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AGRO ENTERPRISE
PROJECT (AgEnt)

SECTOR ASSESSMENT OF SRI LANKA ONION, POTATO AND TOMATO PRODUCTION

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EXECUTIVE SUMMARY

The concern of this five week consultancy was to address the major constraints of onion, potato and tomato producing enterprises in Sri Lanka, all these crops are important income and employment generators as well as being major elements of the national diet.

Each crop has unique problems; each grower groups is in thirst for improved technology and most of the enterprises share the small holder problem, which means restricted opportunity for land rotation, mechanization, economics of scale and lastly the potential for on-farm testing of new technology.

The farmer association movement seems to have solidified markedly during the past two years; perhaps the strength in numbers concept has evolved with the growth in constraints. I personally feel that the ADA group has been an important change
AgEnt and that the small holders feel this growing alliance. It is through this ADA-Farmers Association linkage that the AgEnt Project may be able to inject significant improved technology and stimulate higher yield, income and employment. The Project could achieve this through simple training and demonstration support.

1. Improvement potential in onion enterprises is highly likely with the injection of several well established improved technologies and improved bulb onion production could have a great bearing on import substitution. During the period of scarcity more than 12 million dollars of foreign exchange leaves Sri Lanka for imported large onions. Technology is available (details reflected in this report) to produce, mature, cure and store sound onion bulbs for 3-4 months beyond their normal rest period. This technology is not tied to expensive refrigeration; it is environmentally friendly, simple and uses storage temperatures in the range of 30 - 35 •C but good natural ventilation is mandatory.

   The second constraint is seed related. India is reluctant to sell first grade onion seed to its neighbors as bulb export is at risk. The seed that does enter Sri Lanka is often below grade, out of prime age and ;is highly variable. The Project could helps support the in-country seed production and helps support variety testing of other foreign seed services so dependence on Indian seed will be lessened.

2. Potato constraints are related to build-up of viruses in this intense cropping cycle; high cost of imported seed and the difficulty in recharging soil fertility and soil structure as potatoes follow potatoes year after year.

The new technology of generating virus-free seedlings from tissue culture or growing young seedlings from the true, small tomato like seeds of the potato fruit ball have reached global acceptance. These two practices require only one vital step and move from the laboratory to the farm field. That step is one which the AgEnt Project could assist with small investment and reap high return. The link is called containerized seedling production in which tiny virus free 3-4 leaf seedlings are grown to field ready status under controlled conditions. The structure made from a crude frame and polyethylene film, requires only special plant growing trays and in-country devised soil-like growing media and a grower capable of detailed production. These young plants could be used to generate 18 to 20 fold seed stock thus rebuilding the Sri Lankan potato seed supply in a few short years and decreasing seed import dependence.

3. The tomato industry is in need of the best management practices program used throughout the developed would to maximise water and fertilizer use, reduce pesticide use, reduce harvest labor and provide the grower greater control over his enterprise. The package includes low cost information centered practices such as plant support; mulching; wize pesticide use; modern varieties having multiple disease resistance, heat tolerance, yield and better keeping quality.

   The AgEnt Project could be helpful in its support for limited research activities and demonstrations at the Growers Associations where sub-elements of this program could be exhibited, and perhaps at same site the entire improved package could be compared with traditional tomato production. This program sells itself, is easy to learn, low cost and profitable. The containerized seedling system is highly compatible with this set of improved practices.

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1. OVERVIEW : ONION PRODUCTION

The four onion family members of greatest value to the diet of Sri Lankans are the Shallot (Red Onion); leek; garlic and bulb onion. Each are distinctly different in form and function but they do have many similar cultural and environmental requirements. The Shallot is the most prevalent, most readily affordable and fortunately enjoys the most trouble free production over most of the island.

The Shallot (ALLIUM CEPA L. PROLIFERUM GROUP) is generally grown from SETTS or small bulbs which generate multiple, similar small bulbs (after 4.6) in approximately 60 days from field planting. Garlic (ALLIUM SATIVUUM L.) is also grown from vegetative material (cloves); it generally forms multiple cloves from its base in approximately 90-120 days from planting.

The leek (Change to ALLIUM AMPELOPRASUM L. PORRUM GROUP) does not form bulbs, is grown from seed and requires from 120-150 days. The bulb onion is one of the most complex of the group and has the most demanding environmental requirements and cultural needs. Technically, the bulb onion or big onion, as it is known in Sri Lanka (ALLIUM CEPA L. CEPA GROUP) can be grown from seed sown directly in the field; from small seedlings transplanted into the field; or from small bulbs or setts grown from a previous, very crowded planting usually seeded the year before and held in storage until needed.

