

# Revolution in Mango Production

## Success Stories of Some Farmers

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Fruits and vegetables are considered to be the protective food because these help us to develop defense mechanism in our body. Mango, which is the king of fruits, is also our national fruit. More than 50 percent of world mango production is contributed by India but unfortunately mango productivity in the country is declining over the years. This paper briefly deals with general mango culture, the causes of low productivity, and suggests some measures to enhance the productivity in the country. Some success stories of individual farmers and corporate sectors also find a place.

During 2008-09 India had an area of 2.1 million hectare under mango with a production of 12.7 million tonnes and productivity of 5.5 tonnes/ha. India ranks first in mango production in the world. But due to certain limitations, mango productivity is declining in the country. In the traditional low density cultivation, per ha plant population in mango orchard ranges from 75 –100. In such situation, mango trees become very big, which make it difficult to perform the needed cultural operations, like training, pruning, disease pests control etc. As a result, irregular bearing of fruits becomes the rule rather than an exception. Low yield or no yield is

also common due to alternate bearing. Poor nutrient and water management are also very important factors to improve the needed productivity.

Of late, high-tech horticulture known as high density planting (HDP), has come into vogue, which is capable of removing the limitations of mango productivity in the India.

### Mango Production Scenario in India

India tops in the mango production in the world. The important mango producing states are Andhra Pradesh, Uttar Pradesh,

Karnataka, Bihar, Gujarat, Maharashtra, Tamil Nadu, West Bengal, Kerala, and Orissa. The productivity of mango unfortunately declining over the years. The national average productivity is as low as 5.5 t/ha while Uttar Pradesh, which tops in the productivity produces more than 10 t/ha (Table 1 & Figure 1). Poor plant population, growing of traditional low yielding varieties, poor nutrient and water management are the key factors of low productivity.

Mango (fresh fruits) and processed mango products are exported to different countries. From India major mango

Table 1 – Statewise area, production and productivity of mango  
(Area in 000'ha, production in 000' Mt and productivity in tonnes/ha)

State	2006 - 07			2007 - 08			2008 - 09		
	Area	Production	Pdy.(t/ha)	Area	Production	Pdy.(t/ha)	Area	Production	Pdy((t/ha)
U.P.	261.4	2980.5	11.4	265.9	3365.0	12.7	271.2	3465.9	12.8
A.P.	471.4	3865.2	8.2	483.5	4157.9	8.6	497.7	2522.0	5.1
Bihar	140.8	1306.9	9.3	142.2	870.4	6.1	144.1	1329.8	9.2
Karnataka	129.1	1368.8	10.6	134.6	1223.3	9.1	141.3	1284.4	9.1
T. N.	135.1	580.8	4.3	136.6	753.6	5.5	148.8	821.4	5.5
Maharashtra	447.7	646.3	1.4	455.8	710.9	1.6	457.0	712.8	1.6
W. B.	78.2	549.8	7.0	80.9	623.3	7.7	86.0	548.9	6.4
Orissa	140.1	431.4	3.1	148.2	251.8	1.7	164.3	449.7	2.7
Kerala	76.7	445.4	5.8	76.7	445.4	5.8	76.7	445.4	5.8
Gujarat	102.0	834.3	8.2	167.4	665.1	4.0	206.2	869.5	4.2
<b>TOTAL</b>	<b>2153.9</b>	<b>13734.0</b>	<b>6.4</b>	<b>2201.4</b>	<b>13996.8</b>	<b>6.4</b>	<b>2309.0</b>	<b>12749.8</b>	<b>5.5</b>

Source : (6)

