

**RESEARCH ACCOMPLISHMENTS
AND
RECOMMENDATIONS**

2014



**DIRECTORATE OF RESEARCH
ANAND AGRICULTURAL UNIVERSITY
ANAND 388 110**

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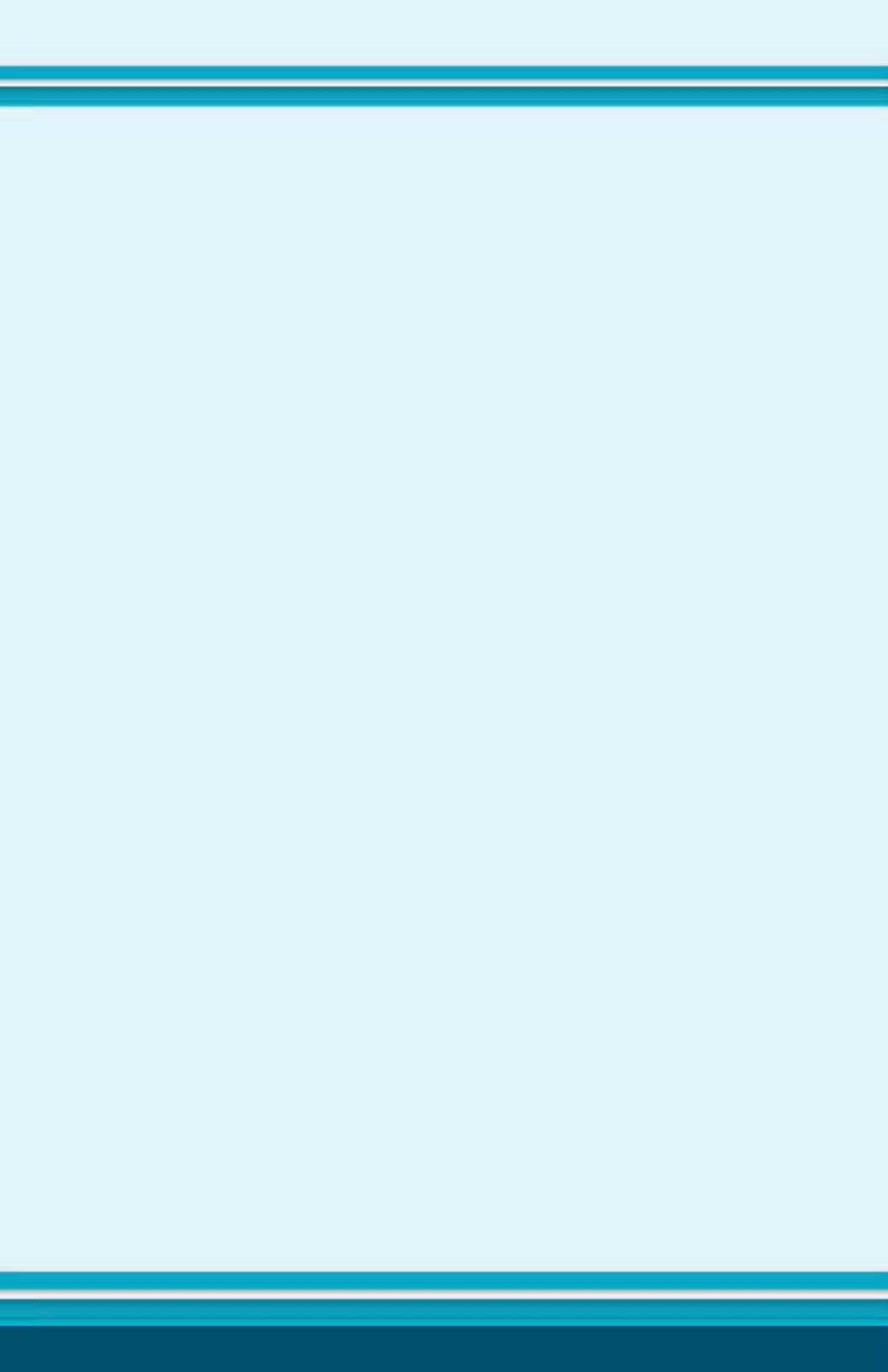
VICE CHANCELLOR

MESSAGE

It gives me an immense pleasure to bring out the publication on 'Research Accomplishment and Recommendations' for the year 2014 prepared by the Directorate of Research, Anand Agricultural University, Anand. This informative publication is meant for larger circulation among the extension workers of line departments, entrepreneurs, NGOs, industrialists etc. to disseminate the technologies for the improvement of agriculture and related fields. I am sure that this booklet will definitely serve as source of information to update the knowledge of agriculture extension workers, private organizations, entrepreneurs, students and others those who are directly or indirectly associated with farming community.

I complement and congratulate to our scientists who made dedicated efforts for developing the technologies for the benefit of farming community. I also congratulate Director of Research and his team for the brief compilation of information and bringing out this publication.

(N. C. PATEL)





ANAND AGRICULTURAL UNIVERSITY
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DIRECTOR OF RESEARCH

FOREWORD

I feel immense pleasure to put foreword the ninth publication of 'Research Accomplishments and Recommendations' of 2014 containing technologies developed by the scientists of Anand Agricultural University for the farmers, animal keepers, entrepreneurs and other end users. I congratulate all the scientists who are involved directly or indirectly in developing the new technologies for the benefits of farmers and rural communities of Gujarat. I am thankful to all the conveners of AGRESCO sub-committee of Agricultural Research Council of this university for conducting all meeting smoothly and staff members of Directorate of Research for the preparation of this informative publication.

At this juncture, I take opportunity to express my heartfelt thanks to Dr. A. M. Shekh, Ex Vice Chancellor and Dr. N. C. Patel, present Vice Chancellor of Anand Agricultural University for their constant guidance and inspiration for bringing out this publication.

I am confident that the technologies developed by the scientists of all the faculties of AAU will definitely help to improve the quality and quantity of agricultural produce for better earning and upliftment of socio-economic status of farmers.

(K. B. KATHIRIA)

PREFACE

The research work carried out in different fields of agricultural sciences during the year 2013-14 has been very well discussed by different AGRESCO sub-committees for bringing out useful and beneficial recommendations for farmers, scientific community, entrepreneurs and stake holders.

The recommendations made by different committees are listed below.

