INTEGRATED PRODUCTION STANDARDS

"SWAT VALLEY APPLE"

PAKISTAN

1. CHOICE OF ENVIRONMENT AND GROWING SUITABILITY

The evaluation of the soil and climatic conditions of the cultivation area is of fundamental importance in reference to the requirements of the crop. The choice shall be particularly accurate in introducing new crops and/or varieties in the cultivated environment.

1.1 Soil

Apple trees adapt to different types of soil, tolerating both lime and clay soils, although the best soils are deep, permeable and have good fertility. Apple trees tolerate up to 12-15% of lime so long as the soil is well drained. The preferred pH values are between 6.5 and 7. Soils with a pH under 5.4 and greater than 8.8 and with a salinity greater than 2 dS/m should be avoided.

Recommended soil parameters

Determination	**Approximate reference values**
pH	6.5-7.5
Tissue	average consistency
Total lime	2-10%
Active lime	< 10%
Organic Matter	from 1% for sandy soils in 3% for clay soils
Total nitrogen	
Available phosphorus	10-20 ppm (Olsen) 20-40 ppm (Bay-Kurtz)
Cation exchange capacity (C.S.C)	from 10 to 20
Exchangeable potassium	70-120 ppm with C.S.C.<10 100-200 ppm with C.S.C. from 10 to 20
Exchangeable sodium	100ppm
Exchangeable calcium	800-1800 ppm with C.S.C.<10 1500-3500 ppm with C.S.C. from 10 to 20 3000-6000 ppm with C.S.C.>20
Exchangeable magnesium	70-120 ppm with C.S.C.<10 100-180 ppm with C.S.C. from 10 to 20

1.2 Climatic requirements

Temperatures in autumn and early winter must be such as not to cause damage from frost and allow bud dormancy to take place. With regard to the cold requirement in winter, most of the cv require on average 600/800 hours where the temperature remains within 7.2° C.

2. VARIETAL CHOICE AND PROPAGATION MATERIAL

2.1 Choice of varieties

The varietal choice must be performed by evaluating the specific soil and climatic conditions for cultivation. In general, once the fitness of the environment is verified, the choice will be made by preferring the cultivar most widely accepted by the market for the qualitative features of the fruit. The variety and/or varietal groups recommended for the "*Swat Valley Apple*" are: *Gala* group*, Red delicious* group*, Golden* group*, Toor Kulu, Braip Cupush, Booni Cupush.* The cultivation of varieties of or issuing from Genetically Modified Organisms (GMOs) is not permitted.

2.2 Selection of rootstock

When planting the orchard, the choice of rootstock is of fundamental importance for the adaptation of the cultivar to the different soil, environmental and agricultural conditions so as to ensure the optimum success of the plants. The rootstocks considered most suitable are :

- **M111**: It adapts well to various soil types, particularly those dry and limey. Average susceptibility to root asphyxia and wooly apple aphid (*Eriosoma lanigerum*), it is very resistant to cold winters. Slightly sensitive to *Phytophthora* spp. stimulates medium-high to high vigour and consistent high productivity;
- **M 9**: prefers fertile soils with good water availability. It is ill-suited to soils subject to waterlogging and those with water deficits. Not sensitive to *Phytophthora* spp. It is the retardant rootstock par excellence and induces early fruiting and high, consistent productivity;
- **M 26**: prefers land not subject to waterlogging. Average sensitivity to *Phytophthora* spp. It is a retardant rootstock but more vigorous than M 9.

2.3 Selection of pollinators

Since apple varieties are unable to self-fertilize, intercropping cultivars with two or three intercompatible main varieties that flower simultaneously is indispensable. In the *Swat Valley* for pollinating the *Red* group, it is recommended to use some varieties of the *Golden* group, for the *Gala* group instead, to use the local variety *Spartan.*

2.4 Selection of planting material

The propagation material must be of good agricultural and sanitary quality.

In the case of grafted plants, if this involves grafts "with dormant bud", plants with a good root system are recommended, at least one rooted bud and with a diameter at 10 cm from the collar of not less than 1 cm.

