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MAHAWELI ENTERPRISE DEVELOPMENT

MED/EIED PROJECT

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FIELD MANUAL
FOR
CULTIVATING PROCESSING TOMATOES

A short-term consultancy report
by
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Report 2/1992

INTERNATIONAL SCIENCE AND TECHNOLOGY INSTITUTE, INC.

WITH :

ERNST & YOUNG CONSULTANTS (Sri Lanka)
DEVELOPMENT ALTERNATIVES, INC.
HIGH VALUE HORTICULTURE, PLC.
SPARKS COMMODITIES, INC.
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CONSULTANTS TO THE MAHAWELI AUTHORITY OF SRI LANKA

The Mahaweli Enterprise Development Project

The Government of Sri Lanka and the international donor community have given high priority to the development of the natural and human resources of the Mahaweli river basin. The first phase of this development, the construction of dams, irrigation and power systems, roads and other physical infrastructure, is largely complete. The second phase, settling the land and forming an agricultural production base, is well under way. The third phase, the major challenge for the 1990's, is the building of a diverse and dynamic economy, improving employment and income prospects for Mahaweli settlers and their families. In this phase the private sector has a leading role to play.

The Mahaweli Enterprise Development Project (MED) is a USAID-supported initiative of the Mahaweli Authority of Sri Lanka to promote investment and business development in agribusiness, manufacturing, tourism, minerals and services. MED directly assists small, medium and large-scale investors with technical assistance, marketing support, training, business advisory services and credit. MED also provides policy assistance to improve access to resources, such as land, water and capital, and the legal and institutional framework for enterprise development.

The official MED implementing agency is the Employment, Investment and Enterprise Development Division of the Mahaweli Authority. The main MED technical consultancy is provided by a consortium led by the International Science and Technology Institute, Inc., a private consulting firm with head offices in Washington DC. Other firms in the consortium are Agroskills, Development Alternatives, Ernst and Young, High Value Horticulture and Sparks Commodities. Marketing services are provided by SRD Research and Development Group, Inc.

PREFACE

Mr Peter Florance, a tomato production agronomist is a MED consultant who is assisting Mahaweli investors in the development of processing tomatoes. He was in the field in Mahaweli Systems H and C during January/February 1992.

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	01
2.	VARIETIES	01
3.	NURSERY GUIDELINES	01
4.	GROUND PREPARATION, BED FORMING AND ROW SPACING	05
5.	PLANTING - DIRECT SEEDING AND TRANSPLANTS	07
6.	SUPPLEMENTARY FEEDING	07
7.	IRRIGATION AND USE OF SOIL PROBES	07
8.	MAJOR FACTORS THAT REDUCE CROP HEALTH	10
9.	WEEDS	10
10.	INSECT PEST CONTROL - KNAPSACK PUMPS AND SPRAY UNITS	12
11.	DISEASES OF TOMATOES CAUSED BY VIRUSES	12
12.	BACTERIAL WILT	13
13.	HARVESTING, CONTAINERS AND TRANSPORT TO FACTORY	13

FIGURES

1.	MARKER FOR SEED BEDS	04
2.	BED FORMATION	06
3.	SOIL AUGER	09
4.	HOES	11

INTRODUCTION

Tomato production for processing differs in many respects from production for the fresh market. To be successful it requires more exact management and precise cultural practices. Everything must be planned - varieties, soil, cultural methods including land preparation, proper irrigation, establishment of good seed beds and optimum stands, the role of pesticides and weedicides, disease control, and good sanitation. The new tomato grower must face many decisions - and mistakes can be serious.

All these factors must be considered in order to produce a consistent supply of good quality tomatoes for processing into world standard paste, and/or whole peeled, pieced or pulped tomatoes and juice for corning.

VARIETIES

Varieties for processing should have the following qualities:

a) Adaptability and good yield potential

b) Be resistant to Verticilium and Fusarium wilt diseases.

c) Be heat tolerant and hopefully in the future, tolerant or resistant to Bacterial wilt disease.

d) Have fruit with desirable processing factors, such as low pH, high soluble solids, good colour, flavour, and peelability, and consistency favourable solids/acid ratio and high Vitamin A and C content.

e) How fruit that is firm and can withstand rough conditions during transport.