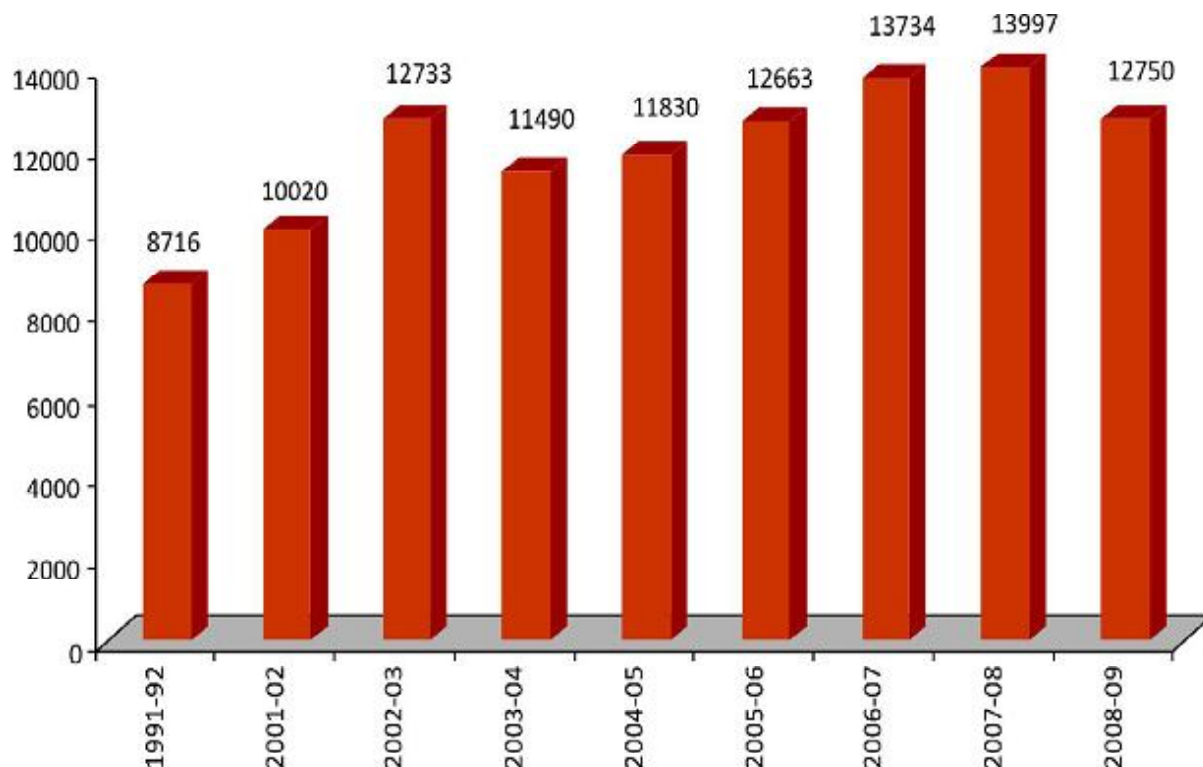


Figure 1 – Production (000t) trend of mango

importing countries are—United Arab Emirates, Bangladesh, United Kingdom, Saudi Arabia, Kuwait, Qatar, Bahrain, Nepal, USA, Oman, Singapore, etc and the foreign exchange earned from such exports amounts to about Rs 2005 millions (Table 2).

Before the intended subject is discussed, it is imperative to discuss some basic points related to mango culture like soil and climate, season of planting, propagation, varieties, dwarfing, culture, spacing, irrigation, intercropping, manures and fertilisers, training and pruning, use of growth regulators, plant protection measures, harvest season, harvest and yield, post harvest treatment, uses etc.

#### Soil and Climate

**Soil:** The mango tree is not too particular as to soil type, provided it has good drainage. Rich, deep loam soil certainly contributes to maximum growth, but if the soil is too rich and moist and well fertilised, the tree will respond vegetative but will be deficient in flowering and fruiting. The

Table 2 – Foreign exchange earning from fresh mango fruit

Country	2007-2008		2008-2009		2009-2010	
	Qty	Value	Qty	Value	Qty	Value
<b>United Arab Emirates</b>	22,469.62	6,320.93	24,570.91	7,818.28	25,608.15	10,382.97
<b>Bangladesh</b>	17,063.60	1,595.46	45,104.46	4,085.69	33,549.89	3,295.82
<b>United Kingdom</b>	2,575.37	1,981.66	2,527.39	1,403.20	2,958.65	1,746.88
<b>Saudi Arabia</b>	1,488.95	459.77	2,141.27	836.28	3,147.13	1,345.40
<b>Kuwait</b>	460.84	306.18	546.05	398.78	804.15	520.09
<b>Qatar</b>	77.9	33.24	265.41	117.54	659.02	512.78
<b>Bahrain</b>	474.23	175.7	1,154.59	324.61	1,238.49	402.33
<b>Nepal</b>	7,550.89	636.3	4,765.02	374.99	4,058.15	378.63
<b>United States</b>	142.49	195.77	202.64	292.87	175.4	256.58
<b>Oman</b>	38.77	17.52	400.49	312.29	269.5	200.24
<b>Total</b>	<b>54,350.80</b>	<b>12,741.72</b>	<b>83,703.18</b>	<b>17,071.26</b>	<b>74,460.62</b>	<b>20,053.96</b>

Source: DGCIS Annual Export (\*Qty in Mt. & Value in Rs. Lakh)  
Source (7)

mango performs very well in light soil.

**Climat**e: The mango is naturally adapted to tropical lands between 25°N and 25°S of the Equator and up to elevations of 915 meters. It is grown as a dooryard tree at slightly cooler altitudes but is apt to suffer cold damage. Mango grows well in the rainfall range of 750-2500 mm in the four summer months (June to September) followed by 8 months of dry season.

#### Season of Planting

Planting spreads from July to December.

#### Varieties

Neelum, Bangalora, Alphonso, Rumani, Baganapalli, Kalepad, Peter, PKM 1, PKM 2, Sendura, Jahangir, Mulgoa, Himayuddin, Paiyur 1, Mallika, Amrapali and Salem Bangalora, Arka Anmol, Arka Aruna, Arka Neelkiran, Arka Puneeth and Sindhu are popular varieties in mango. Mango varieties grown in different states are mentioned in **Table 3**.

#### Propagation

Mango trees grow readily from seed. Germination rate and vigour of seedlings are highest when seeds are taken from fully ripen fruits. Seeds of polyembryonic mangos are most convenient for local and international distribution of desirable varieties. However, in order to reproduce and share the superior monoembryonic selections, vegetative propagation is necessary. Inarching and approach-grafting are traditional in India. Tongue, saddle, and root grafting are also common Indian practices.

Horticulture nursery is a good business. Some intelligent and devoted farmers have made excellent progress in such endeavor. One such example find a place in this paper.

#### Dwarfing

Reduction in the size of mango trees is the most desirable goal for the commercial and private planter. In India, double grafting

