

Research Recommendations Released during 2024 by Mahatma Phule Krishi Vidyapeeth, Rahuri

Crop Improvement

1. *Rabi Sorghum* variety Phule Revati having higher grain yield is recommended for cultivation under irrigated condition in deep soils of Maharashtra state.

Natural Resource Management

Agronomy

2. The following regression equation based on weather parameters for forecasting (one week prior) whitefly occurrence in brinjal is recommended for Western Maharashtra.

$$\text{Equation: Brinjal Whitefly} = -26.313 + (1.042 \times T_{\max}) - (0.871 \times \text{WS}) + (0.04 \times \text{Epan}) + (0.348 \times \text{BSS})$$

Where,

Whitefly = Av. Number of whitefly/leaf/plant (in equation),
 T_{\max} = Maximum temperature (25.0-32.4 °C),
 WS = Wind velocity (0.8-4.0 Km/h),
 Epan = Pan evaporation (4.1-5.4 mm),
 BSS = Bright sunshine (3.3-9.3 hrs)

3. The following regression equation based on weather parameters for forecasting (one week prior) thrips occurrence on Chilli is recommended for Western Maharashtra.

$$\text{Equation: Chilli thrips} = -34.757 + (1.182 \times T_{\max}) - (1.255 \times T_{\min}) + (0.426 \times \text{RH-I}) + (0.12 \times \text{RH-II}) - (0.0159 \times \text{WS}) + (0.707 \times \text{BSS})$$

Where,

Thrips = Av. number of thrips/leaf/plant (in equation),
 T_{\max} = Maximum temperature (27.6-32.4 °C),
 T_{\min} = Minimum temperature (8.6-22.7 °C),
 RH-I = Relative humidity morning (56.0-81.6 %),
 RH-II = Relative humidity evening (28.0-62.4 %),
 WS = Wind speed (0.4-4.5 Km/h).
 BSS = Bright sunshine hours (3.5-9.5 hrs/day)

4. The post emergence application of Ethoxysulfuron 15% WDG @ 100 g per hectare in 500 L of water at 15-20 days after transplanting and one hand weeding at 45 days after transplanting is recommended for effective control of weeds and higher economical returns in transplanted paddy of Sub-montane Zone of Maharashtra.
5. Application 70% recommended dose of fertilizer (420:161:81 kg N, P₂O₅, K₂O ha⁻¹) through fertigation at weekly interval in 31 splits and farm yard manure 25 t ha⁻¹ and planting by settling is recommended to obtain higher two eye bud setts yield and net monetary returns with following fertigation schedule.

Fertigation schedule of drip irrigation for sugarcane seed production :

| Weeks | Quantity of Nutrients (kg ha ⁻¹) | | | No. of splits |
|----------|--|-------------------------------|------------------|---------------|
| | Plant cane | | | |
| | N | P ₂ O ₅ | K ₂ O | |
| 2 to 5 | 16 (4.00) | 6 (1.50) | 2 (0.50) | 4 |
| 6 to 11 | 76 (12.66) | 29 (4.83) | 14 (2.33) | 6 |
| 12 to 15 | 84 (21.00) | 32 (8.00) | 16 (4.00) | 4 |
| 16 to 21 | 101 (16.83) | 39 (6.50) | 19 (3.16) | 6 |
| 22 to 27 | 76 (12.66) | 29 (4.83) | 14 (2.33) | 6 |
| 28 to 32 | 67 (13.40) | 26 (5.20) | 16 (3.20) | 5 |
| Total | 420 | 161 | 81 | 31 |

6. Paired row planting of *Bt.* Cotton (60 – 120 x 90 cm) and two lines of green gram (2:2) or soybean (2:2) is recommended as intercrop for achieving higher seed cotton equivalent yield and maximum monetary returns in western Maharashtra.
7. Pearl millet + Cowpea (2:1) intercropping in shallow soil under scarcity zone of Western Maharashtra is recommended for getting higher yield and monetary returns.
8. In integrated farming systems model for ecological, nutritional and economic security, the small and marginal farmers are suggested to adopt the Soybean-Onion as a predominant existing cropping system, Soybean-Chickpea for soil health management, Maize + Green gram (1:1) - Groundnut for household nutritional security, Cowpea-*Rabi* Sorghum for livestock nutrition and for Income enhancement Cotton-Onion cropping systems are recommended under irrigated condition.
9. The Integrated Farming System (IFS) model developed for by Mahatma Phule Krishi Vidyapeeth for 1.0 ha. area to small and marginal farmers under irrigated condition comprises of crops /cropping systems, forage crops, horticulture crops (mixed fruits), livestock component including dairy, goatery, poultry and vermicompost unit is recommended for achieving economic viability, sustainable resource management in system with special reference to soil, water, nutrients, energy and to reduce green house gas emission and also attracting rural youth in agriculture.