NURSERY GUIDELINES

For the establishment of a nursery to grow open pollinated (O.P.) tomato seedlings for transplanting.

The nursery site should be free of pathogens, and this can be achieved by steam or chemical fumigation of seed beds, and/or by the use of fresh country. Depending on the soil type, a mixture of approx. 12% to 15% of coarse sand, 70% fine sand, and not too much silt is a suitable medium. Soil should have a pH of 6.5, and if possible samples should be taken and analysed. If organic fertilizer is used make sure that it is decomposed and worked well into the soil to a depth of at least 15 cms. If phosphorous is available, use as a basic fertilizer in preference to excess nitrogen.

The optimum size of nursery beds is 1.25 M. across the top, so that labour can work from both sides, and 15 cms in height. Good drainage is essential. The tops of the beds should then be marked into rows 15 cms apart with a wooden device called a "marker". This is fashioned from three pieces of timber 3.5 by 2.5 cms, boat-shaped on the underside and 1.4 M. in length. These are held together by four support timbers 14 cms in width by 50.6 cms long screwed to the marker timber at intervals for two workers to stand on. Their weight will make the indentations to take the seed. See diagram on page 3.

It is recommended that seed should be treated with seed-bed dust before planting to help control damping off, etc. Seed that has been dusted some time previously tends to lose vigour. Seed should be dropped into the depressions made by the marker at 1/2" intervals. Broadcasting seed is <u>not</u> a good practice. It should be said here that uniform maturity of fruit is one of the objectives when growing processing tomatoes, so that each seedling should be given a chance by spacing to grow without restriction. After dropping the seed is covered using a light rake, and is then watered by watering can or hose. water should be <u>clean</u> and not splashed from the furrow by hand.

To maintain even growth through the seedling stage, overhead feeding with liquid ammonium nitrate, calcium nitrate or urea is advisable. If urea is used as a side dressing, make sure it is <u>low</u> biuret. Regular spraying or dusting with an available insecticide will be necessary to prevent curly top virus due to white fly. If there is an infestation of this pest some protection for seedlings will be necessary. Shade cloth would be desirable as a cover for the seed beds.

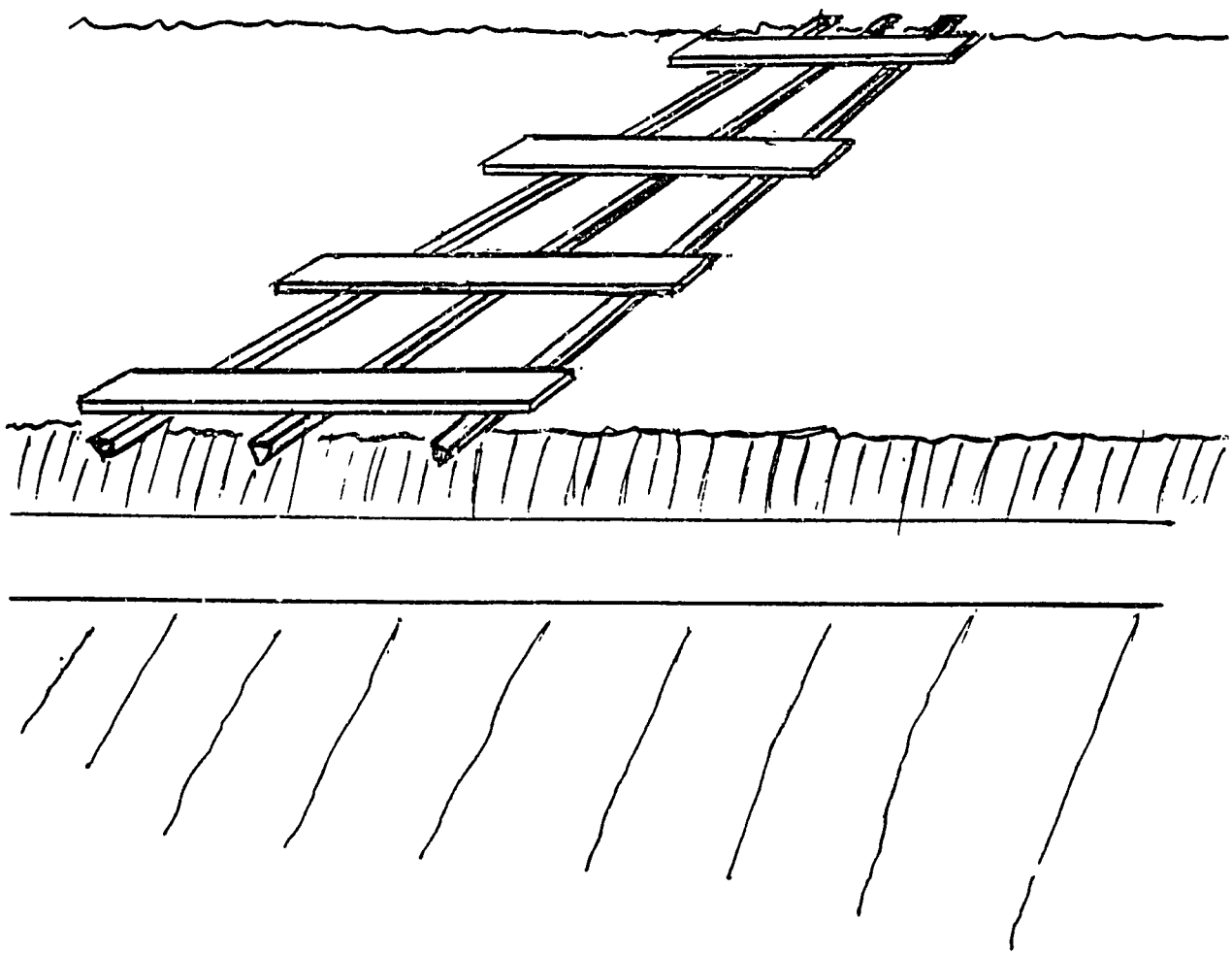
Good sanitation is critical when growing seedlings. Be as strict as you can with the labour force about hygiene. No smoking while handling tomato plants, or Tomato Mosaic Virus (TMV) is likely to occur. Ideally, implements should be sterilized before use. Any bacterial problems that appear should be treated with Shell chemical Kocide (copper hydroxide) which is much more effective than copper oxychloride.

