Strategies to Enhance Productivity and Production in Vegetable Crops

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Fruits and vegetables account for 92% of production of horticultural crops.
Horticulture has paid rich dividend

- Income security
- Nutritional security
- Employment opportunities

- **Production >>** 2.5 folds in 20 years (1991-2011)
  96.5 mil MT -- 240.53 mil MT

- **Export earnings -** 20 fold increase (1991-2011)
  Rs 482 - to Rs 9960/- Crore
Horticulture growth (per annum)

Area: 3.8%

Production: 6.8%

Productivity: 2.4%
## India’s global ranking for vegetables

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Area</th>
<th>Production</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brinjal</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Cabbage</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Cauliflower &amp; Broccoli</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Okra</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Onion</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Potato</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Tomato</td>
<td>2</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>All vegetables</td>
<td>2</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>
Vegetables

- These states account for 83.4% of production
**Veg Snapshot**

- **Potato, 27%**
- **Tomato, 12%**
- **Onion, 11%**
- **Brinjal, 8%**
- **Cabbage, 5%**
- **Cauliflower, 5%**
- **Okra, 4%**
- **Peas, 3%**
- **Others, 25%**

- **Total Production 162.4 mill MT (2013-14)**
- **Average productivity 17.52 MT/ha (up 21.6% from 2001-02)**

*State of Indian Agriculture 2012-13, NHB*
Growth in vegetable crops

GROWTH RATE, 2001-2010 (% per annum)

AREA: 4.09%  PRODUCTION: 6.32%  PRODUCTIVITY: 2.14%

• Growth in production is more due to expansion in AREA than productivity
What we need?

• We need to sustain growth
  – Growing demand
  – Enhance returns per unit of area
  – Harness existing potential

• We need to address critical issues & challenges
Critical Issues

• Low productivity
• Poor quality of the produce including food safety issues
• Inadequate availability of quality seed & planting material of improved varieties
• Emergence of diseases & pests – climate change
• Slow pace in adoption
• Inadequate infrastructure facilities for post harvest management
• Environmental concerns due to indiscriminate use of inputs
• Climate change- hailstorm, drought, high moisture, frost
• Lack of adequate trained manpower
### Productivity of different vegetables in India and world

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Highest productivity</th>
<th>Productivity In India</th>
<th>Average world productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brinjal</td>
<td>Egypt (49.2 t/ha)</td>
<td>17.5 t/ha</td>
<td>25 t/ha</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Japan (66 t/ha)</td>
<td>21.5 t/ha</td>
<td>27.7 t/ha</td>
</tr>
<tr>
<td>Cauliflower/broccoli</td>
<td>Pakistan (24.8 t/ha)</td>
<td>18.3 t/ha</td>
<td>16.9 t/ha</td>
</tr>
<tr>
<td>Okra</td>
<td>S. Arabia (13.3 t/ha)</td>
<td>11.6 t/ha</td>
<td>6.9 t/ha</td>
</tr>
<tr>
<td>Onion</td>
<td>Turkey (30.3 t/ha)</td>
<td>14.2 t/ha</td>
<td>19.1 t/ha</td>
</tr>
<tr>
<td>Potato</td>
<td>USA (44.3 t/ha)</td>
<td>22.7 t/ha</td>
<td>17.7 t/ha</td>
</tr>
<tr>
<td>Tomato</td>
<td>Spain (74 t/ha)</td>
<td>19.5 t/ha</td>
<td>32.8 t/ha</td>
</tr>
<tr>
<td>Productivity (t/ha)</td>
<td>States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-30</td>
<td>Tamil Nadu</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-25</td>
<td>Kerala, J&amp;K, UP, Punjab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-20</td>
<td>Karnataka, West Bengal, HP, AP, Gujarat, Bihar, Delhi, Jharkhand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-15</td>
<td>Tripura, Odisha, Haryana, MP, Chhattisgarh, Maharashtra, Uttarakhand, Assam, Manipur, Goa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>Arunachal Pradesh, Meghalaya, Nagaland, Mizoram, Rajasthan, Sikkim</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
World Productivity of Vegetables (2012-13)
(19.6MT/ha)