The details of integrated farming system (IFS) model are

| Farming System Components | Area (ha.) / Numbers | Area (ha) / Numbers | Per cent Area |
|---|--|--|---------------|
| Crops/Cropping systems (60%) | CS ₁ : Maize-Chickpea-Vegetable | 0.15 ha | 15% |
| | CS ₂ : Soybean-Onion-Sweet corn | 0.15 ha | 15% |
| | CS ₃ : Cotton-Wheat- Sunhemp | 0.15 ha | 15% |
| | CS ₄ : Sugarcane | 0.15 ha | 15% |
| Forage Crops (15%) | Lucerne | 0.10 ha | 10% |
| | Hybrid Napier | 0.05 ha | 5% |
| Horticulture Crops (Mixed Fruits) (20%) | Mango + Pomegranate + Custard apple + Drumstick + Marigold | 0.20 ha. | 20% |
| Livestock (3%) | | | |
| Dairy | Cross Breed Cow | 02 Nos. | 3% |
| Poultry | Breed: RIR/Kaveri | 500 birds lot ⁻¹ 2000 birds yr ⁻¹ | |
| Goat | Breed: Sangamneri | 10 Does + 1 Buck | |
| Vermicompost Unit (2%) | Vermicompost/Vermiwash/ Vermiculture | 0.02ha | 2% |
| Boundary plantation | Papaya, Drumstick, Coconut, Neem tree , Karanj | | |
| Total | | 1.0 ha. | 100 % |

10. Sweet corn (*kharif*) - Rajmah (green pods) (*rabi*) -Okra (summer) or Sweet corn (*kharif*) - Onion (*rabi*) - Cucumber (summer) annual cropping sequences with 100 % recommended dose of water soluble fertilizer through fertigation are recommended for higher cropping system yield and profitability under irrigated condition in Plain zone of Western Maharashtra.

Crop wise recommended water soluble Fertilizer dose with Fertigation schedule

| Crop | FYM (t ha ⁻¹) | Fertilizer Doses (Kg ha ⁻¹) | | | No. of weekly equal splits of fertilizer dose after sowing/ planting |
|------------|------------------------------|---|-------------------------------|------------------|--|
| | | N | P ₂ O ₅ | K ₂ O | |
| Sweet corn | 10 | 120 (13.33) | 60 (6.66) | 40 (5) | 09 |
| Rajmah | 5 | 60 (7.5) | 80 (10) | 0 | 08 |
| Okra | 20 | 100 (10) | 50 (5) | 50 (5) | 10 |
| Onion | 15 | 100 (10) | 50 (5) | 50 (5) | 10 |
| Cucumber | 20 | 100 (10) | 50 (5) | 50 (5) | 10 |

Note: Figures in brackets indicates per split quantity

11. Intercropping of leafy vegetables *viz.* Fenugreek or Spinach or Dill or Safflower in Sweet corn with 1:4 ratio (Sweet corn at 75 cm + 4 rows of leafy vegetables intercrop with at 10 cm each) is recommended for peri-urban area in Plane zone of Western Maharashtra during *rabi* season for higher total crop system production and remuneration.
12. Sowing of Phule Samadhan variety of wheat upto 51st MW (17th to 23rd December) is recommended for obtaining higher grain yield and monetary returns under late sown condition in deep black soils of plain zone of Maharashtra.
13. The Pre- emergence spraying of Diclosulam 84 % WDG @ 30 g per hectare in 500 L of water followed by one hand weeding at 25-30 DAS is recommended for effective weed control and maximizing the yield with economic returns in *kharif* groundnut of assured rainfall zone of north Maharashtra.
14. Agri-horti system with plantation of Mango (10 m x 10 m) + Custard apple (5 m x 5 m) and in between alley first seven years cultivation of intercrops of soybean in *kharif* and chickpea in *rabi* in irrigated area of Western Maharashtra in deep soil is recommended for obtaining sustainable yield, monetary returns and improvement in soil health.
15. Application of GRDF (FYM 5 t ha⁻¹ and 15:30 N:P₂O₅ kg ha⁻¹) at the time of sowing and foliar spray of DAP 2 per cent at 35 and 45 days after sowing to horsegram in shallow soils of Scarcity Zone of Western Maharashtra is recommended for higher grain yield and monetary returns.

Soil Science

16. Application of nitrogen, phosphorus and potassium as per IPNS based fertilizers prescription equations for achieving yield targets of 300-350 q ha⁻¹ in *rabi* Onion, with higher monetary returns and maintaining the soil fertility is recommended for Western Maharashtra in Inceptisols.

A) Without Vermicompost (VC)

$$FN = (0.83 \times T) - (0.65 \times SN)$$

$$FP_2O_5 = (0.41 \times T) - (3.21 \times SP)$$

$$FK_2O = (0.45 \times T) - (0.18 \times SK)$$

B) With Vermicompost (5 t ha⁻¹)

$$FN = (0.65 \times T) - (0.51 \times SN) - (5.05 \times VC)$$

$$FP_2O_5 = (0.39 \times T) - (3.06 \times SP) - (5.22 \times VC)$$

$$FK_2O = (0.38 \times T) - (0.15 \times SK) - (4.04 \times VC)$$

C) With Vermicompost (5 t ha⁻¹) along with biofertilizer (each 500 ml ha⁻¹)

$$FN = (0.63 \times T) - (0.49 \times SN) - (6.57 \times VC)$$

$$FP_2O_5 = (0.27 \times T) - (2.13 \times SP) - (5.00 \times VC)$$

$$FK_2O = (0.36 \times T) - (0.15 \times SK) - (5.49 \times VC)$$

Where, FN, FP₂O₅ and FK₂O are the fertilizers nutrients added in kg ha⁻¹, T is yield target of Onion (q ha⁻¹) and SN, SP and SK are soil available nutrients in kg ha⁻¹

17. Application of 80% inorganic fertilizers as per STCR yield target (150 t ha⁻¹) equation to *suru* Sugarcane and *ratoon* yield target (125 t ha⁻¹) through fertigation is recommended for economically beneficial and higher cane and CCS yield of sugarcane.