A good seedling should be ready to transplant in 5/6 weeks, or possibly less time in higher temperatures. Transplant in the field at about the six leaf stage when the first clusters of flowers are forming. There should not be any open flowers on the plant, and the stems should be purple and hard. Seedlings should be pulled into <u>clean</u> containers for transporting to the field.

Growing seedlings in containers, e.g. plastic cells, seedling trays, etc.

Advantages	Disadvantages
No damage to root system when pulling, and therefore no transplant "shock" (Tap roots of O.P. seedlings are broken when pulled.) Seedlings are grown in a sterile soilless mix, which obviates weeds and some disease problems.	Financial cost is higher. Benches, containers are necessary

MARKER FOR SEED BEDS



NOTE: Rough sketch - not drawn to scale

GROUND PREPARATION BED FORMING AND ROW SPACING

Ground Preparation

If possible, pH testing and soil sampling should be carried out to ascertain if trace elements are needed. Soil should be within the moderate range of pH 6-5.5. Rotation of tomato culture with paddy might be helpful in controlling Bacterial Wilt. After paddy, deep ripping to break up the sodium layer caused by flood irrigation will enable tomato roots to grow unchecked, and incorporation of fibrous matter e.g. rice hulls, well decomposed poultry or farmyard manure, will provide humus and promote better penetration of water. Modern cultivation techniques are aimed at minimum tillage to prevent disintegration and consequent compaction of soil, so tyned implements give a better result than disc ploughs. It is important to eliminate weeds. Light growth can be controlled by hand hoeing and pulling, but those tough weeds e.g. Nutsedge that spread by underground rhizomes or root systems will need pre-watering and the spraying with a weedicide Sencor or Roundup, pre- or post-emergent, are excellent to control broadleaved weeds. Devrinol as a pre-emergent, will control grasses. Fusilade is for use when plants are 6/8" high.

