Micro-irrigation Advancements for high Water Use efficiency to Secure Food systems

Goverment Of India

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Indian Agriculture has made Rapid Progress since Independence

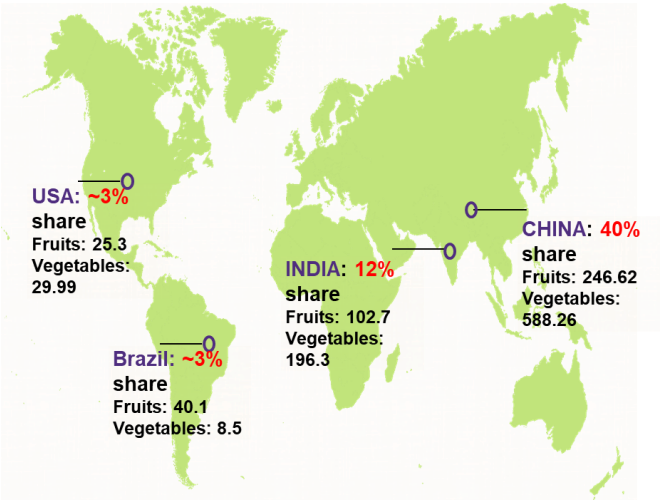
What we achieved in food grains and horticulture
(Base year1950-51 to 2022-23)

- **6.5 times Food grains (50 to 331 million ton)**

Green revolution, 2nd Green revolution: Food Self sufficiency

- **14 times Horticulture (25 to 351 million ton)**

Silent revolution took place: Nutrition & Health



Key Technologies: Transformed horticulture

- Hybrid seeds of vegetable crops
- Greenhouses technology (Polyhouse, shadenet, low tunnel, mulching)(2.5 lakh ha)
- Biopesticides & biofertilizers (8.25 lakh tons)
- Micro-propagation and tissue culture in plant production
- Integrated cold chain including cold storages (36 million ton capacity)
- Drip and sprinkler systems and fertigation (16.3 million ha)

DESHACKLERS

- Back up of Technologies
- Development Initiatives
- Policy Support

Concerns in agriculture

- **Increasing demand - horticultural produce, pulses, oil seeds, fodder**
- **Ensuring food, nutritional security for growing population**
- **Plateauing of agricultural productivity**
- **Impact of climate change – drought, high temp, salinity, hail storm, flood, cyclones and new pathogens**
- **Excessive use of natural resources- Declining resources land and water**

Achieving high water use efficiency for sustainable agriculture is challenge before all of us…….

% Water Losses from Source to field:

SOURCES OF LOSSES	SEEPAGE	EVAPORATION	TOTAL
Main Canals & Branches	13.6	3.4	17.0
Distributaries	6.4	1.6	8.0
Field Water Courses	16.0	4.0	20.0
Field application losses	13.2	3.3	16.5
TOTAL	49.2	12.3	61.5

Water conservation is important in irrigated agriculture

- *Limited water resources*
- *Losses during irrigation*
- *Competition for water among the different users*

Huge potential for water conservation if potential tapped

Indian Scenario of Irrigation -

- Above 90% irrigation systems are flooding and subsurface irrigation
- Around 18.7 % Micro irrigation of potential covered (16.3 mha out of 69.5 mha as per task force report is potential)
  - 48 % drip irrigation system
  - 52% Sprinkler irrigation system

A potential solution is Use of Micro Irrigation System

Excessive exploitation of water resource

- **Intensive cultivation of paddy- wheat in the Indo-Gangetic Plains:**
  i. Agro-ecological problems
  ii. Deterioration of soil fertility
  iii. Changes in physical conditions of soils, etc.
- **Excessive exploitation of underground water:**
  i. Fall in water table
    - Punjab (19 districts - 109 blocks)
    - Haryana (10 districts- 78 blocks)
    - Western UP (11 districts- 113 blocks)
- **Excessive use of water in canal network: more soil salinity, alkalinity**

How to address these problems ?