Name of the sub-committee / faculty	No. of recommendations	
	For farmers/ entrepreneurs	For scientific community
Crop Improvement	06	-
Crop Production	14	01
Plant Protection	08	06
Basic Science (Plant Physiology, Biochemistry and Biotechnology)	-	02
Dairy Science and Food Processing Technology	18	-
Agri. Engineering and AIT	02	02
Animal Production	06	03
Animal Health	-	04
Social Science	-	01

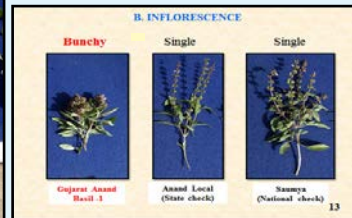
Recommendations for farming community and entrepreneurs

CROP IMPROVEMENT

PLANT BREEDING

1. Crop : Basil

Variety : Gujarat Anand Basil 1 (GAB 1)



Basil variety GAB-1 produced 89.59 and 95.22 % higher green leaf yield as well as 148.70 and 96.85 % higher oil yield than Anand local and Somya check varieties, respectively. Therefore, based on performance of higher green leaves (579 q/ha) and oil yield (158 kg/ha), GAB-1 (Gujarat Anand Basil 1) is recommended for cultivation in Middle Gujarat Zone.

(Research Scientist (M & AP), Medicinal and Aromatic Plants Project, AAU, Anand)

2. Crop : Oat

Variety : JO-03-91



The genotype JO-03-91 of oat produced 29.7, 20.6 and 18.9 % higher green forage yield as well as 13.6, 9.2 and 6.9 % higher dry matter yield than check varieties OS 6, Kent and JHO 822, respectively. The genotype JO-03-91 produced 608 q /ha green fodder. It has produced 608 q/ha green foder and found resistant to leaf blight, root rot and powdery mildew diseases. Hence, it is endorsed for cultivation in Gujarat state.

(Research Scientist (Forage), Main Forage Research Station, AAU, Anand)

3. **Crop : Dill seed (Leafy vegetable)**

Variety: Gujarat Anand Vegetable Dill seed 1 (GAVD 1)



The genotype SD 1 of leafy vegetable dill seed produced 260 q/ha green foliage which was 2.39, 15.63 and 5.58 % higher than the check varieties GD 1, GD 2 and GD 3, respectively in Middle Gujarat. It has dark green foliage and late maturity. This genotype can also be grown under residual moisture. It is approved for release in middle Gujarat.

(Research Scientist (Veg.), Main Vegetable Research Station, AAU, Anand)

4. Crop : Brinjal

Variety : Gujarat Anand Brinjal Hybrid 3 (GABH 3)



This hybrid of brinjal exhibited 613 q/ha fruit yield which was 34.22 and 19.66 % higher over the check hybrids ABH 1 and GBH 2, respectively at Anand. The hybrid contains higher vitamin C (11.182 mg/100 g), anthocyanin (538.64 mg/100 g), acidity (0.971%) and total carbohydrates (4.12 %) and lower in total phenol (1.15 mg/100 g) and total soluble sugar (1.80 %) as compared to the checks ABH 1 and GBH 2. It is released for middle Gujarat.

(Research Scientist (Veg.), Main Vegetable Research Station, AAU, Anand)

5. Crop : Onion

Variety : Gujarat Anand White Onion 2 (GAWO 2)



This genotype of white onion exhibited 24.64 and 44.85 % higher bulb yield over the check varieties GWO 1 and PWF 131, respectively at Anand. The genotype contains higher TSS (14.05 brix), pyruvic acid (36.47 mg/100 g), reducing sugar (1.62 %), non-reducing sugar (3.58 %), total carbohydrates (10.61 %) and total phenols (1.556 mg/100 g) as compared to the checks, GWO 1 and PWF 131. This genotype has low purple blotch disease index (1.67) and thrip incidence (5.87 per plant) as compared to both the checks. It is released for middle Gujarat.

(Research Scientist (Veg.), Main Vegetable Research Station, AAU, Anand)

6. Crop : Garlic

Variety : Gujarat Anand Garlic 6 (GAG 6)



This genotype of garlic exhibited 27.39 and 36.41 % higher bulb yield over the check varieties GG 4 and G 282, respectively with average yield of 91.89 q/ha at Dahod. This genotype has more number of long dark green leaves, purple colour of dry external scales and purple scale colour of clove. It contains higher TSS (35.47 brix), pyruvic acid (3.11 mg/100 g), ascorbic acid (7.37 mg/100 g), total soluble sugar (21.47 %), reducing sugar (2.28 %), non reducing sugar (19.19 %), terpenoids, glycosides and flavonoids as well as lower in total phenol (0.118 mg/100g) as compared to the checks GG 4 and G 282. It is released for purple coloured garlic cultivated area of middle Gujarat.

(Research Scientist (Veg.), Main Vegetable Research Station, AAU, Anand)

Crop : Mungbean

Variety : Gujarat Anand Mungbean 5 (GAM 5)



This proposed genotype of mungbean is highly resistant to YMV disease and the average yield advantage is to the tune of 46.5 and 18.6 % over check varieties GM 4 and Meha, respectively in summer season and yielded 1811 kg/ha. The proposed variety is early in maturity and has bolder seed. This genotype will be released in next year.

(Associate Research Scientist (Pulses), Pulses Research Station, AAU, Vadodara)

(II) CROP PRODUCTION

CULTURAL PRACTICES

1. Effect of different dates of sowing and spacing on seed yield of vernonia (*Kalijiri*) [*Vernonia anthelmintica* (L) Willd.] under middle Gujarat conditions

The farmers of middle Gujarat agro-climatic zone-III (AES-III) growing vernonia (*kalijiri*) during *rabi* season are advised to sow the crop during October up to third week at 45 cm row spacing for securing higher seed yield and net return.

(Research Scientist (M&AP), Medicinal and Aromatic Plants Project, AAU, Anand)

2. Study on plant density and levels of nitrogen of newly released *Herbaceum* cotton variety Anand Desi Cotton - 1 (ADC-1)

The farmers of North-West agro-climatic zone-V growing rainfed *desi* cotton variety ADC-1 are advised to sow the crop at 210 x 30 cm spacing and fertilize @ 40 kg N/ha (20 kg/ha as basal and 20 kg/ha as top dressing at 30-40 DAS) to get higher seed cotton yield and net return.

(Associate Research Scientist, RCRS, AAU, Viramgam)

NUTRIENT MANAGEMENT

3. Effect of NADEP compost on yield and quality of tomato

The farmers of middle Gujarat agro-climatic zone-III intending to grow determinate tomato organically are advised to apply NADEP compost @ 7 t mixed with castor cake @ 350 kg/ha and 1 litre *Azotobacter* culture at the time of transplanting for securing higher yield with better quality, more net return and maintaining soil fertility.

(Professor & Head, Department of Agronomy, BACA, AAU, Anand)

4. Integrated nutrient management in cotton - wheat crop sequence

The farmers of middle Gujarat agro-climatic zone-III adopting *Bt* cotton (early group) - wheat crop sequence are advised to apply 10 t FYM/ha or 1.0 t castor cake/ha to both the crops along with 240 kg N/ha (75% RDF) to cotton and 90-45-0 kg N-P₂O₅-K₂O/ha (75% RDF) to wheat for obtaining higher yield and net return.

