Technology developed and recommended

Sr. No	Recommendations
1	**Effect of spacing and nitrogen on castor grown on heavy black soil (2023)** The farmers of Middle Gujarat Agro-climatic Zone (AES-IX) growing castor (GAC 11) are recommended to sow their crop in paired row at the spacing of 60-120-60 cm and fertilize the crop with 50 kg N/ha, besides, 50 kg P_2O_5/ha and 5 t FYM/ha as basal. The nitrogen should be applied in three splits i.e., 12.5 kg N/ha as a basal, 25 kg N/ha at 30 DAS and 12.5 kg N/ha at 60 DAS for getting better yield.
2	**Response of castor (GCH 10) to spacing and nitrogen under irrigated condition (2023)** The farmers Middle Gujarat Agro-climatic Zone are recommended to sow castor (GCH 10) at 120 x 60 cm spacing and fertilize the crop with 120 kg N/ha and 1L/ha *Azotobacter* liquid biofertilizers mixed with 500 kg FYM, besides, 40 kg P_2O_5/ha and 4.5 t FYM/ha as basal. Nitrogen should be applied in four equal splits *i.e.* 30 kg N/ha each as basal, at 30, 60 and at 90 DAS to get higher yield.
3	**Effect of topping and nitrogen management on growth, yield attributes and yield of *Bt* cotton under drip irrigation (2018)** The farmers of middle Gujarat Agro climatic zone growing *Bt* cotton in heavy black soil under drip irrigation system are recommended to practice detopping of cotton plant (removal of apex) at 100 days after sowing and fertilize the crop with 240 kg N/ha in four equal splits i.e., 60 kg N/ha in basal and remaining 180 kg N/ha in three equal splits at one month interval through fertigation to get higher yield at minimum cost.
4	**Water requirement and irrigation scheduling in wheat. (1993)** The farmers of the AES-IX Middle Gujarat Agro-climatic Zone growing wheat (Lok-1) in deep black soils are advised to apply seven irrigations each of 80 mm depth to wheat to get NICBR of 1: 32.2. They should follow the schedule of irrigation as under: First irrigation just after dry sowing. Second irrigation at 19-20 days after first one. Remaining five irrigations at an interval of 12-13 days.
5	**Requirement of flow rate and basin size for wheat. (1994)** It is recommended that the farmers of AES-IX of Middle Gujarat Agro-climatic Zone growing wheat (Lok-1) on deep black soils are advised to adopt border length of 60 m with 2.0 m width with a flow rate of 2 to 5 lit/second.
6	**Irrigation scheduling through sprinkler in wheat. (1996)** In the black soils of Narmada Command of AES-IX of Middle Gujarat Zone, the farmers are advised to irrigate their wheat crop 7 times through sprinkler (52% water saving and 56% increase in net return). Irrigation should be scheduled as under: First irrigation of 80 mm on the day of sowing. Second irrigation of 50 mm 17 days after first one. Third and fourth irrigations of 50 mm at an interval of 13-14 days. Remaining three irrigations of 50 mm at an interval of 10 days. (The sprinklers spaced at 12m x 12m need be operated for 5 hours to get 80 mm depth and 3 hours for 50 mm depth at a pressure of 2.75 kg cm^{-2}

7	**Irrigation scheduling based on critical growth approach in wheat. (1998)** Farmers growing wheat variety Lok-1 in AES-IX of Middle Gujarat Agro climatic Zone under constraints of irrigation water are advised to give four irrigations each of 80 mm depth instead of the recommended seven irrigations. The first two irrigations should be given at post sowing and crown root initiation. Next two irrigations should be given at tillering and panicle initiation or flowering or milky stages. They can also irrigate other two irrigations at panicle initiation and milking or flowering and milking or panicle initiation and dough stages.
8	**Requirement of basin size in gram. (1993)** It is recommended that the farmers of AES-IX of Middle Gujarat Agro climatic Zone growing gram (ICCC-4) on deep black soils are advised to adopt a basin of 4 m x 8 m (4.2 m x 8 m) to obtain higher grain yield as well as higher response to applied water.
9	**Irrigation scheduling based on critical growth approach in gram. (1992)** The farmers in heavy black soil areas of AES-IX of Middle Gujarat Zone are advised to give only two irrigations (75 mm) to their gram crop (first at sowing and second at flowering) to get 27% more income than unirrigated crop.