- Mexico, 17.7
- Spain, 36.9
- Italy, 28
- Russian Fed., 19.4
- Egypt, 24.4
- Turkey, 26.7
- Iran, 27
- USA, 32.2
- India, 17.4
- China, 23.1
- Others, 13.9
Impact of high yielding varieties

- Enhancement of productivity in the range of 6.25–40.34%.
- Kashi Kanchan in cowpea, Kashi Pragati in okra and Kashi Anmol in chilli recorded 20% increase in productivity.
- Garden Pea (Kashi Nandani, Kashi Udai and Kashi Mukti), Pumpkin (Kashi Harit), Brinjal (BR-14) and sponge gourd (Kashi Divya) show an average increase of more than 10% yield.

**Keshav Prasad**, a vegetable grower from Jamalpur block of Mirzapur, Uttar Pradesh grows IIVR cowpea variety Kashi Kanchan. From an area of 1.5 ha he earns Rs. 1.50 lakh by selling green pods by September. Later, due to decline in the market price on cowpea pods, he keeps the crop in the field for seed production and earns about Rs. 50,000 from seed sales. Thus, with a single crop of cowpea, Keshav Prasad earns a net return of Rs. 1.60 lakh from an area of 1.5 hectare.
Arka Rakshak: Triple disease resistant

(Bacterial wilt, Leaf curl virus and early blight)

First early blight resistant variety

Yield ~ 90 t/ha in farmers field
Season: Summer

Net profit: > Rs. 10 lakh/ha

Best performer across hybrids
## RIL mapping population development programme at IIVR

<table>
<thead>
<tr>
<th>Crop</th>
<th>Trait</th>
<th>Parents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tomato</strong></td>
<td>Leaf curl virus</td>
<td>Punjab Chuhara x EC520180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Punjab Chuhara x H-88-78-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Punjab Chuhara x Fla-478</td>
</tr>
<tr>
<td>Lycopene</td>
<td></td>
<td>VRT-32 x BL1208</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H-86 x EC538380</td>
</tr>
<tr>
<td>Early blight</td>
<td></td>
<td>NCEBR-4 x Co3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Co3 x EC520061</td>
</tr>
<tr>
<td><strong>Pea</strong></td>
<td>Powdery mildew</td>
<td>VRP-16 x VRP-22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VRP-16 x VRPPMR-9</td>
</tr>
<tr>
<td><strong>Muskmelon</strong></td>
<td>Downy mildew</td>
<td><em>C. melo</em> (Kashi Madhu) x <em>C. melo</em> var. <em>momordica</em> (B-159)</td>
</tr>
</tbody>
</table>
### Vegetable seed requirement vs production in India

<table>
<thead>
<tr>
<th>Crop</th>
<th>Requirement (t)</th>
<th>Production (t) (organized sector)</th>
<th>Other quality seeds (t)</th>
<th>Shortage (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Tomato</td>
<td>360</td>
<td>190</td>
<td>80</td>
<td>90</td>
</tr>
<tr>
<td>2 Brinjal</td>
<td>465</td>
<td>85</td>
<td>50</td>
<td>330</td>
</tr>
<tr>
<td>3 Chilli</td>
<td>200</td>
<td>68</td>
<td>80</td>
<td>52</td>
</tr>
<tr>
<td>4 Cauliflower</td>
<td>280</td>
<td>130</td>
<td>35</td>
<td>115</td>
</tr>
<tr>
<td>5 Cucumber</td>
<td>70</td>
<td>37</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>6 Muskmelon</td>
<td>110</td>
<td>37</td>
<td>40</td>
<td>33</td>
</tr>
<tr>
<td>7 Watermelon</td>
<td>320</td>
<td>135</td>
<td>100</td>
<td>85</td>
</tr>
<tr>
<td>8 Bottle gourd</td>
<td>615</td>
<td>105</td>
<td>100</td>
<td>410</td>
</tr>
<tr>
<td>9 Onion</td>
<td>1200</td>
<td>200</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>10 Okra</td>
<td>4250</td>
<td>1350</td>
<td>800</td>
<td>2100</td>
</tr>
<tr>
<td>11 Radish</td>
<td>650</td>
<td>300</td>
<td>200</td>
<td>150</td>
</tr>
<tr>
<td>12 Carrot</td>
<td>700</td>
<td>200</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>13 Beet root</td>
<td>400</td>
<td>100</td>
<td>120</td>
<td>180</td>
</tr>
<tr>
<td>14 Peas</td>
<td>6000</td>
<td>1500</td>
<td>2000</td>
<td>2500</td>
</tr>
<tr>
<td>15 Cabbage</td>
<td>200</td>
<td>80</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15820</strong></td>
<td><strong>4517</strong></td>
<td><strong>4335</strong></td>
<td><strong>6968</strong></td>
</tr>
</tbody>
</table>
Global vs Indian seed market