(Research Scientist, RRS, AAU, Anand)

5. Permanent small plot trial for studying the long term effect of phosphorus on yield of *Herbaceum* cotton under rainfed conditions

Application of phosphorus to *deshi* cotton grown in North-West agro-climatic zone was not found beneficial (Confirmation of earlier recommendation).

(Associate Research Scientist, RCRS, AAU, Viramgam)

6. **Assessment of organic and inorganic nutrient supply system on yield and quality of cotton variety G.Cot.- 21**

The farmers of North-West Agro-climatic zone-V growing rainfed cotton are advised to apply 100% N through FYM (8 t/ha) or 75% N through fertilizer (30 kg N/ha) + 25% N through vermicompost (600 kg/ha) to get higher seed cotton yield and net return.

(Associate Research Scientist, RCRS, AAU, Viramgam)

7. **Efficacy of potash mobilizing bacteria in potato (*Solanum tuberosum* L.)**

The farmers of middle Gujarat Agro-climatic Zone-III growing potato are advised to apply 1 l of potash mobilizing bacteria- *Fratureia aurentia* or native strain- KMB W1-*Enterobacter* (tuber treatment or soil drenching) for obtaining higher yield and saving of 25% potash (application of 165 kg K₂O/ha instead of 220 kg K₂O /ha). Beside this, N and P should be applied as per recommendation.

(Professor & Head, Department. of Microbiology, BACA, AAU, Anand)

8. **Response of cumin (GC-4) to nitrogen and phosphorus in *Bhal* region**

The farmers of *Bhal* and Coastal Agro-climatic Zone-VIII growing cumin (GC 4) on broad bed and furrow are advised to apply 30 kg N + 30 kg P₂O₅ /ha as basal and 30 kg N/ha as top dressing at 30 DAS for obtaining higher yield and net return.

(Research Scientist, NARP, AAU, Arnej)

9. **Effect of NADEP compost on yield and quality of wheat (GW-1) grown in *Bhal* region**

For obtaining higher yield and net return from durum wheat grown on conserved moisture, in *Bhal* and Coastal Agro-climatic Zone -VIII are advised to apply NADEP compost @ 2.6 t fortified with castor cake (80 kg/ha) at onset of monsoon in place of recommended N fertilizer and follow seed treatment of *Azospirillum* (5 ml/kg seed).

(Research Scientist, NARP, AAU, Arnej)

10. **Effect of bio-organics and chemical fertilizer on growth, yield & quality of sweet corn (*Zea mays* L. var. *saccharata*)**

The farmers of middle Gujarat Agro-climatic Zone-III growing sweet corn (cv. Madhuri) during *rabi* season are advised to apply vermicompost 2 t + castor cake 1.2 t along with 90 kg N + 45 kg P₂O₅/ha for obtaining higher green cob yield and higher net return.

(Research Scientist, MMRS, AAU, Godhra)

WATER MANAGEMENT

11. **Effect of drip irrigation and nitrogen on yield of *Bt* cotton**

The farmers of middle Gujarat agro-climatic zone-III (AES-III) are advised to adopt drip irrigation method (0.8 PEF) and apply 100% RDN

(240 kg N/ha) in *Bt* cotton for obtaining higher yield and net return.

System details :

- 1 Lateral spacing : 1.2 m
- 2 Dripper spacing : 60 cm
- 3 Dripper discharge : 4 lph
- 4 Operating pressure : 1.2 kg/cm²
- 5 Operating frequency : Three days interval
- 6 Operating time : October-November: 1 hour
50 minutes
December-January : 1 hour
25 minutes

(Research Scientist, RRS, AAU, Anand)

12. Nitrogen management in *rabi* drilled fennel (*Foeniculum vulgare* Mill.) under drip irrigation system

The farmers of middle Gujarat Agro-climatic Zone-III (AES-III) growing drilled fennel during *rabi* are advised to adopt drip method of irrigation at 0.8 PEF and fertilize the crop with 72 kg N/ha of which 25% N (18 kg N/ha) as basal and 75% N (54 kg N/ha) in five equal splits at 10 days interval starting from 30 DAS.

System details:

- 1 Lateral spacing : 90 cm
- 2 Dripper spacing : 60 cm
- 3 Dripper discharge : 8 lph
- 4 Operating pressure : 1.2 kg/cm²
- 5 Operating frequency : Alternate day
- 6 Operating time : 30 minutes

(Associate Research Scientist, ARS for Irrigated Crops, AAU, Thasra)

13. Effect of nitrogen and phosphorus fertigation on yield of sweet corn in *goradu* soil of middle Gujarat conditions

The farmers of middle Gujarat Agro-climatic Zone-III growing *rabi* sweet corn are advised to apply 18 kg N/ha (30% of RDN) along with 50 kg P₂O₅/ha as basal and 42 kg N/ha (70% of RDN) in three equal

splits at 10 days interval starting from 20 DAS through fertigation to get higher green cob yield and net return.

System details:

- 1 Lateral spacing : 90 cm
- 2 Dripper spacing : 60 cm
- 3 Dripper discharge : 4 lph
- 4 Operating pressure : 1.2 kg/cm²
- 5 Operating frequency : Alternate day
- 6 Operating time : 2 hours

(Associate Research Scientist, ARS for Irrigated Crops, AAU, Thasra)

14. Response of root knot resistant *bidi* tobacco variety ABT-10 to irrigation and topping levels

The farmers of middle Gujarat Agro-climatic Zone-III growing *bidi* tobacco variety ABT-10 are advised to apply five irrigations each of 50 mm depth at 15-20 days interval and the plants are to be topped at 18 leaves for obtaining higher yield and net return.

(Research Scientist, BTRS, AAU, Anand)

PLANT PROTECTION

AGRICULTURAL ENTOMOLOGY

1. Bioefficacy of insecticides against Legume pod borer- *Maruca vitrata* (Fab.) of mungbean

The farmers of middle Gujarat agro-climatic zone -III growing mungbean in *Kharif* season are advised to spray chlorantraniliprole 20 SC @ 0.006 % (3 ml / 10 litre of water; 30 g a.i./ha) or flubendiamide 48 SC @ 0.01% (2 ml / 10 litre of water; 48 g a.i./ha) at the time of 50 per cent flowering on plants for effective control of legume pod borer, *Maruca vitrata* (F.). The PHI (Pre harvest interval) for both the insecticides is 30 days.