Bulb onion culture is a fairly recent addition to Sri Lankan agriculture. Effective technology may be found lagging behind this highly profitable production, as many growers mistakingly tend to consider big onion culture as they would red onion production. The Ministry of Agriculture prepared a useful bulb onion guide within the past few years; and the cultural suggestions presented in this report are intended to augment this helpful publication. A table reflecting the relative gross returns for bulb onion production is shown in table 1.

2. STRENGTHS OF THE CURRENT ONION PRODUCTION PROGRAM

a. Onions are one of the top five food items in the Sri Lankan diet and enjoy high continual demand and relatively high prices. In periods of scarcity (November to August) approximately 46 thousand metric tons of bulb onions are imported.

b. Shallots (red onions) are the most plentiful of the group and can be afforded by the general population more than the more cyclical and expensive bulb onions. Shallots are less exacting to grow than big onions and are produced more widely.

c. Sri Lanka has a wide variety of ecozones, several of which match closely the exacting requirements for profitable bulb onion production. The dry zones with agro wells appear to be the most promising, especially if the photoperiod based approach is used. A comparison of Northwest Province, Central and Southern characteristics is presented in appendix 2.

d. Bulb onions are of rather low perishability when grown to proper maturity, cured and stored properly. New technology is presented which shows how properly grown bulbs can be stored for several months after harvest to extend the period of market availability.

e. Meaningful research is underway by the Department of Agriculture and University of Peradeniya on bulb onion variety selection cultural practices and post harvest handling. Supplemental research and demonstration suggestions are presented in this report, appendix listing 3.

f. The Coordinator for Onion Research, already highly competent and experienced is going abroad for further academic training. Another valuable asset to the Sri Lankan program is a Senior Research Officer in seed multiplication. Strong support in post-harvest research is being conducted by a very dedicated and well trained University of Peradeniya faculty member.

3. WEAKNESSES IN THE ONION PRODUCTION PROGRAM

a. Most of the variety testing in Sri Lanka seems to favor short day cultivars from India; but easy trade in high grade one year old, well stored seed from India is difficult. Some of the seed that does enter Sri Lanka is of poor quality as well as high priced.

b. The onion is a cool season, long day length crop; thus growing in the short day tropics is in itself very restrictive. Most of the short day cultivars are not as pungent, solid or of good keeping quality as longer day more slowly grown cultivars.

c. Onions do not fit very well into the rice based agriculture of Sri Lanka and are thus often only "follow on" enterprises, grown between Maha and Yala paddy crops. The high profitability of bulb onions may stimulate a greater commitment in the future but most of the expansion may develop in the higher elevations wherever water is available.

d. Onion technology development is increasing but up until a few years ago more than 80% of agricultural research activity was devoted to rice.

e. Most onion production is on small holdings where there is only limited opportunity for effective crop rotation to enhance soil building and disease reduction practice, or machine use for land preparation, planting or harvesting.

f. The majority of the plantings have been made after the period of critical day length which limits the season for proper maturation of the bulbs, restricts bulb size and lessens keeping quality.

g. Freshly harvested onion bulbs usually have a rest period (similar to dormancy) of approximately one month, after which regrowth of the bulb starts by adding new roots and forming new, interior leaves. This short rest period confines the market period accordingly.

h. Fenced onion fields are evident but many growers suffer losses due to wondering elephants and livestock, some areas have resorted to scare boys to protect this valuable crop.

4. OPPORTUNITIES FOR THE AGENT PROJECT TO ASSIST

a. With modest adjustments bulb onion production could be made more profitable, produce better quality at less cost and extend the market period thus reducing imports. A modified program based on using the growing period before critical day length is appended table 5.

b. Seed supply, a very serious constraint, could be eased by assisting the research officer in charge who is producing the Kalpitya onion seed supply. This officer has been encouraged to submit a request for financial assistance from Agent. We feel this should be given serious consideration.

c. In most of the major onion producing areas of the world sprout suppressing chemicals are applied to the growing crop as they reach maturity in the field or the mature bulbs as they enter storage. These materials extend the rest period 3 to 5 months extending the market potential considerably. Agent personnel should assist in the procurements of toxicological data to help clear approval by the dept of agriculture Sri Lanka.

d. Only well matured, suppressed, properly cured and sound onion bulbs can be expected to maintain satisfactory shelf life for 3 or more months.

AgEnt can assist in demonstrating low cost curing methods, and support research for post harvest storage studies as suggested in Appedix Listing 3.

e. In most parts of the Western world, onion bulbs are kept in refigerated storage (0 to 5°C) to maintain quality, but "almost as good as" is storage at 30-35°C if matured, well-handled bulbs are used. AgEnt can help demonstrate the use of high temperature, well ventilated, simple storage and support research activities studying bulb behaviour under these conditions, as conducted by the University of Peradeniya. This support could be combined with item (d.) above, if agreeable to this very concientious professor.

f. Tentative research and demonstration plans for the 1993-94 onion growing season are presented in Table 4 B. Final arrangements depend on approval for funding by the AgEnt Project and acceptance by the Dept. of Agreculture, University of Peradeniya and Farmers Association officials selected by ADA and Extension.