- Total global seed market: 42 billion US $
- Major players: Monsanto (7.5 bn), Dupont-Pioneer (4.9 bn), Syngenta (2.8 bn), Limagrain (1.2 bn), KWS (1.1 bn), Bayer (0.68 bn), DOW (0.64 bn), Sakata (0.55 bn)
- All companies in India ≈ 0.14 bn US $
- Global vegetable seed market: 8.4 billion US $
- Vegetable seed market in India: 0.56 billion US $
- Indian seed market is dominated by OPs
- Hybrids are gaining popularity in India.
- There are about 200 private players and 14 Govt. organization in seed industry.
- Public sector is mainly dominated by high volume-low value seeds of cereals, pulses and oil seeds.
### Current market for OP vegetable seeds (t)

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okra</td>
<td>3000</td>
</tr>
<tr>
<td>Onion</td>
<td>4000</td>
</tr>
<tr>
<td>Peas</td>
<td>5500</td>
</tr>
<tr>
<td>Radish</td>
<td>4000</td>
</tr>
<tr>
<td>Cucumber</td>
<td>1000</td>
</tr>
<tr>
<td>Beans</td>
<td>9850</td>
</tr>
<tr>
<td>Chilli</td>
<td>400</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>400</td>
</tr>
<tr>
<td>Gourds</td>
<td>1124</td>
</tr>
<tr>
<td>Others</td>
<td>10726</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40000</strong></td>
</tr>
</tbody>
</table>

Current sale of OP seeds in India is about 260 million US $ (Rs. 1300 crores)
ADVANCES IN SEED PRODUCTION

• Isolation
• Seed growing/ certification standards
• Hybrid seed production technology
  – Male sterile lines
  – Line x Testers
• Packaging and labelling
• Seed storage technology
AEROPONICS – HEALTHY SEED POTATO

- Plants are grown in troughs, tubes or other type of chambers
- Roots are hung in air and are sprayed with nutrient mist
- Easily absorb nutrients
- Easily absorb oxygen
- Less chance of root diseases
In crops like potato, ginger, turmeric and a few tuber crops, micro rhizome technology is very efficient in production of disease free clonal planting material of elite genotypes.
HYBRID TECHNOLOGY

- Mango
- Ber

- Tomato
- Brinjal
- Chilli
- Okra
- Potato
- Cucurbits
- Cabbage
- Cauliflower
- Peas

- Petunia
- Marigold
- Carnation
- China Aster
Public private partnership

Conventional breeding

- Basic germplasm improvement
- Development of inbred lines
- Development of hybrids
- Seed production & marketing

Public sector

Private sector

Biotechnology (Transgenics & MAS)

- Discovery research
- Technology development
- Biosafety evaluation
- Breeding & product development
- Seed production & marketing