Whips are also recommended, well rooted, perfectly intact, possibly branched, with woody part not less than 100 cm, graft point between 10 and 30 cm from the collar, and minimum diameter above the graft point of at least a 1.2 cm.

3. SYSTEMISING AND PREPARING SOIL FOR PLANTING

3.1 Works for the system

In the case of new plantings, the first operations to be performed, only if necessary, are clearing rocks and levelling. If levelling is performed, movement of the earth is limited to avoid compromising the fertility of the layer explored by the roots or the slope stability. If the levelling involves large amounts of the active soil layer, it is advisable to set aside the topsoil and then redistribute it onto the surface after the levelling.

In hilly areas, where there is a high risk of erosion, it is important to provide suitable systems depending on the type of soil management.

Slopes up to 10% must have a unified cross systemisation, which consists of having crosswise rows and performing the work along that direction. With gradients of 10-20%, operations must be performed crosswise. When the slope is greater than 20%, it is advisable to systemise in *rittochino*, which consists of positioning the rows and carrying out cultivation operations according to the line of the maximum slope. In this case the no-till technique is appropriate and especially turfing.

The work on said system begins with digging the holes in correspondence to the points for setting the plants of the size of 0.8-1 x 0.8-1 m with a depth of 0.8-1 m. Then it is recommended to make a base fertilisation with seasoned manure. The hole is then covered by filling to the bottom with surface soil. The best time for performing the work is the summer or early fall, depending on the weather conditions.

It is preferable, when possible, to set out the plants in late autumn - early winter, because this reduces transplant stress. Spring planting, on the contrary, in the case of dry springs can compromise the grafts and emergency irrigation is required.

3.2 Systems and planting distances

In rational systems, the trees are distributed according to a geometrical arrangement to form rows parallel to each other and with areas between rows which allow the transit of people and machines.

The planting distances and forms of cultivation aim at obtaining fruits with high quality and high productive capacity of the orchard. In principle the forms must be chosen that allow maximum light penetration in all parts of the foliage and that facilitate all the cultivating operations (pruning, thinning, harvesting). The currently prevailing tendency is to obtain plants with higher density, with forms of cultivating that are freer, allowing a more rapid entry into production, but which provide a shorter production cycle.

The recommended planting distances are 5x5 or 6x6 depending on the vigour of the cultivated plants.

3.3 Replanting

Replanting should normally occur after 30 years.

Before replanting it is appropriate to:

- allow the soil to rest for at least three years, during which time it is extensively cultivated or manured;
- remove the roots left from the previous crop;
- perform a rich fertilisation with organic matter;
- place the new plants in a position different from the previous ones;
- use suitable rootstocks.

4. MANAGEMENT OF THE TREE AND FRUITING

4.1 Pruning

The cultivating pruning is performed with certain cutting styles depending on the cultivation system used.

Production pruning regulates the vegetative and productive activity of the plant. Its proper execution requires knowledge of vegetative habits, but especially the productive habit of the different cultivars. It is normally carried out once a year during the winter. Topping during the growing season is not normally done but it would be recommended.

4.2 Thinning the fruits

This operation is recommended in order to obtain fruits of high calibre, with good organoleptic characteristics and to control the alternation of production.

The time for performing this and the thinning amount are related to the size and dynamics of the natural flower drop of the apples. The extent can be determined as depending on the production per hectare that is desired, the desired calibre and the plant density.

5. SOIL MANAGEMENT

Soil management and the related processing techniques are aimed at improving the conditions for crop adaptation to maximise the production results, help control weeds, improve nutrient efficiency by reducing losses through leaching, runoff and evaporation, keep the land in good structural condition, prevent erosion and landslides and

preserve the organic matter content and help rainwater and irrigation penetration. Controlled turfing is recommended for the inter-row areas (understood also as spontaneous vegetation managed with mowing).

6. FERTILIZATION

Setting up a proper fertilisation schedule must take into account the characteristics of the species, the variety, the physical and chemical fertility of the soil and soil management, bearing in mind that the mechanical works determine, in general, a reduction of organic matter in the topsoil and turfing creates a more complex and more demanding agricultural system. It should also be noted that the nutritional requirements vary depending on the age of the plant and its production capacity. Applications are thus conditioned by the climate and the availability of irrigation water.