**Table 3 – The important mango varieties cultivated in different states of India**

State	Varieties grown
Andhra Pradesh	Allumpur Baneshan, Baganapalli, Bangalora, Cherukurasam, Himayuddin, Suvernarekha, Neelum, Totapuri
Bihar	Bathua, Bombai, Himsagar, Kishen Bhog, Sukul, Gulab Khas, Zardalu, Langra, Chausa, Dashehari, Fazli
Goa	Fernandin, Mankurad
Gujarat	Alphonso, Kesar, Rajapuri, Vanraj, Jamadar, Totapuri, Neelum, Dashehari, Langra
Haryana	Dashehari, Langra, Sarauli, Chausa, Fazli
Himachal Pradesh	Chausa, Dashehari, Langra
Jharkhand	Jardalu, Amrapalli, Mallika, Bombai, Langra, Himsagar, Chausa, Gulabkhas
Karnataka	Alphonso, Bangalora, Mulgoa, Neelum, Pairi, Baganapalli, Totapuri
Kerala	Mundappa, Olour, Pairi
Madhya Pradesh	Alphonso, Bombay Green, Langra, Sunderja, Dashehari, Fazli, Neelum, Amrapalli, Mallika
Maharashtra	Alphonso, Mankurad, Mulgoa, Pairi, Rajapuri, Kesar, Gulabi, Vanraj
Orissa	Baneshan, Langra, Neelum, Suvarnarekha, Amrapalli, Mallika
Punjab	Dashehari, Langra, Chausa, Malda
Rajasthan	Bombay Green, Chausa, Dashehari, Langra
Tamil Nadu	Baganapalli, Bangalora, Neelum, Rumani, Mulgoa, Alphonso, Totapuri
Uttar Pradesh	Bombay Green, Dashehari, Langra, Safeda Lucknow, Chausa, Fazli
West Bengal	Bombai, Himsagar, Kishen Bhog, Langra, Fazli, Gulabkhas, Amrapalli, Mallika
Source (4)	

has been found to dwarf mango trees and early bearing.

#### Culture

Nearly 6 weeks before transplanting, selecting either a seedling or a grafted plant, the taproot should be cut back to about in 30 cm. As mango trees vary in lateral dimensions, spacing depends on the habit of the cultivars and the type of soils. The young plants should be placed in an enriched hole at least 60cm deep and wide, ¾ of the top should be cut off.

Pits of 1 m x 1 m x 1 m are dug and filled in with top soil mixed with 10 kg of FYM and 100 g Lindane 1.3% dust per pit.

#### Spacing

Mango is normally planted at 7 to 10 m either way. However under high density planting, it varies between 5 x 5 m and 6 x 6 m. Amrapalli, a North Indian variety is

highly suitable for high density planting with the spacing of 2.5m x 2.5m.

#### Irrigation

Regular watering is recommended till establishment. Under conventional irrigation systems, weekly irrigation is essential. With micro-irrigation the requirement is restricted to one-third of the water required for conventional method. Fertigation (application of fertilisers with drip irrigation) in mango is being promoted to get higher nutrient and irrigation use efficiency.

#### Intercropping

Short duration crops like legumes, vegetables, groundnut, etc. can be raised during pre-bearing age.

#### Manures and Fertilisers

Recommended doses of manures and fertilisers in mango plant are mentioned in **Table 4**.

**Table 4 – Plant nutrient application in mango trees**

Manures and Fertilisers (kg/plant)	1 Year old	Annual increase	6th year onwards
FYM	10.0	10.0	50.0
N	0.2	0.2	1.0
P <sub>2</sub> O <sub>5</sub>	0.2	0.2	1.0
K <sub>2</sub> O	0.3	0.3	1.5

Manures and fertilisers may be applied in September – October. Fertilisers are applied 45 to 90 cm away from the trunk upto the peripheral leaf and incorporated. State wise fertiliser recommendation is mentioned in **Table 5**.

### Training and Pruning

Rootstock sprouts and low-lying branches have to be removed. Overlapping, intercrossing, diseased, dried and weak branches in old trees are to be removed to get more sunlight and aeration. For the internal branches, pruning may be done during August – September, once in three years. Flowering should not be allowed

upto three years. Among crowded terminal shoots, weak shoots are trimmed to retain two healthy shoots during August-September annually.

### Growth Regulators

Irregular bearing of mango is a serious problem, which can be solved through spraying some hormones and plant nutrients. NAA @ 20 ppm is sprayed at flowering to increase the fruit retention. During February, 0.5% urea (5 g/liter) or 1% Potassium Nitrate (10g/liter) may be sprayed to induce flowering, if trees do not flower by that time. Spraying of 2% KNO<sub>3</sub> at mustard size will increase the fruit set and retention of fruits.

**Table 5 – Statewise fertiliser recommendations for fruit bearing Mango in India**

State	Spacing	N	P <sub>2</sub> O <sub>5</sub> (gm/tree)	K <sub>2</sub> O	FYM (kg/tree)
A.P.	8x10 m	1000	2000	500	100 - 150 kg
Bihar	10.5x12 m	500	800	200	40 kg
Gujarat	10x10 m	750	160	750	100 kg
Haryana	9x11 m	700	-	1250	100 kg
H.P.	8x10 m	500	160	600	100 kg
Karnataka	13x13 m	730	180	680	25 kg
Kerala	9x9 m	500	360	750	75 kg
M.P.	12x10 m	800	440	1440	100 kg
Maharashtra	10x10 m	500	500	500	45 kg
Orissa	10x10 m	62	40	-	10kg + 250g sterameal
Punjab	9x9 m	250	160	600	100 kg
Rajasthan	10x10 m	575	160	300	75 kg
T.N.	10x10 m	1000	1000	1500	50 kg
U.P.	11x11 m	1000	500	1000	30 kg
W.B.	11x14 m	1000	750	750	100 kg

Source: Fertiliser Recommendations for Horticulture Crops – A Guidebook (2<sup>nd</sup> Edition), Edited by Tandon, HLS (2000)

Application of Paclobutrazol @ 10 g a.i. for non-bearing trees during first fortnight of September will induce flowering and fruit set during off years.

### Plant Protection

Integrated Plant Protection (IPM) measures are to be undertaken to make a real progress in plant protection. Selection of disease resistant varieties/hybrids, treatment of planting materials with plant protection material, maintenance of weed free environment, balanced fertilisation, fertigation, etc, are also the part of the IPM.

### Harvest Season

Harvest spreads from March to June.

### Harvest and Yield

Yield varies with varieties and spacing adopted.

- 8 – 10 t/ha upto 15 years.
- 15 – 20 t/ha from 15 to 20 years.

