.5
Jayathi, (PTB 46)	120-125	White	Resistant to BPH, green leaf hopper, leaf folder blast and bacterial leaf streak, non-lodging, semi-tall, suitable for all the three seasons		
Neeraja (PTB 47)	140-150	White	Moderately resistant to leaf folder, resistant to blast and moderately susceptible to sheath blight, non-lodging, photosensitive, dormant, suited to flood prone and water-logged areas and poonthal padams	5.0- 5.5	4.0
Nila (PTB 48)	160-180	Red, short bold	Photosensitive, capable of producing good grain and straw yields under low fertilizer application. Suitable for Karinkora cultivation. Highly resistant to thrips, BPH and moderately resistant to gall midge, stem	5.5	3.8

			borer and sheath blight.		
PTB 49 (Kairali)			High tolerance to sheath blight.	5.0	4.5
PTB 50 (Kanchana)			Moderately resistant to blast and sheath blight. Highest grain yield recorded during *puncha* season.	5.5	5.0
Aathira (PTB 51)	120-130	Red, short bold	Semi-tall, non-lodging, moderate resistance to blast and blight diseases and BPH. Suited for I and II crop seasons and also for hilly tracts	5.0- 5.5	4.3
Aiswarya (PTB 52)	120-125	Red, long bold	Suitable for *mundakan*. Resistant to blast and blight diseases. Resistant to BPH. Suited for I and II seasons	5.5	4.8
PTB 56 (Varsha)			Short duration, dwarf variety suitable for dry sown and transplanted situations	5.0	4.5
Swetha (PTB-57)	135-140	White, short bold	Suitable for black cotton soils of Chittoor taluk as a transplanted II crop	4.2	3.5
PTB 58 (Anaswara)	-	-	Photosensitive, semi tall variety. Suitable only for *mundakan* season showing reduced lodging nature.	4.0-4.5	3.2
PTB 59 (Samyuktha)	-	-	Suitable for koottumundakan system of cultivation with	4.0	3.2

			Makaram in central zone.		
Vaishak (PTB 60)	117-125	Red, short bold	Suitable for direct seeding during Kharif season in the uplands. Tolerant to moisture stress, resistant to blue beetle, moderate resistance to stem borer and whorl maggot	5.5	3.9
PTB 61 (Supriya)		White	Suitable for *mundakan* season. Long duration, late maturing non-lodging broad leaved variety with short bold white kernels.	8.0	6.5 -7.0
PTB 62 (Akshya)		White	Suitable for *mundakan* season. Long duration, late maturing non-lodging broad leaved variety with short bold white kernels.	8.0	6.5 -7.0

B. Vegetable varieties

Crop	Variety	Characters	Potential Yield (t/ha)
Brinjal	Surya	Fruits purple coloured and oval. Resistant to bacterial wilt	30.00
	Swetha	Fruits white coloured and medium to long. Resistant to bacterial wilt	30.00
	Haritha	Fruits green coloured and long. Resistant to bacterial wilt	62.00
	Neelima	F_1 hybrid, large oval to round glossy violet fruits. Resistant to bacterial wilt	65.00
	Ponny	Inwardly curved light green long fruit. Resistant to bacterial wilt	31.6

Chilli	Jwalamukhi	Green medium ling fruits with wrinkled thick skin, partial shade tolerant	22.50
	Jwalasakhi	Medium long sulphur-coloured fruits with smooth thick skin	19.60
	Ujwala	Fruits erect dark green in clusters Resistant to bacterial wilt, tolerant to leaf curl and mosaic in field	18.00
	Anugraha	Light green long pendant fruits Resistant to bacterial wilt	27.00
	Vellayani Athulya	Pendant light green long fruits	32.00
	Samrudhi (Bird Chilli)	Fruits erect creamy white, and shade tolerant	31.00
	Vellayani Thejus	Dark green fruits, shade tolerant suitable for homesteads	30.00
	Keerthi	Green coloured, semi-wrinkled pendant fruits	11.50
Tomato	Sakthi	Flat round medium sized fruits with green shoulder Resistant to bacterial wilt	32.00
	Mukthi	Fruits white round medium sized without green shoulder Resistant to bacterial wilt, tolerant to heat	43.50
	Anagha	Round red medium sized fruits without green shoulder Resistant to bacterial wilt and crack, tolerant to leaf curl and mosaic	30.00
Tomato	Vellayani Vijay	Light green fruits Resistant to bacterial wilt, high temperature and partial shade	37.26
	Akshaya	Indeterminate growth habit suitable for rain shelter cultivation	*3.50 (kg/plant)
	Manulakshmi	Oval shaped fruits, resistant to bacterial wilt	
	Manuprapha	Round shaped fruits, resistant to bacterial wilt	*1.88 (kg/plant)
	Kiran	Light green long fruits Tolerant to YVMV	11.20
	Anjitha	Long smooth green fruits with prominent ridges Resistant to YVMV and tolerant to shoot and fruit borer	14.60
	Manjima	Light long green fruits	16.00

Okra		Resistant to YVMV and tolerant to shoot and fruit borer	
	Salkeerthi	Light green long fruits	16.20
	Aruna	Red coloured long fruits rich in anthocyanin	15.80
	Susthira	Light green fruits Resistant to YVMV	18.00
Yard long bean	Malika	Long light green pods without purple tip	9.80
	Sharika	Long white pods with purple tip	10.60
	Vellayani Jyothika	Long light green pods Tolerant to fusarium wilt	19.33
	KMV-1	Long light green pods with brown tip	13.50
	Vyjayanthi	Wine red coloured extra-long fruits	12.60
Yard Long Bean	Lola	Long white pods with purple tip	20.00
	Githika	Long thick fleshy pods with light green colour and mosaic resistant	27.60
	Manjari	Light green pods. Tolerant to mosaic	5.6 0
	Mithra	Long light green pods, tolerant to fusarium wilt and pythium rot.	20.70
	KAU Deepika	Long green pods suitable for homesteads	*1.45kg/plant
Bush cowpea	Bhagyalakshmi	Light green medium sized pods	6.48
Semi trailing cowpea	Kairali	Pink coloured medium long pods	7.13
	Anaswara	Light green medium long pods Less incidence of cowpea mosaic in field	12.50
	Varun	Pink coloured long pods Tolerant to mosaic and pod borer	8.40
Winged bean	Revathy	Photo sensitive short-day plant, medium sized green pods	11.00
	KAU Nitya	Photo insensitive, green pods	* 2.68 kg/plant
Hyacinth bean	Hima	Photo sensitive, Light green broad straight pods	14.82
	Grace	Photo sensitive, medium broad greenish purple slightly curved pods	15.00
	Arun	Purple coloured leaves and stem,suitable for multicut and once over harvest	20.00
	Mohini	Leaves dark green with acute tip	13.20

