

**INTEGRATED PROJECTS ON RESTRUCTURING,
POST HARVEST MANAGEMENT AND MARKETING
OF APPLE GROWN IN ARUNACHAL PRADESH
(Final Report)**



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TITLE OF THE STUDY

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EXECUTIVE SUMMARY

The horticulture sector has emerged as an economically rewarding and most viable option in diversification of agriculture. It offers a wide variety of crops suitable for cultivation under different agro-climatic conditions and terrain with possibility of multi-tier cropping system, thus enhancing the returns per unit of land area, generating employment and providing food and nutritional security. The shift in dietary patterns with preference for vegetarian food has led to increased focus on the horticultural crops. In the overall scenario of agricultural development, horticulture sector has a prominent place, contributing 24.5% of agricultural GDP from 8.5% area. It is estimated that systematic development of the sector can generate more than Rs. 35,000 crore of private investment and Rs. 180 crore of man-days of employment during the X-Plan period.

The Project Area

The project area of the present assignment is the state of Arunachal Pradesh in India that is located at the north-eastern corner of India. It has international borders with Bhutan in the west, China and Tibet in the north and Myanmar in the north-east, besides having state borders with Assam and Nagaland in the south. The state of Arunachal Pradesh lies between the North latitude of 26⁰28' to 29⁰30' and East longitude of 90⁰30' to 97⁰30'. The state has a geographical area of 83,743 sq. km with a total population of 10,91,117 (2001 census). The ratio of urban to rural population is 20:80. The state is divided into 15 (fifteen administrative districts namely:

Tawang	West Kameng
East Kameng	Papumpare
Lower Subansiri	Upper Subansiri
West Siang	East Siang
Upper Siang	Upper Dibang Valley
Lohit	Tirap
Changlang	Kurung Kume
Lower Dibang Valley	

There are 38 sub-divisions, 59 blocks, 149 circles and 3649 villages in the state.

Apple Production in Arunachal Pradesh- Present Status

Arunachal Pradesh is the only major apple producing state outside the north-western hill region in the country. Though apple orchards are found in three of the four horticultural zones of Arunachal Pradesh mentioned earlier (namely, Mid Hills, High Hills and Rain Shadow Area), not all of them are accounted and it is the West Kameng, Tawang and Lower Subansiri districts where most of the orchards are located.

Fruit growers in the higher hill region of the state, particularly in the Kameng district have been producing apples, which are known for their good quality. The area under the crop has not changed much over a period of time. There was slight improvement in production/productivity, but it has come down to around 1.3 MT/ha, which is much less than that observed in other apple growing states. This is due to several reasons, which have been discussed later in this report.

Reported Area and Production of Apple in Arunachal Pradesh

The following table provides information of the reported area, production and productivity in the state of Arunachal Pradesh.

Apple production in Arunachal Pradesh

Year	Area (ha)	Production (MT)	Yield (MT/ha)
1991-92	5100	9300	1.82
1992-93	5336	9720	1.82
1993-94	5523	9730	1.76
1994-95	5709	9250	1.62
1995-96	5970	12993	2.18
1996-97	6186	14500	2.34
1997-98	6370	15225	2.39
1998-99	6477	15986	2.47
1999-00	6601	8265	1.25
2000-01	6733	8513	1.26
2001-02	6852	8588	1.25

Source: State Directorate of Horticulture

Though the above table presents a fairly good status of apple production in the state, in reality that is not so. In fact in most of the areas reported, apple orchards are very old and apple produced in those orchards cannot be used for human consumption. Apple from these areas is mostly used for consumption by domestic animals. Hence, the growers are gradually felling the old plants and planting new plants in these areas. This was revealed by the growers and also the field-level department officials during field survey by the various teams of AFC.

District- wise apple production in Arunachal Pradesh

District	Total Area (ha)	Production (MT)
West Kameng	575.00	131.00
Tawang	84.12	43.66
Lower Subansiri	16.67	19.50
Upper Dibang Valley	10.00	Negligible
Total	685.79	194.16

It is reported that productivity of apple in West Kameng district is in the order of about 4.00 MT/ha, whereas the productivity of apple in Tawang district is about 3.00 MT/ha. Productivity of apple in Lower Subansiri district is much lower and the same for Upper Dibang Valley district is not yet available since apple plantation in the district was started in 2001-02 only.

RECOMMENDATIONS

ESTABLISHMENT OF ORCHARDS

Land Preparation and Planting

Fertile sandy-loam to clay-loam soils with pH below 6.5 and free from water-logging conditions are suitable for establishing apple orchards.

In flat lands/valleys, square, rectangular or triangular planting may be adopted. In hill slopes, planting on contours or terraces is recommended. In shallow sloppy lands, small terraces (half-moon terrace) may be made to establish the plants and large scale disturbance of surface soil need to be avoided.