STCR Yield target equation with FYM (20 t ha⁻¹) for *suru* Sugarcane

$$FN = (6.60 \times T) - (2.30 \times SN) - (1.69 \times FYM)$$

$$FP_2O_5 = (2.10 \times T) - (8.00 \times SP) - (0.75 \times FYM)$$

$$FK_2O = (2.60 \times T) - (0.38 \times SK) - (1.26 \times FYM)$$

STCR Yield target equation for *ratoon* Sugarcane

$$FN = (4.47 \times T) - (1.08 \times SN)$$

$$FP_2O_5 = (1.56 \times T) - (2.32 \times SP)$$

$$FK_2O = (3.37 \times T) - (0.64 \times SK)$$

Where, FN, FP₂O₅ and FK₂O are the fertilizers nutrients added in kg ha⁻¹, T is yield target of sugarcane (t ha⁻¹) and SN, SP and SK are soil available nutrients in kg ha⁻¹

Fertigation schedule for *suru* sugarcane

| Weeks after planting | No. of splits | Nutrients (%) | | |
|----------------------|---------------|---------------|-------------------------------|------------------|
| | | N | P ₂ O ₅ | K ₂ O |
| 1 to 4 weeks | 4 | 15 | 10 | 10 |
| 5 to 9 weeks | 5 | 35 | 35 | 15 |
| 10 to 20 weeks | 11 | 50 | 55 | 35 |
| 21 to 26 weeks | 6 | -- | -- | 40 |

18. Split application of general recommended dose of fertilizers (300:200:300 N:P₂O₅:K₂O kg ha⁻¹ + FYM 30 t ha⁻¹) as 60:40:60 N:P₂O₅:K₂O kg ha⁻¹ + FYM 30 t ha⁻¹ at planting and 30:20:30 N:P₂O₅:K₂O kg ha⁻¹ each at one month interval up to 8 months + soil application of Ferrous sulphate @ 20 kg ha⁻¹ + Zinc sulphate @ 10 kg ha⁻¹ (incubated for 15 days 1:10 proportion in FYM before application in soil) to tuberose is recommended for higher yield, quality, nutrient uptake, net monetary returns and maintaining soil fertility.
19. Seed treatment of consortium of phosphorus solubilizing bacteria (*Bacillus subtilis*, *Pseudomonas fluorescens* and *Bacillus megaterium*) @ 10 g per kg seed followed by application of 75% recommended dose of phosphorus (56 kg P₂O₅ ha⁻¹) 100% recommended dose of nitrogen and potassium (50:45 N:K₂O kg ha⁻¹) + FYM 10 t ha⁻¹ is recommended for higher grain yield and monetary returns of soybean for Sub-montane Zone of Maharashtra.
20. Application of bentonite sulphur @ 20 kg ha⁻¹ along with general recommended dose of fertilizer (50:75:45 N:P₂O₅:K₂O kg + FYM 10 t ha⁻¹) at the time of sowing to soybean is recommended for higher yield, better quality, higher monetary returns and for maintaining soil fertility in sulphur deficient medium deep black soils of Western Maharashtra.
21. Foliar application of Phule Liquid Micro Grade II @ 1.5 % (15 ml L⁻¹) at 60 and 90 days after planting with recommended dose of fertilizer to preseasonal sugarcane (340:170:170 N:P₂O₅:K₂O kg ha⁻¹) and ratoon (250:115:115 N:P₂O₅:K₂O kg ha⁻¹) along with 25 t ha⁻¹ FYM for plant cane and recommended trash management practice to ratoon is recommended for economically beneficial and higher cane and CCS yield of sugarcane.
22. Two sprays with 2% (20 g L⁻¹) sulphate of potash, first spray after removal of male bud and second spray 15 days after first spray on banana bunch along with recommended dose of

fertilizer (150:60:150 g N:P₂O₅:K₂O + FYM 10 kg per plant) is recommended for improving quality of banana, higher yield and net montary returns.

23. Application of recommended dose of fertilizer (300:140:140 N:P₂O₅:K₂O kg ha⁻¹) along with FYM 20 t ha⁻¹ and 25 kg ha⁻¹ micronutrient grade I or 25 kg ha⁻¹ ferrous sulphate and 20 kg ha⁻¹ zinc sulphate (incubated for 15 days 1:10 proportion in FYM before application in soil) and drenching of phosphorous solubilizing bacteria @ 2.5 L ha⁻¹ and potash mobilizing bacteria @ 2.5 L ha⁻¹ in suru season (Sugarcane variety Co 86032) for higher cane, CCS yield and monetary returns is recommended as per the following schedule for calcareous soils of Western Maharashtra.

Split application of fertilizer nutrients

| S N | Fertilizer added (kg ha ⁻¹) | At planting | | 45 days after planting | | 90 days after planting | | 120 days after planting | | Total | |
|--------|---|----------------------|----------------------|------------------------|---------------|------------------------|---------------|-------------------------|---------------|----------------------|----------------------|
| | | Co-86032 | Other variety | Co-86032 | Other variety | Co-86032 | Other variety | Co-86032 | Other variety | Co-86032 | Other variety |
| 1 | 62% N-Urea | 7 | 30.59 | 260 | 122.38 | 65 | 30.59 | 71 | 74.10 | 403 | |
| 2 | 20% N-Ammonium sulphate | - | - | - | - | - | - | 250 | 190 | 250 | - |
| 3 | 100% P ₂ O ₅ -Diamonium Phosphate | 150 | 125 | - | - | - | - | 150 | 125 | 300 | - |
| 4 | 20% K ₂ O-Sulphate of potash | 29 | 23 | - | - | - | - | 29 | 23 | 58 | - |
| 5 | 80% K ₂ O-Muriate of potash | 93 | 77 | - | - | - | - | 93 | - | 186 | - |
| 6 | Micronutrient grade I or Ferrous sulphate and Zinc sulphate | 25 or 25 50 | 25 or 25 50 | - | - | - | - | - | - | 25 or 25 50 | 25 or 25 50 |
| 7 | Phosphorus solubilizing bacteria-Drenching | 2.5 lit | 2.5 lit | - | - | - | - | - | - | 2.5 lit | 2.5 lit |
| 8 | Potash mobilizing bacteria | 2.5 lit | - | - | - | - | - | - | - | 2.5 lit | 2.5 lit |

