Plasticultural Technologies RelatedRecommendations

Compiled by

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(Sponsored by NCPAH, MoA, GoI, New Delhi)

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Message

Indian agriculture is facing stiff challenges in terms of ever-increasing food demand triggered by population increase on one hand and shrinking land and water resources on the other. Not only this, but there is need to fulfill the demand of quality food including fruits and vegetable, it is necessary to focus more towards horticultural crops. In this context, MoA, GoI, New Delhi liberally funding the project *viz.,* Precision Farming Development Centre through NCPAH in net work mode across the country, is the step in right direction. Navsari center is working in close association with the state Government. The research and developmental work done under this project is essential for increasing input use efficiency, crop productivity and sustaining soil health through plasticulture application in agriculture. The technologies generated through this project have positively impacted the state agriculture production scenario. I feel proud that NAU, Navsari is affiliated with central government program and serving the Gujarat state in most effective ways. I hope the work done under PFDC Navsari centre will go long way in bringing prosperity to Gujarat Agriculture and recommendations useful for increase the income of farmer's. I congratulate the team of PFDC scientists for bringing out this publication on **" Plasticultural Technologies Related Recommendations "**. I am sure; this will useful to farmers' for increasing the productivity of crops. I wish all the success for future activities of this project.

Place: Navsari

Date: 10-10-2018

(C. J. Dangaria)

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Foreword

Under the circumstances of shrinking land and water resources, precision farming technologies provide an excellent option for enhancing input use efficiency and increase the farmers' income. In this direction, PFDC, Navsari has been doing excellent work *i.e.,* covering technology development / refinement and demonstrations of technology on farmers' field. Over 20 years, PFDC, Navsari has developed many technologies and given recommendations to the farmers. Not only this, but PFDC centre has also done some additional activities within the sanctioned budget and contractual staffs. I am happy to forward publication on **"Plasticultural Technologies Related Recommendations".**

I congratulate PFDC team for compilations and publishing a book useful book for farming community for which will certainly help them in increasing the production of various crops and income.

Place: Navsari
Date: 10-10-2018

(S. R. Chaudhari)

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Recommendations since inception of PFDC, NAU, Navsari

SN	Year	Location	Crop	Variety	Spacing (cm x cm)	Tech. applied	Title	Recommendation
A. Drip								
1	1989 - 1992	PRS, Deesa, Gujarat	Potato	Khufri Badsah	60 x 15	Drip irrigation	Studies on drip *v/s* surface method of irrigation in potato	The farmers of North Gujarat zone are advised to adopt drip irrigation system for potato to save 44 % water and bring 0.78 additional hectare under this crop with a total net additional income of Rs. 9000 with the same quantity of water used for the surface method. The system should be laid out with one lateral for each row and drippers of 4 lph placed at 60 cm distance. They should operate the system for 0.6 to 0.8 hrs. during Dec. – Jan. and 1 to 1.4 hrs during Feb.-March on alternate day
2	1989 - 1993	FRS, Paria, Gujarat	Mango	Alphanso	10 m x 10 m	Drip irrigation	Perform-ance study of drip irrigation method in mango	The mango growing farmers of South Gujarat heavy rainfall zone are advised to adopt drip system for new mango plantation for water saving (12 – 31 %) and better growth of the trees and earliness in fruiting. The system should be laid out with two drippers spaced at 50 cm

								from the tree during first two years and 4 drippers at 1 m distance from the trunk after two years till 5 years. The system should be operated for 3 to 4 hrs on alternate day
3	1990 - 1995	HRF, Anand, Gujarat	Kagzi-lime	Kagzi-lime	6 m x 6 m	Drip irrigation	Study on relative efficiency of drip over surface method of irrigation in Kagzilime	The farmers of middle Gujarat zone under conditions of water scarcity are advised to drip method of irrigation to save about 63 % irrigation water and bring 1.75 ha additional area under irrigation. The system should be laid out at 4 drippers of 4 lph capacity at a distance of 1m around the trunk and operated as below on alternate days at 1.2 kg/cm^2 pressure. **Months** **Time(hrs)** January 2.0 February 3.0 March 4.0 April to June 5.0 July to September 2.0 October to December 3.0

4	1991 - 1995	FRS, Paria, Gujarat	Sapota	Kalipatti	10 m x 10 m	Drip irrigation	Study on acceptability of drip irrigation system in sapota	The sapota growing farmers of South Gujarat heavy rainfall zone are advised to adopt drip system for new sapota plantation for water saving (17 to 41 %), better initial growth of the trees, earliness in fruiting and 70-75 % increase in net income per hectare or around 120% for the same quantity of water used as in the surface method. The system should be laid out with two drippers spaced at 50 cm from the tree during first two years and four drippers at 1m distance from the trunk after two years till 5 years. With dripper discharge rate of 4 lph the system should be operated for about 4 hrs during winter and 7 hrs during summer on alternate day. Under conditions of water scarcity, the corresponding operating periods should be 3 hrs and 20 min. during winter and 5 hrs and 40 min. during summer.

5	1995 - 1999	Gandevi, Navsari, Gujarat	Banana	Basarai	Pair row (100 x 120 x 200)	Crop geometry + Drip irrigation	Study on crop geometry with drip for banana crop	The farmers of South Gujarat heavy rainfall zone adopting drip irrigation for banana crop are advised to adopt paired row planting at 1 m x1.2 m x 2 m to reduce drip set installation cost by about 40 % and to get 28 % more yield and 31 % more income. The drip system be laid at 3.2m lateral spacing and 1m dripper spacing with 8 lph dripper. The system may be operated for 2.5 to 3 hrs in winter season and 3.5 to 4.5 hrs in summer season.
6	1992 - 1996	RHRS, Navsari, Gujarat	Sapota	Kalipatti	1000 x 1000	Drip irrigation	Study on drip irrigation in sapota	The sapota growing farmers of South Gujarat heavy rainfall zone are advised to adopt drip system in young sapota plantation (3 to 6 years old) for better initial growth of trees and more fruit yield. The system should be laid out with two drippers (8 lph) spaced at 1 m away from the trunk. The system should be operated for the following periods on alternate day with pressure of 1.2 kg/cm^2. **Season/year Winter Summer** 4th(hr-min) 2 -34 4 -00 5th(hr–min) 3 -02 4-44

								6th(hr–min) 4 -28 6– 55 7th(hr–min) 6-26 10-00 In water scarcity conditions, the system should be operated for half of the time
7	1993 - 1996	ARS, Mahuva, Gujarat	Coconut	West cost fall	7.5 m x 7. 5 m	Drip irrigation	Compara-tive study of drip and surface methods of irrigation in coconut	Under constraints and poor quality of irrigation water the farmers of South Saurastra zone having coconut plantation are advised to use drip method of irrigation and get 68% more income for the same quantity of irrigation water used. The drip system should be operated at 1.2 kg/cm^2 pressure with 4 drippers of 6 lph per palm capacity and operate it for about 1 hr daily during winter and 2 hours during summer.
8	1993 - 1996	NIRP, Khandha, Gujarat	Tomato	Indo-American	90 x 60	Drip irrigation	Feasibility study of drip in tomato	The farmers of the middle Gujarat zone growing hybrid tomato are advised to adopt drip irrigation and mulch their crop (one month after T. P.) with black plastic (50 micron thickness and 80% coverage) to increase yield by around 60 % and save 57% irrigation water. With this method they can increase their net income also by about 24 5 %. If available, farmers should apply FYM @ 30 t/ha along with drip + plastic

								mulch. They should lay out the drip system as one lateral for each crop row (90 cm spacing) with 4 LPH dripper placed at a distance of 120 cm (one dripper between two plants) and operate it at 1.2 kg/ cm^2 pressure for about 1 hr on alternate day during November –January and 1 hr and 30 minutes during February- March.
9	1993 - 1996	NIRP, Khandha, Gujarat	Brinjal	Surati ravaiya	75 x 60	Drip irrigation	Economic feasibility of drip in brinjal	The farmers of the middle Gujarat zone growing brinjal under black soil area of Narmada command are advised to adopt drip method of irrigation along with mulching of black plastic (50 µ thickness and 80% coverage), when the problem of constraints of irrigation water, to save 40% irrigation water and to increase the 35% yield. Further, they can get about 25% more income for the same quantity of water used as in the surface method. They should lay out the drip system as one lateral for each crop row (75cm) with 3 LPH dripper placed at a distance of 120 cm (one dripper between two plants).

								The system should be operated at 1.2 kg/cm^2 pressure for 1hr and 50min. on alternate day during Oct-Jan and 2 hr. and 50min during Feb-March. Under extreme shortage of water they should operate the system along with plastic mulch for 1 hr and 15 min (0.5 PEF)during Oct- Jan and 1hr and 50 min. during Feb-March on alternate days to bring an additional 1.3 ha. Area under cultivation of brinjal and can get 25 % increase in the net return for the same quantity water used in surface.
10	1993 - 1999	PDC, RRS, SK Nagar, Gujarat	*Ber*	Gola	6.5 m x 6. 5 m	Drip irrigation	Study on drip irrigation in *ber*	In the established ber orchard (3 to4 years) of North Gujarat zone, the farmers should give 4 to 6 irrigations after cessation of monsoon (0.4 IW/ CPE, 60 mm depth) for getting 14 % more yield and 7 % more net income over rainfed. Farmers who can afford drip technology should give 60 to 70 liters / tree on alternate days(0.4 PEF) to get 17 % more yield and 163 % additional income over the additional net income obtained under surface method.

