

PRECISION FARMING

A PROVEN METHOD FOR PRODUCTION AND
PRODUCTIVITY ENHANCEMENT

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INDIAN AGRICULTURE SCENARIO

Land : India has overall geographic area of 329m ha of which about 140m ha is sown area. 2nd largest arable land bank in the world.

Water : Despite having the highest irrigation acreage globally, 70m ha of agri-land in India is rain-fed (50%) & 17m ha is partly irrigated (12%). 70% of water used in Irrigation.

Climate : Diverse climatic conditions. 12 hours average sunshine per day. Average Rainfall 1000 mm. However erratic and unevenly distributed.

Population : More than 1000 Million (growing at a rate of 2% per annum). 53% of the population is directly dependant on agriculture with another 27% indirectly dependant on the sector.

Land Holding : At less than 1.5ha, India's average land holding size is one-hundredth that in the USA. Marginal holdings (< 1ha) make up 70% of total land holdings.

Productivity : Agricultural productivity in India are still one-third to half that of world best levels in many crops. China produces 40% more agri-output than India from 40% less area than in India. Better nutrient management and agri-input usage is a key reason.

GDP : Indian Agriculture accounts for 18% of the nation's GDP (Gross Domestic Produce) & 14% of Exports. Share of agriculture in overall GDP came down from 57% in FY51 to 18%.

Against above, the government is now targeting 4% growth over the next two decades.

CHARACTERISTICS OF EXISTING AGRICULTURE

- Marginal Land Holdings
- Widening productivity disparities between irrigated and rain-fed areas
- Uneven and slow acceptance of technology
- Lack of adequate incentives and appropriate institutions
- Degradation of natural resource base, e.g. Water Pollution, Soil Degradation etc
- Rapid and widespread decline in ground water table.
- Increased non-agricultural demand for land and water
- Inadequate mechanization and labour shortage
- Inefficient use of inputs e.g. fertilizers, irrigation and pesticides
- Wastage of agricultural produce due to inadequate Post Harvest operations.
- Lack of awareness among farmers for modern crop production methods
- Ineffective extension service
- Insufficient financial resources for investments.
- High level of consumption subsidies resulting in wastages
- Low per hectare income for farmers

DEMANDS OF FUTURE

PROJECTED FOODGRAIN DEMAND AND IRRIGATED CROP AREA				
	unit	2010	2025	2050
Food grain demand	million t	247	320	494
Net cultivated area	m ha	143	144	145
Total cropped area	m ha	193	204	232
Total irrigated crop area	m ha	79	98	146

Source: National Commission on Integrated water resources development, GOI

KERALA CROP PRODUCTION

- Kerala is characterized by extreme diversity in its physical resources and agro-climatic conditions.
- In earlier periods, the choice of cropping pattern was guided by **agronomic considerations** and **consumption needs** of farmers but now **the market forces** decide it.
- Official reports show that agricultural income in Kerala showed a steady growth up to mid seventies, followed by a decline thereafter and an oscillating trend in the eighties.
- By the end of eighties, **cash crops** started generating higher income to the farm sector.
- The contribution of agriculture to the state's income has been **on decline** as the other sectors registered higher rates of growth.
- **Food crops in general have suffered a set back in area and production** despite a sizeable investment.

CROPS

- **Coconut** remains dominant, but its productivity is hampered by **aging trees and diseases**.
- **Vegetable** production has surged to 17.2 lakh metric tonnes in 2023-24, increasing from 6.28 lakh in 2015-16.
- **Paddy** : Although the total area under rice has declined, productivity has shown resilience, reaching 3105 kg/ha, with government support promoting, including fallow land cultivation.
- **Plantation crops** : The sector faces a downward trend in total output, with production of major crops like rubber and tea dropping from 9.1 lakh tonnes in 2010–11 to 7.06 lakh tonnes in 2023-24.