### Post Harvest Treatment

Dip the fruits in 52 ± 1°C hot water immediately after harvest for 5 minutes followed by 8% plant wax (Fruitox or Waxol) to reduce anthracnose disease in mango during storage. Two pre-harvest sprays of 0.20% mancozeb (2.0 g/lit) will also reduce the incidence.

Mango fruits are to be sent to far distance places in India and also to the foreign countries. Therefore, keeping quality improvement is very important. Ozone gas (O<sub>3</sub>) diffusion in the mango container before it is kept in the cold storage may help in the improvement of mango keeping quality. This technology has to developed and fine-tuned in India.

### Uses

All parts of the mango plant from the seeds and flowers to the leaves and gum are used in traditional South Asian medicine, but the fruits are most important. The mango is very rich in medicinal properties. The

properties of different part are mentioned below:

**1. Root and bark:** The root and bark are acrid; cooling; astringent to the bowels.

**2. Leaves:** The leaves are acrid; astringent to the bowels cure “vata”, “pitta”, and “kapha”.

**3. Flowers:** The flowers are cooling and astringent to the bowels; improve taste and appetite; cause “vata”; cure leucorrhoea, bad blood; good in dysentery, bronchitis, biliousness, urinary discharges.

**4. Unripe fruit:** The unripe fruit is acrid, sour, tasty; cures “vata”, “kapha”, biliousness, “tridosha”, blood impurities; astringent to the bowels; cures thought troubles, ulcers, dysentery, urinary discharges.

The unripe fruit roasted, dissolved in water and made into syrup with sugar is freely taken by the Indians to prevent sunstroke. Unripe mangoes toasted and made into syrup form a reputed remedy for heat apoplexy. The dried kernel of the ripe fruit is used in native India as an astringent in diarrhea. The gum of the mango tree is used for cracked feet with good effect.

**5. Ripe Fruit:** The ripe fruit is sweet and oily; aphrodisiac, tonic; increases appetite; cooling; beautifies the complexion; astringent to the bowels; cures “vata”; heart troubles, urinary discharges, ulcers, blood impurities.

Ripe mango is a suitable choice for hypertensive patients as it is a good source of potassium and only contains traces of sodium. The mango is highly recommended for pregnant women and individuals suffering from anemia because of its iron content. Mango helps the skin become softer, gives it a shining glow and is effective in opening clogged skin pores. Mango contains a large amount of tryptophan, the precursor to the ‘happiness-hormone’ serotonin. Mango products are good complementary food for

children of weaning age as they contain necessary vitamins. Mango improves the appetite and is an effective antidote for various body toxins. Mango juice helps prevent mental weakness and improves concentration and memory. In the Ayurvedic text Bhavaprakasa, a syrup made of the juice of the ripe fruit, sugar and aromatics is recommended as a restorative tonic.

**6. Seed:** The seed is sweet, sour, acrid; cures vomiting, dysentery, burning in the region of the heart. The oil from the seeds is acrid, sweet, bitter; cures stomatitis and “vata”.

#### New Technique of Nursery

In Tamil Nadu Thanjavur based Mr. Kulandaisamy developed a new technique for growing grafted mango seedlings. He maintains a nursery in 36 ha called Tari Bio-Tech. The nursery supplies close to 12 lakh planting materials annually and home to nearly 50 mango varieties.

Usually the grafted seedlings are planted in the field and grown. Through this new technique (polybag growing), mango seedlings come to commercial bearing in 2-3 years. Good bearing mother plants are selected and the desired variety is grafted together and grown for 45 days in plastic bags in a controlled environment. After emergence of first flush of leaves, the seedlings are moved to open conditions and kept under shade and watered.

Grafting ensures purity in variety. Till date, many growers simply plant the grafted seedlings they buy straight into the open field. The investment, maintenance and labour for growing the plants are quite high. Whereas, in the polybag method, the plants are grown for 1 to 2 years and then planted in the main field. The cost of cultivation drastically comes down. Farmers need to take care of the tree only for 2 to 3 years, after which it comes to bearing and fruits can be harvested. He uses his own bio plant growth promoters while he plants his grafted seedlings in the polybags. The plants are

regularly sprayed with his own bio growth promoters and grow quite well. He has been sending his seedlings to several parts of the country and receiving encouraging feedback. More than half a dozen mango varieties are being grafted in his farm and grown to be sold.

Even a single tree, if grown by this method and taken care of properly, can yield more than 150 fruits. For one hectare about 200 seedlings are required and in a year a farmer can get an income of at least Rs. 3.75-4.00 lakhs (minimum).

#### High Density Planting (HDP)

Biswas and Kumar, have documented the underlying philosophy of high density planting of fruit crop, 2010 (2). HDP is the most modern scientific technique to obtain very high fruit yield. This technique has been very well demonstrated by the scientist at the Jalgoan base Jain Irrigation Company at Udumalpet near Coimbatore. The company planted 4033 plants in 1.8 ha of land with a spacing of 3m x 2m in Elayamuthur near Udumalpet.

The cost incurred in HDP was Rs. 30,000/ha against the traditional system cost of Rs. 15,000 – 20,000/ha. The yield obtained was 10 – 15 tonnes/ha.

Krishanagiri district in Tamil Nadu has the largest mango production in the state. The district is well known as hub for mango pulp manufacturing in India and local farmers with small land holding are flourishing because of this industry. Mr. Dhandapani has 2.8 ha of mango orchard in this area. The variety he grows is Alphonso. He made an earning of Rs. 10 - 11 lakh from 2.8 ha of land.

#### Advantages of HDP

There are many added advantages of HDP over the traditional method of planting.

1. Various operations like spraying, thinning, harvesting of fruits etc are easy in HDP.
2. Disease –pest infestation is less,

because of better light penetration in the orchard.