Public sector

Private sector
Major Achievements: Vegetable Production

Integrated plant nutrient management (IPNM) modules developed at IIVR increase profit, quality and reduce use of chemical fertilizers by 15-20%.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Organic manure</th>
<th>NPK (Kg/ha)</th>
<th>Biofertilizer</th>
<th>Yield enhancement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato</td>
<td>Poultry manure (5 t/ha)</td>
<td>60:30:40</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td>Cowpea</td>
<td>FYM (10 t/ha)</td>
<td>30:30:30</td>
<td>Phosphate solubilizing bacteria</td>
<td>13</td>
</tr>
<tr>
<td>Bottle gourd</td>
<td>Vermicompost (2.5 t/ha)</td>
<td>120:60:60</td>
<td>Micronutrient mixture</td>
<td>18</td>
</tr>
<tr>
<td>Capsicum</td>
<td>Poultry manure (5 t/ha)</td>
<td>150:80:100</td>
<td>-</td>
<td>26</td>
</tr>
<tr>
<td>Brinjal</td>
<td>Vermicompost (5 t/ha)</td>
<td>120:60:60</td>
<td>Azospirillum</td>
<td>77</td>
</tr>
</tbody>
</table>
Integrated Nutrient Management

- Balanced use of nutrients
- Leaf and soil test based fertilizer recommendations
- Use of amendments and micronutrients
- Understanding nutrient dynamics
Nutrient Status

Figure: Emergence of Nutrient Deficiencies on time scale
Micro-irrigation

- Water saving up to 40-60%
- Yield increase 60-100%
- Saving in fertilizers and chemicals (40 - 60%)
- Improved produce quality and Higher returns
- Less pests and diseases incidence
FERTIGATION IN VEGETABLE CROPS
PROTECTED CULTIVATION

Tomato  (300 t/ha/year)  Capsicum (200 t/ha/year)
Cucumber and Muskmelon
GROWN HYDROPONICALLY:
Big Plant, Small Roots

VS.

GROWN IN SOIL:
Small Plant, Big Roots

Why Hydroponics?
Major Achievements: Vegetable Protection

- IPMs for shoot and fruit borer in brinjal (82% protection) and fruit fly in cucurbits (70% protection).
- **Trap crops**: Marigold for tomato leafminers and the fruit borer and Chinese cabbage DBM.
- **Biocontrol**: *Trichoderma* (seed treatment/seedling root dip and soil application) for management of soil borne pathogens in tomato and chilli. *Bacillus* isolates (BS-2 & BA-1) against soil borne pathogens of tomato and foliar spray @ 1.0 % against leaf spot pathogens of cowpea.
- **Diagnostics**: Serological and PCR based diagnostics were standardized for detection of groundnut bud necrosis virus (GBNV), watermelon bud necrosis virus (WBNV), squash leaf curl China virus (SLCCV), bhendi yellow vein mosaic virus (BYVMV) and tomato leaf curl New Delhi virus (ToLCNDV).
Crop loss savings per acre : 4 quintals

Farm gate sale price : Rs.16/- kg

Economic impact : Rs 25.46 crores

No. of trap sold: 2,38,687
No. of traps /ac : 6
Area covered : 39,781 ac
Integrated Pest Management

Trap crops
Post- harvest handling and management

- Maturity standards worked out
- Harvesting and handling
- Physiology of fruits and vegetable
- Packing for enhanced shelf life
- Storage system to enhance shelf life
- Diversified products
Impact of R&D strategies

- Increased availability of horticulture produce
- Adoption of technologies
- Increased exports of horticultural crops
- Attraction for corporate in horticulture
- India emerged as a major player in horticulture – Golden revolution
- Increased availability for processing
Emerging Concerns

- Provide food, feed, fibre, biofuel, nutrition and health care to 9.5 billion human population by 2050 from declining land and water
- Safeguarding the environment and natural resources
- Manage the uncertainties due to climate change - drought, flood, high temperature, salinity and new pathogens
- Food safety
How we can address the concerns?