11	1994 - 2003	RRS, SKNagar, Gujarat	Mango	Rajapuri	8.0 m x 8.0 m	Drip irrigation	Study on drip irrigation system in mango	The farmers of North Gujarat agro-climatic zone (AES-I), growing mango Rajapuri are advised to adopt drip system to irrigate new mango plantation for better growth and earliness in fruiting. The system should be laid out with two drippers (8 lph) spaced at 30 cm from the trunk of tree during first two years, four drippers at 60 cm distance for 3 to 5 year and 5 dippers at 90 cm distance for 6 to 8 year. Under ample water availability conditions, the system should be operated as per the scheduled given below on alternate day with at 1.2 kg/cm^2 pressure. (Table1). Under scarce water availability conditions farmers are advised to irrigate the crop through drip @ 0.6 PEF for getting similar fruit yield and net profit as that of surface irrigation with a saving of the water to the extent of 21 per cent. The system should be operated as per the schedule given below on alternate day at 1.2 $kg.cm^2$ pressure. (Table 2).

								(Table1) **Month** **Year** 1-2 3-4 5-6 7-8 Sept-Jan. 1.05 - - - Feb.-March 1-45 3-10 4-50 5-50 April-May 2-45 5-50 8-15 9-15 **(Table 2)** **Month** **Year** 1-2 3-4 5-6 7-8 Sept-Jan. 0-40 - - - Feb.-March 1-00 1-55 2-55 3-30 April-May 1-40 3-30 5-00 5-30
12	1994 - 1997	FRS, Dehgam, Gujarat	Pome-granate	Ganesh	6.0 m x 6.0 m	Drip irrigation	Study on drip irrigation method for pomegranate Var. Ganesh	Under water scarcity conditions, the pomegranate growing farmers of North Gujarat are advised to adopt drip irrigation system for obtaining higher yield (3.8 t/ha) and saving of water (49%). With this technology, they can double the area under cultivation with same quantity of water used for surface method. They should operate the system for 5 hrs. 18 minutes during October to January and 6 hrs. 54 minutes during February to May with two dripper per plant having 8 LPH discharge rate and 1.2 kg/cm^2 pressure on alternate day.

13	1995 - 1998	FRS, Dehgam, Gujarat	Guava	L-49	6.0 m x 6.0 m	Drip irrigation	Study on drip irrigation in Guava	Under constraints of irrigation water the guava growing farmers of North Gujarat zone are advised to irrigate the established orchard through drip irrigation system for obtaining more yields and save 53% of irrigation water which can cover more than double the area under irrigation. They should apply 140 l/tree on alternate day through drip system operating at 1.2 kg/ cm^2.
14	1996 - 1999	PFDC, Navsari, Gujarat	Cluster beans	Pusa Navbahar	60 x 30	Drip irrigation	Comparative study of different micro irrigation systems for vegetable crops (cluster bean)	The farmers of South Gujarat heavy rainfall zone are advised to adopt typhoon irrigation method of micro irrigation for cluster bean. Typhoon method should be scheduled at 60 % fraction of pan evaporation which gave 25 % more yield with 33 % saving of irrigation water over surface method of irrigation and with this, an additional 0.5 ha area can be brought under irrigation. Further, the net income can be increased by 35%. The system should be laid out as one lateral with 60 cm spacing of inline dripper between crop pair row of 45 cm distance and operated for 3 to 3.5 hrs during March to May on alternate day at pressure of 1.2 kg/ cm^2

								with a discharge rate of 2 LPH.
15	1997 - 2000	FR S, Paria, Gujarat	Banana	Basarai	150 x 150	Drip irrigation	Irrigation and intercrops management in banana	The banana (Basarai) growing farmers of South Gujarat heavy rain fall zone are advised to adopt drip irrigation system for banana planted at 1.5 x 1.5 m spacing along with bottle gourd as intercrop for water saving of 27 % and increase in net income by 35 % as compared to surface method of irrigation. The intercrop should be sown 50 cm away from banana plant on either side. The system should be laid out with 2 drippers (one on either side of the plant) of 4 lph capacity placed 30 away from plant on either side and lateral should be placed at a spacing of 1.5 m. The system should be operated on alternate days for 1 hrs and 45 minutes during winter and 2 hrs and 45 minutes during summer season at 1.2 kg/ cm^2 pressure.

16	1998 - 2000	WMP, Achalia, Gujarat	Banana	Basarai	150 x 150	Drip irrigation	Study on drip irrigation in banana	The farmers of South Gujarat zone are advised to adopt drip system of irrigation with planting geometry of 1.5 x 1.5 m for banana crop. Drip method of irrigation gave 14 % more fruit yield than surface method with saving of 48 % water. The system should be laid out at 150 cm lateral spacing. Dripper having discharge of 4 LPH should placed at 45 cm away on either side of the plant and operated at a pressure of 1.2 kg/cm^2 on alternate day for 60 min. during October to January, 110 to 130 min. during February and March and 180 min. during April, May and June.
17	1998 - 2000	PDC, RRS, SK Nagar, Gujarat	Okra	Parbhani Kranti	Pair row (30 x 25 x 60)	Drip irrigation	Drip irrigation in okra	The farmers of North Gujarat zone growing okra during summer are advised to give 16 irrigations (0.8 IW/CPE, D= 50 mm) at weekly interval. Under the constraint of irrigation water, they are advised to adopt drip irrigation to save 45 % water and bring about 0.8 ha additional area under irrigation with this crop. In the paired row (30 x 25 x 60 cm) sown crop, the system should be laid out at a lateral distance of 90 cm

								(middle of paired row) with dripper discharge of 4 LPH along with 50 cm dripper distance and operated at 1.2 kg/cm^2 pressure for 70 min. during February – March and 85 min. during April – May on alternate day.
18	1999 - 2000	PFDC, Navsari, Gujarat	Tube rose	Duble	60 x 30	Drip irrigation	Performance evaluation of tuberose under drip irrigation system	Farmers of South Gujarat heavy rain fall zone cultivating tuberose are advised to adopt drip irrigation (0.8 PEF) to get 42 % more yield and 45 % more income. The system should be operated for 50 min. during October to February and 85 min subsequently till the onset of monsoon. Under irrigation water constraint, they should operate the system for about 35 min. during October to February and 55 min. subsequently to get 30 % more yield, 24 % water saving and 27 % more income.
19	2001 - 2002	PFDC, Navsari, Gujarat	Brinjal	Surati ravaiya	Paired row (60 x 60 x 120 cm)	Drip irrigation	Low cost drip technology for kitchen garden and hilly area	The farmers of hilly areas/ kitchen garden of South Gujarat are advised to irrigate brinjal crop through low cost drip system in about 25 to 35 m^2 area using 35 litre of water per day for realizing a net profit of Rs. 300 to 350. The crop should be planted in

								paired rows (0.6 x 0.6 x 1.2 m) with row length of 4.8 m. Such 4 sets of pair rows can be made in the available area. The lateral should be placed in between two rows and micro tube should be placed at 60 cm apart *i.e.* each micro tube (1.2mm) cover two plants. The system should be operated on alternate day.
20	2004 - 2006	PFDC, Navsari, Gujarat	Castor	GCH-4	Paired row (60 x 60 x 120)	Drip irrigation	Irrigation and planting management in *rabi* castor	The farmers of of South Gujarat heavy rainfall zone are advised to grow castor after *kharif* paddy and apply 8 irrigations (60 mm) of which the first 4 irrigations should be applied at 20-25 days interval and the remaining 4 at an interval of 12-18 days for getting higher net income. Under the constraint of irrigation water, they are advised to plant castor in paired row (60 x 60 x 120 cm) and adopt drip method of irrigation to save 39 per cent water, 40 per cent fertilizer. The system should be laid out at a lateral distance of 1.8 m and dripper (8 lph) spacing of 1.2 m and be operated at 1.2 kg/cm^2 pressure for 40 to 60 minutes during November to January

								and 60 to 100 minutes during February till harvest on alternate day.
21	1991 - 1995	PFDC, Navsari, Gujarat	Chilli	Surya rekha	Pair row 45 x 60 x 75	Drip irrigation	Comparative study of different micro irrigation systems for chilli	The chilli growing farmers of South Gujarat heavy rainfall zone are advised to adopt micro tube irrigation for their crop for 40 % water saving coupled with 23 % increase in yield, 53% weed control and 10% more income per hectare or 86% more income for equal quantity of water used as in surface method of irrigation. The system should be laid out with micro tube (appropriate length and diameter to deliver 5.3 LPH discharge) at 60 cm regular spacing on lateral with 120 cm lateral spacing on manifold and should be operated at 1.2 kg/cm^2 on alternate day for 40 to 50 min. during November to February and 60 to 75 min. during March to June.
22	2007 -08	PFDC, Navsari, Gujarat	Brinjal	Surati ravaiya	Pair row 60 x 60 x 120	Drip, fertigation, mulch	Large scale testing of precision farming technologies for brinjal on research	The farmers of South Gujarat growing brinjal (Surati ravaiya) are recommended to adopt following package of practices for higher yield (40%) and net profit (44%). i) Paired row planting(0.6 x 0.6 x1.2 m) ii) Drip irrigation schedule: Nov to Jan. 1.5 hr,

							farm	Feb. to March 2.5 hr and April to June 3.0 hr on alternate day. iii) Fertigation schedule: 80:50:50 NPK kg/ha (*i.e.* 80% N of RD) of which 16:50:50 NPK kg/ha basal and 64 N kg/ha was applied in 4 equal splits at monthly interval from date of transplanting. iv) Black plastic mulch: 25 µ, 45 % coverage.
23	2008 -10	PFDC, Navsari, Gujarat	Banana Onion Garlic Cauliflower	Grand Naine Puna red Local Maharani	240 x 120	Drip	Intercropping studies in banana under drip irrigation	The farmers of South Gujarat who have adopted drip irrigation in banana are recommended to take onion as intercrop for realizing higher net income. Four rows of onion (*i.e.* 40 cm) should be planted on both sides of banana row by leaving about 20 cm space on all the sides of stem + 8 rows (80 cm) in between two row of banana or 8 rows (80 cm) of onion only in between two rows of banana. This intercropping system also improves the land use efficiency. They are further advised to apply respective recommended doses of fertilizer to both the crops.