- **Growing alternate crops that need less water**
- **Bringing more area under water saving technologies.**

Increasing WUE: Interventions

Laser land levelling

Improving Irrigation Water Management:

- Improving conveyance and distribution system of irrigation network
- Canal supply & demand management through automation
- Improved on-farm water management including structures
- Laser land leveling, zero-tillage & resource conservation technologies
- Conjunctive use of good and poor quality GW / wastewater
- Multiple use of water
- **Micro irrigation (drip & sprinklers)**

Raised Beds

Mulching

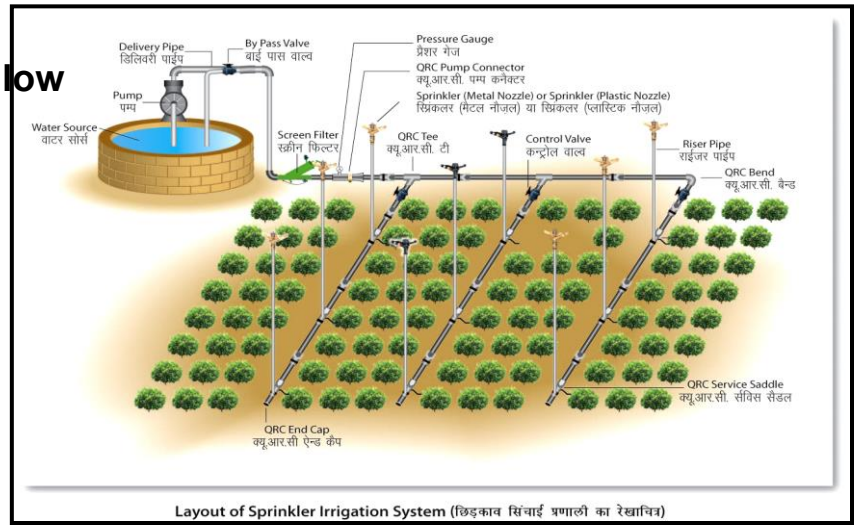
Microirrigation

Zero Tillage

Micro irrigation: Huge potential 27 million ha for Drip & 42.5 million ha for Sprinkler

Drip Irrigation

- Uniform & precise application of water at low pressure
- Saves water , fertiliser & labour
- Use of saline water is



Layout of Sprinkler Irrigation System (छिड़काव सिंचाई प्रणाली का रेखाचित्र)

Sprinkler Irrigation

- Protects crop against frost
- Saves crop from insects & pests
- Irrigation is possible on undulating terrains

- **Benefits**
  - Better water use efficiency (60-70%)
  - Increase in yield (30 – 100%)
  - Saving in Fertilizer usage (40%)
  - Cultivation in saline land possible
- **Status in India as on (up to Dec 2023)**
  - 6.5 million ha under Drip Irrigation
  - 7.5 million ha under Sprinkler Irrigation

Per Drop More Crop under PMKSY has to play role

PER DROP MORE CROP

PMKSY: Slogan

Per Drop More Crop=

Water Use Efficiency(WUE) and Water Productivity

1. Irrigation efficiency = Water utilised/Water supplied

2. Physical Water use efficiency = Crop Yield (Kg) /Water Supplied (m3)

3. Economic or Value Creation Efficiency= Crop Income (Rs)/Water Supplied (m3)

PMKSY - Enhancing water use efficiency

Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) being implemented since 2015-16:

Four components:

1. **Accelerated Irrigation Benefit Program (AIBP)-** includes major and medium irrigation projects implemented by D/o Water Resources, RD & GR
2. **Har Khet Ko Pani (HKKP) -** includes source augmentation, distribution, surface and groundwater Minor Irrigation projects implemented by D/o Water Resources, RD & GR
3. **Watershed Development Component-** includes ridge area treatment, drainage line treatment, soil and moisture conservation, water harvesting structure, livelihood support activities and other watershed works by D/o Land Resources
4. **Per Drop More Crop (PDMC)- includes micro-irrigation systems (drip and sprinkler) being implemented by Dept of Agri. & FW**

PMKSY- PER DROP MORE CROP (PDMC)