CHALLENGES

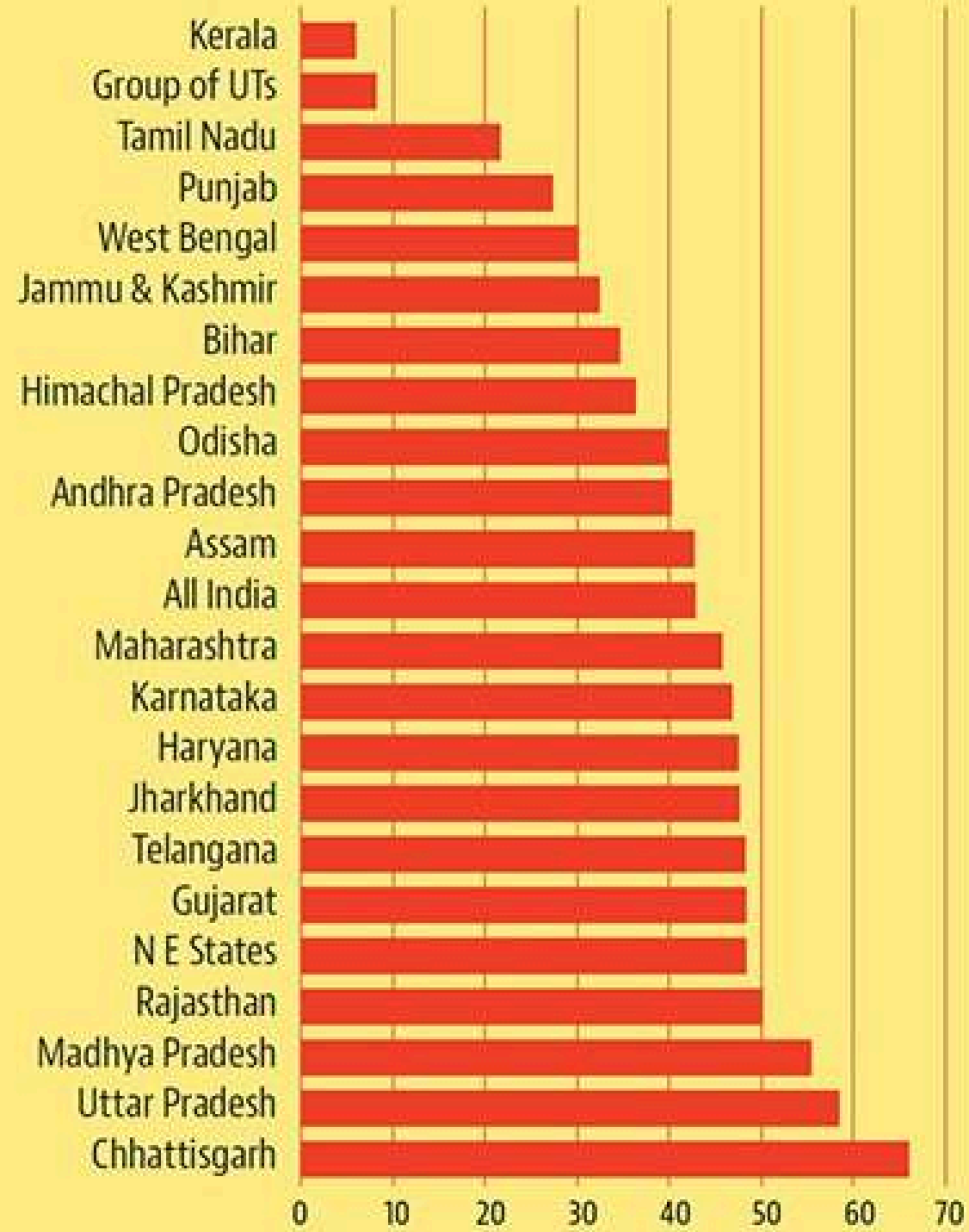
Key constraints include **climate change, high input costs**, and persistent **wild animal threats**.

- **Initiatives** The government is focusing on **value addition**, with projects like the ₹2,365-crore Kera Products and Keragramam, along with promoting agri-tech start ups.
- **Import substitution Required** **Kerala imports vegetables worth of 1000 Crore Annually from Neighbour states.**