Amaranthus		Stem thick green with red colour at the basal parts	
	Krishnasree	Red fleshy stem with reddish green leaves, suitable for multicut	14.80
	Renusree	Red fleshy stem with green leaves, suitable for multicut	15.50
	KAU Vaiga	Red coloured stem and leaves suitable for multicut	*783.2 g/plant
Bittergourd	Priya	Long green spiny fruits with white tinge at stylar end	25.00
	Preethi	White spiny medium long fruits	25.00
	Priyanka	White large spindle shaped fruits with smooth spines	28.00
Snakegourd	Kaumudi	White long fruits with white acute tip	50.00
	Baby	Small sized white fruits Tolerant to mosaic disease	50.70
	Manusree	Medium long white fruits with green markings at pedicel end	60.00
	Harithasree	Green fruits with white stripes**	
Ash gourd	KAU Local	Medium sized oval to oblong fruits with high flesh thickness	28.20
	Indu	Medium sized round fruits with flat stylar and pedicel end Tolerant to mosaic disease	24.50
	Thara	Small fruited variety suited for homestead and commercial cultivation	22.00
Pumpkin	Ambili	Fruits flat round with yellow flesh and yellow brown skin at maturity	33.00
	Suvarna	Medium sized flat fruits with orange flesh	37.00
	Saras	Elongated medium sized fruits with orange thick flesh	39.00
	Sooraj	Globular medium sized fruits with orange flesh and tan skin colour at maturity	47.00
Oriental picking melon	Soubhagya	Small to medium sized oblong fruits	17.10
	Mudicode	Long oval fruits	30.00
	Arunima	Cylindrical shaped fruits	30.00
	KAU Vishal	Medium to large cylindrical shaped fruits	33.00

Cucumber	Heera	F1 hybrid with light green fruits, suitable for open and rain shelter cultivation	102.8
	Subra	F1 hybrid with greenish white fruits, suitable for open and rain shelter cultivation	102.3
	KPCH 1	Parthenocarpic F1 hybrid with long dark green fruits, suitable for polyhouse cultivation	*1 t /100 m^2
Ridge gourd	Haritham	Light green cylindrical fruits with typical ridges tapering towards the base	13.20
	Deepthi	Green coloured medium sized fruits with finely wrinkled surface	12.70
	KRH 1	High yielding F_1 hybrid with long slender fruits	*7.42 kg/plant
Water melon	Swarna	Bright yellow fleshed seedless triploid hybrid	3.18 kg/ fruit
	Shonima	Red fleshed seedless triploid hybrid	3.92 kg/ fruit
Cluster bean	KAU Suruchi	Long green pods	392.29g/plant
Ivy gourd	Sulabha	Pale green fruits with continuous striations	60.00
Drumstick	Anupama	Medium long green fruits	32 kg/plant
Cassava	Nidhi	Short duration non branching variety, tolerant to cassava mosaic	25.10
	Kalpaka	Short duration non branching variety with high tuber starch Tolerant to cassava mosaic and brown leaf spot	61.20
	Vellayani Hraswa	Short duration branching variety	44.00
Sweet potato	Kanjangad	Purple tubers with yellow flesh, tolerant to partial shade	12.00
Greater yam	Indu	Digitate tubers with brownish black skin and white flesh	*3.93 kg/plant (intercrop)
Coleus	Nidhi	Medium sized oblong shaped tubers with characteristic aroma	27.90
	Suphala	Bigger sized tubers emerge mostly form basal nodes	15.93

C. Fruit crops varieties from KAU

Crop	Variety	Characters	Potential Yield (t/ha)

Banana	BRS-1	No. of fingers – 75 Highly resistant to sigatoka leaf spot and panama wilt. Resistant to pseudostem borer and rhizome weevil Duration – 9 to 10 months Suitable for intercropping	12 to 13 kg/ bunch
	BRS-2	No. of fingers – 125 Resistant to sigatoka leaf spot and panama wilt Duration – 10 to 11 months Suitable for intercropping	14 to 16 kg/bunch
Jack fruit	Sindoor	Suitable for table purpose Attractive sunset orange flakes Fruits with distinct aroma, taste and sweetness Bear fruits twice/ year	25 fruits/ tree / year
Pineapple	Amritha	It is a first hybrid variety. 13-15 months duration Fruit is firm with mild external aroma, skin 6 mm thick, flesh firm, non-fibrous, crisp and pale yellow in colour with rich aroma Taste is good with high total soluble salts and low acidity	1.5-2.0 kg/ fruit

D. Plantation, Spices, Medicinal and Aromatic Crops Varieties

Crop	Variety name	Special characters	Potential Yield
Black pepper	Panniyur-1	Long spike. High yield. Best performance under open condition. Driage- 35.3 % Oleoresin- 11.8 % Volatile oil- 3.5 % Piperine- 5.3 %	1242 kg/ha (dry berry yield)
Black Pepper	Panniyur-2	Tolerates shade. Driage- 35.7 % Oleoresin- 10.9 % Volatile oil- 3.4 % Piperine- 6.6 %	2570 kg/ha (dry berry yield)
	Panniyur-3	Long spikes. Bold berries Prefer open condition. Driage- 27.8% Oleoresin- 12.7% Volatile oil- 3.17% Piperine- 5.2%	1953 kg/ha (dry berry yield)
	Panniyur-4	Tolerates adverse climatic conditions. Driage- 34.7 % Oleoresin- 9.2% Volatile oil- 3.12%	1277 kg/ha (dry berry yield)