RESEARCH
- Genetic resource management and enhancement
- Enhancing the productivity of water and nutrients
- Efficient utilization of resources
- Use of frontiers in science & technology
- More investment in research

DEVELOPMENT
- Use of new seeds and technologies
- Quality assurance of seed, plants and produce
- Linking farmer’s with market
- Infrastructure for production and marketing
- Investment in development.
Approaches
Horticulture Divisions of ICAR and DAC

**RESEARCH**
- Basic & strategic research
- CRP and Challenge programs
- Extra murals fund
- Flagship programs
- AICRP
- International programs

Schemes: 10 institutes, 7 Directorates, 6 NRC

**DEVELOPMENT**
- Area based annual & perspective plans
- Applied research with focus on region & crop
- Demand driven production
- Best quality seed & planting material
- Technology driven program to improve productivity-quality
- Post harvest management
- Market infrastructure dev.

Schemes: NHM, HMNEH, NBM, CDB, CIH, DCCD, DASD, NBB, NVIUC (RKVY)
**Important Challenge Programs (13)**

**ICAR Horticulture Division**

<table>
<thead>
<tr>
<th>Program Description</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-specific hybridization for multiple disease resistance (IIVR)</td>
<td></td>
</tr>
<tr>
<td>Exploitation of male sterility in vegetable crops (IIHR)</td>
<td></td>
</tr>
<tr>
<td>Breeding for resistance to YVMV in okra (IIVR)</td>
<td></td>
</tr>
<tr>
<td>Leaf spot diseases in horticultural crops (IIHR)</td>
<td></td>
</tr>
<tr>
<td>Canopy management and architectural engineering in fruit crops (CITH)</td>
<td></td>
</tr>
<tr>
<td>Pomegranate nodal blight (NRCP)</td>
<td></td>
</tr>
<tr>
<td>Papaya ring spot virus (IIHR)</td>
<td></td>
</tr>
<tr>
<td>Management of Phytophthora, fusarium and ralstonia wilt (IISR)</td>
<td></td>
</tr>
<tr>
<td>Borers in cashew, citrus (NE), apple, banana, coffee (IIHR)</td>
<td></td>
</tr>
<tr>
<td>Sucking pests - thrips, white fly, mealy bugs &amp; vectors (IIHR)</td>
<td></td>
</tr>
<tr>
<td>Micronutrient management in horticulture crops (IIHR)</td>
<td></td>
</tr>
<tr>
<td>Protected horticulture (IIHR)</td>
<td></td>
</tr>
<tr>
<td>Tissue culture in date palm (CIAH)</td>
<td></td>
</tr>
</tbody>
</table>
MIDH—Mission Interventions

- Production & productivity improvement
- Production & distribution of planting material
  - Nurseries, TC units, vegetable seed production, import of planting material, seed infrastructure
- Establishment of new gardens
- Mushroom production
- Rejuvenation/replacement of senile orchards/canopy management
- Creation of water resources
- Protected cultivation
- Precision farming development
- INM, IPM
MIDH- Mission Interventions........

• Organic farming
• GAP
• COE in Horticulture
• HRD
• Pollination support through bee keeping
• Horticulture mechanization
• Technology dissemination/FLD
• Integrated Post harvest management
• Creation of market infrastructure
• Processing & value addition
Outcomes: XII Plan Period

Holistic development across horticulture sector, empowering marginal & small stakeholders

- Enhanced Production & Productivity
- Better Quality
- Greater Resource Use Efficiency
- Higher returns
- Improved Access to Markets
- Value Addition & Longer Shelf Life
- FPOs for economies of scale & scope
Rain Deficit Moisture Stress Management in Vegetable crops
IMD Report - Rain deficit monsoon

• Probability of a normal monsoon is 35%,
• **Below normal monsoon is 33%**.
• Aberrant monsoon may lead to moisture deficit
• **Preparedness - advisory plan for horticultural crops have been developed.**
• General and specific recommendations
General recommendations

• Selection of suitable crops and varieties:
• Improved method of seedling production:
• Adoption of soil and moisture conservation techniques:
• Enhancing soil organic matter content:
• Application of foliar nutrition:
• Use of drip irrigation:
• Use of micro sprinkler irrigation:
• Moisture saving methods under limited water resource conditions:
• Water saving irrigation method
• Mulching Practices in Vegetable
• Wind breaks, hedges and intercropping:
• Use of protected cultivation for vegetables:
• Control of leaf miner and mite during high temperature stress.
Other recommendations