- PMKSY launched in 2015-16
- PDMC for enhancing water use efficiency at farm level through Micro Irrigation (Drip and Sprinkler): 14 million ha
- Associated micro level water conservation structures
- Fertigation made compulsory
- 55% to small and marginal farmers and 45% subsidy to others
- Subsidy payment limited to unit costs specified in scheme guidelines.
- Karnataka, TN, Gujarat, Maharashtra, AP, Rajasthan (6 states 80%), Telangna, UP, MP (9 states, 90%)
- 25% higher amounts have been taken into calculation of subsidy for the North Eastern and Himalayan states and
- 15% higher for States with low penetration of MI namely Bihar, Chhattisgarh, Jharkhand, Odisha, Uttar Pradesh, West Bengal and Union Territories.
- Rs. 43022 crores earmarked for five years (2021-22 to2025-26).

Cost of installation of Drip Irrigation System for different spacing and land size

Lateral Spacing (m)	Amount in Rupees				
	1ha	2ha	3ha	4ha	5ha
A. Wide Spaced crops					
8m & above	23,500	38,100	59,000	74,100	94,200
4m to <8m	33,900	58,100	89,300	1,13,200	1,42,400
2m to <4m	58,400	1,08,000	1,61,800	2,20,600	2,71,500
B. Closed Spaced crops					
1.2m to <2m	85,400	1,61,300	2,43,400	3,32,800	4,12,800
<1.2m	1,00,000	1,93,500	2,92,100	3,99,400	4,95,400

Normative Cost – Sprinkler System

S. No.	Type of System	Average / Normative Unit cost of installation in Rs. per hectare as per Scheme Guidelines.
1.	Micro Sprinkler	58,900
2.	Mini Sprinkler	85,200
3.	Portable Sprinkler	19,600
4.	Semi-Permanent Irrigation System	36,600
5.	Large Volume Sprinkler Irrigation System (Rain Gun)	31,600

ICAR & NARS Reducing Water Foot Print

- Surface irrigation schedules for 26 crops and 8 cropping systems in 12 agro-ecological regions
- Designed and standardized mini pan evaporimeter for on-farm irrigation scheduling
- Drip fertigation schedules save 30-40% irrigation water, 25-30% energy and 20-25% nitrogen over surface irrigation besides 10- 15% higher yield; Fertigation schedule of three crops added during 2021-22
- Realtime Contingency Plans for managing Water and Weather Cycles
- Four new Crop Plans developed; total 15

Intercrop of chickpea and mustard

Surface Irrigation scheduling in Cropping Systems

SOP for micro-irrigation systems

- Partitioning the whole field into blocks of desired dimensions
- Determination of most appropriate layout plan for main, sub main and lateral pipes in the field
- Estimation of water requirements at plant, lateral, sub main and main pipe level based on agro-climatic data
- Determination of suitable water application rate as per the soil properties
- Determination of sizes of laterals, sub main and main pipes based on their frictional loss analysis
- Estimation of size & type of accessories such as filters & fertigation equipment based on water quality and crop demand
- Determination of largest fraction of area that can be irrigated in one go based on the well source
- Determination of possible shifts and total time of irrigation for each irrigation
- Determination of total head requirement including the lift involved from ground water data
- Determination of size of motor pumping unit and the power requirement
- Estimation of the cost of the system based on costs of individual components

Financial & Physical progress/Achievement

Financial Rs. in crore				Physical Area coverage Micro Irrigation (Lakh Ha)
Year	**BE**	**RE**	**Release**	**Achievement**
2015-16	1800	1550	1556	5.73
2016-17	2340	1990	1991	8.40
2017-18	3400	3000	2819	10.49
2018-19	4000	2954	2918	11.59
2019-20	3500	2032	2700	11.72
2020-21	4000	2563	2562	9.37
2021-22	4100	2572	2570	10.20
2022-23	4200	2655	2700	10.98
Total	**19340**	**19317**	**19817**	**83.06**

Target from 2021-22 to 2025-26: 112 lakh ha

Farmer’s perspective on drip irrigation in Tamil Nadu: Rice, Sugarcane and Banana

Ravichandran Vanchinathan
10 June at 11:02
This is my rice crop raised using drip system. I maintained just moist level through out. My feeling is I could save 80% water when compared with the conventional rice cultivation.