		Piperine- 5.0%	
	Panniyur-5	Tolerates adverse climatic conditions. Driage- 35.71% Oleoresin- 12.33% Volatile oil- 3.8% Piperine- 5.3%	2352 kg/ha (dry berry yield)
	Panniyur-6	Stable and regular yielder. Tolerates partial shade. Driage- 32.93% Oleoresin- 8.27 % Volatile oil- 1.33 % Piperine- 4.94 %	2127 kg/ha (dry berry yield)
	Panniyur-7	Stable and regular yielding. Driage- 33.57 % Oleoresin- 10.61 % Volatile oil- 4.20 % Piperine- 5.70 %	1410 kg/ha (dry berry yield)
	Panniyur-8	Suitable for growing in open as well as partial shade. Regular bearer. Field tolerant to *Phytophthora* foot rot and drought. Driage- 37.0 %	2130 kg/ha (dry berry yield)
	Panniyur-9	Performs well in open condition and hilly tracts. Field tolerant to *Phytophthora* foot rot, drought and cold stress. Volatile oil- 5.00 % Oleoresin- 12.71 % Piperine- 6.11 %	2.86 kg/vine (dry berry yield)
Black Pepper	Panniyur-10	High yielding climate resilient variety. Long spikes, bold berries. Tolerant to *Phytophthora* foot rot. High piperine & oleoresin.	2.3 kg/vine (dry berry yield)
	Vijay	Bold berries, high oil, oleoresin and piperine content. Tolerant to *Phytophthora* foot rot. Driage- 39.80 % Volatile oil- 3.33 % Oleoresin- 10.19 % Piperine- 4.9 %	2646 kg/ha (dry berry yield)
	PV 1	Malabar type. Early bearing.	268 kg/ha (dry capsule yield)

Cardamom		Performs well under the elevation from 900-1200 m above MSL. Highly suitable for marginal farmers owing to its earliness in bearing. Higher number of panicles that are devoid of shedding. Dried capsules are attractive green coloured. Tolerance to thrips and capsule borer and drought. Driage- 19.90 % Essential oil- 6.80% 1,8 cineole- 34.06 % Alpha-terpinyl acetate- 29.60 %	
	PV 2	Vazhuka type. Capsule is bold. Tolerant to capsule borer. Driage: 23.8 % Essential oil- 10.45 %	982 kg/ha (dry capsule yield)
	PV 3	Malabar type. Suited for partial shade Adaptable for all cardamom growing tracts of Kerala. Parrot green colour capsule after curing. Medium tolerance to drought. Moderately tolerant to capsule borer. Driage: 18.5% Essential oil- 7.2 % 1,8 cineole- 28.94 % Alpha terpinyl acetate- 26.88 %	416 kg/ha (dry capsule yield)
Cardamom	PV 5	Vazhuka type. Suited to partial shade. Adaptable for all cardamom growing tracts of Kerala. Tolerance to drought and capsule borer. Essential oil- 7.2 % 1,8 cineole- 28.94 % Alpha terpinyl acetate-26.88 %	416 kg/ha (dry capsule yield)
Turmeric	Kanthi	Big mother rhizomes and bold fingers with short internodes. Driage (%)-18.7 Curcumin (%)-7.18	39.25 t/ha (fresh yield)

		Oleoresin (%)-2.13 Essential oil (%)-5.15	
	Sobha	Big mother rhizomes and bold fingers with short internodes Driage (%)-18.3 Curcumin (%)-7.39 Oleoresin (%)-15.95 Essential oil (%)-4.24	31.37 t/ha (fresh yield)
	Sona	Field tolerant to leaf blotch Driage (%)-18.88 Curcumin (%)-7.11 Oleoresin (%)-18.0 Essential oil (%)-4.40	37.34 t/ha (fresh yield)
	Varna	Bold rhizome with short internodes, field tolerant to leaf blotch. Driage (%)-19.05 Curcumin (%)- 7.87 Oleoresin (%)-13.88 Essential oil (%)-4.56	33.44 t/ha (fresh yield)
Ginger	Athira	Bold rhizomes. Ideal for pure crop and intercrop. Suitable for fresh and dry ginger. Tolerant to soft rot and bacterial wilt. Dry recovery -22.6% Crude fibre-3.4% Oleoresin-6.8% Essential oil-3.1%	21.0 t/ha (fresh yield)
	Karthika	Ideal for pure crop and intercrop. Suitable for fresh and dry ginger. Tolerant to soft rot and bacterial wilt. Low infestation of shoot borer. Dry recovery-21.6% Crude fibre-3.7% Oleoresin-7.2% Essential oil-3.2%	19.0 t/ha (fresh yield)
Ginger	Aswathy	Ideal for pure crop and intercrop. Suitable for fresh ginger. Suited for homesteads. Tolerant to *Phyllosticta* leaf spot. Dry recovery-19.7%	23.0 t/ha (fresh yield)

		Crude fibre-3.5% Dry recovery (%) Oleoresin-7.5% Essential oil-3.3%	
	Chitra	Extra bold rhizomes. Less fibre. High starch and high driage. Recommended for dry ginger production. Dry recovery- 23.4% Crude fibre- 3.01% Oleoresin- 4.71% Essential oil- 1.6%	22.06 t/ha (fresh yield)
	Chandra	Less fibre. High oleoresin. Recommended for fresh and dry ginger. Dry recovery- 22.26% Crude fibre-3.0% Oleoresin- 5.17% Essential oil- 1.6%	23.51 t/ha (fresh yield)
Nutmeg	KAU-Mundathanam	Mace weight (dry): 2.49g Nut weight (dry): 12.6g. Kernel oil: 6.9 % Mace oil: 11.0 %	Mace yield/tree: 3.89 kg, Nut yield/tree: 19.7 kg
	KAU- Poothara	Mace weight (dry) : 2.06g, Nut weight (dry): 10.0g, Kernel oil: 4.16 %, Mace oil: 7.0 %	Mace yield/tree: 4.53 kg Nut yield/tree: 22.0 kg.
	KAU- Pullan	Mace weight (dry): 1.36g, Nut weight (dry): 10.85g, Kernel oil: 4.6%, Mace oil: 12.06 %	Mace yield/tree: 2.86 kg, Nut yield/tree: 22.79 kg
	KAU-Kochukudy	Mace weight (dry): 2.49g, Nut weight (dry): 11.60g, Kernel oil: 6.9 %, Mace oil: 11.0 %	Mace yield/tree: 4.48 kg, Nut yield/tree: 20.88 kg
	KAU-Punnathanam	Mace weight (dry): 3.02g, Nut weight (dry): 13.85g, Kernel oil: 4.5%, Mace oil: 9.5%	Mace yield/tree: 4.23kg, Nut yield/tree: 19.39 kg
Cambodge	Amrutham	Compact tree. Mean HCA content 51.58%	16.38 kg/ tree (dry rind)
	Haritham	Suitable for homesteads. Good quality fruit rind with HCA content 52.99%	9.91 kg/ tree (dry rind)
	Nithya	Intensive branching with spreading canopy.	10.11 kg/tree (dry rind)