(Assistant Research Scientist (Ento.), Pulse Research Station, AAU, Vadodara)

2. Bioefficacy of newer insecticides against pod borer *Helicoverpa armigera* and Pod fly *Melanogromyza obtusa* of pigeonpea.

The farmers of middle Gujarat agro-climatic zone-III growing pigeonpea are advised to apply first spray of chlorantraniliprole 20 SC @ 0.006 % (3 ml/ 10 litre water; 30 g a.i./ ha) at 50 per cent flowering and second at 50 per cent pod setting for the effective control of *Helicoverpa armigera* and *Melanogromyza obtusa*. The PHI for this insecticide is 29 days.

(Assistant Research Scientist (Ento.), Pulse Research Station, AAU, Vadodara)

3. Bio-efficacy of synthetic insecticides against gram pod borer of chickpea

The farmers of middle Gujarat growing chickpea are advised to give two sprays, either of chlorantraniliprole 20 SC 0.006% (3 ml/ 10 litre water; 30 g a.i./ha) or emamectin benzoate 5 WG 0.0025% (5 g/ 10 litre water; 12.5 g a.i./ha) for the control of pod borer. The first spray should be given at pod formation on 50 per cent plants and the second at 15 days after the first spray. The PHI for chlorantraniliprole 20 SC and emamectin benzoate 5 WG is 11 and 14 days, respectively.

(Assistant Research Scientist (Ento.), ARS, AAU, Derol)

4. Bio-efficacy of insecticides against pigeon pea pod fly and pod borer

The farmers of middle Gujarat growing pigeon pea are advised to spray the crop twice with thiamethoxam 25 WG 0.01% (4 g in 10 litres of water; 60 g a. i. /ha) for the control of pod fly. The first spray should be applied at pod formation on 50 per cent plants and second at 15 days after the first spray. The PHI of this insecticide is 29 days.

(Assistant Research Scientist (Ento.), ARS, AAU, Derol)

5. Combine impact of number of bird perches and pheromone traps on incidence of gram pod borer, *Helicoverpa armigera* (Hubner) Hardwick, pod damage and yield in chickpea crop raised under conserved soil moisture condition of *Bhal* and Coastal Zone.

The farmers of *Bhal* and Coastal agro-climatic zone VIII are advised to install 40 bird perches and 20 pheromone traps with lure in one hectare area for effective and economical management of gram pod borer (*Helicoverpa armigera*). The bird perches and traps should be installed 15 days after sowing at three and one foot height above the crop canopy, respectively covering the whole field uniformly. The lure should be changed at an interval of 21 days.

(Research Scientist, ARS, AAU, Arnej)

PLANT PATHOLOGY

6. Management of bean common mosaic in mungbean vis-à-vis its vector (aphid) through insecticides

The farmers of middle Gujarat agro-climatic zone - III growing mungbean crop in *Kharif* are advised to treat the seeds with thiamethoxam 35 FS @ 10 ml/kg seed (3.5g a.i./kg) at the time of sowing and apply two sprays of thiamethoxam 25 WG 0.01% (4 g/10 litre of water; 30 g a.i./ha) first at 30 days and second at 45 days after sowing for the effective and economical management of aphid (vector) and thereby management of Bean Common Mosaic disease of mungbean. The PHI of thiamethoxam 25 WG is 45 days.

(Professor & Head, Department of Plant Pathology, BACA, AAU, Anand)

7. Management of damping-off using new fungicides in *bidi* tobacco nursery

For effective and economical management of damping-off in *bidi* tobacco nursery, farmers are advised to apply two to three spray drenches of azoxystrobin 23 SC 0.023 % (230 g a.i./ha; 10 ml/10 l water/100 m²) at the initiation of the disease and as and when required thereafter.

(Research Scientist (Pl. Path), BTRS, AAU, Anand)

8. Evaluation of new fungicides for the management of frog-eye spot disease in *bidi* tobacco nursery

For effective and economical management of frog eye spot disease in *bidi* tobacco nursery, farmers are advised to apply two sprays of carbendazim + mancozeb (75 WP) 0.225 % (1.125 kg. a.i./ha.; 30 g/10 l water /200 m²) at 10 days interval starting from initiation of the disease.

(Research Scientist (Pl. Path), BTRS, AAU, Anand)

DAIRY SCIENCE AND FOOD PROCESSING TECHNOLOGY

DAIRY SCIENCE

1. Development of technology for value-addition in indigenous and western dairy products

A probiotic culture *Lactobacillus rhamnosus* MTCC-5462 isolated by AAU, along with Yoghurt Culture (Yo-Flex) is recommended for probiotic shrikhand manufacture, which has a shelf-life of 28 days on storage at 7±2°C temperature.

(Professor & Head, Department of Dairy Technology, DSC, AAU, Anand)

2. Standardization of method for preparation of reduced-fat paneer using whey protein concentrate and selected emulsifiers

Technology for manufacture of reduced fat paneer from 2% fat milk developed by Anand Agricultural University is recommended to dairy industries to have 12% fat and 22% protein as compared to 23% fat and 17% protein in normal paneer. The reduced fat paneer has about 10 % lower cost of production.

(Professor & Head, Department of Dairy Technology, DSC, AAU, Anand)

3. Exploring finger millet (ragi) as an ingredient for value addition to ice cream

A technology for production of medium-fat chocolate flavored ice cream supplemented with 4% malted ragi flour (on dry basis) developed by AAU is recommended to produce ice cream having lower cost and added advantage of higher fiber content compared to the standard ice cream.

(Professor & Head, Department of Dairy Technology, DSC, AAU, Anand)

4. **Assessing the suitability of sweet cream buttermilk in preparation of burfi**

A technology for dairy industries to prepare *burfi* from sweet cream buttermilk is developed by A.A.U., Anand. The product is prepared by using sweet cream butter milk standardized to 6 % fat and addition of 34% sugar to buttermilk khoa. The sweet cream butter milk *burfi* packed in PVC tray box has shelf-life of 4 days at $37\pm 2^{\circ}\text{C}$ and 28 days at $7\pm 2^{\circ}\text{C}$ temperature.

(Professor & Head, Department of Dairy Technology, DSC, AAU, Anand)

5. **Process standardization for manufacture of chamcham**

A technology to manufacture *Cham Cham* is developed by Anand Agricultural University, Anand. The product was prepared from milk standardized to 4.8% fat, coagulating it at 87°C temperature followed by cooking in 60°Brix sugar syrup. The *cham cham* packed in PVC tray box has shelf life of 4 days at $30\pm 2^{\circ}\text{C}$ and 14 days at $7\pm 2^{\circ}\text{C}$ temperature.