By adopting drip system and following the good agronomic practices, Cauvery Delta Farmers with bore well can take advantage of conducive conditions of Kuruvai season.

Field day held on 19th June 2018 at Poongulam, Nannilam Tamil.

Fruits & Vegetables-Fertigation

Micro Irrigation helps in water saving as well as reduced fertilizer usage through fertigation, labour expenses, other input costs and overall income enhancement of farmers etc.

Micro-irrigation System Adoption - Its relevance in present scenario of climate change

Crop	Yield (MT/ha)				
	Conventional	Drip	% Yield increase	Water Savings (%)	Increase in water use efficiency (%)
Banana	57.5	87.5	**52**	45	176
Grapes	26.4	32.5	**23**	48	136
Sweet Lime	100	150.0	**50**	61	289
Pomegranate	56.0	109.0	**98**	45	167
Tomato	32.0	48.0	**50**	31	119
Water Melon	24.0	45.0	**88**	36	196
Chilies	4.2	6.1	**44**	63	291
Sugarcane	128.0	170	**33**	56	204

Food security

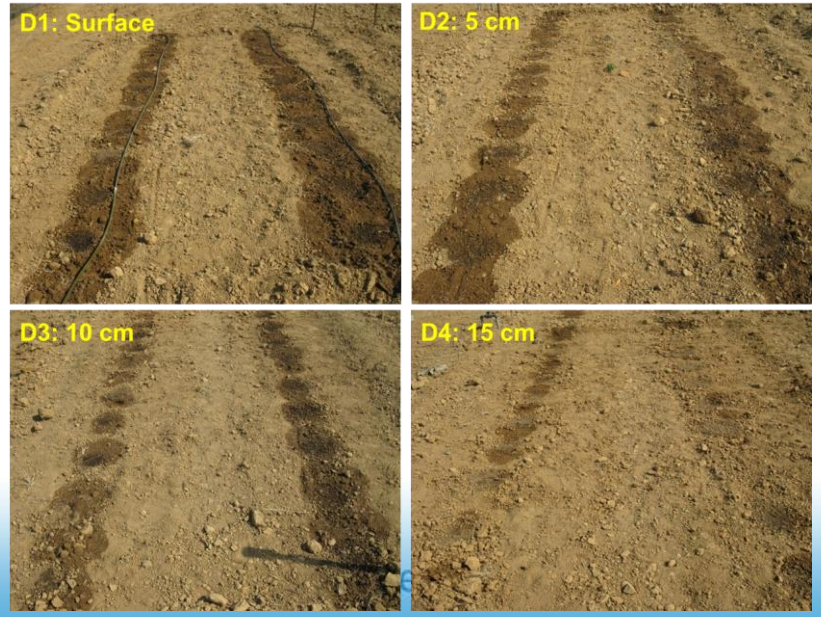
Water security

Energy Security

Enhancing Farmers Income

Subsurface drip irrigation

- **Subsurface drip irrigation**
  - Laterals are placed 10-15 cm below soil surface
  - Non-clog type emitters are used
  - Applies water and nutrient directly in the crop root zone
  - Reduces water loss by evaporation and runoff



Small scale drip systems

- Gravity drip irrigation for small plots
- Runs on small head up to 1.5-2.0 m
- Areas ranging from 100–500 m^2
- Low cost (7000-8000 per kit of 200 sq m.)
- Suitable for areas with intermittent electricity supply
- Easy to install – no trenching required
- Can be used in shifts of laterals in two plots