5. THREATS TO THE BULB ONION PRODUCTION AND MARKETING PROGRAM

Encouraging inexperienced onion growers to adopt a best management practices program can result in disappointing results unless adequate training and monitoring accompany the operation itself.

Unless the bulbs are fully matured they will not be suppressed, cured or stored as well as ones which have reached proper maturaity. The photoperiod based program requires slightly longer field time as the bulbs can be expected to be much longer than the 5 - 8 cm average diameter currently produced.

If new bulbs grow too large the transplants must be spaced closer. The bulbs in storage must be sorted frequently to remove un-sound bulbs which could infect other good onions.

6. PRESENTATION OF A PHOTOPERIOD BASED BULB ONION PROGRAM IN SRI LANKA

A. BACKGROUND

The desire to improve the import substitution position for bulb onions in Sri Lanka is economically significant, agronomically feasible and physiologically possible.
With minor changes in the current bulb onion production program, more mature, larger and longer keeping onions could be produced. These onions could have a major impact on the November to August period of importation from India.

A sequence of closely inter-related, improved practices is proposed which is based on initiation of the crop before the critical day length for bulbing commences. The onion plant is one of nature's most sensitive plants in its response to the number of hours of daylight. The young seedling becomes inductive as soon as 7-9 leaves are formed, when this happens only small, immature poor keeping bulbs can be expected. To produce larger bulbs which will proceed to proper maturity and enhance their keeping quality a larger number of leaves (often 16 - 20) must be produced before the critical day length stimulates bulb formation.

In the case of the short day varieties popular in Sri Lanka, which usually from bulbs as soon as the 12 hour day - 12 hour night period arrives, there are only 4 months in which less than 12 hour days occur (Nov, Dec, Jan, Feb) Appendix 6. By planting in these months, larger more fully developed onion plants can be produced before the onset of bulb development thus improving the chances for better maturity at harvest.

B. OVERVIEW OF THE PHOTOPERIOD BASED PROGRAM

1. Select the most adaptable, highest yielding, most pest resistent variety having good market acceptance.
   Sri Lankans prefer high pungency, red skinned bulbs of medium size such as the Kalpitaya, Pusa Red and Rampur Red Cultivars.

2. Select the most reliable and stable source of one year old, well stored onion seed possible. This seed should be of high germination, true to type and free of disease and weed seed.

3. Select a production area in which soil moisture control is possible, as dependence on rainfall for specialty crop production is often risky and unprofitable. Agro-wells in the dry and intermediate zones should be adequate for high yields with good management. Onions mature quicker on lighter soils but greatest pungency is associated with clay soils.

   a) Onions require approximately 53 cms of water per season to produce a 25 mt crop per hectare, and the water demand is greatest in the germination and early plant development period. It is desirable to have the water supply slowly decreased as bulbs mature.

The 4 stages of onion development are germination and seedling period (40 days) 1 period of active leaf development (35-40 days); bulb development stage (50-60 days) and bulb maturation (25-30 days). Any interruption of the smooth progression through these stages can result in split, double or malformed bulbs. The more stress free the production, the more uniform and better quality can be expected.

b) A 25 mt per hectare crop of onions requires 160 Kg/ha of elemental nitrogen, 110 Kg/ha of elemental phosphorus, 150 Kg/ha of elemental potassium and a soil pH range of 6.0 to 7.0. The fertilizer should be applied in three equal increments; the first third as a bed application; the following two as side dressed applications.

4. Sow seed as early as weather permits in November or December. A polyethylene film rain shield may be needed to protect open beds. Containerized seedlings are often grown in protected structures. All soil or media used in ground beds or containers should be treated by chemicals, burning or solar pasteurization to reduce insect, disease, nematode and weed problems. Soil or media should be friable, uniform in structure and composition, and have good soil moisture holding capacity but only moderate fertility. Approximately 85 grams of seed are needed to produce 10,000 seedlings. Transplants for a full hectare would require 27 of these units.

5. As soon as the young onion seedlings have reached 6 to 7 mms in diameter and have 3 leaves they should be graded into small, medium and large plants. The largest plants should be discarded as they are most likely to cause splits, seed stalks and thick necked, hard to cure bulbs.