Note: RDF for Co-86032 300:140:140 kg ha⁻¹ N:P₂O₅:K₂O

RDF for other varieties 250:115:115 kg ha⁻¹ N:P₂O₅:K₂O

24. Application of fertilizer dose (144:120:90 N:P₂O₅:K₂O kg ha⁻¹) as per following fertigation schedule for strawberry in 19 splits at an interval of 10 days along with FYM 15 t ha⁻¹ at the time of planting is recommended for higher yield and monetary returns of strawberry.

Table: Fertigation Schedule for strawberry

| Sr. No. | Crop Stage | Days After Planting | Splits | N | P ₂ O ₅ | K ₂ O |
|---------|------------------------|---------------------|--------|------------------------|-------------------------------|------------------|
| | | | | (kg ha ⁻¹) | | |
| 1 | Vegetative | Upto 30 | 4 | 44 | 24 | 18 |
| 2 | Flowering | 40-60 | 3 | 36 | 42 | 18 |
| 3 | Flowering and Fruiting | 70-90 | 3 | 30 | 30 | 27 |
| 4 | Flowering and Fruiting | 100-180 | 9 | 36 | 27 | 27 |

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25. Application of 80 % recommended dose (80:40:40, N: P₂O₅: K₂O kg ha⁻¹) of water soluble fertilizers through fertigation in 18 splits at weekly interval as per following schedule is recommended for higher yield, efficient use of water and nutrient in summer bottle gourd cultivation in medium deep soils of Western Maharashtra.

Fertilizer Schedule

Nutrients applied in 18 splits at weekly interval to summer bottler gourd

| Days after transplanting | Weeks/ Splits | Nitrogen (N) kg ha ⁻¹ | Phosphorus (P ₂ O ₅) kg ha ⁻¹ | Potassium (K ₂ O) kg ha ⁻¹ |
|--------------------------|---------------|----------------------------------|---|--|
| 1-35 | 5 | 20 (4.00) | 12 (2.40) | 06 (1.20) |
| 36-70 | 5 | 28 (5.60) | 14 (2.80) | 14 (2.80) |
| 71-105 | 5 | 24 (4.80) | 10 (2.00) | 12 (2.40) |
| 106-126 | 3 | 08 (2.67) | 04 (1.33) | 08 (2.67) |
| Total | 18 | 80 | 40 | 40 |

Note : Figures in brackets indicates quantity kg per split

26. Application of silver black polyethylene mulch with irrigation water at 80% of crop evapotranspiration through drip irrigation system is recommended to obtain higher yield, efficient water use and economic returns of *rabi* potato cultivation in light to medium soils for Western Maharashtra.
27. Application of irrigation through subsurface drip at 80% ET_c and settling treatment of *acetobacter* and PSB with 75 percent recommended dose of fertilizers to preseasonal sugarcane (255:128:128 N, P₂O₅, K₂O kg ha⁻¹, FYM 25 t ha⁻¹) and its 4 successive ratoons (188:86:86 N, P₂O₅, K₂O kg ha⁻¹) with trash management practice as per following schedule in 44 splits at weekly interval is recommended for higher cane, sugar yield and net monetary returns.

Fertigation schedule through subsurface drip irrigation for preseasonal sugarcane and its ratoon

| Weeks after planting | Weeks/ splits | Quantity of nutrients (kg ha ⁻¹) | | | | | |
|----------------------|---------------|--|-------------------------------|------------------|------------|-------------------------------|------------------|
| | | Plant cane | | | Ratoon | | |
| | | N | P ₂ O ₅ | K ₂ O | N | P ₂ O ₅ | K ₂ O |
| 2 to 5 | 4 | 10 (2.50) | 5 (1.25) | 3 (0.75) | 7 (1.75) | 4 (1.00) | 2 (0.50) |
| 6 to 11 | 6 | 46 (7.67) | 23 (3.83) | 8 (1.33) | 34 (5.67) | 15 (2.50) | 5 (0.83) |
| 12 to 15 | 4 | 51 (12.75) | 26 (6.50) | 5 (1.25) | 38 (9.50) | 17 (4.25) | 4 (1.00) |
| 16 to 21 | 6 | 61 (10.17) | 31 (5.17) | 15 (2.50) | 45 (7.50) | 21 (3.50) | 10 (1.67) |
| 22 to 27 | 6 | 46 (7.67) | 23 (3.83) | 15 (2.50) | 34 (5.67) | 15 (2.50) | 10 (1.67) |
| 28 to 31 | 4 | 20 (5.00) | 10 (2.50) | 15 (3.75) | 15 (3.75) | 7 (1.75) | 10 (2.50) |
| 32 to 37 | 6 | 20 (3.33) | 10 (1.67) | 31 (5.17) | 15 (2.50) | 7 (1.17) | 21 (3.50) |
| 38 to 41 | 4 | - | - | 21 (5.25) | - | - | 14 (3.50) |
| 42 to 45 | 4 | - | - | 15 (3.75) | - | - | 10 (2.50) |
| Total | 44 | 255 | 128 | 128 | 188 | 86 | 86 |