10	**Irrigation scheduling through sprinkler in gram. (1999)** The farmers of AES-IX of Middle Gujarat Zone growing gram (ICCC-4) under irrigated conditions in deep black soils of Narmada Command are advised to give three irrigations through sprinkler method to get about 69% more yield and about 53% saving in irrigation water over flood irrigation. The first irrigation should be applied at the time of sowing, the second after 25 to 30 days (at branching) and third after 45 to 50 days (at pod formation) with 50 mm depth. The sprinkler should be laid out at 12 m x 12 m and should be operated at 2.75 kg/cm^2 pressure to achieve 16.7 mm/hr application rate. The set should be run for about 3 hours for a total application of 50 mm water. Under constraints of irrigation water even only one irrigation at branching can increase the yield by 49 per cent with water saving of 68 per cent.
11	**Water and P requirement and irrigation scheduling in Lucerne. (1994)** The farmers of AES-IX of Middle Gujarat Agro climatic Zone growing lucerne (A-2) on deep black soils are advised to apply eleven irrigations (for five cuttings) each of 80 mm depth at an IW/CPE ratio of 0.9 (NICBR 1: 39.26) as under. First irrigation at sowing. Second irrigation seven DAS. Five irrigations at an interval of 16-18 days during December to February. Rest at an interval of 10-12 days. Farmers are also advised to apply P_2O_5 @ 80 Kg/ha. To lucerne crop to obtain NICBR of 1: 4.73.
12	**Requirement of basin size for Lucerne. (1994)** It is recommended that the farmers of AEX-IX of Middle Gujarat Agro - climatic Zone growing Lucerne (A-2) on deep black soils are advised to adopt a basin size of 4m x 8m with any flow rate of 3 to 6 lit. / Sec.
13	**Water, fertilizer and spacing requirement and scheduling irrigation in cabbage. (1993)** The farmers of AEX-9 of Middle Gujarat Zone cultivating cabbage advised to give 6 irrigations each of 80 mm depth. The first irrigation should be given on the day of transplanting, second one week later and the rest at 26 days interval. They should fertilize the crop @ 200 kg N/ha and plant at an inter row spacing of 30 to 45 cm and intra row spacing of 30 cm.

14	**Drip and plastic culture as water saving technique in brinjal. (1996)** The farmers of AEX-IX of Middle Gujarat Zone growing brinjal under black soil area of Narmada Command are advised to adopt drip method of irrigation along with mulching with black plastic (50 micron thickness and 80 % coverage), when they face the problem of constrains of irrigation water, to save about 24% irrigation water and to increase the yield by about 50%. Further they can get about 25% more income for same quantity of water used as in the surface method. They should lay out the drip system as one lateral for each crop row (75 cm) with 3 LPH dripper placed at a distance of 120 cm (one dripper in between two plants). The system should be operated 120 kPa pressure for 2 hr. and 30 min. on alternate day during October to January and 3 hr. and 40 min. during February and March. Under extreme shortage of water they should operate the system along with plastic mulch for 1 hr & 15 minutes (0.5 FPE) during October to January and 1 hr and 50 minutes during February and March on alternate days to bring an additional 1.3 ha area under cultivation of brinjal and can get about 25% increase in the net return for the same quantity of water used as in the surface.
15	**Water requirement and irrigation scheduling in brinjal. (1996)** The farmers of the AEX-IX of Middle Gujarat Zone growing brinjal in deep black soil of Narmada Command are advised to apply twelve irrigations each of 80 mm depth. The first irrigation should be given at the time of transplanting. The next three irrigations should be at an interval of 10-12 days, five irrigations at 15-17 days and last three at 10 days interval. They are also advised to mulch their crop with black plastic (50 micron thickness with 80 % coverage) to get about 27 % more yield and 12 % more income compared to no mulch treatment. In the 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 with one month after transplanting.
16	**Drip and plasticulture techniques in tomato. (1996)** The farmers of AEX-9 of Middle Gujarat Zone growing hybrid tomato are advised to adopt drip irrigation and mulch their crop (one-month T.P.) with black plastic (50-micron thickness and 80 % coverage) to increase their yield by about 60 % and save 57% irrigation water. With this method they can increased their net income by about 24%. If availability of FYM is not a constraint they should apply FYM @ 30 t/ha and adopt drip system with plastic mulch. They should layout the drip system as one lateral for each 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 about 1 hour on alternate day during November- January and 1 hour & 30 minutes during February-March.
17	**Water and irrigation cum nitrogen management in chillies. (1998)** Farmers of AEX-IX of Middle Gujarat Agro - climatic Zone cultivating chillies are advised to give 7 irrigations each of 80 mm depth. The first irrigation should be given one month after cessation of monsoon and rest at 20 to 25 days interval. They should fertilize the crop @ 200 kg N/ha in five splits (25 % basal + 25 % one month after T.P. + 20 % at one and half month after first split + 30 % in two equal splits each at an interval of one and half month after preceeding split).