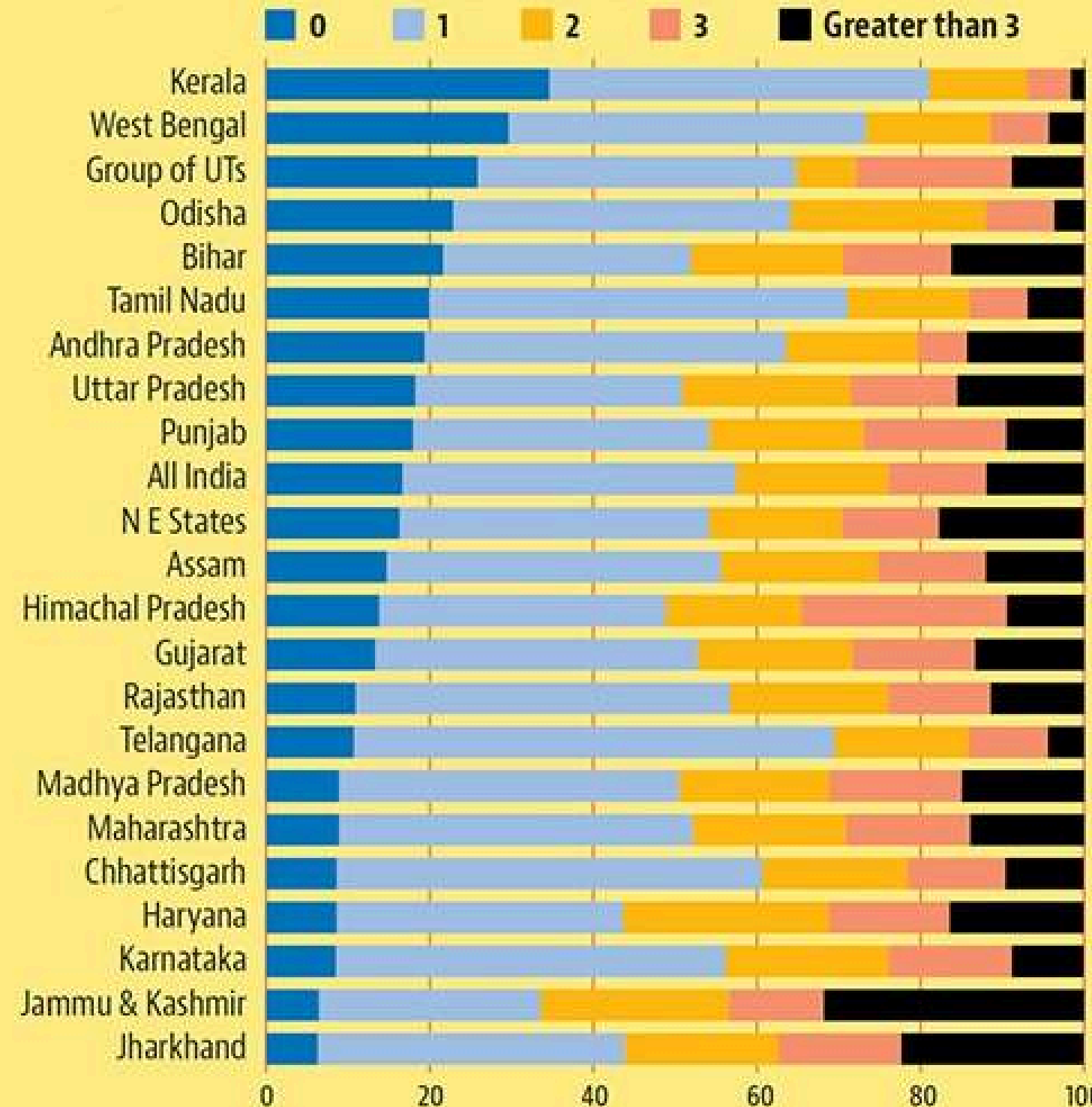
KERALA HAS THE LOWEST SHARE OF FARMERS IN INDIA

HHs engaged in cultivation (% share)



Source: Household Ownership and Operational Holdings in India, 2012-13 NSSO

% HHs with number of member(s)* associated with HH operational holding during for major states



*other than the main operator





PRECISION FARMING



What is Precision Farming ?

- A management strategy which identifies, analyses and manages **within field variability** for increased profit and reduced environmental impact
- farming by the foot, farming by satellite, site specific management, prescription farming.....