Note : Figures in brackets indicates quantity kg per split

Horticulture

28. Grafting of Muskmelon on sponge gourd rootstock is recommended for higher graft success, yield, net monetary returns with less incidence of fusarium wilt.
29. Grafting of Watermelon on sponge gourd rootstock is recommended for higher graft success, yield, net monetary returns with less incidence of fusarium wilt.
30. Grafting of Phule Raja tomato hybrid on tomato rootstock *Solanum pimpinellifolium* L. is recommended for higher graft success, better growth, maximum crop duration, net monetary returns with less incidence of fusarium wilt.
31. Ultra high density planting in mango (cv. Kesar) along with following package of practices is recommended for higher yield in Western Maharashtra.
 - Planting of mango at a distance of 3 x 2 m. (1666 plants/ha)
 - Application of Paclobutrazol @ 0.5 ml (a.i.) per feet of plant canopy in the month of August (3rd year onward)
 - Spray of Water Soluble KNO₃(13:00:45)@ 20 g/l of water after 1 month of flowering.
32. Use of tree cover with 60 GSM UV stabilized white polymer in pomegranate crop is recommended for protection of fruit from sunburn, quality improvement and yield of marketable fruits with reduction of pest disease incidence.
33. In vertical farming, planting of strawberry in staking up pots material is recommended for obtaining higher yield and monetary returns.
34. The transplanting of Basil in the month of July with spacing 60 x 45 cm is recommended to obtain maximum fresh herbage, oil yield and monetary returns in Western Maharashtra.

Animal Husbandary and Dairy Science

35. Use of 17.00 % blend of jamun pulp and jamun seed powder (7:1), 0.20% aspartame and 10 % water to the weight of toned milk dahi is recommended to prepare low calorie jamun lassi.
36. It is recommended to add 20 % mango or 25% banana or 15 % Jackfruit or 25 % sapota or 25 % custard apple pulp to 50 % condensed milk from indigenous cow along with 5 % sugar to prepare instant ice cream.
37. It is recommended to add 10 % betel vine extract with 9% sugar or 30% guava pulp with 7% sugar to 50 % condensed milk from indigenous cow to prepare instant ice cream.
38. It is recommended to add 30 % tender coconut pulp with 7.5% sugar to 50 % condensed milk from indigenous cow to prepare instant ice cream.

Basic Sciences, Food Science and Biotechnology

39. Application of endophytic bacteria Gluconacetobacter @ 5 ml L⁻¹ (1 x 10⁸ c.f.u.) at the time of planting by dipping the setts for 15 min. and subsequent spraying at 30, 45 and 60 days after planting is recommended based on the plant physiological and biochemical parameters for amelioration of salinity stress in sugarcane.
40. Molecular markers DRR-08, DRR-13 and DRR-18 are recommended for distinguishing different isolates of the fungus causing dry root rot of chickpea.
41. The sorghum flour of cultivar PhuleYashomati is recommended for the preparation of nutritious sorghum muffins up to six days storage at the ambient temperature (30 ± 40C) and 15 days at refrigerated temperature (5 ± 20C) is as follows,
 1. Use of sorghum flour 700 g, wheat flour 300 g, sugar 500 g, vanaspati ghee 450 g, baking powder 25 g with 2 eggs.

2. Use of sorghum flour 700 g, refined wheat flour (Maida) 300 g, sugar 500g, Vanaspati ghee 450 g, Baking powder 25 g with 2 eggs.
42. The good quality sugar free biscuits and cookies prepared from Stevia powder and Maida wrapped into HDPE packaging material is recommended to stored up to 90 days at room temperature ($32 \pm 2^{\circ}\text{C}$) as follows,
 1. For sugarless biscuits and cookies use of 1000g refined wheat flour (Maida), 25g stevia powder, 200 sugar, 500 g Vanaspati ghee, 5 g ammonium bicarbonate and 5 g sodium bicarbonate.
 2. For sugar free biscuits and cookies use of 1000g refined wheat flour (Maida), 150 g stevia powder, 500 g Vanaspati ghee, 5 g ammonium bicarbonate and 5 g sodium bicarbonate.
43. It is recommended to prepare good quality nutritious sorghum starch soup from 50 g sorghum starch, vegetables powder 10 g (2.5 g carrot, 2.0 g tomato, 1.5 g curry leaves, 1.5 g coriander leaves, 2.5 g green pea powder), spices powder 10 g (2.0 g ginger, 2.0 g garlic, 3.0 g onion, 1.5 g salt, 1.0 g turmeric and 0.5 g black pepper powder) and boiling in 1000 mL water.

Plant protection

Entomology

44. Drenching of entomopathogenic nematode, *Heterorhabditis indica* or *Heterorhabditis bacteriophora* (1×10^5 IJs/ml) WP formulation @ 12.5 kg ha^{-1} in 500 lit. of water at earthing up of sugarcane, followed by second drenching after two months interval is recommended for the control of sugarcane white grub.
45. Installation of domesticated bee, *Apis cerana indica* hives @ 5/ ha at 10 per cent flowering is recommended for better seed quality and higher yield in onion seed production plots.
46. Installation of blue colour light trap @ 1 ha^{-1} in the middle of crop, 2 feet above the crop canopy at square formation and flowering stage is recommended for the monitoring of cotton pink bollworm and to minimize the population of male and female moths.