24	2014 -16	PFDC, Navsari, Gujarat	Banana	Grand nain	240 x 120	Drip, fertigation, Sleeving	Comparative study of different sleeving materials in banana	The drip irrigated banana growing farmers of South Gujarat heavy rainfall zone are advised to cover fully emerged fruit bunch with either 16 micron plastics (transparent or blue plastic) or PP non-woven film for getting better quality fruits (minimum load of bacteria and fungus) and premium price as well.
B. Fertigation								
1	1994 - 1996	PFDC, Navsari, Gujarat	Banana	Basarai	150 x 150	Fertigation	Determination of frequency of application of NPK fertilizer dose for banana crop	The farmers of South Gujarat heavy rainfall zone are advised to adopt fertigation in drip irrigated banana crop. They should apply a total dose of 108 : 54 : 108 g plant NPK / plant in equal seven splits at 20 days interval. They should apply either soluble or liquid fertilizers only. This will result in 40 % fertilizer saving and 35 % reduced irrigation water requirement without any adverse effect on crop growth, yield and quality.
2	1994 - 1996	PDC, S.K. Nagar, Gujarat	Potato	Khufri Badsah	45 x 15	Drip irrigation	Study of nitrogen use efficiency under drip and surface method	The farmers of North Gujarat Agro-climatic zone having light textured soil and having drip irrigation system for irrigating potato crop are advised to apply 220 to 300 kg N/ha according to economical condition of farmers under drip irrigation system for higher potato tuber yield.

							of irrigation in Potato	Half dose of nitrogen should be applied as basal and remaining half dose in four equal splits at an interval of 7 days after 30 days of planting. The farmers are advised to operate drip system for 45 minutes during December to January and 68 minutes Feb to March at alternate day.
3	1994 - 1996	PFDC, Navsari, Gujarat	Tomato	Avinash -2	100 x 50 Pair row (50 x 50 x 150)	Fertigation	Fertigation and planting studies in tomato	The farmers of South Gujarat heavy rainfall zone are advised to adopt drip fertigation in hy. Tomato (Avinash-2) grown during late *rabi* season for 23 % water saving and 33 % increase in yield over surface method of irrigation. Drip fertigated hybrid tomato should be planted in paired row pattern (50 x 50 x 150 cm) and ferigated with 60 % of RDF of fertilizer *i.e.* 150-75-75 N, P_2O_5 and K_2O kg/ha instead of the 250-125-125 N, P_2O_5 and K_2O kg/ha as soil application for maximization. But under constraints of fertilizer availability, a dose of 100-50-50 N, P_2O_5 and K_2O kg/ha can be adopted to get more yield than traditional fertilizer practices. The fertigation should be done at weekly interval. For

								P it was 4 splits and for N and K it was 12 splits.
4	1998 - 2000	Dept. of Hort., Junagadh , Gujarat	Papaya	Madhub indu	250 x 250	Fertigation	Study on fertigation in papaya	For remunerative cultivation of papaya var. Madhubindu under South Saurashtra zone conditions, farmers are recommended to apply 160 g N + 160 g P_2O_5 + 200 g K_2O / plant in 8 equal splits starting from 45 days after transplanting and subsequently at 20 days interval through drip. The system should be operated for 3 hrs daily during October to February and 5 hrs from March on ward with 1 dripper of 8 LPH (1.2 kg/ cm^2), keeping dripper 20 cm away from the base of papaya plant for getting maximum net income.
5	1999 - 2000	PFDC, Navsari, Gujarat	Chilli	Surya rekha	60 X 60	Fertigation	Fertigation study in chilli	Farmers of South Gujarat heavy rain fall zone cultivating chilli with micro irrigation are advised to apply 80 % of recommended dose of NPK as soluble fertilizer in 6 splits at an interval of 20 days. In the case of shortage of fertilizer, they can save 40 % of the RDF without getting any significant reduction in the yield.

6	2000 - 2003	RRS, SKNagar, Gujarat	Brinjal	BSR-1	75 X 75 Pair row (50X75 X100)	Fertigation	Fertigation study in brinjal	The farmers of North Gujarat agro climatic zone growing brinjal (BSR-1) in paired row (50 x 75 x 100 cm) are advised to irrigate the crop through drip at 0.8 PEF and apply fertilizers @ 100 kgN/ha as fertigation for obtaining higher fruit yield (27 %), net profit (25 %) and water saving (8 %) as compared to surface method. Recommended dose of P_2O_5 and K_2O (50 kg/ha) along with 20 % of N (20 kg N/ha) should be applied as basal and remaining 80 % N (80 kg N/ha) should be applied in four equal splits at monthly interval through drip commencing from 30 days after transplanting. They should place lateral at 150 cm and dripper (4 LPH) at 75 cm apart. The system should be operated at 1.2 kg/cm^2 pressure for 180 minutes during September to October, 140 minutes November to February and 220 minutes till harvesting on alternate day. Under scare water availability,they are advised to irrigate the crop through drip @ 0.4 PEF with 100 % RDN for getting more or less similar fruit yield and net profit as compared to control

								i.e. surface irrigation, with a water saving 45 per cent.
7	2000 - 2003	CESWM, Anand, Gujarat	Potato	Khufri lanker	45 X 15	Fertigation	Effect of fertigation in potato through drip irrigation system.	The farmers growing potato in sandy loam soils of middle Gujarat agro climatic zone are advised to adopt drip system for getting 29 per cent higher tuber yield with a saving of 43.3 per cent of water. The crop should be fertilized @ 60 per cent (180 kg N / ha of recommended dose of nitrogen. They should apply 25 per cent of the total nitrogen as basal and remaining 75 per cent through fertigation in 4 equal splits at 10 days interval through drip. The fertigation should be started after 40 day of planting. The system should be laid out lateral spacing of 90 cm (middle of two crop rows) with 4 LPH discharge dripper placed at a distance of 45 cm(six plants per dripper) and operated at 1.2 kg / cm^2 pressure for 50 minutes on alternate day.

8	2001 - 2003	SWM, Achhaliya , Gujarat	Brinjal	Surati ravaiya	Paired row (60 x 60 x 120 cm)	Fertigation	Effect of drip irrigation and fertigation on yield of brinjal (Cv. Surati ravaiya)	The farmers of South Gujarat zone growing brinjal (Surati ravaiya) during rabi/summer are advised to adopt drip irrigation (0.6 PEF) and fertigate the crop with 80 kg N/ha. By adopting this they can get 11% higher yield and 5% higher net profit along with saving of 36 % water and 20% of fertilizer N. The crop should be planted in paired row (60 x 60 x 120 cm). The lateral should be placed at a spacing of 1.8 m and dripper spacing 0.6 m using dripper of 4 lph capacity. The system should be operated at 1.2 kg/cm^2 on alternate day for 1.5 hrs during December to February, 2.5 hrs during March and April and 3.0 hrs thereafter up to harvesting.
9	2009 -10	PFDC, Navsari, Gujarat	Sweet corn	Sugar 75	60 x 20	Drip, fertigation	Lateral spacing and fertigation study in sweet corn	The farmers of South Gujarat heavy rainfall zone growing sweet corn at a row spacing of 60 cm. during *rabi* season are advised to adopt drip method of irrigation along with fertigation of N and K @ 100% RDF (120: 60: 60 NPK kg/ha) for getting higher yield and net profit. N and K fertigation should be done in 5 equal splits starting from 30 DAS. Full dose of P should be applied as basal.