CLIMATE RESILIENCE

- Adjusting and Adapting to Physical stresses –
(water , heat, soil, nutrient and other environments factors)
- Assess the Resources and plan the Cultivation package
- Introduce resource optimizing technologies
(micro irrigation, Integrated nutrient management, fertigation etc.)
- Select the Tools required

(Changing – crop, seed, cropping system, crop geometry, soil surface formation, soil texture, Soil Organic matter, Irrigation method, Fertilizers, fertigation method, IPM, Immediate post-harvest Techniques)
- Training the grower and ensuring that the changes are inculcated.
(Capacity building)

PRECISE CONTROL

OF THE ENVIRONMENT AND INPUTS IN FARMING

To achieve

CROP PERFORMANCE NEAREST TO THE POTENTIAL OF THE
GENOTYPE / VARIETY

Technologies behind PF

- Global Positioning System (GPS)
- Yield Monitoring
- Variable Rate Technology (VRT)
- Remote sensing
- Geographic Information system (GIS)

PRECISION IN TROPICAL CLIMATES

Soil Preparation : Humus level, microbial load, aeration & drainage,

Nursery : Physically, physiologically uniform seedlings with intact roots

Crop geometry : Single ,double ,triple and tetra rows, High Density

Fertigation : Nutrients at critical stages,

Growth management : Regulation of flowering, training the canopy,

Plant protection : Monitoring System , IPM

Field Level PHM : Harvest Index, handling, sorting and grading

AVENUES FOR PRECISION PRACTICES

- Land preparation
- Seed Bed formation
- Field Surface management
- Soil improvement
- Crop selection
- Selection of planting material
- Canopy /Plant architecture
- Irrigation and fertigation
- Pest management
- Weed management
- Harvest
- Post harvest management
- Market requirement and identification

SPATIAL VARIABILITY IN NUTRIENT AVAILABILITY

PRECISION FARMING FOR SMALL LAND HOLDERS

REQUIRED SOLUTIONS

- **Localized crop growing solutions to achieve high yields and incomes**
- Crop yield enhancement by Precision inputs and management
- Advisory services

Crop diversification

Cropping systems advise and support

Protected cultivation methods

Advise on Marketing of produce

- Buy back and value addition –Organize
- **Farmer net working and formation of producer cooperatives.**
- **Training and capacity Building**

Precision farming: The **VISIBLE CHANGE**



5-6 ton/acre



11-15 ton/acre

FARM LEVEL PRODUCTIVITY INCREASE

CROP	Conventional Cultivation	Precision farming with drip & fertigation
Apple **	2.4	4.8
Banana	20	36
Beans	7	11
Brinjal (eggplant)	14	26
Canola/ Mustard	0.7	1.3
Capsicum	12.0	30.0
Cardamom, kg/acre/year	50.2	232
Cashew nut	0.65	1.2
Cassava	10.0	16.0
Castor	1.0	1.5
Chilly (dry)	2.5	4.0
Citrus- Orange	4	8
Citrus-Sweet lime	9	15
Coconut, nuts/year/acre	6000	8400
Coffee (Robusta)	0.45	0.60
Cotton	0.7	2.0
Curry leaf (2nd year)	1.8	3.2
Custard apple	3	5

Maize	2.4	4.0
Mango	2.5 (12 th year)	6.5 (5 th year)
Oil palm	7	12
Okra	6	13
Onion	6	14
Papaya	23	35
Pigeon pea	0.6	1.4
Pomegranate	6 (10 th year)	9 (5 th year)
Potato	10	21
Radish	9.0	15.0
Rice	2.0	3.9
Soybean	0.6	1.4
Strawberry@	...	15
Sugarcane	32	70
Sunflower	0.45	1.0
Tea	1.0	1.8
Tobacco (cured leaf)	0.58	1.00
Tomato	25	40
Turmeric (dry)	2.5	5.3
Water melon	10	19
Wheat	1.8	2.9

@ Strawberry is always under irrigation

© Data collected from farmers by the author

Gherkin (cucumber)	7.0	11.0
Ginger	6.0	9.0
Gourds (bitter gourd)	6	10
Grapes	10	25
Guava	0.4	1.2
Guava	4	10



Lessons learned.

- **We have seen that over a period of 2 decades, the awareness level among farmers has grown tremendously in the country. The spread of technology in states like Maharashtra, Andhra Pradesh, Gujarat, Tamil Nadu, Karnataka, Madhya Pradesh, Telangana and Rajasthan are to be noted. The productivities achieved in these states are a good example to quote.**
- **In Kerala apart from fruits and vegetables, plantation crops offer a special place for adoption of PF.**
- PF technology has now been spreading to agricultural and commercial crops like, sugarcane, Cotton, Tobacco, oil seeds and few pluses and spices.
- The adaptation of a technology, that used to serve large farms in the developed countries, to the small farm holdings of the Indian farmer and assisting him with TECHNOLOGY SUPPORT, information and training requires large efforts.