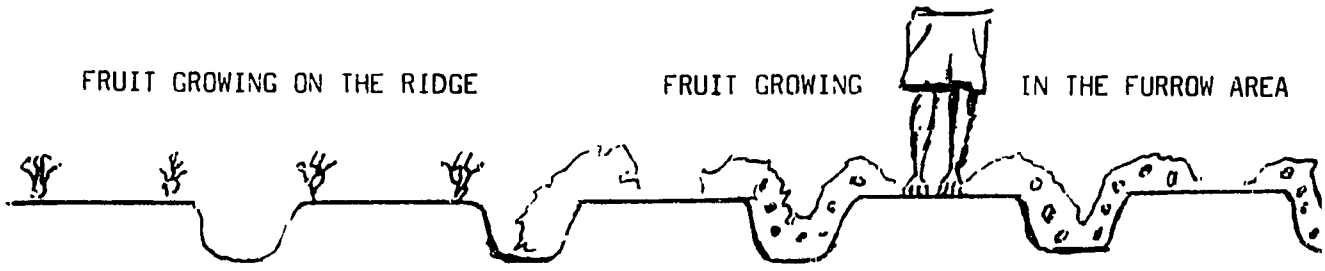
Basic fertilizer should be applied to tomato ground before seeding or transplanting at the rate of at least 100/150 kgs per acre of superphosphate. To give best results this should be incorporated into the soil. Fertilizer remains where it is placed, so it should be within the range of the root system of the growing plants, though not in contact.

Bedforming and Row Spacing

To get high yields we must strive to grow a vine that will provide a number of hands of tomatoes. This vine should sit on the ridge of the bed and not hang into the irrigation furrow where the fruit will be spoilt by fruit rots and breakdown. It is essential that labour is prevented from walking on the bed particularly when it is damp or wet, because this can cause compaction. This upsets the water/oxygen ratio in the soil and causes waterlogging of roots. Also, when the soil dries out it becomes baked hard and resists further penetration of water. Paddy farmers, who are used to flooding their crops, should be taught that tomato culture (and this applies also to peppers) demands a dry bed top with lateral penetration of water to the roots through the furrow. This requires a high bed, three (3) feet wide, with a furrow at least nine (9) inches deep to start with. Attention should be paid to the degree of slope of the land-that it is enough for drainage, but not too much to prevent even watering. It is recommended that the single row system should be used for planting which will enable beds to be moved over when the plant is large enough. This is called the sugar beet method.

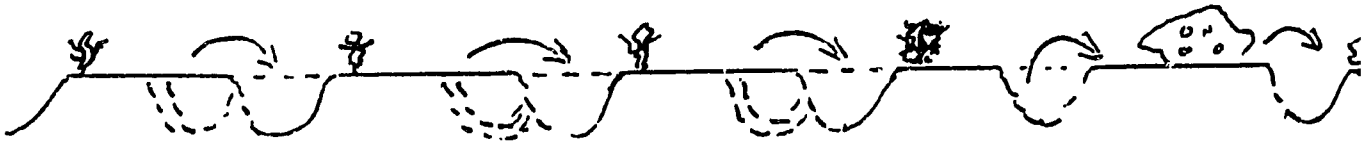
TRADITIONAL BED

TRADITIONAL BED :



ON THE RIDGE DOUBLE ROW

MOVING THE FURROW OVER



PLACEMENT OF SIDE DRESSING

SINGLE ROW PLANTING SUGAR BEET BED

SINGLE ROW PLANTING

PLANTING

Direct Seeding

This method has the advantage, if the soil is suitable and beds are well prepared of doing away with the need for a nursery. Seeds are dropped at nine (9) inch intervals in clumps of two to three (2/3). These three (3) seeds grow together and should not be disturbed. Do not broadcast seed. When the plants are at about the six (6) leaf stage the bed should be side dressed with nitrogen (Urea is the cheapest form) and then moved over. Stringent weed control is necessary in a successful direct seeding operation.

Transplants

In transplanting on the bed, the plant is placed on one side of the ridge at one (1) to one and a half (1 1/2) feet intervals, depending on tomato variety (large or small bush). When the plant is established, the furrow is moved over.

When transplanting open rooted seedlings the hole to receive them should be made with a "dibble" stick (about the size of a pencil) and the soil firmed around the plant. This is less harmful to roots than the method of "puddling" into the mud by hand.

In module plastic bag type planting or when using "seedling" from trays with cells, where the roots are not disturbed, "transplant shock" does not occur, and the plant is not vulnerable to infection through broken roots as can happen when open rooted seedlings are pulled. More uniform seedlings are produced by this method hence a more consistent yield.