								The system details are: • Lateral spacing: 120 cm • Dripper spacing: 100 cm • Dripper discharge: 8 LHP • Operating pressure: 1.20 kg/cm^2 • Operating time: ♦ Dec-Jan 50 min ♦ Feb-March 65 min Operation frequency: Alternate day
10	2010-11	PFDC, Navsari, Gujarat	Gladiolus	*Psittacinus Hybrid*	20 x 20 x 60 cm (Normal: 30 x 20 cm)	Fertigation	Study on moisture regimes and fertigation in gladiolus	The farmers of South Gujarat intending to grow gladiolus (cv. *Psittacinus Hybrid*) during *rabi* season are advised to adopt paired row planting (20 cm x 20 cm x 60 cm) on raised bed with drip irrigation (0.8 PEF) method (water saving 24 %) along with fertigation of N and K @ 200:100 kg/ha. Fertigation should be done in 10 equal splits at an interval of 7 days starting from 30 DAP. Full dose of P (100 kg/ha) should be applied as basal in addition to common dose of FYM @10 t/ha. By adopting these practices, farmers can get higher yield and net profit as compared to conventional method of irrigation. *The system details are:* Lateral spacing: 1.2 m Dripper spacing: 0.6 m Dripper discharge: 3 lph

								Operating pressure: 1.20 kg/cm^2 Operating frequency: Alternate day Operating time: Nov.: 1.0 hr & 45 mins Dec.: 1.0 hr & 20 mins Jan.: 1.0 hr & 35 mins Feb.: 2.0 hr & 05 mins March: 2 hr & 25 mins
C. Drip + mulch / fertigation								
1	1989 - 1992	PFDC, Navsari, Gujarat	Tomato	Rupali	100 x 50	Drip irrigation + Mulching	Feasibility of drip irrigation for tomato crop with mulches	The farmers of South Gujarat heavy rainfall zone who are growing tomato (Rupali) are advised to irrigate the crop with drip and mulch their crop with either sugarcane trash @ 10 t/ha or black plastic mulch to get 53 and 57 % increase in yield, respectively. With drip alone the yield could be increased by 42 %. Use of drip can result in a saving of water to the tune of 44 % and bring another 0.78 ha area under irrigation with the same quantity of water used for surface method. The net income can be increased by 56 % using same quantity of water through drip and 41 % and 85 %, respectively, when they mulch the crop with either plastic (50 micron) or sugarcane trash mulches.

								The use of drip can reduce weed incidence by 55 % while drip coupled with either of the mulches can reduce the weed intensity by more than 90 % and the fruit borer attack can be reduced by 30 %. The drip system layout as one lateral for each dripper serving 2 plants and with the dripper capacity of 4 lph with following schedule. **Month Drip alone (hrs) Drip with mulch (hrs)** September 6.00 3.00 October 7.00 3.50 November 6.00 3.00 December 5.50 2.75 January 7.00 3.50 February 7.50 3.75
2	1990 - 1993	PFDC, Navsari, Gujarat	Banana	Basarai	150 x 150	Drip irrigation + Mulching	Nitrogen management in banana under drip method with mulching	The banana growing farmers of South Gujarat heavy rainfall zone adopting drip irrigation alongwith sugarcane trash mulch to apply 72 g of N per plant instead of the recommended dose of 180 g N. Thus can saving of 60 % nitrogen fertilizer in addition to 30 % saving in water and 60 to 90 % reduction in weed infestation. By fertigating the crop

								with more than 72 g/tree, they can get additional return ranging from 10 to 19 % at different levels of recommended dose up to 180 g/ plant. (Yield 54.19 t/ha)
3	1990 - 1993	PFDC, Navsari, Gujarat	Banana	Basarai	150 x 150	Drip irrigation + Mulching	Effect of plant spacing and mulches on banana yield under drip method with mulching	The farmers of South Gujarat heavy rainfall zone growing banana are advised to adopt the geometry of 1.5 x 1.5 m with drip irrigation and mulch with sugarcane trash @ 10 t/ha. This will result in 30 % saving in water. Further farmers can harvest about 60 % more yield and 55 % more income than that obtained with 1.8 x 1.8 m spacing with surface irrigation or, 24 % more yield and income as compared to 1.5 x 1.5 m spacing with surface method of irrigation. In unavailability of sugarcane trash mulch, they can mulch with black plastic (50 micron) with 4 lph two drippers at 30 cm on either side of the plant. They should operate the system for 1.6 to 2.0 hrs during winter and 2.5 to 2.75 hrs during summer months on alternate day.

4	1992 - 1995	PFDC, Navsari, Gujarat	Chilli	Surya rekha	Pair row 40 x 60 x 75	Drip irrigation + Mulching	Effect of mulching and micro irrigation on chilli	The farmers of South Gujarat heavy rainfall zone are advised to grow chilli under drip along with green plastic (50 micron) mulch to get about 15 % more yield and 16 % more income per hectare. But for the use of same quantity of water used as in surface method (660mm), the net extra income will be 58 %. In the case of un availability of green plastic, they should mulch the crop with sugarcane trash @ 10 t/ha.
5	1994 - 1996	Collage Agronomy Farm, B.A.C.A, , Anand, Gujarat	Chilli	Jwala	Double paired row system (45 x 45 x 75 x 75)	Drip irrigation + Mulching	Economic feasibility of drip irrigation and plastic mulch in chilli	The farmers of middle Gujarat zone are advised to grow chilli (Var. Jwala) in double paired row system (45 x 45 x 75 x 75) and adopt drip irrigation method with black plastic mulch (50 micron) and apply N @ 125 kg/ha as fertigation to get 47 % higher yield and Rs 20,000 more net income over surface method. The nitrogen should be applied in 12 equal splits at forth nightly interval (P&K application as basal). The system should be laid at a lateral and dripper spacing of 1.2 m with dripper discharge of 4 LPH and operated at a pressure of 1.0 kg/cm^2 for 1.5 hrs on alternate day.

6	1995 - 2000	PFDC, Navsari, Gujarat	Rose	Gladiator	Pair row 100 x 100 x 200	Drip irrigation + Fertigation + Mulching	Irrigation, fertigation and mulching studies in rose	The farmers of AES-III of South Gujarat heavy rainfall zone cultivating rose for cut flowers are advised to adopt paired row planting at 1m x 1m x 2m and irrigate the crop through drip (20% water saving) along with application of 60 : 20 : 20 g NPK/plant only through fertigation (10 days interval during April-May and Oct-Nov.) to increase the yield by 40%. Further, they are also advised to mulch the crop with 50 micron or 100 micron LLDPE BPM (70% coverage) to get about 40% more yield and reduce the weed infestation by 90%. The drip irrigation along with fertigation and BPM increase the net realization by 70%. The system should be laid at 3.0 m lateral spacing and 1.0 m dripper spacing with 8 LPH dripper and it should be operated for 2.5 to 3 hrs (9 to 11 l/plant) during winter and 3.5 to 4.5 hrs (13 to 17 l/plant) during summer on alternate day.

7	2000 - 2003	RRS, SKNagar, Gujarat	Potato	Khufri Badsah	Pair row (30 x 15 x 60)	Drip irrigation + Mulching	Study on drip with mulch in potato	The farmers of North Gujarat agro-climatic zone adoption drip irrigation in potato are advised to follow paired row planting (30 x 60 cm) for securing 17 per cent higher yield and Rs. 65922/ha net profit as compared to drip line in every row (45 cm). Use of black plastic mulch (50 micron) was not found beneficial in drip irrigated potato. The lateral should be placed at 90 cm by keeping dripper (8 LPH) at 50 cm spacing. The system should be operated at 1.2 kg/cm^2 for 25 to 30 minutes during November to February and 35 to 40 minutes during March onward on alternate day.
8	1998 - 2001	PFDC, Navsari, Gujarat	Brinjal	Surati ravaiya	60 X 60	Drip irrigation + Mulching	Saline water usage through drip with mulch in brinjal	The farmers of South Gujarat heavy rainfall zone with poor quality under ground water, can grow brinjal with micro irrigation system. Saline water having EC up to 4.0 dS/m can be used through drip irrigation. They are also advised to mulch the crop with 25 micron LLDPE black plastic mulch (60 % coverage) to get 21 % more yield and 15 % higher profit. The system should be operated for 1.25 to 1.5 hrs during *rabi* and 1.5 to

								2.0 hrs during summer on alternate day using 4 lph capacity dripper. The salinity built up during crop season gets washed away / diluted during the subsequent heavy rainfall in monsoon.
9	1998 - 2000	PFDC, Navsari, Gujarat	Okra	GOH-1	Pair row 30 x 30 x 90	Drip irrigation + Mulching	Effect of drip with mulch on yield of okra	The farmers of South Gujarat heavy rain fall zone growing okra (GOH 1) are advised to adopt drip irrigation system to get 12 % more yield and 49 % saving water over flood irrigation. The crop should plant in paired row at 30 x 90 x 30 cm. The system should be laid out at 1.2 m lateral spacing with dripper spacing of 60 cm and dripper discharge 4 lph and operated on alternate day for 26 minutes during crop growth period at 1.2 kg/cm^2 pressure. Mulching the crop with black plastic (50 micron) can result in 46 % increase in yield with drip and 25 % without drip which correspondingly results in 26 % and 17 % increase in additional net income.