MODELS FOR LARGE SCALE FIELD IMPLEMENTATION

1. **PPP model** One of the different types of engagements in popularising Micro Irrigation and Precision farming technologies and its large scale adoption, is **the case of *supplier – Farmer and Product Processing Company* that took place is in the case of sugarcane business.** From 2000 onwards, the supplier-farmer-and sugar company collaborative arrangements helped in large scale adoption, especially in States like TN, Maharashtra and AP.

2. Another model in the PPP mode is the **community based integrated projects** with multiple beneficiaries. Along with the efficient administration of Government support schemes, several states in the country are implementing PF as a project of a sizable command in the current decade. Here individual land holder level implementation has been surpassed into large communities with a certain common water source. Hundreds of farmers spread in large number of villages that are contiguous geographically are part of such projects.

Example of a large community level project

This fully Automated Integrated Project in Almatti Dam Command near Marol village, in Hungund Taluka, Bagalkot District is a good example of the model. **Overall command area of this Project is 24000 ha.**

Objectives of the project were,

- To irrigate 24000 ha as per crop water requirement during Kharif & Rabi season within the available quantum of 2.77 TMC water.
- To increase the overall conveyance efficiency of project.
- To increase the water use efficiency of project.
- To achieve the equitable sharing of water throughout the command area.
- **To increase agricultural production in the command area including new high value crop introductions.**

ADOPTION OF PRECISION FARMING TECHNOLOGIES IN THE STATE

- Success in precision farming depends on the accurate assessment of the field variability, its management and evaluation in space-time continuum in crop production; I e. **precision and timeliness for each operation.**
- In PF a level of precision is practiced in input management-fertilizer, irrigation water, pesticides and timing of operations, and ensuring quality for all inputs –seed, nursery seedlings, fertilizers, pesticides etc.
- The major reason of lack of progress in Kerala of PF is the popular belief that Micro irrigation system per se itself is just a tool for irrigation; conveying water from the source to the crop; and nothing beyond that!

The technology is not fully understood as a productivity enhancing positive input and a major implementable factor in PF. Most Kerala farmers are still considering MI as only a water conveyance tool.

- The State should regain the superiority in its *niche* crops like Coconut, Arecanut, Pine apple, Banana and Mango and in the exotic crops those were adapted to Kerala climes in the recent past- Avocado, Rambutan, Cocoa etc.
- The state should work towards self-sufficiency in vegetables, fruits and herbs in the first place.
- It should regain its prime status in Black pepper, Ginger, Cardamom etc. The state has the potential to become the number one production centre of the country.
- **Large scale Adoption of Crop specific PF is a solution to these challenges**

Kerala requires a strategy with multiple steps:

1. To identify crops and regions where the acceptance would be high.
2. **Field level interaction meetings with growers to popularise PF technology that will enhance crop yield.**
3. **Provision for training the adoptees in the correct water and fertilizer scheduling and other crop management measures to obtain higher productivity.**
4. **Assisting the formation of Farmer Producer groups with full commitment to utilize the technology to achieve higher farm incomes.**
5. Linking the primary producers to product processing industries.

These steps would involve issues beyond crop production and even reach to marketing and value chain development.

1. Vegetables

- Increase in production and productivity of traditional and exotic vegetables is essential for Kerala as the state depends on neighboring states very much for its vegetable requirements. **Kerala imports vegetables worth of 1000 Crore Annually from Neighbour states.**
- The production has reached about 17.2 lakh ton by 2023. But still the production meets only 40% of the consumption within the state. It is also to be noted that the increase in production has resulted from increase in the area of cultivation and not by an increase in productivity *per se*.
- Area of vegetables increased from 46500 ha (2015-16) to around 100,000 ha by 2024. It is understood that further expansion of cultivated area is not possible in this land-limited state. Therefore *productivity enhancement* is the only way out.
- The large gap in vegetable production can be covered by adopting high tech cultivation practices, and creation of **Centre of Excellences in different districts**. These centers should adopt latest production technologies and Precision input management tools.
- As for vegetables, PF practices have resulted in doubling the yields of most vegetables.
- Such high production hubs with initial post- harvest processing can become supply centers for domestic and export markets.