3. Better quality fruits suited to the market demand are produced.

Special attention, care and management are needed in HDP planting. Some of them are mentioned.

1. Selection of high yielding hybrid according to market demand.

2. Planting materials are to be obtained from a reliable nursery.

3. Selection of suitable land, which is well drained, free from soil acidity, alkalinity etc.

4. Proper spacing is to be provided on the basis of the variety grown.

5. Micro irrigation and mulching are to be provided.

6. Balanced fertilisation on the basis of soil test, leaf analysis and water test is a must.

7. Integrated nutrient management is the key to success.

8. Fertigation is a very effective method of water and fertiliser application in such an orchard.

9. Training and pruning are to be done timely and effectively.

10. On the 5<sup>th</sup> or 6<sup>th</sup> month the upper portion is pruned to get only 3 to 4 branches.

11. These branches grown up to a height of 1.5-2 feet.

12. These branches are again pruned when they attained a height of about 2feet.

### Plant Nutrient and Water Management

Plant nutrients and water are the two key inputs enhancing the mango productivity. Application of these key inputs at critical stages of plant growth enhances the crop productivity. Unfortunately the scientists have not attended the plant nutrient management adequately. Nutrient removal from different fruit crop is mentioned in **Table 6** and nutrient removal by different mango varieties are mentioned in **Table 7**.

Crop	Yield (t/ha)	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
<b>Fruits</b>				
Apple	25	100 (4.0)	45 (1.8)	180(7.2)
Banana	40	294 (7.4)	67 (1.7)	1140(28.5)
Citrus	30	136 (4.5)	74 (2.5)	322(10.7)
Grape	30	230 (7.5)	83 (0.5)	356(11.8)
Mango	10	39 (3.9)	5 (0.5)	30 (3.0)
Papaya	50	126 (2.5)	38(0.8)	194(3.88)
Pineapple	50	214 (4.3)	63 (1.3)	378(7.6)
<i>Source: (5)</i>				

Varieties	N kg/t fresh fruit	P kg/t fresh fruit	K kg/t fresh fruit
Langra	3.616	0.164	2.581
Dusheri	4.313	0.223	2.887
Totapuri	2.944	0.137	1.561
Raspuri	5.156	0.269	2.885
Banganapalli	4.088	0.176	2.543
Alphonso	3.866	0.199	2.562
Neelam	3.303	0.254	2.560
Mean	3.898	0.203	2.511
<i>Source: (5)</i>			

Parameter	Suitable	Potential problems	Units
pH	6.2-8.3	6.2< to >8.3	Unitless
EC	0-3.0	>3.0	dS/m
SAR	0-9	>9	(mmol/L) <sup>1/2</sup>
K	>125	0-125	mg/kg
P	15-100	0-14	mg/kg
<i>Source (5)</i>			

General guidelines of soil analysis suitable and potential problem soils for orchard are mentioned in **Table 8**. In perennial crop like mango tissue analysis is equally important. Plant tissue sampling guidelines for fruit crop is mentioned in

**Table 9**. An optimum nutrient norm for mango crop is mentioned in **Table 10**.

Irrigation is also very important inputs for enhancing mango productivity. Irrigation need 4-5 years mango orchard depending

**Table 9 – Plant tissue sampling guidelines for fruit crops**

Fruit Crop	Index Tissue	Growth Stage / Time
Banana	Petiole of 3 <sup>rd</sup> open leaf from apex	Bud differentiation stage.
Custard Apple	5 <sup>th</sup> leaf from apex	2 months after new growth
Fig	Fully expanded leaves, mid shoot current growth	July-August
Grape	5 <sup>th</sup> petiole from base	Bud differentiation stage for yield forecast. Petiole opposite to bloom time for quality
Citrus	3 to 5 month old leaf from new flush. 1 <sup>st</sup> leaf of the shoot	June
Guava	3 <sup>rd</sup> pair of recently matured leaves	Bloom stage (August or December)
Mango	Leaves + Petiole	4 to 7 months old leaves from middle of shoot
Papaya	6 <sup>th</sup> petiole from apex	6 months after planting
Passion Fruit	Matured leaf opposite to last open flower	Bloom.
Pineapple	Middle 1/3 <sup>rd</sup> portion of white basal portion of 4 <sup>th</sup> leaf from apex	4 to 6 months.
Pomegranate	8 <sup>th</sup> leaf from apex	Bud differentiation. In April for February crop and August for June Crop.
Sapota	10 <sup>th</sup> leaf from apex	September
Phalsa	4 <sup>th</sup> leaf from apex	One month after pruning
Ber	16 <sup>th</sup> leaf from apex from secondary or tertiary shoot	Two months after pruning
Rubber	Basal leaves of top whorl of shoots of branches in shade of canopy	
Coffee	Third or fourth pairs of leaves from tip of fruit bearing branches at mid height of trees	
Cocoa	Third or fourth leaves of the last maturing flush	
Coconut	14 <sup>th</sup> frond	
Oil palm	17 <sup>th</sup> frond	
Source (5)		

**Table 10 – Optimum nutrient norms for Mango crops**

Nutrient	Unit	Mango	
		Alphonso	Totapuri
Nitrogen	%	0.78-1.65	0.84-1.53
Phosphorous	%	0.02-0.33	0.064-0.147
Potassium	%	0.77-1.73	0.52-1.10
Calcium	%	0.76-1.63	1.97-3.20
Magnesium	%	0.40-0.65	0.40-0.65
Sulphur	%	0.035-0.131	0.0147-0.215
Iron	ppm	657-963	48-86
Manganese	ppm	13-408	57-174
Zinc	ppm	7.8-18.3	25-33
Copper	ppm	14.3-17.8	3.10-8.00
Yield Limit	—	6 t/ha	10 t/ha
Source (5)			

on climatic condition is mentioned in **Table 11**. Impact of irrigation on mango yield (var Dhashehari) is mentioned in **Table 12**.