18	**Water requirement and irrigation scheduling in cotton in combination with mulch. (1994)** The farmers of AEX-IX of Middle Gujarat Zone growing cotton Hy-6 in deep black soils are advised to apply five irrigations each of 80 mm depth (IW/CPE ratio of 0.7 and NICBR of 1: 28.46). The first irrigation should be given one month after cessation of monsoon and rest of the irrigations should be given at an interval of 18 to 21 days. Use of either wheat straw @ 10 t/ha or black polythene (50 micron) as mulch increase the yield of cotton but with their present cost, they are not economical. Those farmers who can afford to apply wheat straw as mulch can do so to get about 17 per cent

	more cotton yield.
19	**Drip irrigation system in cotton. (1999)** In the black soils area of Narmada Command of AEX-IX of Middle Gujarat Zone, the farmers are advised to adopt drip system for cotton to get about 33 % increase in yield. For the same quantity of water usage in surface method, they can multiply their cotton area by 1.6 times with drip and get about 70 % increase in total net return. (They should lay out the system with lateral spacing of 1.2 m and the 4 LPH dripper be placed at a distance of 90 cm and the system should be operated at 1.2 kg/cm2 pressure for 2 hours and 15 minutes subsequently).
20	**Cotton based crop sequence studies. (1998)** Farmers of Narmada command area growing cotton in black soils of Middle Gujarat Zone (AES-IX) are advised to follow cotton-wheat sequence for getting higher net income (7 per cent) over cotton alone. Rabi sunflower and soybean were not promising.
21	**Fertigation studies in cotton. (1999)** Farmers of Narmada Command for Middle Gujarat Zone (AES-IX) cultivating cotton (G. Cot. Hy.10), adopting drip system are advised to apply the recommended dose of N (240 kg/ha) in the form of urea as fertigation to get about 20 % increased in yield. After 25 % of nitrogen applied as basal, the rest of the nitrogen should be applied in 10 equal splits at weekly interval. Applications of 180 kg N instead of 240 kg (surface application) as fertigation does not reduce the yield.
22	**Scheduling of irrigation based on soils-crop-climate approach in comparison to other methods of irrigation for cotton. (2000)** The cotton growing farmers of AES-IX of Middle Gujarat Zone of Narmada command area are advised to give three irrigations to their kharif cotton crop. The first irrigation should be given one month after cessation of monsoon. The second one should be 45 days after the first and third 35 days after the second. Recommendation for planner: Irrigation engineer can adopt soil-crop-climate approach for scheduling irrigation in the command area in which he needs the information on soil water availability and potential evapotranspiration of region and crop co-efficient. This approach has wider applicability than other approaches.
23	**Time and method of sowing of cotton hy. -10 with and without soil amendments. (2000)** The farmers of AES-IX Middle Gujarat Zone growing cotton in heavy black soils are advised to apply gypsum 6 t/ha every year to get about 34 % more return. Under conditions of non-availability of gypsum, they should apply FYM 10 t/ha to get about 21 % more net return.
24	**Water requirement and irrigation scheduling in castor. (1994)** The farmers of AES-IX of Middle Gujarat Agro - climatic Zone growing castor GCH-4 on deep black soils are advised to irrigate castor crop with four irrigations each of 80 mm depth at an IW/CPE ratio of 0.5 (NICBR of 1:48.76). They should apply first irrigation 40 days after cessation of monsoon, second after 20 to 25 days after one and remaining two at an interval of one month.
25	**Drip irrigation system in castor. (1997)** The kharif castor growing farmers in the black soil region of Narmada Command (AES-IX) of Middle Gujarat Agro- Climatic Zone constraints of irrigation water are advised to adopt drip method of irrigation for getting 25 % more yield and saving 73% water with 3 LPH dripper spaced at 90 cm. (The system should be operated at 1.2 kg/cm^2 pressure for about 25 to 30 minutes between October and January on alternate days).

26	**Water and P requirement and irrigation scheduling in pigeon pea. (1996)** The farmers of AES-9 of Middle Gujarat Zone growing pigeon pea (BDN-2) are advised to irrigating their crop 3 times to get about 22 % increase in yield. The three irrigations of 80 mm each should be given at monthly intervals after cessation of monsoon.
27	**Water and spacing requirement and irrigation scheduling in rabi pigeon pea. (1998)** Farmers of black soil region of Narmada Command (AES-IX of Middle Gujarat) growing rabi pigeon pea (BDN-2 or GT-100) are advised to sow the crop at 30 cm or 45 cm spacing and irrigate the crop 6 times with 80 mm depth of water. The first irrigation should be immediately after sowing, next four irrigations at 4 weeks interval and the last 3 weeks after the fifth.