10	2000 - 2001	PFDC, Navsari, Gujarat	Bitter gourd	Hybrid Namdhari	Pair row 50 x 50 x 150	Drip irrigation + Mulching	Evaluation of drip and mulch for bitter gourd	The farmers of South Gujarat heavy rain fall zone growing bitter gourd as summer crop are advised to adopt mulch with black plastic for getting 18 % more yield and net return. Under constraint of irrigation water, they are advised to adopt drip along with mulch for getting 40 % saving in water and 0.67 ha additional area under irrigation with this crop. In the paired row (50 x 50 x 150 cm) sown crop, the system should be laid out 2 m lateral distance (middle of pair row) with 8 lph discharge dripper in the middle of 4 plants and operated at 1.2 kg/cm ^{2} pressure for 100 min. on alternate day.
11	2000 - 2003	RRS, SKNagar, Gujarat	Castor	GCH-4	Paired row sowing (45 x 60 x 135)	Drip irrigation + Mulching	Effect of drip and mulching on yield of castor	The farmers of North Gujarat agro-climatic zone growing castor crop are advised to adopt paired row sowing (45 cm x 135 cm x 60 cm) and irrigate through drip. They should fertilize the crop @ 200 kg N/ ha for obtaining maximum yield and net profit. Full dose of P_2O_5 (50 kg ha^{-1}) and 30 kg N/ ha should be applied as basal and remaining 170 kg N/ ha should be applied in five equal splits at monthly interval starting from

								October through drip as fertigation. The system should be laid out at 180 cm lateral line distance and 60 cm dripper distance with dripper discharge of 8 lph. The system should be operated at 1.2 kg/cm^2 pressure for 125 minutes during October, 105 minutes during November and February, 80 minute during December-January, 160 minutes during March and 200 minutes till harvesting on alternate day.
12	2003 - 2005	PFDC, Navsari, Gujarat	Smooth gourd	Namdhari	200 x 100	Drip irrigation + Mulching	Irrigation management in smooth gourd	The farmers of South Gujarat heavy rainfall zone growing smooth gourd as *rabi*-summer crop are advised to mulch the crop with sugarcane trash @ 2.5 t/ha for getting 23 and 18 per cent more yield and net return. Under the constraint of irrigation water, they are advised to adopt drip along with sugarcane trash mulch (2.5 t/ha) to save 57 per cent water and 1.30 ha additional area of this crop under irrigation. The system should be laid out at a lateral distance of 2.0 m and dripper (4 lph) spacing of 1.0 m and be operated at 1.2 kg/cm^2 pressure for 30 to 60 minutes during October to January and

								60 to 120 minutes during February till harvest on alternate day.
13	2009 -10	PFDC, Navsari, Gujarat	Papaya	Taiwan 786	250 x 250	Drip, fertigation, mulch	Drip and mulching studies in papaya under South Gujarat conditions farm	The farmers of South Gujarat growing papaya are recommended to adopt following package of practices for higher fruit yield and net profit . i. Planting (2.5 m x 2.5 m) ii. Drip irrigation schedule alternat day Winter:20-30lit/plant Summer:30-50lit/plant The system details are: • Lateral spacing: 2.5 m • Dripper spacing: 30 cm away on either side of stem • Dripper discharge: 8 LPH • Operating pressure: 1.20 kg/cm^2 iii. Fertigation schedule : (200:200:250 g/plant) N as urea and K as muriate of potash in 14 equal splits at an interval of 15 days starting from 30 days after planting. The whole amount of P should be applied in the form of single super phosphate as basal. iv. Black plastic mulch: 50 micron, 20 % coverage Adoption of this package of practices also saves 40 % water.

14	2010 -11	PFDC, Navsari, Gujarat And farmers' fields	Sugae cane	-	60 x120 paired row	Drip + fertigation	Large scale testing of improved package of practices for sugarcane on research farm as well as on farmers' fields	Adoption of improved practices (paired row, irrigation @ 0.6 PEF, fertigation of N & K) could enhance sugarcane productivity by 16 to 20 per cent along with saving in water as well as fertilizer to the tune of 40 %. Apart from increase in cane yield, improvement in quality parameters of sugarcane with improved practices over conventional practices.
15	2010 -11	PFDC, Navsari, Gujarat And farmers' fields	Banana	Grain naine	60x120 paired row	Drip + fertigation + mulch	Pilot scale testing of improved package of practices for banana on research farm and farmers' fields	Adoption of improved practices (irrigation @ 0.6 PEF, fertigation 60 % of RD N & K and mulching @ 42 – 67 %) in banana could enhance banana productivity by 13 to 21 per cent along with saving in water as well as fertilizer. This ultimately improves the net realization of banana cultivation by 25 %. Banana fruit yield can be predicted precisely well in advance using lower girth at the age of six month or by using length of bunch, number of hands per bunch and number of fingers per bunch. This will help the farmers or co-operative in planning the sound marketing strategy well in advance.

<table>
<tr>
<td>16</td>
<td>2015 -2017</td>
<td>PFDC, Navsari</td>
<td>Water melon</td>
<td>Honey baby</td>
<td>200 x 100</td>
<td>Drip + fertigation + mulch</td>
<td>Study on combined effect of irrigation, fertigation and mulching levels on fruit yield and quality of water melon</td>
<td>The farmers of South Gujarat heavy rainfall zone growing summer water melon are recommended to apply irrigation through drip system at 0.6 PEF, fertilize the crop at 150:75:75 kg NPK/ha and mulch with silver black plastic sheet (25 micron and 50 % covering) for achieving higher yield and net return. By adopting these practices, saving of 38 % water, 80 % weed control and obtain good quality fruits.
Drip detail:
Lateral spacing: 2 m
Dripper spacing: 1 m
Dripper discharge: 8 lph
Operating pressure: 1.20 kg/cm^2
System operating schedule: Alternate day
Stages wise water application and system operating time:
<table>
<tr><th>Plant growth stage</th><th>Water application (l/ plant)</th><th>System operating time</th></tr>
<tr><td>Vegetative</td><td>2.25</td><td>20 min.</td></tr>
<tr><td>Flowering</td><td>2.25 - 8.25</td><td>20 min.to 2 hrs</td></tr>
<tr><td>Fruit setting</td><td>8.25 - 18.00</td><td>1 hr to 2 hts 15 min.</td></tr>
<tr><td>Maturity</td><td>18.00 - 15.50</td><td>1 hr 55 min. to 2 hts 15 min.</td></tr>
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								Fertigation schedule: Full dose of P_2O_5 and 10 % of N and K_2O applied as basal and remaining N and K through drip system in eight equal splits at weekly interval starting from 15 days after germination.
D. Sprinkler								
1	1988 - 1990	SCRS, Jagudan, Gujarat	Fenugreek	Local	Broadcasting	Sprinkler irrigation	Studies on sprinkler *vs* surface in fenugreek	The farmers of North Gujarat zone are advised to irrigate the fenugreek through sprinkler instead of surface method to achived 200 to 240 % more returns. They are advised to irrigate their crop though sprinkler on the day of sowing and subsequently 22^{nd} 49^{th}, 65^{th} and 95^{th} days after sowing. This will result in about 60 % saving in irrigation water. The system should be laid out at 12 m x 12 m grid and operated at 2.75 kg/cm^2 with an application rate of 17 mm/hr.

2	1988 - 1991	PRS, Deesa, Gujarat	Potato	Khufri Badsah	45 x 15	Sprinkler irrigation	Studies on sprinkler *vs* surface method of irrigation in potato	The farmers of North Gujarat zone are advised to adopt sprinkler method instead of surface method for potato crop. By this, they will get an additional return of 6 thousand rupees per hectare and also save 46 % of irrigation water. With the use of saved water for the same crop through sprinkler an additional area of 0.86 ha can be brought under irrigation which will result in about 23 thousand rupees additional income over surface method for the same quantity of water used. The crop should be irrigated on the day of planting and 8 days later, subsequently the crop need irrigation at 12 – 14 days interval till February and weekly interval during March. The system should be laid out at 12 m x 12 m grid and operated at 2.75 kg/cm^2 with an application rate of 17 mm/hr.

3	1988 - 1991	RFRS, Navsari, Gujarat	Cabbage	Golden acre	45 x 30	Sprinkler irrigation	Study on sprinkler method of irrigation for cabbage	The farmers of South Gujarat heavy rainfall zone are advised to irrigate the cabbage crops through sprinkler method. When irrigation water is not a problem they may irrigate the crop with sprinkler at an interval of 11-14 days to supply 5 cm of water at each irrigation. This will result in about Rs 7300 extra income over surface method of irrigation. In the years constraint of irrigation water, they may irrigate the crop through sprinkler about 15-20 days interval so that they can bring almost double area under irrigation and get about 40,000 rupees more income than surface method of irrigation. The sprinkler and laterals may be laid at 12 x 12 m grid and operated at 2.75 kg/cm^2 with an application rate about 17 mm/hr
4	1990 - 1992	RFRS, Navsari, Gujarat	Cowpea	Pusa Falguni	45 x 15	Sprinkler irrigation	Study on sprinkler method of irrigation in cowpea.	The farmers of South Gujarat heavy rainfall zone who are cultivating summer cowpea are advised to irrigate the crop through sprinkler instead of surface method to get about Rs. 1300 more income from one and save 19 % irrigation water. They should operate the

								sprinkler at 9 to 10 days interval up to March and 7 to 8 days interval during April and May. Every time they should operate the sprinkler of 1.67 cm/hr capacity for about 3 hours. The system should be laid out at 12 m x 12 m grid.
5	1992 - 1995	Dept. of Hort., N. M.C.A., Navsari, Gujarat	Cauli flower	Pusa dipali	45 x 30	Sprinkler irrigation	Study on sprinkler v/s surface method of irrigation for cauliflower	The farmers of South Gujarat heavy rainfall zone cultivating cauliflower are advised to adopt sprinkler method of irrigation to save 34 % water and get Rs 5600 more income per hectare. They should operate the system at 2.5 kg/cm^2 pressure for 3 hrs to apply 50 mm water. The irrigation should be given at 11-14 days interval.
6	1994 - 1995	RHRS, Navsari, Gujarat	Okra	Parbhani kranti	50 x 25	Sprinkler irrigation	Comparative study of sprinkler v/s surface method of irrigation for summer okra	The farmers of South Gujarat heavy rainfall zone growing summer okra are advised to adopt sprinkler irrigation method. Under limited water availability condition, the system should be operated for 3 hours at 18 days interval to get 70 % increase in net return by doubling the area under irrigation over surface method for the same quantity of water used as in surface method.