#### Fertigation

Fertigation is a method of fertiliser application in which fertiliser is incorporated within the irrigation water by the drip system. In this system fertiliser solution is distributed evenly in irrigation. The availability of nutrients is very high therefore the efficiency is more. In this method liquid as well as water soluble fertilisers are used. By this method,

### Fertiliser Used in Fertigation

• Urea, potash and highly water-soluble fertilisers are available for fertigation.

• Application of super phosphate through fertigation must be avoided as it makes precipitation of phosphate salts. Thus phosphoric acid is more suitable for fertigation as it is available in liquid form.

• Special fertilisers like monoammonium phosphate (Nitrogen and Phosphorus), NPK (Nitrogen, Phosphorus and Potassium), Multi K (Nitrogen and Potassium), Potassium Sulphate (Potassium and Sulphur) are highly suitable for fertigation as they are highly soluble in water (**Tables 14 and 15**). Fe, Mn, Zn, Cu, B, Mo are also supplied along with special fertilisers.

### Economics of Drip Irrigation System

The initial investment in drip irrigation system mainly depends upon the spacing of crops. The initial cost will be almost 20-25 thousand rupees per hectare for wider spacing crops such as coconut, mango, grapes and for orchard crops. The initial cost is approximately Rs 50-70 thousand rupees per hectare for close spacing crops such as sugarcane, banana, papaya, mulberry, turmeric, tapioca, vegetables and flower crops. High amount of subsidies (50 – 75%) are provided by central and state governments (8).

**Table 11 – Irrigation requirements of 4-5 years mango orchard depending upon climatic conditions and soil type**

Age (years)	Interval between two irrigations (days)			
	Winter Season		Summer Season	
	Heavy soil	Light soil	Heavy soil	Light soil
1	6-7	4-5	4-5	2-3
2-3	10-11	8-9	8-9	6-7
4-5	14-15	12-13	10-11	8-9

Source: Ravishankar et al, 2010, Indian J Fert. 6(11),2010)

**Table 12 – Fruit yield of mango CV. Dashehari fruit (kg tree<sup>-1</sup>) as influenced by irrigation**

Treatment	Nitrogen levels			
	75%	50%	No N fertiliser	Mean
90% of open pan evaporation	89.67	99.87	81.33	90.29
70% “	97.11	116.59	95.03	102.91
60% “	127.66	135.6	94.18	119.15
Control	83.35	79.81	63.76	75.64
Mean	99.45	107.97	83.57	

Source: Ravishankar et al 2010, Indian J. Fert 6(11), 2010

fertiliser use efficiency is increased from 80 to 90% (8)

### Advantages of Fertigation

- Nutrients and water are supplied near the active root zone through fertigation which results in greater absorption by the crops.
- As water and fertiliser are supplied evenly to all the crops through fertigation

there is possibility for getting 25-50 per cent higher yield.

- Fertiliser use efficiency through fertigation ranges between 80-90 per cent, which helps to save a minimum of 25 per cent of nutrients.
- By this way, along with less amount of water and saving of fertiliser, time, labour and energy use is also reduced substantially (**Table 13**).

**Table 13 – Water saving, yield and profit under drip and drip fertigation systems in some fruit crops**

Crops	Water Saving (%)	Yield (t/ha)			Profit (Rs/ha)		
		Conventional	Drip	Drip+Fertgn	Conventional	Drip	Drip +Fertgn
Banana	35	26	30	37	81000	98000	120000
Sugarcane	29	120	160	207	30000	47000	68000
Tomato	32	45	56	65	56000	77000	95000

Source (8)

Contd on page 21....



# Revolution in Mango Production

## Success Stories of Some Farmers

(Continued from page 8)

### SUCCESS STORIES OF FARMERS

#### Success Story I

Tamil Nadu has only 6% area, 6 % production with average productivity of 5.5 t/ha. The interesting feature of the state is that a lot of importance is being attached with promotion of micro-irrigation and fertigation. A Success story of a farmer is narrated below.

Mango is a biennial bearer. The tree gives good yield in the first year, which slightly declines in the ensuing year. Though the tree grows well in a variety of soils, with proper fertiliser applications and good irrigation techniques, the tree can be made to bear fruits every year. Mr. P. Veerabhadran (PV) a farmer from Mampakkam village, Chengalpattu district, Tamil Nadu is a mango farmer who has planted both Banganapalli and Rumani mango varieties in his 0.7 hectares land.

#### Water Shortage Made PV a Mango Farmer

A decade back Mr PV was growing crops such as rice and vegetables. Because of severe water shortage and successive monsoon failures he lost a major portion of his crop. To overcome this problem, he thought of planting alternative crops, which would require less water unlike rice and decided to plant mango in his field. At present he has about 250 Banganapalli and 400 Rumani varieties of mango trees in his field. Both the varieties are able to fetch him a sizable income every year.