   Seedlings should be spaced 6 cms apart in the rows, rows 50 - 60 cms apart. This provide 420 sq cms per plant 24 plants per square meter and a yield potential of 240,000 bulbs per hectare. Care should be taken to minimize root damage when lifting from the plant bed. Containerized seedlings avoid this transplanting shock.

   Containerized seedlings should be watered-in soon after field setting to insure intimate contact between roots and soil.

6. Early transplanting and early development help to produce resistant tissues before the onset of many fungal and insect problems prevail.

Insecticides may be withheld until insect pressure is evident; but an application of fungicide with a good spreader - sticker should be applied every 7 - 9 days until outer tissues are well developed after bulbing.

7. The onion crop must be kept weed free until after bulbing. Onion roots are poor penetrators of the soil and compete poorly with aggressive weeds. If cultivation is done the hoeing must be shallow to avoid root damage and growth checking.

8. As the swollen bulb matures leaf production stops and yellowing can be observed and the tissue above the bulb softens and some stems start to fall over. When approximately 20% of the plants in the onion field start to fall over, a chemical spray to inhibit sprouting and rooting in storage can be applied. The material used in most production areas in MALEIC HYDRAZIDE (2500 ppm rate) and must be applied on a rain free day while green leaves are present. A spreader sticker must be used to enhance absorption of the active ingredient. Onions produce a natural inhibitor in the leaves which moves into the bulb as it matures. This natural inhibitor provides only about 1 month of rest period before regrowth may begin.

9. Approximately 12-14 days after the sprout supperessant has been applied most of the necks should have fallen over and begun to wither and dry up. The bulbs should be lifted gently from the soil and if the day permits the bulbs should be allowed to dry on top of the soil for about 8 to 10 hours. After bed top drying, the onions should be moved to a <u>sloping area</u> in full sun over which a "tunnel" type plastic film covered frame should be placed over the slatted crates, mesh bags or baskets for about 6 to 8 hours. The polyethylene covered "tunnel" should be open at both ends to allow the warmed, moistured air to pass over the bulbs and escape freely. This process dries the outer 2 scales of the bulbs and is called curing. Cured bulbs store almost twice as long as non-cured bulbs.

10. After the curing process the dried bulbs should be sorted carefully to removed damaged or rotted bulbs. After sorting, the cured bulbs should be transferred to a shaded, well ventilated, long term holding area. If the storage smells of onions the ventilation is not adequate and shelf life may suffer.

    Properly matured, suppressed cured and sound bulbs can be stored at fairly warm temperatures (25 - 35 C) for 3 - 5 months. Frequent checking for rotted bulbs and their removal is necessary.

Bulbs should not be packed tightly in the storage, as ventilation is critical.

Bulbs stored in cold storage experience "respiratory upsurge when placed in warm display areas" whereas, warm stored bulbs avoid this problem.

C. ASSESSMENT : POTATOES

1. OVERVIEW : POTATOES IN SRI LANKA

Potatoes are one of the highest value crops in Sri Lanka; in fact, their high price precludes their consumption to a great extent by the lowest income groups. This trend is almost opposite in relation to the rest of the world, where potatoes provide one of the cheapest forms of bulk find carbohydrate to the diet of the poor. The reason for this artificial pricing is largely due to the high production costs, specifically dy to seed price.

Potatoes are a cool season crop. They are grown primarily at the higher elevations such as Nuwara Eliya; mid elevations (Badulla area) and some at the low elevations of Jaffna and Puttalum. At the low elevations, disease pressure from virus and bacterial wilt is accompanied by high temperature problems, waterlogging and high soil salt problems.

At both upper elevations two crops a year are produced. In Badulla the November planted crop is harvested in March using imported seed. The June planted crop is grown from the March produced tubers and is harvested in October. In Nuwara Eliya a much cooler, higher location imported seed is used to produce the February crop which is harvested in June. The second crop, September planted and harvested in January on February is usually from seed produced in the spring crop.

Growers have and currently produce profitable crops, but the consensus is that yields have reached a plateau over the past 5 - 10 years, that input costs have increased significantly and that net profit has and is declining.

The quality of potatoes from the mid-and-upper elevations is quite good although size is small and variability is great within the harvest. The range and size of Sri Lanka potatoes would probably not be competitive on the world market. Domestic consumption utilizes all sizes and shapes; and market saturation, even when it does occur, is more of a problem of price than market. Necessarily the best sizes, shapes and conditions move to the highest level of buyers and the smaller and off-shapes go to the lower class outlets.

Procurement of good quality seed at a reasonable price is one of the chief complaints of the growers. The imported seed is preferred because it yields more (1:11) than crops grown from their own seed 1:9. These yields are far below the world average which usually generates 20 to 25 Kgs of marketable tubers from each Kilogram of seed planted.