(Professor & Head, Department of Dairy Technology, DSC, AAU, Anand)

6. **Standardization of technological parameters for manufacturing paneerburfi**

A technology to manufacture *Paneer based Burfi* developed by AAU, Anand. It can be prepared from Paneer employing standardized milk having 0.65 Fat: SNF ratio, 79°C coagulation temperature of milk and addition of 27.27 % sugar. The *Paneer based Burfi* packed in PVC tray box has shelf life of 4 days at $30\pm 2^{\circ}\text{C}$ and 21 days at $7\pm 2^{\circ}\text{C}$ temperature.

(Professor & Head, Department of Dairy Technology, DSC, AAU, Anand)

7. **Process standardization for the manufacture of thabdi peda**

A technology for manufacture of *thabdi peda* is developed by A.A.U., Anand. *Thabdi peda* is prepared from milk standardized to 6 % fat, 9 % SNF and 8.33 % sugar to have optimum qualities.

(Professor & Head, Department of Dairy Technology, DSC, AAU, Anand)

8. **Shelf-life study of peda using selected packaging techniques**

Thabdi Peda can be stored in Polyester/PE pouches up to 6 days when stored at $37\pm 2^{\circ}\text{C}$ and 20 days at $20\pm 2^{\circ}\text{C}$ temperature when packed under partial vacuum (110 mm of Hg) and N_2 gas flushing.

(Professor & Head, Department of Dairy Technology, DSC, AAU, Anand)

9. **Performance evaluation of refrigeration system of bulk milk cooler with evaporative cooling system**

The supply of evaporative cooled air from air cooler having pads of 140 mm x 65 mm x 25 mm size, to an air cooled condenser having 200 kg capacity of bulk milk cooler decreases the condensing pressure of the refrigeration system. It reduces electrical power consumption in the

order of about 10 to 15% in the month of March, April and May when the evaporative cooling system is maintained at 80-85% efficiency depending on the environmental dry bulb and wet bulb temperature of the air.

(Professor & Head, Department of Dairy Engineering, DSC, AAU, Anand)

10. Development of ragi (*Eleusine coracana*) fortified probiotic ice cream

Probiotic ice-cream supplemented with 4% malted ragi (dry basis) and incorporated with probiotic *Lb. helveticus* MTCC 5463 at the rate 0.1% (w/w) in concentrated form, could be prepared with comparable acceptability with normal ice cream (non-probiotic, non-ragi) and with viability of probiotic cultures above 8 log cfu/g maintained until 90 days of storage at -20°C temperature.

(Professor & Head, Department of Dairy Microbiology, DSC, AAU, Anand)

FOOD PROCESSING TECHNOLOGY

11. Production technology of wheat grass juice

The entrepreneurs and food processors interested in production of wheat (*Jawara*) juice are advised to use technology developed for this purpose by Anand Agricultural University wherein the undiluted juice is extracted from the foliage of 7 days old wheat seedling after germination and is processed using sonication at 70 % amplitude for 10 minutes for extension of shelf life up to 10 days at refrigerated temperature (7±2°C).

(Professor & Head, Department of PHE, College of FPT & BE, AAU, Anand)

12. Precooling protocol to maximize shelf life of tomato fruits

The farmers, entrepreneurs, agro- processing units involved in post harvest handling of tomato fruits are advised to precool tomato fruits for extending shelf life. Based on minimum physiological loss in weight and superior quality, precooling using forced air at 4°C @ 150 cum/min for storing tomato under room temperature. For storage under refrigerated transport condition, hydro- precooling with chilled water at 8°C and @25 lit/min is recommended. Such precooling will result in 12-15 days additional extension in shelf-life compared to tomatoes stored under ambient conditions without precooling.

(Professor & Head, Department of PHE, College of FPT & BE, AAU, Anand)

13. Production technology for bottle gourd juice

The entrepreneurs and food processors interested in production of bottle gourd juice are advised to use juice processing technology developed by AAU. The technology includes hot water blanching (85 °C for 3 Min.), thermal processing at 85 °C for 4 min. and hot filling. It enables production of juice from bottle gourds without addition of chemical preservatives. The final product can be stored up to 15 days

under ambient (30 ± 2 °C) and 30 days under refrigerated (7 ± 2 °C) conditions with good organoleptic quality.

(Professor & Head, Department of PHE, College of FPT & BE, AAU, Anand)

14. Standardized recipe and process for the mechanized Kajukatli production

The entrepreneurs, food processors involved in commercial *Kajukatli* preparation are advised to use the standardized recipe and process developed by Anand Agricultural University. The technology includes wet grinding of presoaked kaju, incorporating 35 % sugar and cooking ($80-90$ °C for 30 Min.). A superior quality product with longer shelf-life can be produced without addition of any chemical preservative. The *kajukatli* can be safely stored at refrigerated condition (7 ± 2 °C) for 24 days.

(Professor & Head, Department of FE, College of FPT & BE, AAU, Anand)

15. Production technology for aonla juice.

The entrepreneurs and food processors interested in production technology of superior quality of aonla juice are recommended to use the production technology developed by Anand Agricultural University. This technology involves maximum recovery of juice from aonla fruits using steam blanching, shredding and destoning, pulverization and thermal treatment (85 °C for 3 min.) without addition of any preservative. The product is microbiologically stable and acceptable for 6 months under ambient conditions.

(Professor & Head, Department of FPT, College of FPT & BE, AAU, Anand)

16. Production Technology for okara based extruded RTE product.

The entrepreneurs and food processors interested in production of extruded snack food using soymilk by product “Okara” are advised to follow the protocol for recipe and extrusion process developed by Anand Agricultural University. The technology includes incorporation of dried okara powder at the rate of 10 % and extrude at 115 °C temperature. The technology enables production of protein rich snack item using by product of soymilk processing.

(Professor & Head, Department of FPT, College of FPT & BE, AAU, Anand)

17. Technology for production of biodiesel from Rice Bran Oil (RBO).

For efficient production of biodiesel from high FFA Rice Bran Oil (RBO), the combined process of esterification followed by trans-esterification developed by Anand Agricultural University is recommended. The process yielded more than 90 % biodiesel from the low grade non edible crude rice bran oil.

(Professor & Head, Department of FQA, College of FPT & BE, AAU, Anand)

18. Protein fortification of mixed fruit bar using Whey Powder

The food processors interested in development of low cost nutritious mixed fruit bar are advised to follow the protocol developed by Anand Agricultural University. The technology involves mixing of fresh pulps of papaya and banana fruits in the proportion of 75:25, processed further and packed in metallized cast polypropylene (MPP). The product can be stored at ambient storage condition (27 °C/ 65 % RH) for 6 months.