Enhancement of Productivity through PF Technology Intervention

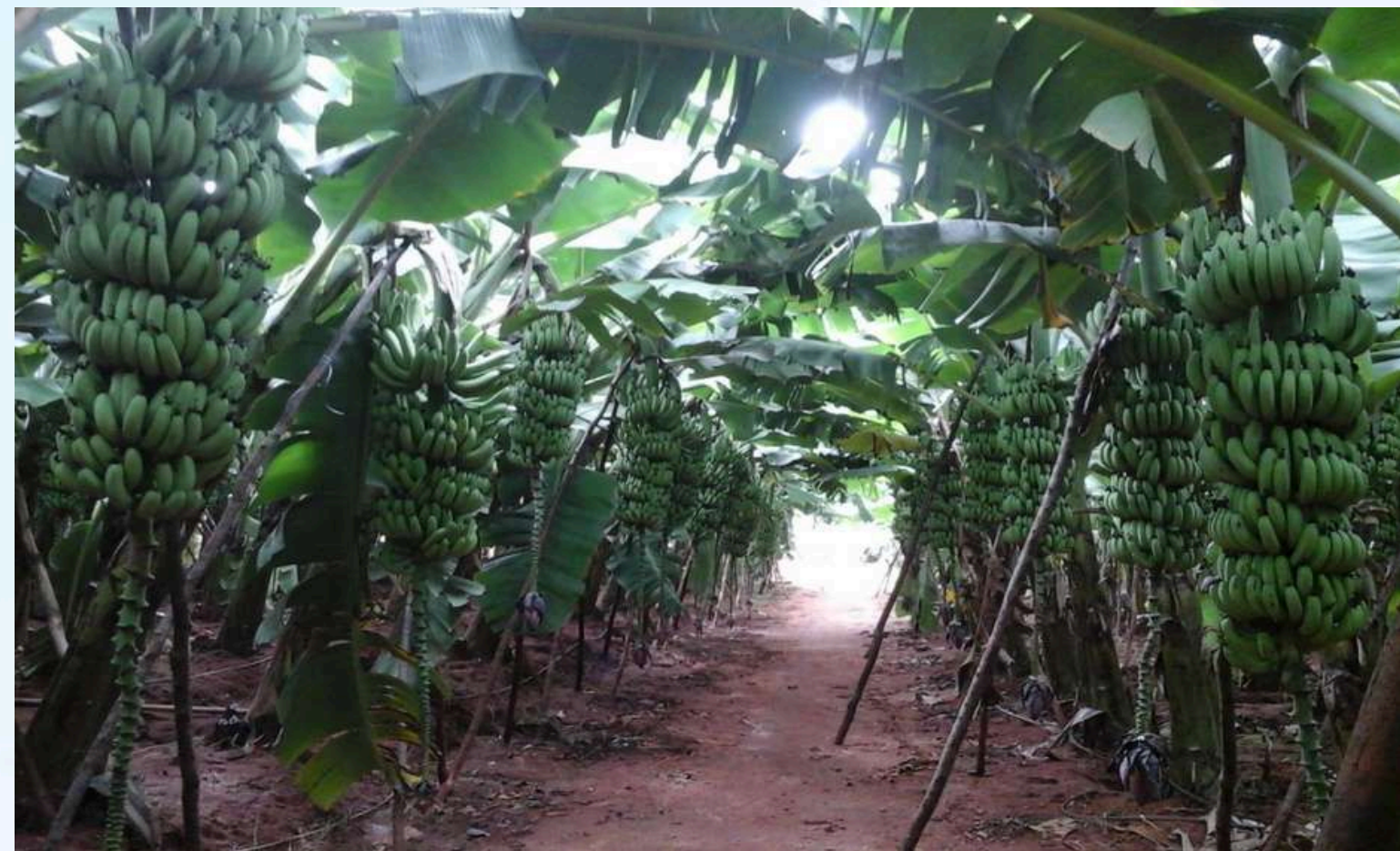
Crop	National Average t/ha	Yield after Technology adoption t/ha
Tomato	17.35	150.00
Chilly	12.02	35.00
Brinjal	10.46	130.00
Okra	6.28	16.00
Onion	11.32	21.00
Cabbage	14.38	110.00
Cauliflower	14.22	33.00
Ash Gourd	11.91	50.00
Bitter Gourd	6.23	15.00
Ribbed Gourd	15.85	35.00
Bottle Gourd	12.21	66.00
Cucumber	6.48	20.00
French Beans	5.8	12.00
Beetroot	16.75	35.00

Data collected from adoptor farmers.