		Acidity- 53.67% Tannin- 520 mg/100 g Driage- 9.76% HCA -16.96 %. Suitable for loamy to laterite soil.	
Coconut	Lakshaganga	Copra content/nut-195g Copra yield -21.1kg /p/y Oil content -70% Recommended for Kerala	108 nuts/palm/year
	Keraganga	Copra content- 201g/nut Copra yield - 21kg/p/y Oil content - 69 % Recommended for Kerala	100 nuts/palm/year
	Anandaganga	Copra content- 216g/nut Copra yield - 20.5kg/p/y Oil content - 68 % Recommended for Kerala	95 nuts/palm/year
	Kerasree	Copra content- 216g/nut Copra yield -24.0 kg/p/y Oil content - 66 %	130 nuts/palm/year
	Kerasowbhagya	Copra content/ nut – 195g Copra yield – 25 kg/p/y Oil content – 65 % Recommended for Kerala	130 nuts/palm/year
	Kerasagara	Tall palms Flower in 8 years, Copra content - 203.4 g Oil content - 68 %	99 nuts/palm/year
	Keramadhura	Dual purpose variety (tender nut and copra) More quantity of tender nut water (287 ml) with excellent quality. Copra yield (196 g/nut).	119 nuts/palm/year
	Kerasulabha	Large bold nuts with thick kernel & weight of copra (218g), Suitable to lateritic soil Better performance even under unfavorable conditions.	88.72 nuts/palm/year
Cashew	Anakkayam-1	Early flowering type Nut weight - 6.0g Shelling % - 27.99 Kernel grade - W280	12.0 kg/tree
	Madakkathara-1	Early flowering type Nut weight - 6.2g Shelling % - 26.8 Kernel grade - W280	13.8 kg/tree

	Madakkathara-2	Late flowering type Nut weight - 7.3g Shelling % - 26.0 Kernel grade -W 240	17.0 kg/tree
	Kanaka	Mid flowering type Nut weight - 6.8g Kernel weight - 2.1g Shelling % - 31.0 Kernel grade -W210	19.0 kg/tree
	Dhana	Mid flowering type Nut weight - 9.5g Kernel weight - 2.2g Shelling % - 28.0 Kernel grade -W210	17.5 kg/tree
	Dharasree	Mid flowering type Nut weight - 7.8g Kernel weight - 2.4g Shelling % - 30.5 Kernel grade -W240	15.02 kg/tree
	Sulabha	Mid flowering type Nut weight - 9.8g Shelling % - 26.5 Kernel grade -W210	13.2 kg/tree
Cashew Nut	Mrudula	-	
	Priyanka	Mid flowering type Nut weight -10.8g Kernel weight - 2.8g Shelling % - 26.5 Kernel grade -W180	16.9 kg/tree
	Anagha	Mid flowering type Nut weight - 10.0g Kernel weight - 2.9g Shelling % - 29.0 Kernel grade -W180	13.7 kg/tree
	Amrutha	Mid flowering type Nut weight - 7.2g Kernel weight - 2.2g Shelling % - 31.6 Kernel grade - W210	18.3 kg/tree
Cashew Nut	Akshaya	Mid flowering type Nut weight -11.0g Kernel weight - 3.12g Shelling % - 28.36 Kernel grade -W180	11.8 kg/tree
	Poornima	Mid flowering type Nut weight - 7.8g Kernel weight - 2.6g Shelling % - 31.0 Kernel grade -W210	14.1 kg/tree

	Sree	Tolerant to tea mosquito bug	
	KAU Nihara	Dwarf and compact cashew variety suited for urban and peri urban households. First dwarf type cashew variety released in India.	1.25 t/ha
	Damodar	Mid flowering type Nut weight - 8.2g Kernel weight - 2.0g Shelling % - 27.3 Kernel grade -W240	13.36 kg/tree
	Raghav	Mid flowering type Nut weight - 9.2g Kernel weight - 2.27g Shelling % - 26.6 Kernel grade -W210	14.65 kg/tree
Cocoa	CCRP-1	Mean number of pods - 56.2 Mean pod weight (g) - 384.7 Number of beans/ pod - 46.2 Mean wet bean yield (kg/plant)- 6.2	2.5 kg/plant (dry bean)
	CCRP-4	Mean number of pods - 66.2 Mean pod weight (g) - 402.1 Number of beans/ pod - 45.4 Mean wet bean yield (kg/plant) - 8.3	3.9 kg/plant (dry bean)
	CCRP-5	Mean number of pods - 37.9 Mean pod weight (g) - 425.0 Number of beans/ pod - 45.2 Mean wet bean yield (kg/plant) - 4.3	1.7 kg/plant (dry bean)
Cocoa	CCRP-6	Selection, pods are big, green to yellow, self-incompatible Mean number of pods - 50.1 Mean pod weight (g) - 895.0 Number of beans/ pod - 48.0 Mean wet bean yield -11.3 (kg/plant)	3.1 kg/plant (dry bean)
	CCRP-7	Mean number of pods - 78.1 Mean pod weight (g) - 526.7 Number of beans/ pod - 46.9 Mean wet bean yield (kg/plant)- 9.7	4.0 kg/plant (dry bean)
	CCRP-8	Pod weight (g) - 389.3 Wet bean weight/pod (g) - 126.3 Bean Number- 48.8	90.4 (No. of pod yield/tree)