Drum Kit Drip Irrigation

Statewise Micro-irrigation coverage 2015-16 to 2023-24

S. No.	State/UT	Area covered underMicro Irrigation in hectare [2015-16 to 2023-24 (till date)]	% to total coverage inthe Country [2015-16 to 2023-24 (till date)]
1	**Andhra Pradesh**	**910546**	**10.96**
2	Bihar	28258	**0.34**
3	Chhattisgarh	148146	**1.78**
4	Goa	875	**0.01**
5	**Gujarat**	**1071399**	**12.90**
6	Haryana	168336	**2.03**
7	Himachal Pradesh	12235	**0.15**
8	Jharkhand	34675	**0.42**
9	Jammu & Kashmir	1104	**0.01**
10	**Karnataka**	**1801629**	**21.69**
11	Kerala	5608	**0.07**
12	Madhya Pradesh	356091	**4.29**
13	**Maharashtra**	**938089**	**11.29**
14	Odisha	95475	**1.15**
15	Punjab	14502	**0.17**
16	**Rajasthan**	**708193**	**8.53**
17	**Tamil Nadu**	**1083784**	**13.05**
18	Telangana	326339	**3.93**
19	Uttarakhand	32252	**0.39**
20	Uttar Pradesh	354715	**4.27**
21	West Bengal	95964	**1.16**
22	Arunachal Pradesh	12442	**0.15**
23	Assam	44356	**0.53**
24	Manipur	15894	**0.19**
25	Mizoram	8559	**0.10**
26	Nagaland	19180	**0.23**
27	Sikkim	12972	**0.16**
28	Tripura	4145	**0.05**
29	Ladakh	3	**0.00004**
	Total	**8305765**	

Evaluation Study by NITI Aayog (2020)

i. The scheme is relevant in achieving national priorities such as substantially improving on-farm water use efficiency, enhancing crop productivity, generating employment opportunities etc.
ii. Saving of water across various states are around 30 to 50% in studied States.
iii. Income of farmers increased in the range of 10% to 69%
iv. Water use efficiency improved around 30% to 70%
v. Created direct and indirect employment opportunities.

Target of 112 lakh ha proposed (2021-22 to 2025-26).

Challenges in the adoption of this technology:

- **Electricity:** Uninterrupted availability of electric power is required.
- **Expensive:** The adoption of this technology has high initial costs.
- **Declining landholdings and farm income:** Expensive micro-irrigation on small farms.
- **Maintenance:** Greater maintenance requirements. Soil particles, algae, or clogging with mineral precipitates.
- **Water availability:** According to the natural hydraulic cycle, per capita availability is reducing progressively owing to the increasing population.
- **Hidden costs for** replacing plugged emitters and dripline, Increased pressure differentials, Loss of water, and energy due to increased backflushing. Increased labor cost to maintain your drip irrigation system

Harnessing the potential and addressing the challenges

How to harness the potential?

- Promote **Solar based Micro irrigation systems**
- C**anal command area with pressurized irrigation** systems
- I**ncentivizing farmers to** conserve electricity, both grid and solar, could pave way for conserving water and in fast pacing MI adoption
- **Strengthening capacity of farmers on and off farm** and institutions
- **Scaling out MI system through Business models** - PPP, microfinance based cooperatives, FPOs
- Use of space technology, **soil moisture sensors and IoT based solutions** to precision irrigation: Automated irrigation system.
- GST inclusion in cost: Policy decision
- Oilpam cultivation: Micro-irrigation more subsidy for NER
- **Transparent system, application procedure: Effective subsidy disbursement**

Integrate with solar and storage in the remote area of no power

HAR KHET KO PANI WITH SECONDARY STORAGE STRUCTURES ,
SOLAR BASED PUMPING-Kusum Scheme AND
MICRO IRRIGATION SYSTEMS (Per Drop More Crop).

Average daily water requirement of various crops / consumptive use

Crop	Surface Irrigation		Sprinkler		Drip		Avg hp of solar pump with drip (Avg. 30 Mtr. dept of water)
	Water requirement in mm/day	Water requirement in Litres/ha *	Water requirement in mm/day	Water requirement in Litres/ha	Water requirement in mm/day	Water requirement in Litres/ha	
Pulses	6	60000	4.2	42000	3	30000	2 hp
Wheat	8	80000	5.6	56000	4	40000	3 hp
Vegetables	7	70000	5	50000	3.5	35000	2 hp
Banana 1.5x1.5m	24 lit/plant	96000	NA	NA	12 l/d/p	48000	3 hp
Fruits 5mx5m	100 lit/plant	40000	90 lit/plant	36000	50 lit/plant	20000	1.5 hp
Irrigation efficiency	30-35%		50-60%		80-90%		

1. Total number of irrigation cycles will depend upon availability of water, agro climatic conditions and soil type.
2. Above figures are considering that the soil is medium/ sandy loam
3. For 1 hp pump about 1 kw solar system is required.