Plant Pathology and Microbiology

47. Spraying of combi-fungicide tebuconazole 50% + trifloxystrobin 25% WG @ 6g per 10 L water on appearance of disease followed by second spray 15 days thereafter is recommended for effective management of stem rust disease, obtaining higher grain yield and monetary returns in wheat crop.
48. Two sprays of combi-fungicide azoxystrobin 18.2% w/w + cyproconazole 7.3% w/w SC @ 10ml per 10L water or azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC @ 10ml per 10L water first on appearance of disease and second after 15 days are recommended for effective management of Turcicum leaf blight disease, higher yield and monetary returns in maize.
49. Two sprays of tebuconazole 25.9 % EC @ 625 ml/ha by drone immediately after appearance of the disease at an interval of 10 days are recommended for effective management of pod blight of soybean and maximum monetary returns.
Drone parameters : Height above canopy : 2m; Drone flying speed : 5m/s; droplet size : 150 micron; Nozzle : High pressure flat spray nozzle; Water volume 25 lit/ha).
50. Three sequential sprays viz., mancozeb 75% WP (25g/ 10 L of water) followed by cymoxanil 8% + mancozeb 64% WP (30g/ 10 L of water) followed by mancozeb 75% WP

(25g/10 L of water) at an interval of 10 days on the appearance of disease is recommended for the management of late blight disease, higher yield and net monetary returns from potato crop.

51. Two sprays of tebuconazole 25.9% EC @ 12.5 ml/ 10 L of water or combi-fungicide tebuconazole 10 % + sulphur 65% WG @ 25 g/ 10 L of water at an interval of 10 days after the appearance of disease is recommended for the effective management of Leaf Spot and Pod blight disease in soybean seed production, higher germination, seedling vigour, yield and reduction in seed mycoflora.
52. One of the following applications is recommended for getting higher cane and CCS yield and saving of 50% nitrogen (125 kg/ha), 25% phosphorus (29 kg/ha) and 25% potassium (29 kg/ha) in *suru* sugarcane:
 - Before planting, sugarcane setts should be dipped for 30 minutes in a solution prepared by mixing 1 lit. each of liquid Acetobacter, phosphate solubilizing bacteria and potassium mobilizing bacteria in 100 lit. of water/ hectare.

OR

- In sugarcane planting by seedling method, spray the 30 days old seedlings before transplanting with liquid Acetobacter @ 1 lit. in 50 lit. of water per hectare and drench liquid phosphate solubilizing bacteria and potassium mobilizing bacteria @ 1 lit. each mixed in 100 lit. of water at 60 days after transplanting.
 - For the ratoon crop of sugarcane planted by either of the above methods, spray 1 lit. of liquid Acetobacter in 100 lit. of water/ha and drench liquid phosphate solubilizing bacteria and potassium mobilizing bacteria @ 1 lit. each mixed in 100 lit. of water at 60 days after ratooning.
53. Sugarcane sett treatment at planting and drenching at 30, 60, 90 & 120 days after planting with 3-7 days old microbial slurry (water - 1lit, *Desi* cowdung-50g, organic Jaggary-10 g, home made chana flour - 5g, butter milk -10 ml, biofertilizer applied field soil - 5g and wooden cold pressed groundnut oil-1ml) @ 500 lit. ha⁻¹ with 8 days old 5.0 lit cow urine to *Suru* sugarcane with recommended dose of fertilizer (250:115:115 kg N:P:K ha⁻¹ and FYM 25 t ha⁻¹) is recommended in medium deep black soils for higher cane & sugar yield and improving soil fertility.

Agril. Engineering

54. MPKV developed improved farm implements package is recommended to save inputs, time, cost of operation, reduce drudgery and increasing yield for dryland agriculture.
The improved package of Implements developed by MPKV for dryland agriculture includes
 1. Tractor operated Phule automatic reversible MB plough
 2. Tractor operated Phule Mole Plough
 3. Tractor Operated Phule Check Basin Former
 4. Tractor Operated Phule Basin Lister
 5. Tractor Operated Phule Multicrop Ridger-Planter
 6. Small Hp (Less Than 25 Hp) Tractor Operated Phule Multicrop Planter
 7. Power tiller drawn Phule multicrop planter
 8. Power operated Phule Chaff cutter
 9. Bullock drawn multipurpose Phule Sheti Yantra (03 tyne)
 10. Manually operated drumstick harvester
 11. Manually operated sorghum uprooter

55. Wind operated bird scaring unit is recommended for protection of sorgum earheads from birds upto distance of 25 m.

Agril. Process Engineering

56. The irradiated chitosan (1%) coated custard apple fruits packed in LDPE bag (50 micron) with 1-MCP (810 ppb) is recommended for 16 days storage at 15°C temperature.

Soil and Water Conservation Engineering

57. It is recommended to use the spectral band ratio '(Green × Red Edge 1)/Red' for assessing and monitoring the spatio-temporal variation of suspended sediment concentration in large reservoirs having low suspended sediment concentration.
58. The implementation of compartmental bunding in agricultural land and deep continuous contour trenches in forest, horticultural (Mango) and barren land is recommended to increase carbon sequestration in soil.
59. Preparation of semi-circular basins across the slope for rainfed custard apple during kharif season (second fortnight of June) and the vertical mulching of crop residue at 1 m upstream of plant, across the slope in the trench of 30 cm width, 45 cm depth and 1.5 m length is recommended for soil moisture conservation, higher yield and improvement in soil fertility in scarcity zone of western Maharashtra.
60. Opening of ridges and furrows one month before sowing and transplanting of pigeonpea seedlings on 180 cm x 30 cm (transplanting of seedlings on alternate row and dibbling of blackgram on middle row) along with the application of 37.5 kg K₂O ha⁻¹ and general recommended dose of fertilizer (25:50 N:P₂O₅ kg ha⁻¹ + 2 t ha⁻¹ FYM) at the time of sowing grown on deep black soil. Considering the uncertainty of onset of rainfall in scarcity zone of Maharashtra is recommended for obtaining higher yield, monetary returns, to maintain nutrient status and retain moisture in soil.
61. The following scale of Impact Index developed using weightages decided by Analytical Hierarchy Process is recommended for ranking the watershed development programmes.