	CCRP-9	Pod weight (g) - 370.4 Wet bean weight/pod (g) - 84.9 Bean Number - 36.7	105.7 (No. of pod yield/tree)
	CCRP-10	Pod weight - 332.5 Wet bean weight/pod (g) - 102.5 Bean Number - 41.5	79.6 (No. of pod yield/tree)
	CCRP-11	Average pod weight - 639.1g (37.1 beans). Oven dry bean weight – 1.3g	131 pods/tree/year
	CCRP-12	Average pod weight - 562.7g (37.1 beans) Dry bean weight – 1.1g	137.6 pods/tree/year
	CCRP-13	Average pod weight – 716.7g (35.3 beans) Oven dry bean weight – 1.3g	99.3 pods/tree/year
	CCRP-14	Average pod weight – 546.4g (40.6 beans) Dry bean weight – 1.3g	119.5 pods/tree/year
	CCRP-15	Average pod weight – 870 g (48.4 beans), Dry bean weight – 1.4g. Resistant to VSD	86 pods/tree/year
Kacholam	Kasthuri	Driage: 32.78 % Volatile oil content: 1.6 % Oleoresin content: 3.4 %	2.52 t/ha (dry rhizome)
	Rajani	Driage: 34.48 % Volatile oil content: 1.0 % Oleoresin content: 7.68 %	2.55 t/ha (dry rhizome)
Adapathiyan	Jeeva	High soluble sugars (8.33%) Protein (0.56 %)	5.4 t/ha (fresh root yield)
Chethikoduveli	Agni	High plumbagin 0.80%	10.47 t/ha (fresh root)
	Mridhula	Low plumbagin 0.22%	11.20 t/ha (fresh root)
Atalodakam	Ajagandhi	High vasicine 2.46% Ideal leaf crop	46.33 t/ha (fresh weight)
	Vasika	High vasicine 5.55% Ideal for root crop	49.3 t/ha (fresh weight)
Long pepper	Viswam	Bearing period –240 to 270 days /year	800-850 kg dry spikes/ha
Asoka	Aswini-1	High tannin content (3.30 %) Moderately resistant to stem borer	2.753 kg dry weight /plant

Lemon grass	Sugandhi (OD-19)	Red stemmed variety Profuse tillering. Adapted to a wide range of soil and climatic condition. Much suited for rainfed cultivation	
Vetiver	ODV-3	Grown mostly in Nilambur area. Av.oil recovery – 0.8%	
	Bhoomika	Good tillering, extensive fibrous roots, covering soil surface, Drought tolerance Efficient barrier to check soil, nutrients, organic matter and water losses, hedge plant for soil and water conservation	200kg/100m^2 (root yield)

Appendix 1

PROCEEDINGS OF THE MEMBER SECRETARY
STATE PLANNING BOARD

(Present: Sri. Teeka Ram Meena IAS)

Sub: - Formulation of Fourteenth Five Year Plan (2022-27) – Constitution of Working Group on Agriculture and Cooperation – Revised Proceedings - reg.

Read: 1. Note No. 297/2021/PCD/SPB dated: 27/08/2021
2. Guidelines on Working Groups
3. This Office order of even number dated 08.09.2021

ORDER No. SPB/342/2021-Agri(1) Dated:14.09.2021

As part of the formulation of Fourteenth Five Year Plan, it has been decided to constitute various Working Groups under the priority sectors. Accordingly, the Working Group on **Agriculture and Cooperation sector** is constituted. For the smooth functioning of the Sectoral Working Group (SWG), it is decided to split the Working Groups into Expert Sub Groups (ESG). Hence the Working Group is categorized into eleven Expert Sub Groups as indicated in the proceedings. The names of the members of the SWG are indicated under each ESG. The Working Group shall also take into consideration the guidelines read 2nd above in fulfilling the tasks outlined in the ToR for the Working Group.

1. A PLAN TO IMPROVE THE EFFICIENCY OF WORKING OF KRISHI BHAVANS

Co-chairperson

- Dr C. Bhaskaran, Professor of Agricultural Extension (Retd), Kerala Agricultural University
- Mr T. V. Subash IAS, Director, Agriculture

Members

- Dr P. Jayaraj, Programme Coordinator, KVK, Kannur
- Dr Sreevalsan J. Menon, Associate Director of Extension, Directorate of Extension, KAU
- Mr V. G. Sunil, Assistant Professor, Agricultural Extension, Communication Centre, Kerala Agricultural University
- Mr P. V. Jinraj, Assistant Director, Agmark Laboratory, Thiruvananthapuram
- Ms Asha K. Raj, Assistant Director of Agriculture, Small Farmers Agribusiness Consortium, Thiruvananthapuram
- Mr Kariyam Ravi,115 Journalist colony, NCC Nagar, Peroorkada
- Mr G. K. Manivarnan, Agricultural Officer, Pallikkal Grama Panchayath
- Mr R. Ajith Kumar, Assistant Professor, IIITM-K

- Mr Joy Sebastian, MD, VCONSOL
- Mr Sidharthan A.K, Assistant Director of Agriculture (Q C),Kozhikkodu

Terms of Reference

- To assess the present functioning of Krishi Bhavans in Kerala and suggest how to improve their effectiveness.
- To identify advanced technologies for use in Krishi Bhavans to ensure better delivery of services and their convergence with LSGIs, Cooperatives, FPOs, and KAU.

2. A PLAN TO EXPAND AND MODERNIZE SUPPLY CHAINS IN AGRICULTURE

Co-chairperson

- Dr Poornima Varma, Faculty, Centre for Management in Agriculture, IIM-Ahmedabad
- Dr A. Prema, Professor & Head, Department of Agricultural Economics, College of Horticulture, Vellanikkara, Thrissur

Members

- Ms L. R. Arathi IES, Mission Director, State Horticulture Mission, Kerala
- Dr A. Suresh, Principal Scientist, CIFT, Kochi
- Dr S. Jayasekhar, Senior Scientist, Social Science Division, CPCRI, Kasaragod
- Mr Valsan Panoli, Kerala Karshaka Sangham, Vapushas, Koothuparamba, Kannur
- Mr.V. P. Unnikrishnan, MFH Flat No.2003, Vrindavan Garden, Pattom Palace P O Thiruvananthapuram
- Ms Deepthi S. Nair, Deputy Director, Marketing, Coconut Development Board, Kochi
- Dr S. Asharaf, Professor, IIITMK
- Mr Mathew Abraham, Assistant Director, Marketing, Department of Agriculture
- Dr Sangeetha K. Prathap, Assistant Professor, School of Management Studies, Cochin University of Science and Technology, Kochi.
- Ms Chitra K. Pillai, Assistant Director of Agriculture, Agricultural Urban and Wholesale Market, Maradu
- Mr L. Subhash Babu, Deputy Director (Retd.), Department of Agriculture and Farmer's Welfare
- Mr Joy Sebastian, MD, VCONSOL
- Mr Ashar Thattarath, PGP IIM, Ahmedabad
- Mr Manu K.G, Public Relations Officer, Directorate of AD & FW

Terms of Reference

- To suggest a design of a unified supply chain for farm inputs and outputs with specific reference to aggregation/procurement, storage, and marketing.