Capacity building and training in drip irrigation

On-farm and off-farm capacity building to farmers- key to success

- Selection of drip system
- Design and layout – spacing based on crops, cultivation practices
- Irrigation scheduling
- Fertigation scheduling
- Placement of drippers
- Mulching-black for fruits, silver for vegetables
- Drip system maintenance
- Regular monitoring and trouble shooting

Demonstration of Group based solar powered micro irrigation system (SPIS)

Biofertilzers and Micro-irrigation Fertilizer Use Efficiency: Fertigation

Fertilizer availability: 56 million ton

For horticulture crops:8 million ton

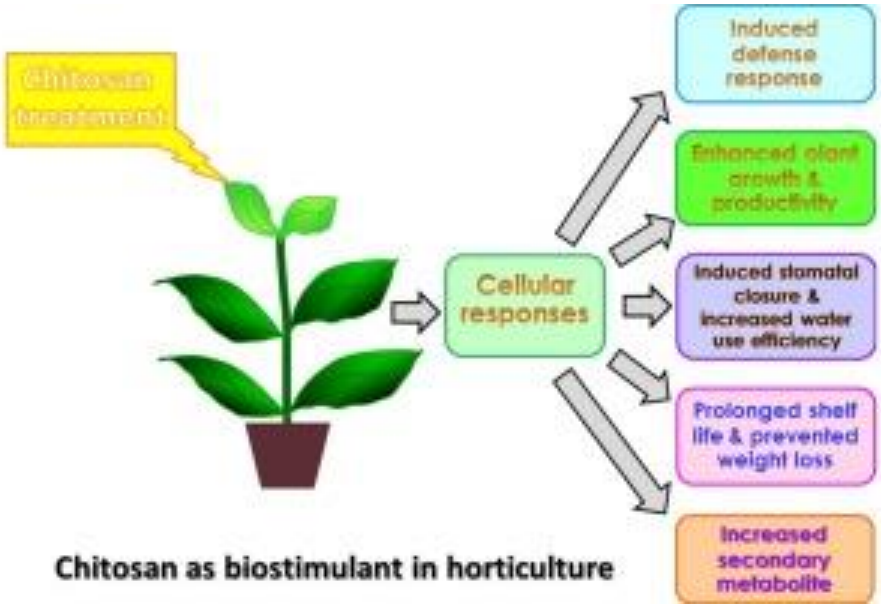
Required (for hortic) :15 million ton

Gap : 7 million ton

- **Biofertlizers : Rhizobium, Azotobactor, Acetobactor, Azospirillium, Phosphate/potash mobilizing bacteria and PGPR , consortia**
- Critical gaps in production and distribution
- Requirement: 6.8 lakh metric ton (MT)
- Production status: 2.3 lakh MT carrier/powder (447 units) & 25369 KL of liquid (133 units) based.
- **We need to enhance present capacity for biofertilsers to 3 times**

Biostimulants in Agriculture: Can we use in Micro-irrigation ?

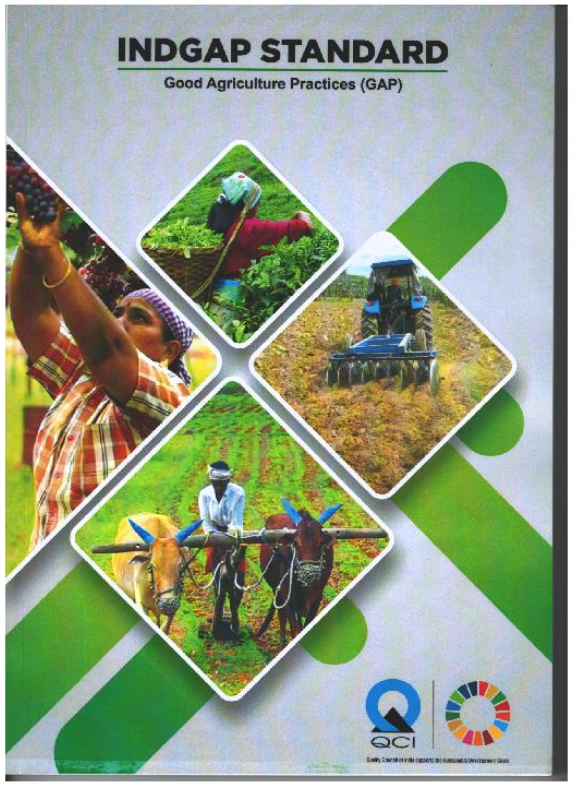
- Biostimulants an emerging input for increasing efficiency for nutrient use, tolerance to stress & quality of produce.
- Sea weed extract, humic acid, fulvic acid, amino acid, cell free cultures, vitamins, protein hydrolytes
- Gazette notification done on 3 Feb 2021
- First Central Biostimulant Committee meeting held 4 June 2021 to set rules.