Numerous consultancies have examined the potato situation in Sri Lanka, most have dealt with seed as the primary constraint. Seed cost is a major constraint but several other factors may be of even greater impediment to a sustainable production in the future.

2. STRENGTHS

a. The varied terrain of Sri Lanka from mountains to rolling hills touching the sea provides innumerable ecozones of varying sizes. The full range of horticultural crops could be produced somewhere on the island although the small areas may not be economically feasible. Potatoes, a cool season crop; appear to be very well adapted to the highlands and has proved to be one of the most profitable ventures. The largest growers procure credit from private sources such as commercial banks rather than remain obligated to traders for inputs as do most small operations.

b. The technology acquired by the potato growers appears to be adequate for the yield levels produced, and of the growers interviewed all were very receptive to new technology. Some even have drip and under-tree type irrigation of Isreali manufacture. Spraying is a mixture of knapsack and power pumps and if anything, over-use of agri-chemicals is the rule rather than the exception. Proper coverage is to be addressed.

c. The potato production area is fortunate to have two research stations near-by as extension delivery systems appear weak. At both stations most of the projects are state-of-the-art and address the seed problem seriously. Variety evaluation, insect, nematodes and disease management are on-going projects but the funding level is restrictive.

d. There is a cadre of large growers in the Nuwara Eliya area which represent a growing political importance. This group is cohesive, well funded, eager to grow into value-added enterprises. Several are highly innovative and credit much of their success to their close relationship with the local research faculty.

e. The ready market for nearly all sizes and shapes of potatoes is a blessing and a root problem. The high and continual demand masks the reason for low yield, that being the slow decline in effective soil management. Potatoes, because of their high profitability, are grown twice a year in the same area because rotation to other crops is not appealing.

3 WEAKNESSES

a. Perhaps because of restricted funds the extension of new technology moves slowly in the potato areas. Even the banking industry is now attempting to assist in technology transfer because they know that successful growers mean better bank business.

b. The research stations in the potato area are adequately staffed most of the time, but quite restricted in support.

c. Seed cost appears to be dictated by " two monopolies" so growers often use their own seed for the second crop to reduce cost. It doesn't appear that seed handling technology has been widespread, thus virus decline is most probable.

d. Golden cyst nematode and a wide variety of rainy weather diseases challenge the area growers. The cultivar Santee has nematode resistance but seed is sometimes difficult to obtain so nematicidal chemical in-row treatment is used.

e. The predominant cultivar, desiree,is considered one of the low yielding varieties, but it is one of the most available, so is used widely.

f. Most growers use small seed (whole) for planting. Such a practice has been abandoned by most growers in developed countries because larger tubers cut into seed pieces each with 1 or more eyes is more economical and breaks apical dominance resulting in stronger, fewer stems with larger yields. Western growers avoid "B" size seed because small seed may have been from virus infected seed crops.

g. Because of the high demand and high prices most potatoes are sold within a short time after harvest. There appear to be little interest in storage technology which could extend shelf life significantly.

h. In most small holder potato production the injection of machinery to reduce labor costs is not feasible because of small scale and accessibility of site.

4. OPPORTUNITIES

1. There are two well established technologies that could help reduce the seed potato constraint; both technologies have been introduced by the local research centers and on-going research is being conducted.

The growing of young virus-free seedlings from tissue culture is being worked on at Bandarawela. The production of virus free seedlings from true potato seed (TPS) is being addressed at the Sita Alyia station.

2. What is needed to get this very important technology from laboratory to the grower is a vital link: a commercial seedling plant producer. There could be a very lucrative enterprise (or a dozen) for a grower who wished to produce seedlings for others under the new containerized seedling production system.

   * AgEnt should give this potential priority consideration. The time is ripe, conditions are favorable, the very strong market for prime seed exists and investment for simple production would be low and provide fast return.

3. If containerized, virus free seedling production were compared to traditional seed performance for yield, quality and cost-benefit the program would be self promoting. This would be a viable alternative to the monopolistic (growers opinion) traditional seed channels; it could break new yield barriers, reduce pesticide usage and provide more potatoes for consumption.

4. The need for storage technology may not seem pressing to growers now, but sprout suppression technics should be tested and be available for the future. The same chemical used to suppress sprouting in storage for onions and carrots applies to potatoes.

   AgEnt should assist in support of such tests and also help procure toxicological information so that various sprout inhibiting chemicals can be approved by the Dept. of Agriculture. These chemicals have been used safely world wide for almost 30 years.

5. Farmers could benefit from training in seed potato handling prior to planting. The diffused light, cut seed, refrigeration and pre-sprouting practices should be worthwhile training themes which AgEnt could support.

6. Potato chip production technology is available and the larger growers are considering its possibility. This specialists feels that production currently would not be adequate for profitable chip manufacture; however this could change in the future. AgEnt could help procure technical assistance on this well developed form of processing.