This operation, carried out before planting the orchard, can involve the entire surface or may be localised in the vicinity of where the future holes will be for planting the seedlings from the nursery. It should be done before the planting and allow incorporating soil improvers. Considering the small needs of the crop in the early years of planting and the processes of leaching and insolubility which fertilizers involve, adding mineral fertilisers of nitrogen, phosphorus and potassium at this stage should be avoided, especially if the orchard is equipped with a fertigation system, or, they could be limited to satisfying short term needs and eventually to reach the minimum fertility threshold required by the species.

Before the plants are set out, they should not be given nitrogen fertiliser; at this stage instead it is necessary to focus on the enrichment of soil with organic matter by using, in the planting year, a green manure, or burial of seasoned manure in the hole dug at the time of planting. To determine more correctly the base fertilisation, a physical and chemical analysis of the soil should be made. For each homogenous plot, at least the following parameters should be determined: the skeleton, texture (sand, silt, clay), pH, total lime, active lime, total nitrogen, available phosphorus, exchangeable potassium, organic matter, exchangeable calcium, exchangeable magnesium, cation exchange capacity, and exchangeable sodium.

The production fertiliser must keep the nutrient availability in the soil proportional to the needs of the plant in the different phoenological stages to achieve a balance between vegetative and productive growth. It must be made on the basis of removals, water availability and soil analysis.

Removals depend on the production, destination of the pruning residues and the overall management of the system, such as the presence or absence of turfing, operations of green manure, irrigation with groundwater etc.

In this case also, nitrogen is the element to which the plant reacts the most; the more fractionated its contribution, the more efficient the response of the plant will be; it must be contributed annually, in a fractionated manner.

It is advisable to distribute inorganic fertilizers with a base of nitrogen, phosphorus and potassium in early spring, 20 days before flowering. Organic fertilisation is recommended if is carried out in late autumn or early winter.

METHOD FOR ASSESSING IRRIGATION REQUIREMENTS

The method for assessing irrigation requirements is based on the calculation of the product between the evapotranspiration reference **ETo**, which depends on climatic conditions, and the crop coefficient **kc** which is a measure of the vegetative development of the crop in different phoenological stages, net of rain contributions **P**:

$$\mathbf{ETo * kc - P}$$

Crop coefficients (kc) per month of the apple tree as a function of the methods of soil conduction (soil covered with grass or bare soil)

	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
S. turfed	0.83	0.98	1.11	1.21	1.23	1.23	1.16	0.93	0.83
S. worked	0.55	0.75	0.90	0.95	0.95	0.90	0.86	0.83	0.70

For the determination of ETo, the values of the maximum temperature (**Tmax**) and minimum temperature (**Tmin**) must be used according to the following formula:

$$\mathbf{ETo = (9.862+15.120 * Tmax - 9.028 * Tmin) / 1000}$$

The value thus obtained shall be multiplied by:

(0.76 n + 55.20)	**from 1 January until 15 June**
(-0.70 n + 299.97)	**from 15 June to 31 December**

Where **n** is the day of the Julian calendar (1 January = 1, 1 February = 32 ...., 31 December = 365).

The irrigation operations must be carried out when the sum of the daily data for (**ETo * kc – P)** reaches the predetermined value of **Irr**, i.e., the maximum water volume (expressed in m3/ha), which will be defined by the daily total, as expressed below:

Irr = daily total (ETo * kc – P)

Maximum amounts of water (Irr) in relation to the type of soil:

Soil type	cubic meters per hectare (m3/ha)	equal to millimeters
Sandy soil	350	35
Loamy soil	450	45
Clay soil	550	55

The irrigation method generally used in *Swat Valley* is surface streaming (*Flood* and *Basin*). In modern orchards it is possible to irrigate following three methods: by the sprinkling of average rainfall; drip microirigation, and spray. The choice of method does not affect the quantitative and qualitative response of tree crops. In fact, the maximum production can be achieved with each of the methods, provided they are properly used.