								The sprinkler should be spaced at 12 x 12 m and operated at 2.75 kg/cm^2 pressure to get 17 mm/hr depth of water application.
7	1999 - 2002	RSRS, Thasra, Gujarat	Cabbage	Golden acre	45 x 30	Sprinkler irrigation	Study on sprinkler v/s surface method of irrigation for cabbage	The farmers of middle Gujarat zone growing cabbage (Golden acre) are advised to give 7 irrigations (1+6) through sprinkler (1.0 IW/CPE ratio) to save 17% of irrigation water and get 10% higher yield .One irrigation of 60 mm depth should be given at transplanting and the rest of 40 mm depth at 10-12 days interval. The sprinkler system should be laid at 12 x 12 m spacing and should be operated at 2.75 kg/cm^2 pressure to achieve 1.67 cm/ha application rate. The set should be operated for about two and half hours per irrigation for achieving a depth of 40 mm.

E. Minisprinkler								
1	1990 - 1992	PFDC, Navsari, Gujarat	Onion	Gujarat red	20 x 15	Mini sprinkler irrigation	Comparative study of mini sprinkler and surface method of irrigation in onion crop	The farmers of South Gujarat heavy rainfall zone are advised to adopt minisprinkler system of irrigation for onion crop to get Rs. 6000 more income than surface method of irrigation. The schedule of irrigation should be (i) First at transplanting (ii) three irrigations at 10 to 12 days intervals till middle of February and rest of 6 to 7 irrigations at weekly interval. During the years of low water availability and in areas of where irrigation water is a constraint they should apply the rest of the irrigation after transplanting at two weeks interval to save 31 % water and bring more area under cultivation with the limited water available.
2	1994 - 1997	PDC, RRS, SK Nagar, Gujarat	Potato	Khufri Badsah	30 x 15	Mini sprinkler irrigation	Studies on minisprinkler v/s surface method of irrigation for	The farmers growing potato on the loamy sand soil of North Gujarat zone are advised to adopt minisprinkler method of irrigation to obtained 17 % higher tuber yield and 35 % saving of water over recommended surface method. They should give 12 irrigations each of 40 mm depth at 8 days

							potato crop	interval. The minisprinkler system should be laid out at 3 m x 3 m grid and should be operated at 1.75 kg/cm^2 (5.6 mm/hr application rate) pressure for 7 hrs to apply 40 mm depth of irrigation at every 8 days interval. Under constraints of irrigation water they should operate the system at an irrigation interval of 10-12 days to save 50 % irrigation water and to get almost equal returns as in the case of surface method.
3	1998 - 2000	PFDC, Navsari, Gujarat	Banana	Basarai	150 x 150	Mini sprinkler irrigation	Feasibility of inter cropping in banana under minisprinkler	The farmers of South Gujarat heavy rain fall zone cultivating banana under micro irrigation system with a spacing of 1.5 x 1.5 m are advised not to use minisprinkler system of 3 m spread
4	2002 - 2004	PFDC, Navsari, Gujarat	Onion	Gujarat red	20 x 15	Mini sprinkler irrigation	Fertigation through minisprinkler in onion crop	The farmers of South Gujarat heavy rainfall zones are advised to adopt minisprinkler system of irrigation along with fertigation for onion crop to get 23 per cent higher net income along with saving of 20 per cent in fertilizer and 42 per cent in water over surface method. The 50 per cent N as urea should be applied at the time of transplanting

								and remaining 50 per cent in three equal splits at 30, 45 and 60 DATP through minisprinkler. The minisprinkler should be laid out at the spacing of 2.5 x 2.5 m and system should be operated at 0.6 IW/CPE with a pressure of 1.5 kg/cm^2 for 8 hrs for getting 50 mm depth of irrigation.
F. Mulching								
1	1991 - 1995	PFDC, Navsari, Gujarat	Banana	Basarai	180 x 180	Mulching	Effect of mulching on yield of banana	The farmers of South Gujarat heavy rainfall zone growing banana are advised to mulch the crop with sugarcane trash @ 15 t/ha to save 40 % irrigation water, get 49 % more yield and increase 86 % net income per hectare. In absence of sugarcane trash, they can follow mulching with black plastic (50 micron) with 50 % coverage and get around 10 % more income in addition to 35 % water saving.
2	1992 - 1994	PDC, S.K. Nagar, Gujarat	Brinjal	Junagadh round	75 x 75	Mulching	Effect of moisture regimes and mulches on growth	The farmers of North Gujarat zone growing *rabi* brinjal crop are advised mulch the crop with castor shell and irrigate it with 14 irrigations each of 30 mm depth to get 33 % more income. Due to high temperature of the film especially

							and yield of rabi brinjal	(black plastic, 50 micron) in summer the plants get damaged.
3	1992 - 1995	SWMC, Achhalia, Gujarat	Brinjal	Pink	100 x 75	Mulching	Effect of different mulches and methods of planting on yield of Brinjal under rain fed condition	The farmers of South Gujarat zone cultivating brinjal as Kharif crop are advised to follow mulching practice with either grass (5 t/ha) or black plastic film (50 micron, 80 % coverage) to get 50 and 36 % more returns, respectively. The mulching should be done within a week after cessation of monsoon.
4	1992 - 1995	PFDC, Navsari, Gujarat	Chilli	Suryare kha	Pair raw 45 x 60 x 75	Mulching	Effect of IW/CPE ratios and mulches on the yield of chilli	The farmers of South Gujarat heavy rainfall zone transplanting chilli in rabi season are advised to give 12 irrigations to the crop (IW/CPE=0.9) each of 80 mm depth. The first irrigation should be given at the time of transplanting, second at 25-30 days after transplanting. Remaining irrigations should be given at 20-25 days interval during January –February and 12-15 days interval during March to May. The farmers are also advised to mulch their crop with black plastic to

								get 63 % more yield and more income.
5	1992 - 1996	FRC, Mangrol, Gujarat	Coconut	Dwarf orange	7.5 X 7.5 m	Mulching	Effect of different types of mulching on growth and yield of coconut.	The farmers of South Saurashtra zone are informed that mulching was not found beneficial in the fully grown (40-50 year old) Coconut (Var. Dwarf orange) orchad.
6	1992 - 1999	HRS, Mahuva, Gujarat	Coconut	Dwarf orange	7.5 X 7.5 m	Mulching	Effect of different types of mulches on yield of coconut	For getting higher nut yield (25 %) and net return, the farmers of South Saurashtra are advised to apply wheat straw as mulch in the 4.1 x 4.1 m basin area of coconut tree. Under the circumstances of unavailability of wheat straw, the use of black plastic (3.8 x 3.8 m) (5o micron) was found beneficial.
7	1993 - 1996	ARS, Mahuva, Gujarat	Coconut	W.C.T.	7.5 X 7.5 m	Mulching	Effect of mulch and irrigation on coconut Cv. W.C.T.	Coconut growers of South Saurashtra region are advised to apply 10 to 11 irrigations each of 50 mm depth of irrigation. During winter the irrigation should be given at 22 days interval and during summer 15 days intervals to 40 to 50 years old coconut orchard (Var. W.C.T.) having basin size 4 x 4 m^2 . The mulching was not

								found beneficial in this type of old plantation.
8	1993 - 1996	NIRP, Khandha, Gujarat	Brinjal	Surati ravaiya	75 x 60	Mulching	Irrigation management in brinjal through mulching	The farmers of the middle Gujarat zone growing brinjal in deep black soil of Narmada command are advised to apply 12 irrigations each of 80 mm depth. The first irrigation should be given at the time of transplanting. The next three irrigations should at an interval of 10 to 12 days, fifth irrigation at 15 to 17 days and last three irrigations at 10 days interval. They can mulch the crop with black plastic (50 micron, 80 % coverage) to get about 27 % more yield and 12 % more income as compared to no mulch treatment. In absence of plastic mulch, the mulching can be done with wheat straw (@ 10 t/ha) to get about 15 % more yield and 11 % more income. The mulching should be done one month after transplanting.
9	1994 - 1997	WMRU, Achhalia, Gujarat	Chillies	G-4	60 X 60	Mulching	Effect of IW/CPE ratio and different mulches on yield	The Chilli growing farmers of South Gujarat Zone are advised to give 4 irrigations to *kharif* crop after cessation of monsoon. They are also advised to mulch the crop with dry grass @ 6 t/ha to get