- To suggest a framework where LSGIs, Cooperatives and FPCs can be effectively integrated into the unified supply chain.
- To suggest ways to ensure that the supply chains are integrated with the objectives of trade, value addition and processing - domestic and global – as well as agricultural finance institutions.
- To suggest ways in which the private agencies in procurement, trade and marketing are integrated with the supply chains.
- To ensure that the supply chains meet the requirements of *niche* sectors, such as organic farming, in certification and traceability.
- To suggest the major technological changes and infrastructural investments required to equip the State's supply chain systems to meet the needs of the farming community as well as domestic and international trade.

3. HOW CAN KERALA DOUBLE ITS VEGETABLE PRODUCTION IN THE NEXT FIVE YEARS?

Co-chairperson

- Ms C. A. Letha. IAS, Secretary, Agriculture, Government of Kerala
- Dr T. Pradeep Kumar, Director (Planning), Kerala Agricultural University, Thrissur

Members

- Dr P. Rajasekharan, Chairperson, State Agricultural Prices Board
- Mr V. Sivaramakrishnan, CEO, VFPCK
- Mr J Sajeev, Managing Director, Horticorp
- Ms L. R. Arathi IES, Mission Director, State Horticulture Mission
- Dr K. M. Sreekumar, Professor of Entomology, College of Agriculture, Padannakkad
- Mr Sridhar Radhakrishnan, Thirunelly Agri Producer Company (TAPCo)
- Mr Reghulal, Deputy Director of Agriculture (Rtd)
- Dr K. Mini, Deputy Manager, VFPCK, Idukki
- Mr Prakash Puthanmadathil, Assistant Director of Agriculture, Vengara
- Ms S. K. Preeja, Kerala Karshaka Sangham, Pallichal, Nemom, Trivandrum
- Mr R Balachandran, Chithiramangalam, Ulloor Medical CollegePO, Thiruvananthapuram,
- Mr Reji Jacob, Kunnamkotu House, Nediyassala PO, Thodupuzha, Idukki
- Ms Bindu.J, Assistant Engineer, Office of the Assistant Executive Engineer, Malampuzha, Palakkad

Terms of Reference

- To assess the progress achieved in increasing area, production, and productivity of vegetables in Kerala over the past five years.
- To suggest a roadmap to double vegetable production in Kerala over the next five years with special focus on increasing productivity and farmer's income.

- To examine the ways in which the institutions of LSGIs, Cooperatives and FPCs can be utilised to participate in vegetable production efforts.
- To suggest ways in which existing systems of vegetable production are modernised and integrated with the different schemes of the government as well as post-production activities.
- To review the existing procurement and distribution systems, including government initiatives, and suggest a transparent, technology-driven platform with the active support of LSGIs, Cooperatives and FPCs.
- To suggest ways to reform the existing government schemes to support vegetable production.

4. CONSTRAINTS TO TECHNOLOGY ADOPTION AND THE POTENTIAL TO RAISE PRODUCTIVITY IN KERALA AGRICULTURE

Co-chairperson

- Dr C. Chandra Babu, Vice Chancellor, Kerala Agricultural University
- Dr K. C. Bansal, Former Director, National Bureau of Plant Genetic Resources, Indian Council of Agricultural Research (ICAR), New Delhi

Members

- Dr M.N. Sheela, Director, CTCRI, Sreekaryam
- Dr C. Thampan, Principal Scientist, CPCRI, Kasargod
- Dr Madhu Subramonian, Director of Research, KAU
- Dr Jacob John, Professor & Head, Integrated Farming Systems Research Station, Karamana, KAU
- Dr P. Indira Devi, Director of Research (Retd), KAU
- Dr R. Beena, Assistant Professor, College of Agriculture, Vellayani
- Dr Archana Sathyan, Assistant Professor, Agricultural Extension, CoA, Vellayani, KAU
- Dr P. Rajeev, Principal Scientist, IISR
- Adv. Thomas V T, Varacheriyil, Pala PO, Kottayam
- Dr Nishanth K. Raman, Assistant Professor, CoA, Padannakkad, KAU
- Mr Rijish Rajan, CEO, Simplified Enterprises Management, Palakkad
- Dr Thomas Aneesh Johnson, Soil Survey Officer, Office of the Deputy Director and Soil Survey, Thrissur (North)

Terms of reference

- To assess the status of productivity of major crops of Kerala and estimate yield gaps.
- To identify linkages between the adoption and use of modern technology and the gaps in yield in major crops.

- To examine the potential for raising productivity in major crops with the existing technologies.
- To identify gap in the availability of technology and suggest measures to hasten the development of these technologies.
- To suggest measures to improve the research-extension linkages in Kerala's agriculture.
- To suggest a policy framework to transform homesteads into profit centres through the practice of technology-driven agriculture.

5. PREPARATION OF SOIL AND LAND USE PLANS IN LSGIs FOR AGRICULTURAL GROWTH

Co-chairperson

- Dr Srikumar Chattopadhyay, Faculty, GIFT
- Mr S. Subramanian IIS, Director, Soil Survey & Soil Conservation, Trivandrum

Members

- Mr T. Gangadharan, Extension Faculty, KILA, KSSP
- Mr K. S. Hiroshkumar, Scientific Officer, IFSRS, Karamana, KAU
- Mr B. P. Murali, Member, Nagaroor, Kilimanoor Block (KBPA)
- Mr R. Sukhalal, Swararagam,Cherthala South PO, Alappuzha
- Mr A. Nizamudeen, Land Use Commissioner, Kerala State Land Use Board
- Mr K.P. Abdussamad, District Soil Conservation Officer, Kannur
- Mr Anand Vishnu Prakash, Agricultural Officer, Manakkad Krishibhavan, Idukki

Terms of reference

- To critically assess the status of preparation of land use plans by LSGIs in Kerala over the past five years and identify the reasons for the poor performance of LSGIs in this regard.
- To suggest and prepare a guidance note for the effective preparation and development of land use plans, and its integration with watershed plans and agricultural production systems.
- To suggest ways to integrate and converge the objectives and activities of multiple government agencies possessing data on land ownership, land use and agriculture to facilitate regular updating of land use plans prepared by LSGIs.
- To suggest a road map for a State-level people's campaign to complete the preparation of land use plans at the LSGI-level over a period of six months.