- In crop like Onion, drum seeder may be used for direct sowing.
- Postpone transplanting of seedlings in the main field and also fertilizer application till the favorable soil moisture is prevailed.
- Resorting to foliar application of (water soluble) major nutrients.
- Protection of young plants with partial shade.
Other recommendations

- In the inter spaces of crops weeding and inter-culture practices may be followed.
- Thinning may be taken up to reduce the plant population.
- Alternate furrow Irrigation may be taken up based on the availability of water.
- Drip Irrigation may be followed. Pitcher irrigation wherever drip is unavailable for protective maintenance.
- Plastic mulching and drip irrigation may be followed for better soil and moisture conservation and weed control.
Other recommendations

• Adopting the conjunctive use of surface and ground water as well as the use of non-conventional sources such as brackish water

• Waste water should not be utilized without pretreatment and safe reuse may be ensured.

• Minimise use of those fertilizers which promote vegetative growth like nitrogen, use K and B as foliar spray to maintain plant turgor.

• Use of super absorbent polymers such as Luquasorb for water absorption and slow release.
If monsoon is delayed by 15 days

- Grow short duration varieties
- Raise crop - ridge-furrow or furrow irrigated raised bed planting system
- Two spraying of water soluble mixed fertilizers (19:19:19 NPK) @ 5-7 g/lit, 30 days after crop establishment ensure early and vigorous plant growth
- Ensure staking of crop wherever required.
# Short duration varieties

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster bean</td>
<td>Pusa Sadabahar, Pusa Mausami, Pusa Navbahar, Durga Bahar, Sharad Bahar, Durgapur Safed</td>
</tr>
<tr>
<td>Cowpea</td>
<td>Kashi Kanchan, Kashi Unнатил, Kashi Gauri, Pusa Barsati, Pusa Rituraj</td>
</tr>
<tr>
<td>Dolichos bean</td>
<td>Kashi Haritima, Pusa Early prolific, Pusa Sem-2, Pusa Sem-3, Rajni, Konkan Bhusan, Arka Jay, Arka Vijay,</td>
</tr>
<tr>
<td>Drumstick</td>
<td>PKM-1, PKM-2, Konkan Ruchira</td>
</tr>
<tr>
<td>Brinjal</td>
<td>Kashi Sandesh, Kashi Taru, Pusa Purple Long, Pusa Kranti, Pusa Anmol, Punjab Sadabahar, Arka Sheel, Arka Kusumakar, Arka Navneet, Arka Shirish</td>
</tr>
</tbody>
</table>
If monsoon is delayed by 30 days

- Use of organic mulch such as paddy straw, dry grass, etc @ 7-10 tones/ha
- Use of organic manures (FYM 15 tones/ha or vermicompost 10 tones/ha) to enhance water holding capacity of soil
- Ensure life saving irrigation at least during critical growth stages
- Water shortage - alternate furrow irrigation should be practiced
- Do not allow weeds to grow during plant’s early growth stage
- Tillage operations only in upper 5 cm soil layer.
Rain deficit during vegetative phase & reproductive phase

• Raise crop on raised beds with drip irrigation.
• Harvest rain water by making storage ponds - two to three life saving irrigations during drought.
• Spray anti-transparent Kaolinite @ 5% to reduce water loss
• Cover soil surface with organic mulch
• In case of poor crop growth - foliar application of water soluble NPK fertilizer
• Foliar application of sulphur 85% WP @ 1.5-2.0 g/liter for quick recovery during active vegetative growth stage.
• Foliar application of micronutrient mixture containing Zn, Mn, Fe, Cu, B at 30, 45 and 60 DAT for better crop stand (5 ml/liter).
• During dry spell, thrips population may increase - spray Profenophos 1ml/L or Carbosulfan 2ml/L or Fipronil @ 1.5ml/l
Terminal drought

• Water harvesting / alternate arrangement
• Life saving irrigation
• Mulching
• Use drip/ fertigation

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Thanks