SUPPLEMENTARY FEEDING

The plant takes up phosphorous in the first weeks of its life. Nitrogen is needed throughout to keep the plant healthy and growing, and can be applied in the form of Urea more than once, as needed, up to first fruit set. When the first fruit has formed, all fertilizing should stop. Added nitrogen from then on will only extend the growth of the vine and will not ripen or increase fruit size. It will also drop total soluble solids which need to be high in processing tomatoes.

IRRIGATION

An irrigation plan should be thought out before planting the crop. Irrigation is probably the most important practice in processing tomato production, and the most difficult to carry out successfully. There must be adequate water to supply the crop from start to finish, so size of areas should be considered in relation to availability. On the other hand, excessive irrigation can damage root systems and promote root diseases, reduce yields and adversely effect quality of tomatoes.

Generally, on sandy and sand-loam soils rows should be short, with significant fall. This prevents excessive water application as these soils have a high infiltration rate. On clay and light clay-loam soils infiltration is usually slow, so runs can be longer with a lesser grade. Dry cracked soil absorbs water quickly at first, but expands with moisture rapidly. Slow watering is more efficient than fast watering - it is not the speed with which it is applied but the speed at which it infiltrates the soils that counts.

Internal drainage of the soil is important for tomato crops. It is essential to get the water on and to get it off again. The soil should drain freely to a depth of two (2) feet within twelve (12) hours of the completion of irrigation or of heavy rain.

Sprinkler or spray irrigation is not recommended for the following reasons:

a) increased risk of fungus diseases, e.g. T.M.V.

b) damage to soil structure and vines which occurs when pipes and sprinklers are manually moved over wet tomato beds.

c) Rotary sprinklers unless they are very carefully positioned, water unevenly sometimes leaving dry spots.

d) Sprinklers working during the day suppress pollination of the tomato flowers

e) Sprinklers working during the day keep bed tops wet when fruit has formed promoting Botrytis and soil rots.

Finally, quality of water is important. Polluted or dirty water is unsuitable for irrigating tomato plants.

Use of Soil Probes in Irrigation

Soil probes for sampling moisture content to ensure that sufficient water is being applied are useful tools. Core samples should be taken from the upper two (2) feet of the bed at several places in each field, and the "feel" test applied (See Figure 3: Soil Auger below).

Coarse textured soils

Soil feels moist, forms a ball, and stainshand. Sufficient water.

Medium textured soils

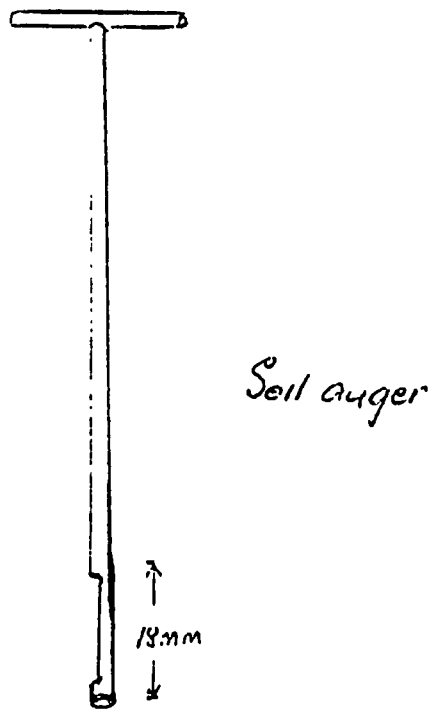
Soil dark and smooth, forms a ball and ribbons out between fingers. Sufficient water

Fine textured soils

Soil dark, may feel sticky, stains hand, and ribbons easily when squeezed. Sufficient water.

Soil probes or augers could be manufactured locally (if they are not already available) or can be procured from India.