							of chilli	18 % more yield and 21 % more income. Under constraint of non availability of dry grass, they can mulch with black plastic (50 micron) to get 19 % more yield and 7% more income.
10	1995 - 1996	PFDC, Navsari, Gujarat	Bhendi	Parbhani kranti	60 x 30	Mulching	Effect of growth regulator and different mulches on okra	The summer okra growing farmers of south Gujarat heavy rainfall zone are advised to spray 50 mg/1NAA twice at 25 and 45 days after sowing (DAS) to get higher yield and more economic benefits. In addition to NAA spray, mulching the crop at 25 DAS with black plastic (50 micron 90 % coverage) is also advised to obtain additional yield (25%) and economic benefits.
11	1995 - 1998	RHRS, Navsari, Gujarat	Caulif lower	Early Snowball	60 x 15	Mulching	Irrigation and mulching studies in cauliflow er	The farmer of South Gujarat heavy rainfall zone transplanting cauliflower during November are advised to give 7 irrigations to the crop (IW/CPE ratio-0.75) each of 60 mm depth. The first irrigation should be given at the time of transplanting, second at 9 and third at 20-25 days after transplanting. Remaining irrigations should be given at 18-20 days interval. The farmers are also advised to mulch the crop with black plastic to get 33 %

								more yield and 27 % more income.
12	1996 - 1999	PFDC, Navsari, Gujarat	Brinjal	Surati ravaiya	90 x 60	Mulching	Mulching study in brinjal	The farmers of South Gujarat heavy rainfall zone planting brinjal during December – January months are advised to give 7 irrigations (0.4 IW/CPE) along with black plastic (50 micron, 100 % coverage) as mulch. The interval between two irrigations during winter should be 45 to 50 days, while during summer it should be 30 to 35 days. Use of plastic mulch will increase the net return by 57 % over unmulched conditions.
13	1999 - 2002	RSRS, Thasra, Gujarat	Okra	GOH-1	45 x 10	Mulching	Irrigation and mulching studies in summer okra	The farmers of middle Gujarat zone growing summer okra var. GOH-1 are advised to give 10 irrigations each of 60 mm depth (0.8 IW:CPE). The first irrigation should be on the day of sowing and at 12-13 days interval till March and weekly interval thereafter. They should also mulch the crop with sugarcane trash @ 5 t/ha to get 10 % more yield and income.
14	1999 - 2002	ARS, Danti, Gujarat.	*Ber*	Gola	500 x 500	Mulching	Agrotechnique for ber cultivation in coastal	The farmers of Coastal areas of South Gujarat heavy rainfall zone who are growing *ber* in the un reclaimed coastal salt affected soils are advised to mulch their trees right from the first year to get 97 % more yield and 84 %

							salt affected soils of South Gujarat	more income even during the initial growth period. The 100 micron thick black poly ethylene film should be kept around the trees 1m x 1 m in the first year and 2 m x 2 m from second to fourth year) immediately after the cessation of the monsoon.
15	2003 - 2004	PFDC, Navsari, Gujarat	Marig old	African tall	50 x 30	Mulching	Irrigation and mulching study in marigold	The farmers of South Gujarat heavy rainfall zone growing summer marigold are advised to give 8 (1+7) irrigations for obtaining higher flower yield and net profit. The first irrigation should be given on the day of planting and the second and third at an interval of 20-22 days. The remaining 4 irrigations should be applied at an interval of 14-16 days. They are further advised to mulch the crop with sugarcane trash @ 5 t/ha (100% coverage) for obtaining 25 and 29 per cent higher flower yield and net profit, respectively, over unmulched control. In absence of trash, they can use black plastic (25 µ, 100 % coverage) for achieving 27 and 14 per cent more flower yield and net profit than control.

G. Green house								
1	1995 - 1998	PFDC, Navsari, Gujarat	Rose	Gladiator	50 x 50	Green house	Green house technology for rose (Gladiater) cultivation	The farmers of South Gujarat heavy rainfall zone are advised to grow rose (Gladiator) in medium cost greenhouse for more production and better quality of the flower. They should keep the plant geometry as 0.5 m x 0.5 m. By this, they can get more net income compared to the planting in open field with the same spacing
2	1996 - 2000	PFDC, Navsari, Gujarat	Palak	Local	Broadcasting	Green house	Green house technology for growing leafy vegetables	The farmers of South Gujarat heavy rainfall zone are advised to grow leafy vegetables such as palak, tandeliya bhajee and green coriander leaves in low cost green house for more production and better quality. The cultivation practices inside the green house are similar to that of open field cultivation. By this they can get 60% more net income compared to open field cultivation.
3	1996 - 2000	PFDC, Navsari, Gujarat	Coriander	Local	Line sowing / Broadcasting	Green house	Green house technology for growing leafy vegetables	The farmers of South Gujarat heavy rainfall zone are advised to grow leafy vegetables such as palak, tandeliya bhajee and green coriander leaves in low cost green house for more production and better quality. The cultivation practices inside

								the green house are similar to that of open field cultivation. By this they can get 60% more net income compared to open field cultivation.
4	1996 - 1999	PFDC, Navsari, Gujarat	Vegetable nursery	Local & hybrid	Line sowing / broadcasting	Green house	Green house technology for raising of vegetable nursery	The farmers of South Gujarat heavy rainfall zone are advised to grow vegetable nursery in low cost and medium cost green houses and rain shelter economically. By this they can get more net return of 150 %, 90 % and 122 % with deshi seedlings and 160 %, 86 % and 115 % with hybrid seeds in MGH, LGH & rain shelter, respectively, as compared to open field planting. However, for economy, low cost greenhouse or rain shelter should be better.
5	1999 - 2001	PFDC, Navsari, Gujarat	Tomato	NS 5130	60 x 50	Green house	Green house technology for growing tomato	The farmers of South Gujarat heavy rain fall zone are advised to grow tomato (Hy. NS 5130) in low cost green house for more production as well as net income per unit area with 125 % recommended fertilizer dose. By this they can get 143 % more yield and 385 % more income as compared to open field cultivation.

6	2002 - 2006	PFDC, Navsari, Gujarat	Tomato	SO-16	60 X 50	Green house	Nutrient management for tomato grown in LCGH, MCGH and open field conditions	The farmers of South Gujarat growing hybrid tomato at high density (60 x 50 cm) under green house conditions are advised to apply fertilizer @ 125 % of recommended dose for getting optimum yield. However, the high production causes micronutrients depletion.
7	2010 -11	PFDC, Navsari, Gujarat	Capsicum	Yellow Orbella	50 x 50 cm	Green house	Effect of NAA and GA3 on yield of capsicum grown under polyhouse conditions	The farmers of South Gujarat are advised to grow capsicum (Yellow Orbella) preferably in naturally ventilated poly house instead of fan and pad cooling system poly house and open field conditions. For achieving higher fruit yield and net profit, two spray of GA3 @ 100 mg/l at flower initiation and 10 days after first spray are recommended.

<table>
<tr><td>H.</td><td colspan="8">Net house</td></tr>
<tr><td>1</td><td>2010 -12</td><td>PFDC, Navsari, Gujarat</td><td>Fenugreek, Coriander, Spinach, Amaranthus (Tandelja)</td><td>Local</td><td>10 line sowing</td><td>Net house</td><td>Influence of different growing conditions on yield of leafy vegetables during summer season</td><td>Farmers of South Gujarat having different shade (%) net house are advised to prefer the following leafy vegetables to be grown during summer season for getting higher yield and net income.
<table><tr><th>Crops</th><th>Ideal shade net house (Summer season)</th></tr><tr><td>Fenugreek</td><td>75 %</td></tr><tr><td>Coriander</td><td>75 %</td></tr><tr><td>Spinach</td><td>30 %</td></tr><tr><td>Amranthus</td><td>30 % or open field</td></tr></table></td></tr>
<tr><td colspan="9">I. Low tunnel</td></tr>
<tr><td>1</td><td>1996 - 1998</td><td>PFDC, Navsari, Gujarat</td><td>Palak</td><td>Local & hybrid</td><td>Line sowing / broacasting</td><td>Low tunnel</td><td>Low tunnel technology for leafy vegetables</td><td>The farmers of South Gujarat heavy rain fall zone are advised to grow palak and green coriander in low tunnels for production and profit per unit area in winter season. The details of tunnel construction material and dimensions are as follow: They can use geotextile and / or transparent white plastic sheet as the cover material for palak cultivation in tunnel.
However, geotextile and / or yellow plastic sheet as the cover material for coriander cultivation in tunnel. The tunnel can be made of iron rodes and angles having the dimensions of 2 m x 1.1 m x 0.6 m (Lx B x H).</td></tr>
</table>

J. Drainage								
1	03-04	Segava, Dist: Surat	S'cane	-	-	CSSD	Drainage technology for combating water logging and salinity conditions in South Gujarat	For combating water logging and salinity problems in canal command areas of south Gujarat, farmers are advised to adopt drainage technology for getting economically viable crop production by maintaining average water table at 60 cm bgl and reducing salinity by about 65 per cent. 1) The close sub surface drainage using corrugated PVC pipe should be laid out at a spacing of 45 m and depth of 0.9 to 1.2 m. Considering the internal rate of return (58 %), benefit cost ratio (1:1.7) and pay back period of 2 years with sugarcane crop, this system is economically viable. 2) Similarly, resource poor farmers can adopt subsurface drainage system at spacing of 60 m and average depth of 80 cm. With paddy crop this system is economically viable as evident from internal rate of return (114 %), benefit cost ratio (1:2.93) and payback period of 2 years.