6. WATERSHED-BASED PLANNING AND AGRICULTURE: THE POTENTIAL IN KERALA

Co-chairperson

- Dr Ishita Roy IAS, Agriculture Production Commissioner
- Mr I. B. Satheesh, MLA, Kattakada Constituency

Members

- Dr K. K. Sathiyan, Dean, KCAET, Thavanur
- Dr Celine George, Senior Principal Scientist & Head, CWRDM, Manimalakunnu
- Dr Anu Mary C. Philip, Assistant Director, Soil Conservation; IWDMK, Chadayamangalam
- Mr S. U. Sanjeev, Assistant Director of Agriculture (Rtd.)
- Mr U. Janardanan, CEO, Mayyil Rice Producer Company Ltd., Kannur
- Dr A. R. Durga, Assistant Professor, Department of Agricultural Economics, College of Agriculture, Vellayani, KAU
- Mr M. Prakasan Master, Kerala Karshaka Sangham, Pranavam, Azheekode South, Kannur
- Mr T. K. Rajan Master, Nini Nivas, Edachery PO, Kozhikode
- Mr Jo Jose, Assistant Principal Agricultural Officer, PAO Office, Kottayam
- Mr Mohanachandran, Deputy Director (Retd), Kollam

Terms of reference

- To critically assess the status of preparation of watershed plans by LSGIs in Kerala over the past five years and identify the reasons for the poor performance of LSGIs in this regard.
- To suggest and prepare a guidance note for the effective preparation and development of watershed plans, and its integration with land use plans and agricultural production systems with active support of geospatial technologies.
- To suggest ways to integrate and converge the objectives and activities of multiple government agencies possessing data on water, water use, land use and agriculture to facilitate regular updating of watershed plans prepared by LSGIs.
- To suggest a road map for a State-level people's campaign to complete the preparation of watershed plans at the LSGI-level over a specified minimum period.
- To study the different successful models of watershed plans prepared by LSGIs in the State and study the possibilities of replications, and preparation of a set of best practices.
- To provide guidance on linking the existing schemes of the government with a broader watershed-based strategy of development planning.

7. A PROGRAMME TO MODERNIZE AND UPDATE STATISTICAL DATABASES IN AGRICULTURE

Co-chairperson

- Dr Madhura Swaminathan, Professor, Indian Statistical Institute, Bengaluru
- Mr P. V. Babu, Director, Dept of Economics & Statistics

Members

- Dr U. S. Mishra, Professor, Centre for Development Studies, Trivandrum
- Ms L. R. Arathi IES, Mission Director, State Horticulture Mission
- Dr Brigit Joseph, Professor, Dept of Agricultural Statistics, CoA, Vellayani
- Dr K. P. Chandran, Senior Scientist, CPCRI, Kasargod
- Mr T. Paul Lazarus, Assistant Professor, Agricultural Economics, CoA, Vellayani
- Dr Pratheesh Gopinath, Assistant Professor, Agricultural Statistics, CoA, Vellayani
- Mr Deepak Mercy Johnson, Senior Fellow, Indian Statistical Institute, Bangalore
- Mr S. Ajayghosh, Vrindavan, Vadakkan Mainagapally PO, Kollam
- Mr Ramesh P K, TA to Director of Agriculture, Directorate of AD and FW

Terms of reference

- To critically assess the status and robustness of Kerala's statistical databases in agriculture and identify areas of concern.
- To suggest measures to improve the design, collection, analysis and dissemination of statistical data, such as area, production, yield, costs of cultivation, trade, farm harvest prices, wholesale prices, retail prices, market arrivals and so on, related to agriculture.
- To provide a framework for a better use of new technologies to improve the statistical system related to agriculture.
- To suggest ways in which Kerala's statistical system in agriculture should be geared towards meeting the challenges posed by integrated multiple-/inter-cropping based in homesteads and garden lands, apart from wetlands.
- To examine the possibilities of integrating all data on agriculture collected by different agencies in a single electronic platform.

8. A PLAN FOR VALUE ADDITION AND INDUSTRIAL INVESTMENT IN KERALA'S POST-HARVEST AGRICULTURE

Co-chairperson

- Dr K. P. Sudheer, Professor & Head, Department of Agricultural Engineering, College of Horticulture, KAU
- Mr Manu George, Strategist, Agency for the Development of Food Processing Industries in Kerala (ADFIK), KINFRA

Members

- Mr Rajeev Bhushan Prasad, Chief Coconut Development Officer, Coconut Development Board
- Dr E. Jayashree, Senior Scientist, ICAR-Indian Institute of Spices Research (IISR), Kozhikode
- Dr Lijo Thomas, Senior Scientist, ICAR-Indian Institute of Spices Research (IISR), Kozhikode
- Dr M. R. Manikantan, Principal Scientist, Harvest & Post Harvest Technology, CPCRI, Kasargod
- Mr K. K. Rajendrababu, Kunnath Veedu, Alappad PO, Thrissur
- Mr R. Manikuttan,Santhivila, Vandanmedu PO, Idukki,
- Dr V. R. Sinija, Professor & Head, Business Incubation Unit, IIFPT, Thanjavur
- Dr M. S. Sajeev, Principal Scientist & Head Crop Utilization Division, CTCRI, Sreekaryam
- Dr P. R. Geethalakshmi, Assistant Professor, Department of Post-Harvest Technology, College of Agriculture, Vellayani
- Ms K. Thulasi, Kerala Karshaka Sangham, Novelty, Matoor, Kalady, Ernakulam
- Dr P. Nisha, Principal Scientist, CSIR-National Institute for Interdisciplinary Science and Technology, Trivandrum
- Mr Abraham John Tharakan, Chairman, Amalgam Foods
- Mr Madathiveetil Ramesh, Director, Brahma Indic Nutriments Private Limited
- Mr Appu Anitha Muraleedharan, Theeram Agro World
- Ms Mini Srinivasan, Annam Flour and Batter Solutions, Coimbatore
- Mr Ajoy Sukumaran, Assistant Director of Agriculture, Directorate of AD and FW

Terms of reference

- To prepare a roadmap for the development of an entrepreneurship-driven system post-harvest value addition in agriculture while ensuring the generation of employment and skills.
- To suggest measures to effectively integrate the functioning of LSGIs, Cooperative institutions, including FPCs, and line departments towards the development of value chains in post-harvest agriculture.
- To suggest measures to ensure facilities for investment, quality control, traceability, logistics and export, including the necessary arrangements for payment systems.
- To suggest measures to augment Kerala's export of processed products, particularly in high value and *niche* segments.