#### Growing Intercrops

For the first four years after planting the mango seedlings, he grew a variety of intercrops such as vegetables and groundnut to supplement income. After harvest the intercrops were ploughed into the soil as green manure. The fruits were plucked only from the fifth year. He had

Name	N - P <sub>2</sub> O <sub>5</sub> - K <sub>2</sub> O content	Solubility (g/l) at 20° C
Ammonium nitrate	34-0-0	1830
Ammonium sulphate	21-0-0	760
Urea	46-0-0	1100
Monoammonium phosphate	12-61-0	282
Diammonium phosphate	18-46-0	575
Potassium chloride	0-0-60	347
Potassium nitrate	13-0-44	316
Potassium sulphate	0-0-50	110
Monopotassium phosphate	0-52-34	230
Phosphoric acid	0-52-0	457

Source (8)

Name	N %	P <sub>2</sub> O <sub>5</sub> %	K <sub>2</sub> O %
NPK	19	19	19
NPK	20	20	20
NPK	11	42	11
NPK	16	8	24
NPK	19	19	19
NPK	15	15	30
MAP	12	61	0
Potassium nitrate	13	0	46
MKP	0	52	34
SOP	0	0	50

Source (8)



Figure 2 - A mango farmer (PV) in Mampakkam village in Tamil Nadu in his orchard (9).

procured the grafts from a local farm and had planted them at a spacing of about 6 feet in straight lines. Before planting, the

land was ploughed well by mixing rotten farmyard manure. About 3 cubic m pits were dug and three-fourth of each pit was filled with about 20 kg of farmyard manure. The mango seedlings were planted in a way that the grafted portion was above the soil surface and the pits were closed with sand and irrigated. Irrigation was mainly done from a tube well and the young seedlings were irrigated once every 5 days. After 3 years of planting, irrigation was done once every 15 days (9).

#### Regular Manuring

The trees were regularly manured during August-September every year with liberal quantities of well rotten farmyard manure and neem cake. Other common practices required for mangoes such as pruning the shoots below the grafted portion, weeding and ploughing the interspaces were also

done. For the first 3-4 years, the trees were not allowed to flower and if flowering was noticed it was removed manually. To protect the trees from pests such as fruit fly and fruit borer, the farmer adopted an indigenous plant protection method. A paste made from the leaves of *Neem*, *Adathoda*, *Pungai*, *Nochi*, and *Perandai* (Tamil names) was soaked in cow's urine for 15-20 days. After 15 days the solution was filtered and then diluted in water (1ml of the paste in 10 ml of water) and sprayed over the crown of the trees.

### Economics

He had spent about Rs 15,000 per hectare for growing, harvesting the intercrops, tree maintenance, and labour. He had expected a harvest of 8-10 tonnes of Rumani fruits this year. Rumani mangoes come to the market usually at the end of the mango season and fetch a good price when most of the other varieties lapse.

### Success Story II

AP has the highest area (21%), highest production (20%) and moderate productivity (above 5t/ha) of mango during 2008-09. It may be mentioned here that UP ranks first in mango productivity (12.8t/ha) with 11% area and 27 % production during the same period. As drip irrigation is being promoted in the state and some fertiliser companies of Southern region are going in for production and promotion of fertilisers well suited for fertigation, the area under fertigation would be increased. Some farmers are also adopting the High Density Planting (HDP), which would help to enhance the mango productivity considerably.

Mr M A Rao of Ranga Reddy district of AP has about a hectare of mango orchard. Varieties grown in 1990 were Rajaapuri, Mallika, Amrapalli, Kesar etc. spacing adopted were 12 X 12 ft to have a plant population of 650 /ha which is about 6-8 times higher than the traditional planting with the plant population of 75 -100 plants/ha. Yield obtained is mentioned in **Table 16**.

Serial number	Year	Yield obtained (t/ha)
1	3 <sup>rd</sup> year	5
2	4th	10
3	5th	20
4	6th	25

Source : (1)

The yield obtained in the traditional method of planting is only 10 t/ha in the area.

### Success Story III

Gujarat has an area of 4 % and production of 2 % with low productivity (2.6t/ha). Some farmers are coming forward to adopt HDP and fertigation. Rich company like Reliance Industry has established a big mango orchard (180 ha) in Jamnagar where the Hi tech mango culture has been adopted. This kind of favourable development is expected to help to enhance mango productivity in the state.

Kesar is a famous mango variety of Junagarh. "Brindavan Mango Farm" is located at the foot hill of Ginar Hill. Progressive farmer Mr M. Hirpura converted the poor hilly area into a mango orchard in 2002. Initially spacing adopted was 25x 25ft which he thought was too high. Therefore, he planted plants in between two rows to convert the spacing into 12 x 12ft. Varieties grown were kesar (mainly), Alphonso and Amrapalli. The per hectare plant population was 688 and yield obtained was mentioned in **Table 17**.

Serial no	Year	Yield obtained (t/ha)
1	3 <sup>rd</sup>	2.5
2	4th	5.0
3	5th	13.7
4	6th	16.2

Source (1)

### Success Story IV

Area under mango in Maharashtra (20%)

is as high as in AP but the average production (5%) and productivity (1.6 t/ha) are low. Irrigated area is low in the state. The state has therefore adopted dry land horticulture on priority. Alphonso is the most famous variety grown in the state and other varieties grown in the states are mentioned in the **Table 3**. Agriculture University located at Dapoli is engaged to promote the cultivation Alphonso variety of mango. Success story of adoption of HDP is mentioned below.

Jalgaon based Jain Irrigation System Ltd (JIS Ltd) is working in this state for the promotion of agriculture with help of promotion of Hi tech horticulture and agriculture in the country. The company has also established a mango orchard in 80 ha near Jalgaon town. It is imperative to make a mention here that on the basis of the recommendation of the chairman of the company two progressive farmers of Jalgaon district namely Rajendra Patil and Hemchandra Patil were invited by Harvard Business School, USA, to attend International Seminar.(3) The participants of the seminars asked them a lot questions and they were very happy to reply the same. This is expected to boost the interest of the farmers of the area to adopt Hi-tech agriculture with greater vigor.

Samir Mule of district Aurangabad has a mango orchard of 7.2 ha. Spacing adopted was 18 x 18ft to get a plant population 335 in 1998. The average yield of variety Kesar in this area is 7.2 t/ha while Mr Mule obtained an average yield of 12.5 t/ha in the 11th year. Yielding started in 5<sup>th</sup> year.

### Success Story V

Karnataka has 6 % area, 10 % production and relatively high productivity (9.1 t/ha) of mango. The farmers of the states have started to adopt HDP. One such example is mentioned below.