| | | | | | |
|--------------|----------------|--------------|--------------|--------------|-----------|
| Impact Index | < 0.20 | 0.21 to 0.40 | 0.41 to 0.60 | 0.61 to 0.80 | > 0.80 |
| Grade | Unsatisfactory | Poor | Moderate | Good | Very good |

Digital Agriculture

62. The generic mobile application, "Phule Crop Management", developed by Mahatma Phule Krishi Vidyapeeth is recommended for creating the crop-specific mobile application for dissemination of crop production and value addition technologies; and management practices.
63. "Phule-Tomato", "Phule-Onion", "Phule-Potato", "Phule-Watermelon" and "Phule-Pumpkin" mobile applications developed by Mahatma Phule Krishi Vidyapeeth are recommended for the dissemination of crop production and value addition technologies; and management practices for tomato, onion, potato, watermelon and pumpkin, respectively.
64. The generic platform, "Phule-VLCCP", developed by Mahatma Phule Krishi Vidyapeeth is recommended for creating the mobile and web-based applications for a village or village cluster level crop-contingent planning.

65. Different types of IoT enabled smart weather stations, “Phule Smart Weather Stations (PSWS)” developed by Mahatma Phule Krishi Vidyapeeth are recommended for real-time recording, storing, displaying and retrieving of specified weather parameters and deriving reference evapotranspiration and sunshine hours as below;
 - PSWS-Type-1: for rainfall
 - PSWS-Type-2: for temperature and humidity
 - PSWS-Type-3: for temperature, humidity and rainfall
 - PSWS-Type-4: for temperature, humidity, rainfall, wind speed and wind direction
 - PSWS-Type-5: for temperature, humidity, rainfall, wind speed, wind direction and solar radiation
 - PSWS-Type-6: for temperature, humidity, rainfall, wind speed, wind direction, solar radiation, noise pollution and air quality index
66. The IoT enabled portable mini weather stations developed by Mahatma Phule Krishi Vidyapeeth are recommended for real-time recording, storing, displaying and retrieving of specified weather parameters as below;
 - Mini-WS- Type-0a: for temperature and humidity
 - Mini-WS- Type-0b: for temperature, humidity and rainfall
67. “Phule Rainfall Erosivity Estimator” mobile application developed by Mahatma Phule Krishi Vidyapeeth is recommended for estimating the real time rainfall erosivity factor based on the rainfall data obtained from tipping bucket type rain gauge.
68. IoT enabled “Phule Trench Water Level Recorder (PTWLR)” along with mobile application developed by Mahatma Phule Krishi Vidyapeeth is recommended for recording real time water level in trenches.
69. ‘Phule Robo’ developed by Mahatma Phule Krishi Vidyapeeth is recommended for spraying in fruit orchards having row spacing 2-4 m and plant height less than 3 m.
70. It is recommended to operate drone at a flight height of 1.5 m above the crop canopy with forward speed of 5 m/s and swath of 4 m for higher spray uniformity and minimizing spray drift while spraying sugarcane with drone (battery operated hexacopter / quadcopter and engine operated quadcopter).
71. Capacitance based 30, 60 and 90 cm depth “Soil moisture sensors” developed by Mahatma Phule Krishi Vidyapeeth are recommended for real time soil moisture monitoring in different soil types required for irrigation scheduling.
72. Temperature-Humidity Index based web and mobile applications, “Phule Amrutkal”, developed by Mahatma Phule Krishi Vidyapeeth is recommended for predicting the heat stress in animals in real time and subsequently providing the advisory services for livestock management.
73. IoT enabled “Phule Smart Amrutkal” developed by Mahatma Phule Krishi Vidyapeeth based on Temperature- Humidity index is recommended for managing heat stress in animal by operating environmental control system in animal shed.

74. The crop coefficients given in the following table are recommended for the estimation of water requirement of *rabi* Gram crop.

| Week Since Sowing | Kc Value | Week Since Sowing | Kc Value |
|-------------------|----------|-------------------|----------|
| 1 | 0.44 | 9 | 1.20 |
| 2 | 0.46 | 10 | 1.25 |
| 3 | 0.57 | 11 | 1.18 |
| 4 | 0.71 | 12 | 1.07 |
| 5 | 0.85 | 13 | 0.92 |
| 6 | 0.91 | 14 | 0.71 |
| 7 | 1.02 | 15 | 0.46 |
| 8 | 1.06 | 16 | 0.29 |

Alternatively, following equation is recommended

$$Kc_t = 5.5518(t/T)^4 - 15.654(t/T)^3 + 10.56(t/T)^2 - 0.6572(t/T) + 0.4485$$

Kc_t = Crop Coefficient on t^{th} day

t = Number of days since sowing

T = Total Crop Period

75. FDR-Capacitance based 30, 60 and 90 cm depth “Soil moisture sensors” developed by Mahatma Phule Krishi Vidyapeeth are recommended for real time soil moisture monitoring in different soil types required for irrigation scheduling.
76. “Phule Spray Indicator” mobile application developed by Mahatma Phule Krishi Vidyapeeth is recommended for suggesting suitable conditions for crop spraying at particular location in real time.
77. ‘Phule Generic Dashboard’ developed by Mahatma Phule Krishi Vidyapeeth using Geographical Information System (GIS) and Remote Sensing (RS) technologies is recommended for benchmarking of Irrigation Projects.

Agricultural Economics

78. The millet export from India is diversified with less international trade risk and has competitive advantage. The most stable and reliable markets for Indian millets are

- UK and Nepal for Indian Sorghum with 84.09 per cent and 77.08 per cent export retention,
- UAE, Saudi Arab and Yemen for Indian Bajara with 87.36%, 82.93%, and 66.19% export retention and
- Nepal for Ragi with 89.07% export retention.