The sensitivity of tree crops to salinity levels will vary depending on several factors; among these, the species and the rootstock are particularly important. EC values between 1 and 2 cause more or less mild damage, while values greater than 2 cause serious damage to almost all species.

8. PLANT HEALTH DEFENSE

8.1 Fungal and bacterial diseases

Adversity	**Intervention criteria**	**Recommended products**
Apple Scab (Scab): *Venturia inaequalis*	Agronomic measures: limit the presence of fallen foliage; ensure adequate ventilation inside the tree top; choose resistant varieties Chemical measures: treatments during the dormancy period to reduce the inoculums and with a cycle starting from vegetative growth. Stop treatments or reduce them significantly after the set phase of the fruit if there were no scab attacks.	Fenarimol Thiophanate methyl Products with copper base
Powdery mildew (*Podosphaera leucotricha, Oidium farinosum*)	Agronomic measures: during the winter pruning remove the twigs with covered buds and in the spring-summer remove the affected shoots Chemical measures: on the more susceptible varieties in areas of higher risk and intervene preventively right from pre-flowering, while in other cases wait for the appearance of the first symptoms	Thiophanate methyl Difenoconazole Trifloxystrobin Pyraclostrobin
Crown rot (*Phitophtora* spp)	Agronomic measures: avoid stagnant waters and promote drainage Chemical measures: localised interventions only	Fosetyl aluminum Metalaxyl M

	in the affected areas after vegetative growth.	Copper products

8.2 Phytophagous insects

Adversity	**Intervention criteria**	**Recommended products**
Codling moth: *Cydia pomonella*	Threshold for intervention: 2 adults per trap caught in 1 or 2 weeks. Where possible, privilege control strategies based on methods of sexual confusion or disorientation	Sexual confusion Disorientation Spinosad Etofenprox Chlorpyrifos ethyl Granulosis virus Diflubenzuron (**) Flufenoxuron (1)
San Jose Scale (scale): *Comstockaspis perniciosa*	Threshold for intervention: presence of the pest Period of intervention: treatment with mineral oil during the winter. If needed in the spring operate during the mating season and/or the appearance of the first generation Agronomic measures: good management of pruning, brush the trunk and branch in the presence of scales, turfing between the orchard rows	Mineral oil Surf+backing soda+mustard oil Calcium polysulfide Chlorpyriphos methyl Pyriproxyfen
Red spider mites (mites): *Panonycus ulmi*	Thresholds for intervention: in the absence of predators: 5 mobile forms per leaf, in the presence of predators (e.g., predatory mites, stethorus): 10 mobile forms PER leaf	Various acaricides: Clofentezine Pyridaben Etoxazole Exitiazox Etc.

9. HARVEST

The taste quality, appearance and good preservation of apples depend on harvesting.

The traditional method to establish the correct harvest period is carried out by the producers through a visual and gustatory check. To determine the optimal time of harvest, it is necessary to use certain assessment criteria:

a) Colour of the epidermis

The colour of the epidermis of the apples is evaluated by a comparison to special colourimetric cards developed for the main cultivars.

b) Hardness of the pulp

The compactness of the pulp is measured through the evaluation of the resistance to the penetrometer.

c) Starch test

The starch content in the pulp is evaluated by colourimetric means using a solution of iodine-potassium iodide (1 g of potassium iodide and 0.25 g of metallic iodine dissolved in 100 cc of distilled water). The cut surface of the fruit cut crosswise through the middle is placed in contact with the solution. On the basis of what colour the pulp turns and from a visual analysis of the areas where this staining occurs, the degree of development of the starch transformation into sugars can be assessed, and thus the progress of maturity. The harvest must be performed before the starch is processed into sugar. The table below shows the values of the iodine test for different cultivars:

d) Refractive index

This parameter also gives indications on the content in sugars.

Table A - Indices of maturity and quality parameters of apples at harvest.

CULTIVAR	STARCH (Cat. 1-5)	RSR (%)	HARDNESS (Kg/ 0.5 cm^2)	ACIDITY (Meq/10 ml)
Red Delicious group	3	12	5.5	0.6-0.77
Gala group	2.5	10-12	5	1.09-1.56

Each lot must be identified at all stages from harvesting to marketing to allow traceability.