K. Survey								
1	2007-08	South Gujarat	-	-	-	Green house	Green house cultivation in South Gujarat- A survey	1. Green house cultivation of gerbera, rose, carnation and capsicum crops is economically viable under South Gujarat. Among the crops, floriculture crops were found more remunerative than capsicum. 2. The major problems encountered by the farmers are: - No erection company in Gujarat - No information available from Govt. - No training centre in Gujarat. - Planting material not available locally - Pest and diseases - High summer temperature - High power charge - High cost of fertilizer - High cost of plants material.
2	2007-08	South Gujarat	-	-	-	Drip	Patchouli cultivation in South Gujarat- A survey	1. Patchouli cultivation is economically viable under South Gujarat conditions. 2. Problems experienced by the growers - Water stagnation during monsoonic months - Pests and disease

								- Weed control - Absence of improved varieties(high oil content) - Water and nutrient management - Poor awareness about cultivation practices among the farmers 3. Other problems - Unavailability of quality planting material - High cost of planting material - Inadequate extraction unit - Lack of marketing net work
3	2008 -09	South Gujarat	-	-	-		Economics of drip irrigation in sugarcane and banana - a survey	• The magnitude of net profit realized by the sugarcane and banana farmers empathetically proves the economic viability of DIS under farmers' fields situation. • Some of the important suggestions given by the farmers based on their experiences may form basis for taking policy decisions by GoG as well as GoI. • For enhancing know – how of the DIS, theres is need to train the farmers.

4	2008-09	North Gujarat	-	-	-	-	Adoption of drip/sprinkler in potato – a survey	• In potato, sprinkler system is preferred over drip system in North Gujarat • There is need to maintain recommended plant population • There is need to train the farmers • This survey needs to be repeated after 2/3 years
5	2008-09	PFDC, Navsari	-	-	-	-	Impact of feed back analysis of trainees of SWMRU, Navsari	• There is need to train the farmers in depth about improved technologies to be adopted by them • In order to cover large number of farmers, there is need to do Human Resource Development minimum at district level • The pattern of adoption of technology is drip > drainage > sprinkler > green house = mulching • The extent of adoption of technology in different zone is South Gujarat > Kutch > North Gujarat > Saurashtra > middle Gujarat

6	2009 -10	Tribal are of Gujarat	-	-	-	-	Impact assessment of "Yuva Tribal Juth" training (1 month duration) organized by GGRC in collaboration with PFDC.	Based on the survey, following conclusions are emerged. • Considering the education level of the trainees (>SSC), receptivity of knowledge and extent of adoption is good. • MIS training helped in securing job to 20 % of the trainees.
7	2009 -10	All Gujarat	-	-	-	-	Impact of trainers' training program on knowledge level of trainees.	From this study, following conclusions are emerged. • Initial knowledge level of trainees was relatively more with drip and fertigation than sprinkler, mulch and green house technology. • There is considerable increase in knowledge level after training and the technologywise increase in level of knowledge was in order of green house > sprinkler > mulch > drip > fertigation.

8	2010-11	South Gujarat	-	-	-	-	Knowledge and adoption level of drip irrigation in sugarcane in collaboration with different sugar factories	❖ Sugarcane growers are not having adequate knowledge about proper use of drip system in sugarcane. There is need to train the sugarcane growers about improved technologies related to MIS. ❖ Special strategy needs to be formulated for sugarcane grown in canal command area. ❖ The sugar factory officers should be trained in depth about technical aspects of drip irrigation and fertigation.
9	2010-11	South Gujarat	-	-	-	-	Indicative survey on quality of irrigation water in relation to clogging of drippers	• The risk of emitter clogging is considerably high when saline water is used through drip system having low discharge rate dripper. • The uniformity coefficient of drip system is distorted when saline water is used in drip system with low discharge rate dripper. • Use of saline water for irrigation through drip deteriorates the chemical properties *viz.,* pH, EC and ESP of soil. • There is need to train the farmers about operation and maintenances of drip system thoroughly.

10	2013-14	South Gujarat	-	-	-	-	Adaptability and problems in adoption of fertigation by the farmers	• Fertigation technology helped farmers in saving about 20-40 per cent of fertilizers as well as the labour cost for application of fertilizers. Thus, because of fertigation, farmers were able to reduce cost of production and thereby increase in their profit • Because of fertigation, farmers could also harvest quality of produce and thereby realized premium prices is some cases • Most of the farmers are using water soluble fertilizers for fertigation. Farmers feel that the cost of commercially available water soluble fertilizers is too high. So there is need to produce low costly liquid fertilizer by govt. agencies
11	2015-16	South Gujarat	-	-	-	-	Adaptability and problems in plastic mulching adopted farmers	Beneficiaries' perception about the technology ➢ Impressed by the plastic and organic mulching technology ➢ Paired row planting was selected by the farmers for reducing the cost of plastic mulching ➢ Good quality production Feedbacks of farmers with respects to drawbacks/bottlenecks/constraints for adopting the technology

								➢ There is also need to train farmers about irrigation schedule for their crops after plastic mulching. ➢ In some farmer opinion plastic mulching cost, compensate by only saving in fertilizer as well as weeding. ➢ Problems observed during monsoon period than control conditions. Feedbacks of farmers on Govt. of India schemes for its adoptions ➢ The damage is more due to cattle, pigs, boar *etc.* Therefore, farmers opined that there is need to extend subsidy benefit in mulching. This will help in expanding area under MIS.
12	2017-18	South Gujarat	-	-	-	-	Adaptability and problems in net house adopted farmers	Beneficiaries' perception about the technology ➢ Impressed most of the farmers' by the net house technology adopt during summer ➢ Get good quality with high production ➢ Get higher price due of their produce due to off season production Feedbacks of farmers with respects to drawbacks/bottlenecks/constraints for adopting the technology

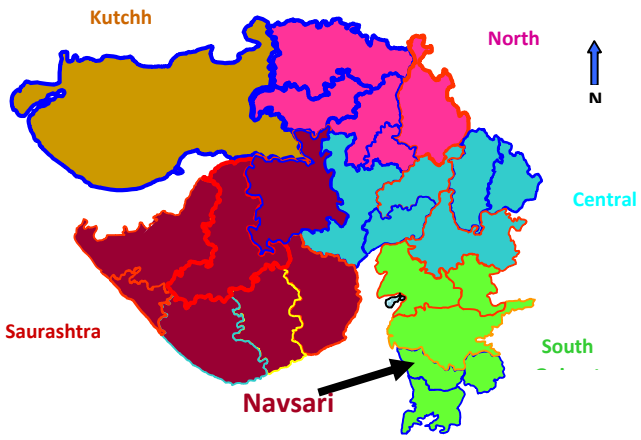
								➢ There is need to train farmers for cropping schedule in net house for round the year production ➢ In some farmer opinion, without crop rotation they suffer from soil born disease ➢ In some crops, problems observed during monsoon period Feedbacks of farmers on Govt. of India schemes for its adoptions ➢ All farmers' taken benefits of subsidy, some farmers' face problems in this ➢ The damage is more due to cattle, pigs, boar, dogs, squirrel *etc.* Therefore, farmers opined that there is need more subsidies for fencing / protected wall around their field. This will help in expanding area of net house.

About PFDC, NAU, Navsari (Gujarat)

Precision Farming Development Centre, Navsari Agricultural University, Navsari was established during 1988-89 under the banner of Plasticulture Development Centre (PDC) and subsequently modified into the present form. Since its inception, this centre was in forefront in the research related to MIS including fertigation, mulching along with protected cultivation and subsurface drainage. During the first decade, major emphasis was given to the technology development in the field of plasticulture along with some transfer of technology. It was sensitization phase in relation to use of plastic in agriculture. However, since 2002-03 onward, the focus of PFDC has been shifted to transfer of technologies (ToT) with due consideration to technology development and refinement wherever necessary. In view of the availability of sound scientific data base and excellent infrastructure facility, team of PFDC along with experts from other departments / colleges of the university at Navsari are doing all out efforts to transfer the developed technologies to the farmers' fields in most effective way.

Location

Navsari is located at about 12 km East of Arabian sea near historical place Dandi, where Mahatma Gandhi launched the Salt Movement during 1942. Geographically, it lies between $20^0 57'$ N latitude, $72^0 54'$ E longitude and at an altitude of about 10 m.



Climate

Navsari falls under agro-ecological situation III of South Gujarat heavy rainfall zone I. It is characterized by fairly warm summer, mild winter and warm humid monsoon with an average rainfall of 1500 mm. As per the delineation done by NB's and LUP, Nagpur, major part of South Gujarat falls in Agroecological Subregion 19.1 (Coastal ecosystem).

Soil

The soil of research farm is placed under the order Inceptisols and sub group Vertic Ustochrepts. It is deep and moderately drained clay soil containing predominantly montmorillonitic minerals.

DECLARATION

The compilation team of this booklet, declare that the plasticultural related available data and information given in this booklet are based on work done by Precision Farming Development Center, Navsari Agricultural University, Navsari. The PFDC project is financially supported by GoI, MoA, New Delhi and overall looking by NCPAH, New Delhi.

The team hopes that this booklet is useful to the farmers, scientists, extension workers, planners *etc.* in their agricultural activities.

Compilation team