Chitosan as biostimulant in horticulture

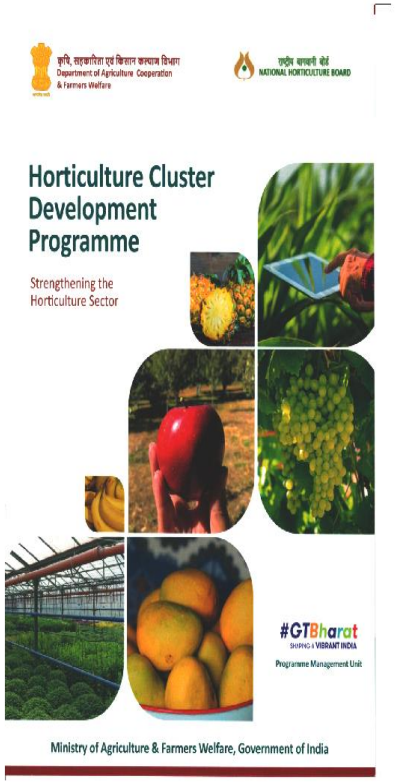
Certification system-IndGAP ?: Microirrigation an important component of GAP

- Safe, healthy and quality food from farm to fork
- Control and compliance system
- Traceability, Environmental protection, welfare
- Preventive and Precautionary action
- Heavy metals, Pesticide residues: safe limits
- *Strengthen farm operations* such as pre harvest, water management, nutrient management, pest management and post harvest operations to ensure sustained supply of quality produce for further processing.
- Reputation in the international market
- Removal of Technical Barriers to Trade (TBTs)
- Drafted common minimum standards for India GAP