9. EASE OF ENTREPRENEURSHIP IN AGRICULTURE: REFORMS IN POLICY AND ADMINISTRATION

Co-chairperson

- Mr S. Harikishore IAS, Director, Industries & Commerce Department
- Dr K. J. Joseph, Director, Gulati Institute of Finance and Taxation, Trivandrum

Members

- Dr Binoo P. Bonny, Professor & Head, Department of Agricultural Extension, CoA, Vellanikkara, KAU
- Dr K. P. Sudheer, Professor & Head, Department of Agricultural Engineering, College of Horticulture, KAU
- Mr G Prakash, Joint Director, MSME Institute, Thrissur
- Mr Roshan Kynadi, Agripreneur, Kynadi Plantations
- Mr T. Thulasidasa Menon, Krishnakripa,Thrithalangode PO, Malappuram,
- Mr M. Ramesh, Industry Expert, RABI-KAU Incubation Committee
- Mr Saji George, CEO, BIONEST
- Mr Shan Kadavil, MD, Fresh to Home Foods Private Ltd
- Mr Jamsheed, Agricultural Officer, Kannamangalam, Malappuram

Terms of reference

- To suggest a broad quantitative framework to regularly assess ease of entrepreneurship in agriculture in Kerala.
- To identify the constraints to the flow of entrepreneurial capital into the processing and value addition segments in agriculture.
- To suggest short-term, medium-term, and long-term measures to improve the ease of entrepreneurship in agriculture.
- To suggest legal and administrative measures to be initiated at different levels of governance, including LSGIs, to improve the ease of entrepreneurship in agriculture.

10. HOW CAN KERALA USE THE POWER OF COOPERATION TO RAISE AGRICULTURAL GROWTH?

Co-chairperson

- Mr P B Nooh IAS, RCS, Kerala
- Mr James Mathew, Ex- MLA, Taliparamba

Members

- Dr P. S. Geethakutty, Professor (Retd.), KAU
- Mr Salin Thapasi, Project Leader, SFAC

- Mr Paleri Ramesan, Chairman, ULCCS
- Mr James, Perambra Coconut FPC
- Fr John Choorapuzhayil, Chairman, BIOWIN, Mananthavady, Wayanad
- Dr J. Thomas, PDS Organic Spices, Kuttikanam, Idukki
- Mr G. R Rajeev, Kollam
- Mr Bimalghosh, MD, Aralam Farming Corporation
- Ms Rema K. Nair, Deputy Director of Agriculture (Retd.), Department of Agriculture
- Mr V Ravindran, Senior Manager, Kerala Bank

Terms of reference

- To critically assess the role and position of Cooperative institutions in Kerala's agricultural development pattern.
- To identify weaknesses in the cooperative institutional framework with respect to their contribution to the agricultural production processes.
- To chart out a pathway to effectively leverage Kerala's historical strengths in cooperative action – including both cooperatives and farmer producer companies (FPC) – to improve agricultural growth and farmer's income.
- To critically assess the performance of Kerala's cooperative credit system to finance agricultural activities.
- To suggest measures to modernise the functioning of Cooperatives in the State.
- To suggest measures on how cooperatives can contribute to the development of supply chains and value addition in agriculture.
- To suggest measures to improve coordination across line departments, LSGIs, Cooperatives and FPCs to contribute to agricultural growth.
- To suggest measures for transforming Kerala Bank to support the resource needs of the productive sector of the State.

11. COOPERATIVE BANKING IN KERALA: REVAMPING THE ROLE OF KERALA BANK

Chairperson

- Ms Mini Antony IAS, Secretary, Corporation

Co-Chairperson

- Dr Pallavi Chavan, Director, Reserve Bank of India, Mumbai

Members

- Mr Sasikumar M V,Director, Institute of Co-operative Management, Parasinikkadavu, Kannur
- Mr Jose T Abraham, Additional Private Secretary to the Finance Minister

- Mr K. C. Sahadevan, Chief General Manager, Kerala Bank
- Mr V. Raveendran, Senior Manager, PACS Development Department, Kerala Bank
- Mr Raja Kurup, Board Member, Kadirur PACS, Kannur
- Mr Anoop Kishore, Development Standing Committee Chairman, Wadakkanchery Municipality and District Facilitator of Decentralised plan
- Mr Romio Kattapana, President, Thankamony Service Co-operative Bank
- Mr K.C.S Nambiar, Director, Ancharakandy FSC Bank and Sahakari Coconut Processing facility
- Mr P. R. Sanjeev, Managing Director (Retd.), MILMA
- Mr R K Bhoodes Pillai, Chairman, Federation of Indian Cashew Industries, Former CEPCI
- Mr Sudheer K, Additional Director of Industries and Commerce
- Mr Damodhar, President, Kerala State Small Industries Association

Terms of reference

- To suggest broad measures to deepen and expand the participation of the cooperative sector in the process of economic growth of the State, and to involve youth in the cooperative movement in the State.
- To suggest measures to upgrade the use of technology in the functioning of primary cooperatives, such as the introduction of unified software.
- To suggest measures to improve professionalism in the functioning of cooperative societies in the State.
- To prepare a guidance note on Business Process Reengineering of the Kerala Bank to serve as a key provider of resources to the productive sectors, such as agriculture and MSMEs as well as tourism.

Convener

Sri. S S Nagesh, Chief, Agriculture Division, State Planning Board

Co- Convener

Smt. G C Roshini, Agronomist, State Planning Board

Terms of Reference (General)

1. The non-official members (and invitees) of the Working Group will be entitled to travelling allowances as per existing government norms. The Class I Officers of GoI will be entitled to TA as per rules if reimbursement is not allowed from Departments.

2. The expenditure towards TA, DA and Honorarium will be met from the following Head of Account of the State Planning Board "3451-00-101-93"- Preparation of Plans and Conduct of Surveys and Studies.

The order read as reference 3 is modified to this extent.

(Sd/-)
Member Secretary

Forwarded By Order

14/09/21

Chief,
Agriculture Division

To

The Members concerned

Copy to

PS to Vice Chairperson
PA to Member Secretary
CA to Member (Dr.Ramakumar.R)
Economic Advisor to VC
Chief, PCD,SPB
Sr. A.O, SPB
The Accountant General, Kerala
Finance Officer, SPB
Publication Officer, SPB
Sub Treasury, Vellayambalam
Accounts Section
File/Stock File