Planting of apple plants is done during winter months from the end of December to mid March. Planting is done in the centre of pits (1m×1m×1m cube or circle), prepared a month before planting. While refilling the pit, 50g of Aldrin powder (15%) is mixed with the soil.

After planting, the young plants are supported with stakes and basins are kept free of weeds. Mulching with dry grass or polyethylene is advisable. Irrigation is provided after planting.

Spacing

Spacing varies from species to species and depends also on the type of rootstocks used. For apple raised on seedlings of crab or other commercial varieties of apple, a planting distance of 6m×6m or 7m×7m accommodating 277-205 plants per ha is recommended. On clonal rootstocks like M4, M7, M26, MM106 a spacing of 4.5m×4.5m (555 plants/ha) is suggested.

For spur type varieties and standard coloured mutants of apple, high density planting on dwarfing rootstocks like M9, M4, M7 and MM107 has been found to be feasible. Fruit yield of 30-35 MT/ha has been achieved in 12-year old orchards of colour mutants of apple on MM106 under a planting density of 2222 plants/ha (3m×1.5m) in cooler hills of H.P. Spacing recommended for apple are shown in Table 12.1.

Optimum plant spacing for spur types and standard colour mutants of apple

Type	Rootstock	Spacing (m×m)	No. of trees/ha
Spur Type	Seedling (Crab)	5×5	400
Spur Type	MM111, MM109	4×4	625
Standard Type	MM106, MM109	5×5	400
Spur Type	MM106, M7	3×3	1111
Standard Type	M9	2×2	2500

Source- Awasthi, R. P. and Chauhan, P. S., 1997. Apple and Pear. In: 50 years of Crop Science Research, ICAR Publication, New Delhi.

Care and Management of Orchards

Training and pruning

Modified central leader system of training has been recommended for apple on seedling rootstocks. The proportional heading back and thinning out system of pruning is adopted after the juvenile phase of plant growth. Spur pruning encourages vegetative growth and helps in new spur development in old plantations. For high density planting on semi-dwarfing and dwarfing rootstocks spindle bush, dwarf pyramids and cordon system of training are suggested. Spindle bush on M7 and modified central leader on MM106 rootstocks are successful.

Manures and fertilizers

Nutrient requirement varies from place to place. In Arunachal Pradesh sporadic cases in deficiencies of N, P, K, Ca, Mn, Zn and B have been reported. A fertiliser dose of 700:350:700 g of N, P and K for full grown bearing apple tree has been recommended. It has been observed that VAM (Vesicular arbuscular mycorrhizea) fungi increases P uptake by apple roots. The following corrective measures for nutrient deficiencies have been suggested for apple (Table 12.2).

Corrective measures for nutrient deficiencies in apple

Elements	Chemical and Dose	Time of Spray
N	Urea, 5.0%	Pre-petal fall
Ca	Ca Cl ₂ , 0.5%	30-45 days before harvest
Zn	ZnSO ₄ , 0.5%	After petal fall
Mn	Mn SO ₄ , 0.4%	After petal fall
B	H ₃ BO ₃ , 0.1%	Before bloom and after bloom

Weeding and mulching

In apple orchards, grass mulching (10cm thick) with one application of post-emergence herbicide Glyphosate (0.8 kg/ha) has been found to be effective. The shrubby weeds, however, could be best controlled by 500 ppm of Gramaxone+100 ppm of 2,4,5-T application.

Moisture conservation in soil is maximum under grass-mulching and therefore, recommended for apple in A.P.

Supplementary irrigation

Trickle irrigation at 75% of field capacity results in better tree growth and higher fruit yield in apple when raised on semi-dwarfing rootstocks.

For apple, most critical period of water requirement is April to August and peak water requirement is just after fruit set. A total depth of 114 cm of water during a year through 19 irrigations has been recommended.

Drip irrigation saves water considerably. Field trials indicate a total irrigation requirement of 3,840 litres of water per tree under conventional system of irrigation. But under drip system 1,695 litres of water is enough. The application efficiency under drip system is about 2.27 times than that of conventional system.

Pest and disease control

Pests-

In apple, about a dozen pests are causing serious damage to the crops. Most important ones are- San Jose Scale, Woolly apple aphid, Root borer, Blossom thrips, Codling moth and European red mite. San Jose Scale can be effectively controlled with eco-friendly miscible spray oils at 2% concentration when applied during February-March. Woolly aphids can be controlled through soil application of Phorate or Carbofuran granules during May and October/November. For codling moth, pheromone trapping is found to be effective and certain bio-control agents have also been identified in apple orchards for controlling certain insect pests.

European red mite is becoming a very serious pest for apple in H.P. and J&K. The scenario in Arunachal Pradesh is not yet exactly clear. The pest attack causes premature leaf fall. Late dormant sprays of miscible oil provide effective control of eggs. The mite can also be controlled by sprays of Dicotol (0.05%) followed by Malathion (0.05%).