Therefore, it is recommended to increase the export of these millets to above mentioned countries.

79. In Maharashtra, the total cost of sorghum, and ragi cultivation has increased with the annual rate of 8 to 10 per cent due to increase in cost incurred on labour, with 7 to 9 per cent per annum growth in gross returns from millet cultivation. With 10 per cent increase in yield, cost of production of sorghum and ragi can be reduced by 15 per cent & 8 per cent.

Therefore, it is recommended to reduce labour inputs and use university recommended dose of seed and fertilizer.

80. It is recommended that farmers may adopt following suitable farming system by considering the available land holding and resources for more income as compare to crops only system.

| Farming system | Benefit Cost Ratio | Incremental Benefit Cost Ratio | Additional returns (times) |
|----------------------------------|--------------------|--------------------------------|----------------------------|
| I. Crops only | 1.66 | -- | -- |
| II. Crops+ Goat | 1.98 | 2.24 | 2.69 |
| III. Crops + Dairy | 2.04 | 2.27 | 3.35 |
| IV. Crops + Dairy + Horticulture | 2.15 | 2.40 | 3.84 |

Agril. Extension Edication

81. "MPKV Idols" is a novel concept which comprises of depicting the innovative technologies adopted by progressive farmers. The transfer of these technologies among other farmers is done through success stories and use of mass media. It assists to motivate the rural youths, agricultural graduates and farmers to adopt these innovative technologies on their farms. Therefore, it is recommended that the other Agril. Universities and Institutes should also adopt this concept for effective transfer of agricultural technologies.

82. From the study of "ICAR Farmer FIRST (F- Farm, I- Innovations, R- Resources, S- Science and T- Technology) Programme", it is revealed that the economic impact of the Phule Sangam variety of soybean has resulted in 45.45 % increase in production and economic returns to the participant farmers over the farmers practice due to adoption of demonstrated technology package. Therefore, it is recommended that the soybean growers should adopt the demonstrated technology package for more production and economic returns from soybean crop.

The study on yield gap assessment in soybean crop on farmers field revealed that seed treatment of biofertilizer, moisture stress management, use of certified seed, foliar application of chemical fertilizers and Broad Bed Furrow (BBF) method of sowing are the critical factors that significantly contribute towards higher per hectare yield in Soybean. Therefore, it is recommended that farmers should follow above practices scrupulously so as to reduce their farm level yield gap in soybean crop.

83. It is observed that majority of the Grape Growers were not aware about the concept of 'Pre-harvesting Interval' about use of chemical pesticides and its norms. Therefore, it is recommended that Grape Growers Association and Extension Functionaries should make efforts for creating awareness regarding Pre-harvesting Interval and its norms and use of maximum Biopesticide products among Grape Growers.
84. The study revealed that majority of the pomegranate growers did not adopt pomegranate production system-based adaptation practices like bagging, sheltering of plants, use of anti-transpirants during extremes of weather. Hence, information on these modern adaptation strategies should be communicated to the farmers to cope with climate change and its variability. This information should be made accessible to pomegranate growers using various means of communication.
85. To bridge the yield gap in cotton, it is recommended that the Sustainable Cotton Technology Package which includes high-quality seed, bio-fertilizers, chemical fertilizers, biopesticides along with university recommended technology information booklet shall be made available and also to use mass media. Therefore, collective efforts should be made by the seed

companies, biopesticide producing companies and extension agencies so as to ensure the successful implementation.

86. It was observed from study that, farmers were dependent on own farm seedlings and private farmer nurseries for seedlings as planting material, most of them were not aware about its seed certification category and faced constraints of low availability of credible planting material/nursery seedlings' and increasing infestation of grassy shoot disease. Therefore it is recommended that Sugar factories in coordination with university research stations (RSJRS, Kolhapur & CSRS, Padegaon) should make efforts to avail credible planting material (Sets/Seedlings) and trainings on Sugarcane Nursery Management should be provided to the sugarcane growers.

Agricultural Statistics

87. On the basis of path analysis, the highest contribution of vermicompost in the yield of *rabi* onion was found 25 and 79 per cent in both with and without fertilized plots respectively. Hence, an application of fertilizer nutrients as per STCR based yield target equations with vermicompost (5 t ha^{-1}) (prepared on farmer's own field) **and** liquid bio fertilizer (**each** 500 ml ha^{-1} Azotobacter **and** PSB) is recommended for obtaining higher yield of *rabi* onion, increasing fertilizer use efficiency and maintaining soil health.
88. On the basis of path analysis, in Halfbred cattle the direct significant contribution of age at first calving (AFC) in the milk yield was 6 to 22.41 per cent observed in all the six lactations. It also significantly affects the lactation milk yield (LMY) and lactation length (LL). Hence, it is recommended that farmers may give proper attention towards the age at first calving (850 to 950 days) to increase the milk yield of Halfbred cattle.
89. The ARIMA model is recommended for the exact future prediction of production and productivity of mango and papaya in Maharashtra State.

Biotic and Abiotic stress

90. Cotton genotype RHC 1409 is recommended as resistant source for jassids based on low infestation of jassids, morphological traits and biochemical parameters.
91. Pigeonpea variety BSMR 736 is recommended as resistant source for pulse beetle based on low infestation of pulse beetle in seed storage, morphological traits and biochemical parameters.
92. Chickpea variety Vijay is recommended as resistant source for pulse beetle based on low infestation of pulse beetle in seed storage, morphological traits and biochemical parameters.