2. Banana

- Kerala has several varieties of Banana and Plantain.
- **Except for limited export of *Nendran* chips, Banana and Plantain based export businesses are very limited in the state compared to other states.**
- Banana centered production and processing hubs can be developed.
- **The high productivity of Banana is proven when PF technologies are practiced.**
- The current productivity levels of Banana 9432 kg/ha (2023 Kerala Statistics) is woefully low compared to the productivity found in other parts of India
- **Productivity increase of 100% (doubling yield) and more were recorded for Banana when PF was adopted.**



CROP GEOMETRY

EXTENSIVE FIELD TRIALS

CARRIED OUT BY JAINS HAVE

SHOWN THAT THE OPTIMUM

SPACING FOR GRAND NAIN

BANANA IS;

- **1.8 m X 1.5 m (1405 plants/acre)**
- **Or 1.8 x 1.8 m (1250 plants/acre)**





RATOON MANAGEMENT



INDIAN BANANA ON SUPER MARKET SHELF



3. Coconut

- **Though Kerala has one of the best climate conditions for Coconut production, its productivity is still low; around 6228 nuts/ha/yr. (2023 Kerala Statistics).** Yields up to 21000 nut/ha/yr. was recorded with regular ETP based Drip irrigation and soil test based Fertigation practices in TN.
- **Coconut based cropping systems Intercrops of Turmeric, Ginger, Cassava, or certain varieties of Banana with PF would be ideal for Kerala conditions.**
- **Taro (Colocasia) is grown in large areas in West African countries and exported to cold Europe.** And Colocasia is a well-adapted tuber crop of Kerala.
- **Can't we develop high production centers for Coconut and Coconut based cropping systems?** Well tested PF technologies are available for this type of cropping systems.

PRECISION FARMING- COCONUT

IRRIGATION SCHEDULE

Month	Water requirement	
	Mm/day	Lt/plant/day
June	2.99-3.56	39-46
July	2.46-3.12	32-40
August	2.39-3.25	31-42
September	2.67-3.01	35-39
October	2.33-2.79	30-36
November	2.27-2.64	29-34
December	1.96-2.46	25-32
January	2.37-2.70	31-35
February	2.89-3.17	37-41
March	4.55-4.98	59-65
April	4.98-5.64	65-73
May	5.07-6.01	66-78

** Actual daily WR is to be estimated after each real location

FERTIGATION SCHEDULE

Yr4 plus palm			170:120:400 g/tree in June_ July	
			330:200:800 g/tree in September - October	
FERTIGATION OF N P and K				
Fert type	Rate g/tree	Fertigation rate	Duration of Fertigation	Doses
Ammo. sulphate	810 g/tree	27g/tree/2 days	June 1wk to July 4 wk	30 doses
Phosphoric acid	200 g/tree	6.7 g/tree/2 days	June 1wk to July 4 wk	30 doses
MOP	665 g/tree	22.2 g/tree/2 days	June 1wk to July 4 wk	30 doses
Ammo. sulphate	1571 g/tree	52 g/tree/2 days	Sept 1 wk to Oct 4 wk	30 doses
Phosphoric Acid	333 g/tree	11.1 g/tree/2 days	Sept 1 wk to Oct 4 wk	30 doses
MOP	1333 g/tree	44.4 g/tree/2 days	Sept 1 wk to Oct 4 wk	30 doses

Fertilizer application in coconuts is best done when soil moisture is high, and drip irrigation provides both soil moisture and nutrients at the same time.

COST ECONOMICS- SINGLE FARMER BASED

ECONOMICS OF COCONUT PRODUCTION IN Tamilnad VILLAGES per ha		
Particulars	PF with DRIP & FERT VILLAGES	CONTROL VILLAGES
Quantity of Water (m3)	3096	10855
Quantity of Energy (kWh)	917	7423
Cost of labour (Rs)	3733	12024
Capital (Rs)	27510	32560
Yield (No of NUTS)	22700	20100
Gross Income (Rs)	105443	86419
Gross Margin (Rs)	72933	53859
Yield per Unit water used (nuts/m3)	7.3	1.9
Yield per Unit Power (nuts/kWh)	28.6	2.6
Return per unit water (Rs/m3)	25	5
Return per Unit Power (Rs/kWh)	98	7
<i>Field Survey Study in South India</i>		
<i>Suresh kumar and Palanisami 2010 : AGRIC. ECONOMIC. REVIEW A Study by IWMI Sri Lanka</i>		