Diseases-

Apple scab caused by *Venturia inaequalis* is a serious disease causing maximum economic loss. A sound forecasting and early warning system has been developed for prediction of scab attack, which should be adopted for Arunachal Pradesh too. Also, a judicious fungicide spray schedule has been devised. Under high disease pressure, systematic fungicides performed better, while under low disease pressure Ergosterol biosynthesis inhibiting (EBI) fungicides were as good as protectants. Ascosporic inoculum produced by over-wintered apple leaves could be substantially reduced by giving post-harvest applications of Bavistin (0.1%) and EBI chemicals Penconazole(0.5%) and Flusilazole (0.01%) as preharvest fungicidal sprays control scab during storage.

Powdery mildew disease can be kept under check by pruning and spraying wettable sulphur (0.2-0.3%) or Karathane (0.05%) during dormancy, bud swell and petal fall stages.

Collar rot and white root rot diseases in apple occur mainly in poorly drained soils. Proper drainage of orchards and soil drenching with 0.1% Carbendazim for white root rot and with 0.3% Mancozeb or 0.3% Ridomil MZ for collar rot is effective.

Virus and virus-like diseases such as mosaic, chlorotic leaf spot, rubbery wood and others have been reported. Virus cleaning through tissue culture and supply of virus free bud wood material are being pursued to contain further spread of the viral diseases in apple.

Intercropping

As apple is grown in hill slopes, seasonal intercropping accompanied by working the soil is not encouraged in order to prevent soil erosion. Where slope of the land is more than 10%, various grasses and legumes should be grown as permanent covers. The tree basins should be kept clean and sod culture in the orchards should be practiced in the hills of A.P. The grasses should be regularly cut when they are 7-10 cm high and the residue be left in the orchards for decomposition. The cultivation of legumes and grasses as intercrop is becoming popular in orchards and should be encouraged in Arunachal Pradesh too. The important legumes are red clover (*Trifolium pratense*), white clover (*T. repens*) and lucern (*Medicago sativa*). Among the grasses, orchard grass (*Dactylis glomerata*), fescues (*Festuca arundinaceae*) and Timothy (*Phleum pratense*) are common. Orchard grass is grown where moisture is high, while fescues is suitable for dry areas or southern aspects. In apple, sometimes filler trees of peaches or dwarf apple plants are grown.

At the young age of orchard plantations, vegetables like cole crops, potato and tomato are grown to supplement the income. However, this practice should be abandoned when the orchard starts bearing after 5-7 years to avoid competition..

Harvesting and Yield of Apple

Maturity standards

In apple, the number of days taken from full bloom to harvest are 132-134 days for Starking Delicious, 138-140 days for Red Delicious and 147-148 days for Golden Delicious varieties in the high hills (above 2000 m). In Jammu and Kashmir, the variety Maharaji requires 160 ± 3 days after full bloom for proper harvest maturity. Apple cultivar Granny Smith takes 180 ± 5 days for maturity. The maturity standards for different cultivars of apple are given in Table 12.3.

Maturity indices for commercial cultivars of apple

Cultivar	Days from Full Bloom	Firmness (kg)	TSS (%)
Royal Delicious	125 ± 5	8.2 ± 0.40	13.0 - 15.0
Red Gold	122 ± 3	8.3 ± 0.20	12.0 - 13.5
Red Delicious	134 ± 5	8.4 ± 0.40	10.0 - 14.0
McIntosh	135 ± 4	6.8 ± 0.25	11.5 - 13.5
Golden Delicious	148 ± 6	8.4 ± 0.40	12.0 - 14.5
Granny Smith	180 ± 5	8.7 ± 0.30	11.5 - 13.0

Fruit drop control

Pre-harvest fruit drop in apple could be effectively checked with the application of 10 ppm of NAA 20-25 days before harvest. Pre-harvest fruit drop is quite serious in early ripening cultivars like Tydeman's Early, Red Gold and Pippins, where loss of 40-60% crop load is often experienced. Mid-season Delicious group cultivars also experience about 15-20% loss.

Colour development and enhancement of ripening

In apple, fruit colour development in warmer and lower (below 1800 m) elevations is generally poor. Application of Ethephon (2-chloroethyl phosphonic acid) about 10 days before harvest improves red colouration. Induction of early maturity by 7-10 days in mid hills situations could be achieved through an application of 500 ppm of Ethephon +10 ppm of NAA 3 weeks before harvesting. Two pre-harvest sprays of 0.5% CaCl₂, followed by a 0.03% surfactant like Tween 20 for 1-2 minutes have been recommended for better shelf life of apple.

Fruit thinning

In apple, for obtaining better grade of fruits of optimum size, a post-bloom spray of 100-200 ppm of Ethephon 2-3 weeks after full bloom has been recommended.

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