(Professor & Head, Department of FQA, College of FPT & BE, AAU, Anand)

AGRICULTURAL ENGINEERING AND AIT

AGRICULTURAL ENGINEERING

19. Development and evaluation of pedal operated maize sheller

A pedal operated maize sheller developed by Anand Agricultural University is recommended to small and marginal farmers for effective shelling of the maize cobs. The machine delivers high shelling efficiency and saving in shelling cost compared to traditionally used hand operated sheller.

(Professor & Head, FMPE, CAET, AAU, Godhra)

AIT

20. A web based soil health card application: Decision support system for agriculture development

By the use of AAU developed Soil health card Portal (<http://shc.gujarat.gov.in>, <http://shc.aau.in>) farmer can get the Agricultural information of their lands. After evaluation of their soil samples, nutrient elements values pH, EC, organic carbon, phosphorus, potash and micro nutrient elements can be extracted. By using the soil analysis results they can get the information on new crops and cropping system suitable for their soils, season and also can develop a better cropping pattern.

(Director, IT, AAU, Anand)

ANIMAL PRODUCTION

1. Release of strain cross (IWN x IWP) - "Anand Commercial Layer"

A high yielding White Leghorn poultry strain-cross (IWN x IWP) has average annual egg production of 300 eggs with more than 52 g egg weight and excellent liveability. The egg production and egg weight have been found comparable with commercial layers available in country. Hence, the IWN x IWP strain-cross is recommended for release as "Anand Commercial Layer" for commercial poultry farming.

(Research Scientist, Poultry Complex, Vety. College, AAU, Anand)

2. Proposal for release of poultry line "Anand Synthetic White Leghorn"

A Synthetic White Leghorn line developed for high egg weight has shown

potential of laying on an average 234 eggs at 64 and 280 eggs at 72 weeks of age with more than 50 g egg weight at 28 weeks and more than 54 g egg weight at 40 weeks of age. Hence, this line is recommended for release as “Anand Synthetic White Leghorn” for improving egg weight.

(Research Scientist, Poultry Complex, Vety. College, AAU, Anand)

3. Proposal for release of poultry breed “Anand Bantamised White Leghorn”

A feed efficient Bantamised White Leghorn is developed with better feed efficiency consumes on an average 10 g less feed to produce one egg as compared to normal White Leghorn strain during 21-64 weeks of age. It has potential of laying on an average 252 eggs at 64 and 302 eggs at 72 weeks of age with more than 50 g egg weight at 40 weeks of age. Hence, this breed is recommended for release as “Anand Bantamised White Leghorn”.

(Research Scientist, Poultry Complex, Vety. College, AAU, Anand)

4. Effect of feeding bypass fat during parturition and during early lactation to buffaloes.

The dairy farmers are recommended that inclusion of bypass fat @100 g/day for 30 days before parturition and 15g/kg milk yield after parturition for 120 days in the ration of buffaloes improves yield of whole milk, fat, 6% FCM, feed conversion efficiency, income per buffalo and birth weight of calves and reduces service period.

(Research Scientist, ANRS, Vety. College, AAU, Anand)

5. Study of nutritional status of dairy animals of Anand district.

Farmers of Anand district are advised to feed daily additional 1.0 kg compound concentrate mixture to the lactating crossbred cows yielding daily 7 to 9 kg milk during monsoon and winter and daily 1.5 kg throughout the year to cows yielding daily 15-18 kg milk.

(Research Scientist, ANRS, Vety. College, AAU, Anand)

6. Study of nutritional status of dairy animals of Anand district.

Farmers of Anand district are advised to feed daily additional 1.0 kg compound concentrate mixture to buffaloes yielding daily 5.5 to 10 kg milk during summer and monsoon and 1.5 kg during winter.

(Research Scientist, ANRS, Vety. College, AAU, Anand)

Recommendations for scientific community

CROP PRODUCTION

1. Analysis and thematic mapping of extreme weather events of Gujarat

The following warming pattern based on daily minimum temperature showed state wide uniformity in Gujarat which is recommended to consider for the climate change adaptation and mitigation related research/planning.

- Increase in hot nights (i.e., summer when Min T > 25 °C)
- Decrease in cold days (i.e., Winter when Min T < 10 °C)
- Decrease in cool nights (i.e., When Min T < 10th percentile in a year)
- Increase in warm nights (i.e., When Min T > 90th percentile in a year)

Except these, the pattern in the climatic extremes of temperature and rainfall recorded during past were ambiguous. Therefore, the location specific climatic trend should be studied before planning of adaptation and mitigation measures/research.

(Professor & Head, Department of Meteorology, BACA, AAU, Anand)

PLANT PROTECTION

AGRICULTURAL ENTOMOLOGY

1. Community structure of birds feeding in cabbage crop

In middle Gujarat, sixteen bird species visiting in cabbage crop are all predators of insect pests, particularly the cabbage aphid, *Lipaphis erysimi* Kalt and hence should be encouraged as biocontrol agents and be included in IPM strategy in cabbage. Important birds are Red-wattled Lapwing (*Vanellus indicus*), Yellow Wagtail (*Motacilla flava*), common Swallow (*Hirundo rustica*) and Common Myna (*Acridotheres tristis*).

(Research Scientist, AINP on Agril. Ornithology, AAU, Anand)

2. Community structure of birds feeding in mustard crop

In middle Gujarat, twenty one insectivorous and nine omnivorous bird species visiting in mustard crop are all predators of insect pests, particularly the mustard aphid, *Lipaphis erysimi* Kalf and hence should be encouraged as biocontrol agents and be included in IPM strategy in mustard crop. Important bird species are Yellow wagtail (*Motacilla flava*), Common Swallow (*Hirundo rustica*), Dusky Crag Martin (*Hirundo concolor*), Jungle Babbler (*Turdoides striatus*) and Rosy Starling (*Sturnus roseus*).

(Research Scientist, AINP on Agril. Ornithology, AAU, Anand)

3. Residue and persistence of acephate 75 SP in/on okra

Two foliar sprays of acephate 75 SP in okra at 10 day interval @ 560 g a.i. ha⁻¹ starting from fruiting stage resulted in its residues below

the MRL of $0.05 \mu\text{g g}^{-1}$ (LOQ-Limit of Quantitation) in okra if fruits are harvested from 10th day after the second spray. Therefore, pre-harvest interval (PHI) of 10 day could be suggested if acephate is recommended on okra.

(Residue Analyst, AINP on Pesticide Residue, AAU, Anand)

4. Residue and persistence of profenophos 50 EC in/on okra

Two foliar sprays of profenophos 50 EC in okra at 10-day interval @ 500 g a.i. ha⁻¹ starting from fruiting stage resulted in its residue below MRL $0.05 \mu\text{g g}^{-1}$ (LOQ-Limit of Quantitation) in okra fruits if harvested 5 days after the second spray. Therefore, PHI of 5-day could be suggested if profenophos is recommended on okra.