5. THREATS

a. The yield of potatoes may seriously decline due to lack of rotation as bacterial wilt, insect borne viruses and fungus diseases increase. Potato, Tomato pepper eggplant and tobacco are related and share the same pest complex generally. Small farms have little chance to alternate crops: the yearly addition of farmyard manure helps but is expensive and temporary.

b. The arsenal of chemicals to manage pests is shrinking; soon many of the materials being used may be withdrawn from Sri Lankan use as they have been in most other areas. This will create an even greater problem for small holders as the more sophisticated biological control integrated and pest management programs would not be practical.

D. ASSESSMENT: TOMATO.

1. OVERVIEW: TOMATO PRODUCTION

Tomatoes are a warm season crop, yet tropical extremes make profitable production difficulties has been found in Sri Lanka during the past two decades. Tomatoes are a popular food item as a cooked component of curry dishes but fresh salad tomatoes are growing in demand due to increased tourism and change of eating habits of Sri Lankans returning from the West.

The crop is grown widely on the Island but seldom as a specialty crop. Tomatoes are usually grown between rice crops except in areas less favorable for paddy production. This crop is not as profitable as bulb or red onions, or potatoes and because of the relative narrow window for production can suffer severe over-supply and low-price periods.

The quality of the crop is fair but the primary cultivar used (Marglobe) does not have the yield potential, disease resistance or fruit quality mpre modern breeding lines provide. This cultivar is being used for fresh market consuption and for limited sauce and paste products processing.

The technology of production has not incorporated many of the improvements utilized buy the major tomato growing areas of the world. Yields for the world range from a low of 3.0 MT/Hectare to a high of 58MT/Ha, but the average of warm season temprate areas is abour 28 MT/Ha. The average yield of tomatoes in Sri Lanka (Islandwide) is about MT/Ha.

A wide range of pesticides is used for tomatoes but many of the farmers feel that there is an increase of white fly and leaf miner during the past 5-10 years. The range of highly toxic insecticides (LANNATE, METASYSTOX, TRIMETON AND MONITOR) has probably decimated the natural enemies of these once minor insects. These materials are generally only avoidable in the West on a <u>restricted basis</u> and only licensed operators are allowed to use them.

2. STRENGHTS

a. Tomatoes are a high labor crop well suited to small holder as well as large farmaers. Sri Lanka has adequate labor and a small population used to detailed farm. Tomatoes can be comatible ;with rice culture but the inerim between MAHA AND YALA

PADDY is restructive, this many crops are planted and harvested within a narrow period which often results in over-supply.

b. Tomatoes can be grown for processing but adequate raw product world have to be well coordinated among small holdings to be profitable for the grower and precessor.

c. Tomatoes are a valuable part of the Sri Lanka diet, providing needed vitamins and minerals to supplement the rice based diet. The crop seems to be included in homestead gardens, thus consuption may be higher that official records show.

3. <u>WEAKNESS</u>

a. Most of the tomato production is carried out by small holders who have limited land, modest resouces for inputs but have adequate labor available. Crop rotation is limited and soil disease build-up is evident. Even in the rolling hiss area, bacterial wilt is obvious. Treatment of soil borne diseases is difficult and expensive; sometimes alternate crops are the only solution.

b. There are several low cost practice which could help small holders increase marketable yields, achieve maroe efficient spray coverage and help reduce losses due to ground rot. Stalking is used in most of the fresh market tomato production areas of Southeat Asia except where wood is very scarce.

c. It is very difficult to schedule tomato harvests when the production window is so narrow. An extended harvest program could be developed at higher elevations having agro-wells which should be very profitable for off-seasen markets.

d. The use of varieties of modern breeding improvement had been rather slowly adopted. The US variety "Marglobe" released in the early 1950s appears to dominate, but newer lines KWR, T146 T245 are becoming popular. There has been very little testing of cultivars specifically bred for processing. Lines resistant to bacterial wilt and heat tolerance are needed urgently.

4. <u>OPPORTUNITIES</u>

a. Improved varieties especially those resistant to soil borne bacterial wilt and having heat tolerance need to be tested more vigouously and introduced to growers through on-farm trials. The Dept of

Agriculture research division could expand its efforts if additional financial assistance could be provided.

The senior rsearch officers have been encouraged to prepare a justification, plan and gudget for AgEnt assistance. AgEnt can also assist in assembly of world-wide germ plasm for testing and help provide processing tomato breeding lines for testing in Sri Lanka.