Horticulture Cluster Development Program: MI

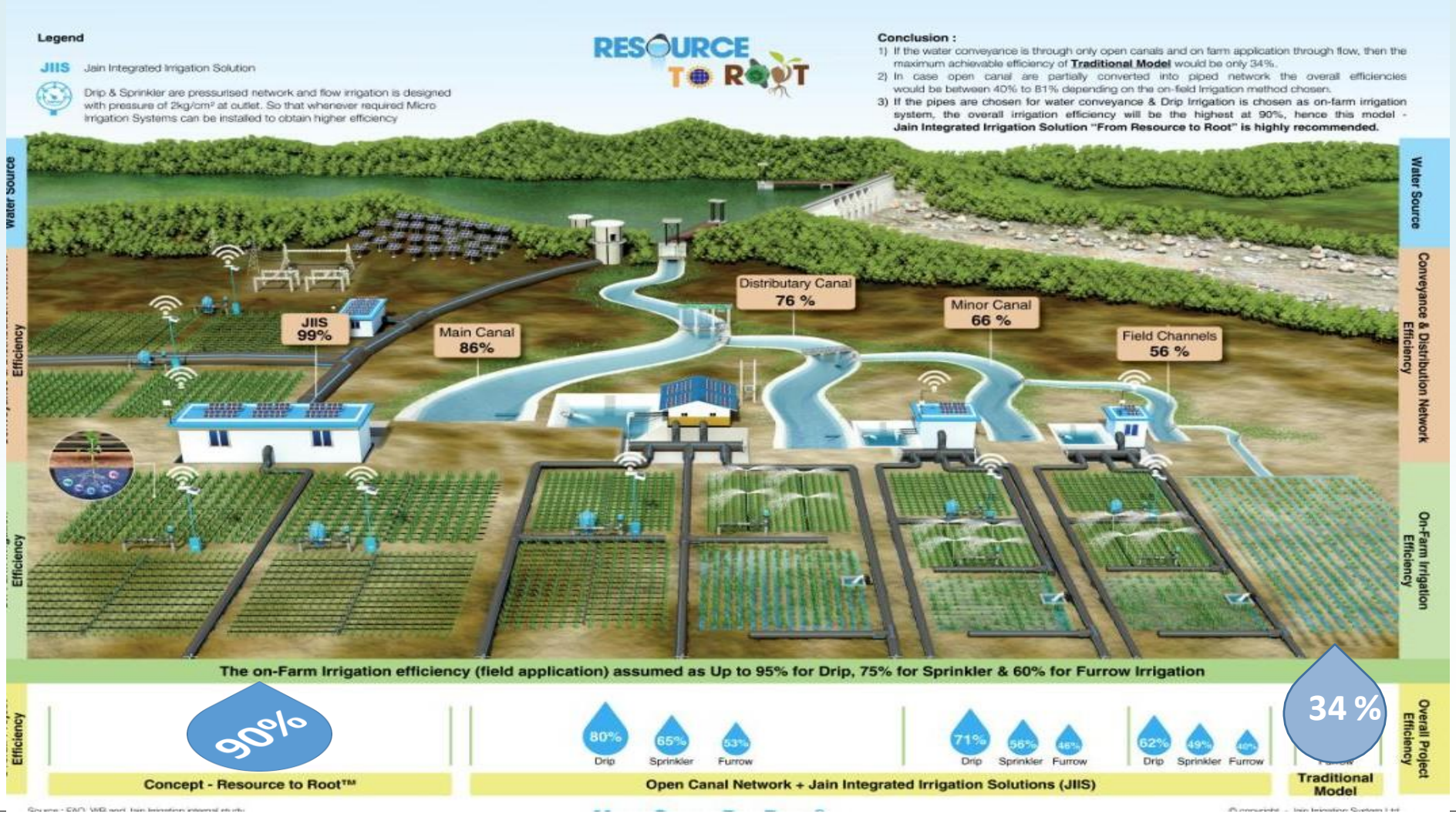
Rs. 21692 Crore



- 12 clusters identified
- Shopian, Kinnaur for apple
- Sholapur, Chitradurga for pomegranate
- Theni, anantpur for banana
- Mehboobnagar, Kutch, Lucknow for mango
- Nashik for grapes
- Sepahijala for pineapple

- Increased productivity
- Micro-irrigation, GAP
- Infrastructure development
- Multimodal transport
- Cluster brands
- Increase in investment by private sector
- Quantum for export

New Perspectives to look upon



New Perspectives to look upon

- Translating advanced MI technologies such as subsurface and fertigation to achieve high WUE & NUE
- Partitioning of nutrient as per critical growth phases viz a viz systems – surface, subsurface layout
- Basic studies needed on biofertigations- integrating nutrients and microbes together specially nanonutrients
- Studies on magnitised water for irrigation through MI to improve water productivity.
- Designing for placement of self compensating drippers to resolve issues of clogging – gradients- uniform discharge of water & nutrients
- Common definition: Which definition to be adopted for WUE. Physiologists, soil scientists, agronomist look from different angles.
- We used to talk about ill soil health- hardly any study has been made on rhizosphere ecology with context to MI/ fertigation.
- Leaf nutrient standards/ soil fertility standards viz a viz fertigation system not studied.
- Ultimate aim is to increase WUE / NUE : How much environmental service the system will provide from carbon foot print and water foot print point of view

Way Forward

- **Improving WUE & Productivity of crops in potential areas (arid & semiarid ecosystem)**

  Micro-irrigation (MI) in more potential areas (69.5 million ha)

- **Potential crops to be covered with MI in potential area**

THANK YOU

INTERNATIONAL YEAR OF
MILLETS
2023

- **INDIA proposal in UN FAO in 2018 accepted & UN General Assembly in 2021 announced**
- **Congratulations for successful celebrations of International Year of Millets-2023**
- **Now water for irrigation is in discussion**