SOIL AUGER



MAJOR FACTORS THAT REDUCE CROP HEALTH

a) Plant pathogens

Cause a variety of diseases, i.e. fungi, bacteria, viruses and nematodes.

b. Insect pests

1) cause damage from feeding
2) are vectors for virus and bacterial diseases

c. Weeds

1) compete with plants for nutrients and space
2) are hosts for pathogens and insects

d. Nitrogen

Is essential for tomatoes which are a quick growing high return crop. Never cut costs by skimping on fertilizer crop residues from decaying debris from previous crops can be a source of infection.

e. Soil Condition

Stunting of plants due to clay-panning salinity or pH disorders. Death through waterlogging. Poor soil condition can lower plant's tolerance to diseases.

f. Climate

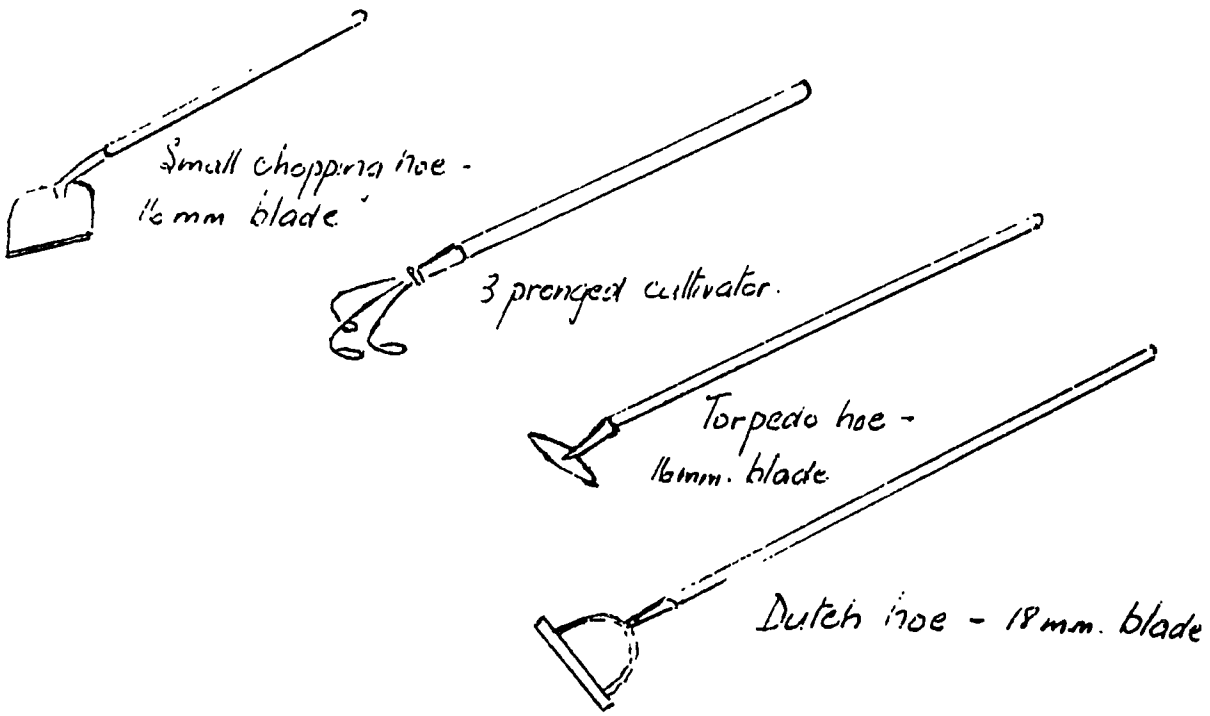
Germination will not occur above temperature of 35°C or 95°F. Fruit set will not occur at very high temperature except with expensive heat tolerant hybrid tomato varieties. Wet seasons promote so many bacterial problems that fruit quality and yields are badly affected.

WEEDS

Weed control depends on types of weeds and weather conditions and soil types. Where possible start with a pre-emergent weedicide, then hand hoeing and pulling. Refer to ground preparation for chemical control.

Chopping hoes for weeding used at present have blades that are too big and heavy for close work near tomato plants, often causing damage to plants and roots. Three .. cultivators, Dutch hoes or small higher hoes that are more manageable; in other words "hand" tools, would do a more effective job (see Figure below).

HOES


Small chopping hoe - 16 mm blade
3 pronged cultivator.
Torpedo hoe - 16mm. blade
Dutch hoe - 18mm. blade

INSECT PEST CONTROL

The following insects have been seen in tomato crops in Sri Lanka:

Leaf Miner	Adults are small black and yellow flies. Larvae create a tunnel in the leaf tissue. Can cause defoliation, and leaves the plant open to infection. Control metasystox.
Heliothus	See diagram (Budworms) Control - Endosulfan. Aphids, whitefly; spray perimeter of fields for control of sucking insects. Methamidophus (Monitor)
Cutworms	Caterpillars cut through plant stems at ground level and feed on foliage. Active mainly at night. Control - Endosulfan
Tomato Russet Mite	Wettable sulphur for prevention ensuring that there is good coverage of the whole leaf surface. Causes brown russeting of stems and leaves and can kill plants.