4. Other Crops

- Similar single crop based high tech production systems or inter or mix crop systems for Pineapple, Jack, Cassava, Drumstick, Cashew, Cocoa, Mango, and Spices like Clove, Nutmeg, Ginger and introduced exotic fruits like, Rambutan, Avocado are possible first call interventions for higher rates of production and Value chain formation In Kerala.
- In all these focused production systems, PF technologies were already proved to be a positive cost effective input. There are cases of private growers establishing gardens for these crops in Kerala adjoining plantation areas.
- Following the establishment of such high productivity centres, member farmers can be supported by encouraging them to form **Farmer Producer Groups**. FPG is the most important part of any product based value chain. This type of cooperative activities has many successful examples in other parts of the country.



EXTENSION AND REACH

1. **Systematically planned exposure visits are a part of government extension programs.** Exposure of for example of coconut growers to the neighboring TN coconut growing areas where very high yields could be achieved. The department of Horticulture and Agriculture could take up for the general benefit of growth in these sectors.
2. **State Government farms should establish long term demonstrations and maintain them. This would help in promoting technology packages among the farmers.** Organize Workshops. Exhibitions and Farmer fairs to promote the benefits of PF technologies with active participation of farmers. Use print and digital media to disseminate information about schemes of the government and the information about existing government supports.
3. **Kerala can also go for establishing a special purpose vehicle (like APMIP of AP)** to specifically focus on PF and MI technology spread. Private companies then can work with this entity in a more focused and collaborative way for extension, capacity building, and implementation and technology transmission to farmers.
4. **Literature and brochures on CROP SPECIFIC PF practices and its role in high crop production should be circulated widely among the growers.** Departments should bring experts from outside and encourage to work with the universities and public institutions in Kerala. The roles played by TNAU, PAU, APAU, UAS Bangalore and UAS Dharwad etc. are very good examples available in the country. I have personally involved in collaborative research with many of these universities (Public-Private mode) on several crops for MI assisted PF technologies.

1. In this activity scenario the role of SAU and departments of Agriculture, Horticulture and Plantation crops who are expected to work in direct collaboration with Private technology providers and growers. This type of model has been successfully demonstrated in many other parts of the country. **The contributions from these public funded institutions are important as the farming public still expects and trusts them to provide solutions for their crop related issues and problems.**

2. **The curricula in various SAUs and ICAR institutions should include Precision Farming technologies as a subject to be imparted to the graduates/post graduates.**

3. There should be more involvement of Banks and Financial institutions in extending crop based technologies.

4. Encourage farmers to form Farmer Produce groups in each command area/ village/ or crop based regions and through training and capacity building make them capable of taking full responsibility and step into the scheme as *owners of the project*. After all, Farmer producer companies are not new to the state of Kerala.

BEGININGS - SOME COMMUNITY LEVEL PROJECTS

Sl. No	Name of the Project	District	Area-Acres	Crop	Current Status
1	Valiyeri- CMI	Palakkad	230	Coconut	Completed. Now under O&M
2	Navithankulam - CMI	Palakkad	126	Coconut	Completed. Now under O&M
3	Pazhayanoor-CMI	Thrissur	74	Arecanut, Rubber, Coconut	Completed. Now under O&M
4	Thrumaradi-CMI	Ernakulam	210	Rubber, Nutmeg, Coconut	Work under Progress
5	Vandanmedu-CMI	Idukki	55	Cardamom'	Work under Progress

A PROVEN MODEL TO FOLLOW – PRECISION FARMING MODEL

- Precision farming is a novel concept in India and it has shown very positive results and found to be a very successful model for high yields and incomes.
- PF is going to be the ultimate comprehensive technological intervention
- Precision farming comprises soil, land management, GIS based soil nutrient mapping, cluster formation based on soil homogeneity, deep plough, seed bed and nursery management thru poly cum shade house technology, drip irrigation and fertigation, use of water soluble fertilizers , IPM and INM practices, appropriate pre and post harvest practices, integrated common infra-structure development for handling produce, IT based market intelligence, value chain formation and collective marketing leading farmer empowerment.





THANK YOU