The transfer of technology (as well as variety spread) is less than ideal, perhaps the ADA working through Farmers Associations could augment delivery with minimum assistance from AgEnt.

b. The demonstration of mulching, staking and more effective spray placement as improved practices is urgently needed. Examples of benefit from these practices is presented in Appendix Tables.... and ... . In many cases for the price of a few stakes, some mulching materials and a few hours of training of the Farmaers Association AgEnt could facilitate minor workers through ADA cooperation.

c. Growing tomatoes in the tropics is difficult. The more the grower know about how the tomato grows, how it responds to temperature and how to work best within these confines the more profitable his enterprise. Table..... and .... are presented to show some of these relationships, a good example of how tomato growers can use these understandings is in selecting a proper harvest maturity. Most of the growers in Sri Lanka pick a fairly advanced maturity, which shortens their effective market period. Bu harvesting at the turning "star-breaker" or mature green stage they gain 8 to 10 days of market period; avoid fruit ..... on-plant; reduce potential insect, disease and abrassion problems.

Traning and demonstrations at fields near where the Farmers Associations hold their meetings would be the least expensive means of technology transfer and deserve consideration by the AgEnt Project. The ADA representatives seem eager to assist and many are planning for future activities if small assistance can be provided.

d. The time period for tomato production is generally restricted by the rainy season or cropping system of rice. The use of soil bed grown seedings is most common in Sri Lanka tomato production, but

soil bed seedlings when pulled out of the soil go into gransplant shock "which may require 10-14 days from which to recover and resume normal growth. Containerized seedling production avoids this and provides growers with healthier, earlier and more uniform plants.

Containerized seedling production has enjoyed global adoption because of its great cost-benefit advantage. A small containerized plant grower could help improve tomato production dramatically once farmars experience their value. These young plant nurssery opeation would require only start-up capital training. and encouragement. AgEnt could be an important change in this development, perhaps as much in the training component as the provision of initiating funds for the business side.

f. A brief list of suggested research and demonstration activities for tomatoes is presented in the Appendix Table T-6

5. THREATS

a. Over-use of pesticides which destroy the natural enemy complex of the white fly (Benesia) and leaf miner (Liriomyza) should be modified as soon as possible. If build-up of the predator complex is thwarted the spread of these once minor insects place the tomato regions at risk.

b. Bacterial wilt can be expected to increase unless resistant varieties and some form of rotation to non-SOLANACEOUS CROPS CAN be practiced. These may be

APPENDIX

Table 1 : Relative Costs of Production for Bulb Onions, (Dept of Agricultural Statistics, Ministry of Agriculture, 1991, Peradeniya)

Materials and operations	Cost pe Hectare Rupees	Per cent Cost of Inputs
Land preparation	12,200	15.0
Nursery Operations, Seed	9,200	11.4
Fertilizer, Application	8,700	10.7
Transplanting to field	6,000	7.4
Weed Control & Pesticides	9,500	11.7
Pest Control & Pesticides	6,000	7.4
Irrigation & Labor	24,500	30.2
Harvesting & Processing	5,000	6.2
	---	---
	81,100	100.0

Note: At yield level of 18,000 Kg/Hectare and price of 18 Rs/Kg cost of production per Kg would be approximately 4.5 Rs/Kg gross.

B. GROSS RETURNS ASSOCIATION WITH VARIOUS YIELD AND PRICE LEVEL

Price Received Rs/Kg	Low Yield 10,000 Kg/Ha	Moderate Yield 15,000 Kg/Ha	High Yield 20,000 Kg/Ha
15	150,000	225,000	300,000
30	300,000	450,000	600,000
45	450,000	675,000	900,000

C: Price: Retail, N.W. Province 1988 - 91 Rs/kg

RANGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
LOWEST	15	16	15	15	15	15	15	16	14	14	14	15
MEDIUM	28	31	24	22	31	32	28	29	22	21	21	24
HIGHEST	46	43	36	35	44	52	36	34	30	35	42	48

APPENDIX 2

TABLE - COMPARISON OF NWP, CP AND SOUTHERN PROVINCE CLIMATE AND BULB ONION GROWING PERIODS

JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	AVE
			MAHA SEASON								YALA SEASON					

NORTHWEST PROVINCE (KURUNEGALA)

MAX T,•C	30	31	31	31	31	30	30	32	34	33	32	31	30	31	31	31	31•C
RAINFALL, MM	122	84	149	369	309	156	51	90	146	292	195	161	122	84	149	369	177
DAY LENGTH,H	12.5	12.3	12.2	12.0	11.8	11.7	11.8	11.9	12.0	12.2	12.4	12.5	12.5	12.3	12.2	12.0	12.04
OPERATIONS										SOW	XPL	....	....	....	HARVEST		

CENTRAL PROVINCE (DAMBULLA)