Mr D Hegde of North Karnar district planted mango in 0.6ha. Varieties grown were Mallika and Alphonso. Spacing adopted was 15x 15 ft. The average mango yield in this area is 5.65 t/ha. In this case

the yield obtained was 10t/ha, the yielding started in the 4<sup>th</sup> year.

The above discussion indicates that though, the farmers belong to different weather, soil, and management conditions, obtained in general higher yield in High Density Planting (HDP). It is imperative to make a mention here that varieties like Totapuri, Banganjapalli, Neelam are higher yielder than Ratna. Mallika are medium yielder while Alphonso is low yielder.

### CORPORATE SECTOR

In addition to the individual farmers, corporate sector has also come forward to establish HDP orchards in different parts of the country. Some examples are given below.

#### I) Jain Irrigation System Ltd (JIS Ltd)

JIS Ltd is engaged in manufacturing the production like drip irrigation systems, sprinkler irrigation systems, automation systems, valves, water filter, fertigation equipments, green houses, plant tissue culture, Nursery plants and systems, bio fertilisers, processed food, fruit processing, onion and vegetables dehydration, PVC pipes and pipe fittings, PE pipes and pipe fittings, SWR pipes and fittings, Plastic products, PVC sheets, renewable energy, turnkey project services, agriculture and engineering consultancy etc. It also provides solution and services to small farmers, urban house hold, urban housing, community development, mining industry, plant tissue culture, chemical industry, sugar industry, oil & gas exploration, optic fiber ducting, advisements, landscaping, greenhouses, watershed development, waste land development, farm production & management, fruit and vegetable processing and so on.

JIS Ltd has established “Jain Model Integrated Watershed” about 7 Km from Jalgaon town on Pachora Road. The objective of the project is to use each drop of rain water in the watershed for the gain full cultivation of crops to make the project

economically viable and profitable venture. Mango was selected as a crop whose water requirement is very low. About 50 percent area (80ha) of the watershed is occupied by mango.

Planting started during 1996-97 with a spacing of 10 x10 and 12 x12 ft against the traditional planting with a spacing of 12m x12m.

It is imperative to make a mention here that Mr. Jain got the idea from a scientist of South Africa in 1990. The scientist ultimately became a mango farmer in due course of time. The yield obtained in the farm is mentioned in **Table 18**.

Table 18 – Yield (t/ha) obtained in JIS Ltd farm			
Age of plant	Var: Totapuri	Var : Ratna	Var: Kesar
5 <sup>th</sup> year	8.25	2.75	5.25
6 <sup>th</sup> year	13.75	7.75	9.00
7 <sup>th</sup> year	18.75	9.00	9.00
Source (1)			

It is nice to mention here that this success story motivated many farmers to start HDP Mango orchards.

#### II) Reliance Industries Ltd (RIL)

RIL is the largest industry in private sector in the country. It started with textile and now it is in the many key sectors of Indian economy.

It had established a mango orchard with an area of 180 ha in Jamnagar area of Gujarat. The planting geometry adopted and plant populations obtained are mentioned in **Table 19**.

Table 19 – Spacing and plant population		
Serial number	Spacing (m)	Plant population
1	5X3	675
2	6X2	865
3	6X3	555
Source (1)		

The orchard plants are 7 to 12 years old.

The variety grown was mainly Kesar. The yielding started from 4<sup>th</sup> on ward. The yield obtained now is about 17-20 t/ha while average yield of Kesar obtained in the area is about 5-7t/ha.

### CONCLUSION

Traditional planting method, poor management of the orchard, low or no use of plant nutrients, improper irrigation or no irrigation, use of low yielding old varieties, problems of alternate bearing of mango trees, etc are some of the important reasons of declining mango productivity in the country. Adoption of HIGH DENSITY PLANTING with hybrids and high yielding varieties, use of fertigation, better management of the orchards, use hormones to induce flowering and fruiting etc result in higher mango productivity which can be considered to a revolution in mango production. Interestingly some farmers have come forward to adopt the high tech mango culture. Contribution of some companies like Jain Irrigation System Ltd and RIL are also worthy to mention in this respect.

### FUTURE LINE OF WORK

1. Mango farmers are still following traditional mango cultivation. They are, therefore, to be trained in Hi-tech mango cultivation, which includes adoption of high-density planting, use of fertigation etc.
2. Alternate bearing of fruits in mango tress is serious problem, which has to be solved through proper application of suitable hormones.
3. Of late, many orchard owners are renting their orchards to the businessman. In this case neither the owner of the orchard nor the businessman is interested to make investment on application of plant nutrient and irrigation water. Horticulture department of state government, agriculture universities, ICAR institutes and KVK should take initiative to motivate the orchard owners through the visit to orchards, which adopted hi-tech mango

culture technique.

4. Hi-tech mango culture technique has not reached the majority of the farmers of the country. Therefore large-scale demonstrations of the techniques have to be laid out in different parts of the country.

5. There is a lack of adoption of proper harvesting techniques among the mango farmers. Therefore they have to be trained to adopt the proper methods of harvesting.

6. Keeping quality of many mango varieties is very poor. Keeping quality of mango through treatment of ozone gas in the container of mango can be enhanced. Government should therefore encourage the agencies to perfect the technologies so that the farmers can harvest the benefits of these techniques.

7. There is a shortage of cold storage to

store mango. Therefore government agencies are to take initiatives to develop the sufficient number of cold storages in the country to store the mango fruit and sell the same in the off-season to get higher price.

8. Plant nutrient management in the mango orchard has not been given adequate attention by the scientists. Therefore, concerned agencies need to provide needed attention to develop proper plant nutrient management techniques. If needed tracher techniques may be employed to find out the suitable techniques.

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