(Residue Analyst, AINP on Pesticide Residue, AAU, Anand)

5. Residue and persistence of triazophos 40 EC in/on okra

Two foliar sprays of triazophos 40 EC in okra at 10-day interval @ 500 g a.i. ha⁻¹ starting from fruit initiation stage resulted in its residue below the MRL of $0.05 \mu\text{g g}^{-1}$ (LOQ) in okra if fruits are harvested 5 days after the second spray. Therefore, PHI of 5 days could be suggested if triazophos is recommended on okra.

(Residue Analyst, AINP on Pesticide Residue, AAU, Anand)

PLANT PATHOLOGY

6. Integrated management of cumin blight

Seed treatment of thiram @ 5 g/kg seed, coupled with 4 sprays of combi-product of carbendazim 12% + mancozeb 63% 0.2 % (26.6 g/ 10 l of water) starting at 30 days of sowing and at 10 days interval either in row sowing (30 x 10 cm, with 12 kg seed /ha) or broadcasting (20 kg seed/ha) method was found effective for the management of blight disease of cumin. However, due to high levels of dithiocarbamate residue (16.5 mg/g) in cumin seed, this can not be recommended for farmers.

(Professor & Head, Department of Plant Pathology, BACA, AAU, Anand)

BASIC SCIENCE

1. Survey and collection of Saffron germplasm

Flowering can be successfully induced in Saffron outside its natural habitat under controlled environmental conditions (Temperature: 20-25°C, Humidity: 35-70% and Direct Sunlight: 10 hours per day) for carrying out downstream gene expression and molecular biology studies related to colour and flavour principles.

(Professor & Head, Department of Agril. Biotechnology, AAU, Anand)

2. Validation of newly developed SSR markers of *Plantago ovata*

Genomic SSR markers of *Plantago ovata* are highly transferable among its allied species and hence can be successfully utilized for improvement of isabgol crop through marker assisted breeding.

Characteristics of SSR loci isolated from *P. ovata*

Sr. No	Primer	Primer Sequence (F/R)	T _m *	Repeat Motif	Amplified fragment size
1	APOM 1	TGGCACTTGGGCAAATCTACTTGG TTGGTATCCACGGATGAACAGCCT	60	GC6	235
2	APOM3	GTTTACCTTGCTCAAGTGCTTGCT AACTCCTTCACCCTTCGCCTAACA	52	TG10	301
3	APOM4	TGTCACACACACACACACACAC AGGGAAACTGCCATGACTCCTCTT	52	CA10	269
4	APOM 5	ATGGAAGGAGGGTGGTGGAAAGTTT AGCTTTATCACAGCGACGGAGCTT	52	AG7	377
5	APOM 6	AATTGAAGACTGTGCACTTGGGCG AAAGGAGAGAGAGAGAGAAGCACG	60	TC7	181
6	APOM 7	AGGAAGGAGTCCCGAAGAGTAAGA AAATTGGGACCACCTATCTCCCGTA	55	GC7	431
7	APOM 8	ATCTAACTTATCCCTTGGAC TGCCTTAGAACTATAAGTGG	52	GC7	140
8	APOM 9	TTATATATCCGTCGATTTTC AAAATATGCACTTGATTAGC	52	CA10	197
9	APOM 10	TTATTGATTTCGGATCTTTA GACACACACAACCTTCTCTC	60	AG7	192
10	APOM 11	ATCTAACTTATCCCTTGGAC TGCCTTAGAACTATAAGTGG	55	AG6	199
11	APOM 12	ATTAAGTGAAGGAGGAAG AGATTGAGTAGTTTCAGCAA	55	GAA5	212
12	APOM 13	CTATTTGTCCTTCTTTGCTA ATATATCTGACAAGTCGCAC	60	AGC7	245
13	APOM 14	AAATTCTAAGGCTTGACCT AAAATTTAGCACGCGA	60	TTC4	249
14	APOM 15	ATGGAGTAGGAAGTGAGAGT GAGATGCATATCTTAAGTGTAG	60	GAT4	183
15	APOM 16	CATAGAGTATGCTGAAAAAT ATTCATGTTCTTGACTGTGT	60	TCC4	190

16	APOM 17	TGTAAGGTATTGAGATTGCT	55	GTG5	156
		CTTCTAATGATGATGATGGT			
17	APOM 19	TGCAATGAGTTTTATTCTCT	60	CTC4	196
		GATTGTCATCATCTTCATTC			
18	APOM 20	ATT AAA TTC GTA GTT TGA CAC ATC	62	CTT4	715
		ACTTGATCAGTTTTGGTAGTG			
19	APOM 21	AATGTACAAGAAGTTTTCCA	58	TCT4	281
		GGAACATATTCCAAGAAGAACTA			
20	APOM 23	AGCTAGTATCAATGCACAAT	47	CTT4	198
		AAGCTACATCATCAGAAGAA			
21	APOM 24	TTGCTGAAACTACTCAATCT	47	CTG4	126
		ATTCTTCTTCAGTATCAGCA			
22	APOM 25	TCCGGAGTATAATAAGTCAA	47	TAA5	278
		ACAATAATGATGTGTTGGT			
23	APOM 27	ACATTTTCCAACATTTAAGA	47	TCA5	191
		CTAGACCAATAACAGCCTTA			
24	APOM 28	TCAACCGATGGACAGT	47	GCT4	279
		CGTTAATTGTTTGTTTGAAT			
25	APOM 29	CATAGAGTATGCTGGAAAAT	47	TTCT4	199
		ATTCATGTTCTTGACTGTGT			
26	APOM 30	TCAACCGATGGACAGT	47	GCT4	279
		CGTTAATTGTTTGTTTGAAT			
27	APOM 31	CGAGTTATCTTTACTCGATG	47	TGA4	192
		TCACCAGTAGTAAGTGAAG			
28	APOM 34	GCGACTCCTCCCTATCTTCTTCAT	57	AC8	273
		TTCATCCCAAATCTATCAATTCACC			
29	APOM 36	AATAAGGGAGGTGCACAGACCGAT	57	TA6	241
		TCCGTGAGCTTCCTTGGACTGAAA			
30	APOM 37	TGGTTTAGGCTTTCCTGCCTTTCG	57	TG7	307

(Professor & Head, Department of Agril. Biotechnology, AAU, Anand)

AGRICULTURAL ENGINEERING AND AIT

1. A web based soil health card application: Decision support system for Agriculture development

Soil Health Card Portal (<http://shc.gujarat.gov.in>, <http://shc.aau.in>) developed by Anand Agricultural University Anand is recommended for agricultural scientists/ line department and decision makers for providing recommendation and suggestion for taluka action plan, villages action plan, crop planning and management, farming methods, fertilizer management, weather forecast, rain fall details etc.