Knapsack Pumps and Spray Units

For small plots (1/2 acre) knapsacks for spraying crops can be efficient provided markers are used when the operator leaves the row to refill his tank or to mix more material. Even small patches missed can harbour insects that can reinfest a field in a short space of time. On larger areas of crop a motorised misting unit with boom spray would be much quicker and more efficient.

DISEASES OF TOMATOES (CAUSED BY VIRUSES)

Tobacco Mosaic Virus (T.M.V.)

Mosaics mottled patches and streaks appear on leaves and stems. Brown patches and streaks appear on leaves and stems. Brown and sunken markings appear on fruit surface and in the flesh of the outer wall. Spread by seeds, contact, soil or water.

Curly Top Virus

Mosaics yellowing, stunting, fruit distortion and shoe-stringing of leaves. Spread by aphids and contact.

Management of Diseases caused by Viruses

1. Use healthy seed (saving your own is not a good idea)

2. Control weeds around crop since they might harbour insects and viruses

3. Avoid unnecessary handling of plants and contact through trouser legs or sarongs

4. Do not handle infected material when working with seed or in the crop

5. Practice hygiene i.e. wash hands thoroughly and dip implements (including handles of hoes) in strong bleach or detergent, or sterilizing solution of hypochloride

6. Spray insecticides to reduce insect levels

7. Try to grow resistant or tolerant tomato varieties

8. NO SMOKING near crops - source of infection of T.M.V.

9. Remove and destroy affected plants and clear away rubbish and debris from previous crops

BACTERIAL WILT (PSEUDOMONAS SOLANACEARUM)

Sometimes called Green Death. This disease is quite widespread throughout the world and is causing problems in many crops in Sri Lanka. There are many strains of the disease and many vectors for it's transmission. Research is in progress to try to breed tolerant or resistant varieties of tomatoes to combat the spread of Bacterial Wilt, and various cultural practices are being tried. The symptoms of the disease are as follows: Affected plants wilt rapidly and die without any spotting or yellowing of leaves. Vascular tissue at ground level often appears brown and water soaked. When placed in water a milky ooze from affected stems causes the water to cloud.

HARVESTING, CONTAINERS AND TRANSPORT TO FACTORY

Processing tomatoes should be picked ripe. Processing varieties should hold well on the vine and the fewer number of times the vines are subjected to handling at any time, the higher the yield will be. Wait until there is enough ripe fruit to make a reasonable quantity to send to the plant for processing. Premature disturbance of vines can also lead to sunscald of tomatoes when the leaf cover is moved.

The processing company should provide containers to the growers to hold approximately twenty (20) kgs. of fruit. Ideally, they should be of rigid plastic construction with lugs, so that they will stack on top of each other. This will prevent squashing or damage to fruit in transit. Plastic containers are easy to clean and light to handle. These crates should be stamped when manufactured with the company's name or logo, and be provided to the out-grower on deposit, to be refunded at the end of the season when the crates are finally accounted for and returned.

There should be a collection point in each area to receive the tomatoes from the grower. This will be called a "grading station" or depot, and here the tomatoes will be graded for quality - two grades from a four (4)% sample take at random, before proceeding to the factory. this will prevent defective, broken down, green or grossly inferior fruit being received at the plant. First quality fruit should be paid for at a higher rate than second grade. A set of scales capable of weighing twenty (20) kgs of fruit plus crate should be provided at the grading station. All personnel involved should be taught standards of grading so that uniform quality is maintained.

The processor will be responsible for transporting the tomatoes from the grading station to the factory. There the fruit is placed in the dump tank or swimming pool in chlorinated water, which enables the crates to be kept in circulation. These are then washed, stacked, and eventually returned to the field. From the number of crates received, it is possible to esumate the day's intake. Cartage vehicles should be reliable to ensure a continuous supply with no hold-up in factory production. The tomatoes from then on will proceed into the processing system, and be reduced to paste.