28	Scheduling of irrigation based on soil-crop-climate approach in comparison to other methods of irrigation for pigeon pea. (2000) The farmers growing pigeon pea of the AES-IX of Middle Gujarat zone of Narmada Command area are advised to give two irrigations to their kharif pigeon pea. First irrigation should be given one month after cessation of monsoon and second should be 35 days after the first irrigation (through IW/CPE ratio and soil-crop-climate approach are at par but farmers get Rs. 2000 more with soil crop climate approach with same quantity of water besides wider applicability of the approach). Recommendation for irrigation planner. Irrigation engineer can adopt soil-crop-climate approach for scheduling irrigation in the command area in which he needs the information on soil water availability and potential evapotranspiration of region and crop co- efficient. This approach has wider applicability than other approaches.
29	**Nitrogen management for sunflower. (1994)** The farmers in the Narmada Command of AES-IX of Middle Gujarat are advised to cultivate sunflower with 40 kg N/ha in 3 splits (50 % basal, 25 % at bud initiation and 25 % at flowering) to get 16 % more income.
30	**Nitrogen requirement of mustard. (1996)** Farmers preferring of Middle Gujarat Zone growing mustard in the Narmada Command of AES-IX of Middle Gujarat Zone should fertilize the crop with 50 Kg N/ha to obtain 70 % more income.
31	**Water requirement and scheduling irrigation in mustard. (1996)** Farmers of AES-IX of Middle Gujarat Zone growing mustard (var. Varuna) are advised to give four irrigations. After the first irrigation (80 mm) at sowing, the rest of irrigations (60 mm) should be given at four weeks interval.
32	**N and P fertilization in soybean. (1994)** The farmers of AEX-IX of Middle Gujarat Agro - climatic Zone growing soybean in kharif in black soils are advised to apply 75 kg N (NICBR 1: 1.17) and 50 kg P_2O_5/ha (NICBR 1: 0.86) along with Rhizobium inoculation (NICBR 1:32.75). The viable cells of Rhizobium should be 10^8 to 10^9 at the time of application.
33	Water requirement and irrigation scheduling in sugarcane with mulch. (1997) The farmers of AEX-IX of Middle Gujarat Agro - climatic Zone growing sugarcane are advised to give 16 irrigations of 80 mm depth each and apply sugarcane trash mulch @ 10 t/ha 1 ½ -2 months after planting. The interval of irrigation should be 18-20 days up to February, 10-12 days during March and April and 9-10 days during May and June.
34	**P and S fertilization in blackgram. (1998)** Farmers of Middle Gujarat Agro - climatic Zone (AEX-IX) growing blackgarm on heavy soils of Narmada Command (medium in available P and S) are advised to apply 40 kg P_2O_5/ha and 20 kg S/ha (through gypsum) at the time of sowing for securing higher yield and net realization (33 per cent).

35	**N and P fertilization for drilled paddy. (1999)** Farmers of AEX-IX of Middle Gujarat Zone cultivating drilled paddy (GR-5), are advised to apply 60 kg N/ha to get about 37% more yield. In soils of medium P availability, the crop does not respond to fertilizer P.
36	**Irrigation scheduling based on critical growth stage approach. (1999)** The farmers of AEX-IX of Middle Gujarat Zone, cultivating sorghum (GJ-37) in rabi season on deep black soils of Narmada Command are advised to give three irrigations of 80 mm depth. The irrigations should be given at knee high, flag leaf and flowering stages besides one post sowing irrigation.
37	Planting of pomegranate is not recommended to black soil of Narmada Command area owing to fruit cracking and cercospora disease on account of water inundation under heavy monsoonic storm. (1997)
38	Comparative evaluation of drip and surface method of irrigation and their economic feasibility for guava. (2000) The farmers of the AES-IX of Middle Gujarat Zone-III growing guava in deep black soils of Narmada command area are advised to adopt drip system for their young plantation (6-8 years) to get about 63 % more yield and 29 % saving in irrigation water (0.9 FPE) over surface irrigation. For the same quantity of water usage in surface irrigation they can cover an additional area of 0.4 ha. They should layout the drip system as one lateral between two trees rows (16 m) with four drippers/tree having discharge of 4 LPH. The system should be operated at 1.25 kg/cm^2 pressure for five hours and 30 minutes on alternate days during October to December. Under extreme constraints of irrigation water, they should operate the system for about three hours (0.5 FPE) during October to December on alternate days and bring an additional 1.53 ha area under guava.