(Director, IT, AAU, Anand)

2. Web user interface assisted live stock research station management information system

A web based LRS system (<http://LRS.AAU.IN>) is recommended for the management of LIVE STOCK data like herd management, service details, roll call details, milk production details, etc. and to generate different kinds of reports as per the needs.

(Director, IT, AAU, Anand)

ANIMAL PRODUCTION

1. Effect of Solid State Fermentation (SSF) biomass on digestibility and nutritional utilization in goats.

It is recommended to scientific community that supplementation of Solid State Fermentation Biomass (SSF) @ 4% in the Jowar hay-based TMR (75% roughage : 25% concentrate) significantly improves rumen total volatile fatty acids production by 11% and digestibility of dry matter, organic matter, ether extract, nitrogen free extract and neutral detergent fiber by 8-11% in Surti goats compared to TMR without SSF Biomass.

(Research Scientist, ANRS, Vety. College, AAU, Anand)

2. Supplementation of appropriate mineral mixture to anestrus and repeat breeder buffaloes in tribal areas of Vadodara and Panchmahal district.

It is recommended to scientific community that the anestrus and repeat breeder buffaloes respond favourably to supplementation of appropriate mineral mixture in ionic/organic form. But chelated mineral mixture (comprising of Zn in chelate form added extra @ 25% to ionic) resulted in better response with 25 & 34% and 27 & 42% lesser cost of rearing for correction of anestrus and repeat breeding in buffaloes in Panchmahal and Vadodara districts, respectively.

(Research Scientist, ANRS, Vety. College, AAU, Anand)

3. Development of area specific mineral mixture formulations for Ahmedabad district.

It is recommended to scientific community that based on the prioritization of limiting minerals in Ahmedabad district, the following area specific mineral mixture has been formulated which would make up the deficiency when fed @ 30g/head/day to dairy animals in addition to the current feeding practices.

Sr. No	Mineral element	Requirement (%)	Mineral salt	Quantity (kg)
1	Calcium	20.00	Dicalcium phosphate Calcite Powder	13.26
2	Phosphorus	12.01	DCP	66.72
3	Magnesium	4.61	Magnesium oxide	8.54
4	Sulphur	1.00	Sodium thiosulphate	2.56
5	Copper	0.10	Copper sulphate	0.40
6	Zinc	1.80	Zinc sulphate	5.46
7	Manganese	0.51	Manganese sulphate	1.64
8	Iron	0.40	Ferrous sulphate	1.33
9	Cobalt	0.01	Cobalt sulphate	0.06
10	Iodine	0.03	Potassium iodide	0.03
Total				100.00

(Research Scientist, ANRS, Vety. College, AAU, Anand)

ANIMAL HEALTH

1. Evaluation of immunomodulatory activity of *Prosopis juliflora* alkaloids in the treatment of bovine sub-clinical mastitis

The intramammary administration of 10 ml of 1% aqueous formulation of *Prosopis juliflora* alkaloids once daily for 5 consecutive days in sub-clinically affected mastitic quarter results in immunopotentiality, hence it is recommended to scientific community for use as a treatment regimen.

(Professor and Head, Department of Vet. Medicine, Vety. College, AAU, Anand)

2. (i) Augmenting fertility in infertile dairy cows and buffaloes using controlled breeding techniques under amul milk-shed area

(ii) Augmenting reproductive efficiency of infertile dairy animals using controlled breeding techniques in tribal areas

It is recommended to scientific community that the true anoestrus crossbred dairy cows and buffaloes having average body condition under field conditions can be treated by the field veterinarians, using estrus synchronization protocols, viz., (i) intra/vaginal insertion of progesterone releasing device (CIDR/PRID) for 7 days and Inj. PGF₂α 25 mg i/m at its removal followed by Inj. Busereline acetate (GnRH) 20 µg i/m on day 9, with fixed time double inseminations performed at 0 and 24 hrs later; and (ii) Ovsynch treatment protocol, comprising Inj. Busereline acetate (GnRH) 20 µg i/m on day 0, Inj. PGF₂α 25 mg i/m on day 7, second Inj. GnRH 10 µg i/m on day 9 and fixed time insemination 16-24 hrs later, to have more than 90 per cent induction of ovulatory estrus and conception rates of 40 to 50 per cent at induced estrus and of 70 to 80 per cent for overall three cycles post- treatment.

(Professor and Head, Department of ARGO, Vety. College, AAU, Anand)

3. (i) Augmenting fertility in infertile dairy cows and buffaloes using controlled breeding techniques under amul milk- shed area
(ii) Augmenting reproductive efficiency of infertile dairy animals using controlled breeding techniques in tribal areas

It is recommended to scientific community that under field conditions, the repeat breeding crossbred cows and buffaloes, having average body condition with a palpable mid-cycle CL, and without any palpable or visible genital abnormalities, can be treated/managed by the field veterinarians, by inducing more than 90 per cent ovulatory estrus using Inj. PGF₂α 25 mg i/m (from day 8 to 12), with conception rates of 40 to 50 per cent at induced estrus and of 70 to 80 per cent for overall three cycles post-treatment.

(Professor and Head, Department of ARGO, Vety. College, AAU, Anand)

4. (i) Augmenting fertility in infertile dairy cows and buffaloes using controlled breeding techniques under amul milk-shed area
(ii) Augmenting reproductive efficiency of infertile dairy animals using controlled breeding techniques in tribal areas

It is recommended to scientific community that under field conditions, the repeat breeding crossbred cows and buffaloes in standing estrus, having average body condition without any palpable or visible genital abnormalities, can be treated/managed by the field veterinarians, using Inj. Busereline acetate (GnRH) 20 µg i/m with AI using good quality frozen-thawed semen with an improvement of conception rate up to 30 to 40 per cent at first service.

(Professor and Head, Department of ARGO, Vety. College, AAU, Anand)

SOCIAL SCIENCE

1. Diversification of cropping pattern during recent decade in Gujarat state

- Decline in area of some food-grain crops (like bajra, jowar, and maize), some pulse crops (like pigeon pea, green gram and black gram) and oilseeds (like groundnut and sesamum) in recent decade is a serious concern and needs proper attention by the government.
- Cotton has emerged as dominant crop in Gujarat State during recent decade and therefore its marketing and export becomes more crucial. A suitable export policy is required for benefit of cotton growers.
- The increased area, production and productivity of horticultural crops have resulted into wide scope for its processing and export. Suitable policy measures are required to tap this new opportunity.
- Decline in diversification needs more attention towards other measures like crop insurance, value addition, minimum support price, future trading, contract farming, etc. for better risk management.

Recommended for Policy Implications

(Professor & Head, Department of Agril. Economics, BACA, AAU, Anand)