MAX T,•C	32	33	33	32	30	29	29	31	34	34	32	32	32	33	33	32	32•C
RAINFALL, MM	33	34	90	260	268	245	91	51	75	193	87	16	32	34	90	260	120
DAY LENGTH,H	12.5	12.3	12.2	12.0	11.8	11.7	11.8	11.9	12.0	12.2	12.4	12.5	12.5	12.3	12.2	12.0	12.04
OPERATIONS										SOW	XPL.	....	....	....	HARVEST		
OPERATIONS				SOW	SOW	....	....	....	HARV	HARV							

SOUTHERN (HAMBANTOTA)

MAX T,•C	30	30	30	30	30	30	30	30	30	31	31	30	30	30	30	30	30•C
RAINFALL, MM	55	49	67	141	193	127	81	56	57	98	92	59	55	49	67	141	89
DAY LENGTH,H	12.5	12.3	12.2	12.0	11.8	11.7	11.8	11.9	12.0	12.2	12.4	12.5	12.5	12.3	12.2	12.0	12.04
OPERATIONS										SOW	XPL.	....	....	....	HARVEST		

PERIOD OF IMPORT

PHOTOPERIOD BASED PROGRAM

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JU	AUG	SEP	OCT
NWP RAIN	M	D	W	W	W	W	D	M	M	W	W	W	L	D	W	W
OPER			S	..T	..	..	..	.H	MARKET				M			
CP RAIN	D	D	M	W	W	W	M	D	M	M	D	D		D	M	W
OPER			S	..T	..	..	..	.H	MARKET				D			
SP RAIN	D	D	D	W	W	W	M	D	D	M	M	D		D	D	W
OPER			S....	T.	...	...	...	.H	MARKET				D			
			S..	..T	...	...	...	.H	MARKET							

APPENDIX LISTING 3.

Suggested Research and Demonstration Activities to Help Assess the Usefulness of the Photoperiod Based Bulb Onion Production Program (PBOP)

1. DATES OF SEEDING AND TRANSPLANTING

A). Objectives

1. To determine the most workable date of planting for a given production area using the period (Nov-Dec-Jan-Feb) prior to critical day length.

2. To characterize crop and grower problems related to these early plantings (rainfall, disease pressure, from operations conflicts etc)

B). Suggested Approaches

Research

A series of seedings at 10-15 day interials (6 or 8) in replicated small plots (3 meters long by 60 cm wide each containing 40 record plants) should yield reliable curvilinear response data.

Demonstration

Important supporting information related to crop and grower problems could be generated from 3-4 week interval observation plantings, if adequate records are kept.

2. INFLUENCE OF SIZE OF TRANSPLANT : DEMONSTRATION

A). Objective

1. To assess the value of seedling sorting and selection of uniform small and medium transplants.

2. To observe the performance of large and extra large seedlings on occurance of double, split and thick neck onion bulb.

B). Suggested approach

Demonstration

1. Prior to field setting the grower may need help in usual sorting into piles of small and medium sizes from the largest seedlings. When set in the field,

some type of marking stake should be used to show that specific rows were S.M.L.

2. A record of performence and vniformity of the small and medium seedlings just before harvest should be made. The largest seedlings usually reflect rather gross difference in muturity of bulbs and deformities providing a strong lesson and obvious records.

3. <u>RATE AND TIMING OF SPROUT SUPPORTING CHEMICALS</u>

Note : It is hoped that the 2 widely accepted sprout suppressing chemicals will be approved by the Government by the time the materials are needed for testing. One material is applied as a pre-harvest spray; the other material is applied as an after harvest pre-storage dip.

A). <u>Objectives</u>

1. To evaluate the effect of 2 rates of sprout suppressant applied at 20% of 50% fall-over stage of maturity of onions, orat entry into storage.

2. To assess the effect of these 2 rates x 2 dates on the keeping quality of sound onions bulbs held in cold and ambient temperatures of well vertiloted storage conditions.

B). <u>Suggested Approach</u> : Reserach

1. Serial sampling over a 3 to 5 month period may be useful to reflect meaningful effects compared to non-treated controls.

2. If possible, valuable information could be generated by comparing the keeping quality of suppressed cured and suppressed non-cured, with non-treated cured and non-treated non-cured bulbs (base line approach and highly useful educational purposes)

4. <u>Assessing Value of Bulb Curing on Shelf Line</u>

A). <u>Objectives</u>

1. To observe the effect of curing of sound mature onion bulbs of their keeping quality and market value.

2. To compare the poly-tunnel method with the warm

shed method (or fan heated method)

B). <u>Suggested Approaches</u> :

Research

It would probably by interesting to test several tunnel curing times (2,6,8 hour exposures) versus non-cured bulbs. Traditionally, curing even for several hours can double shelf lefe. (This could be part of number 3)

Demonstration

1. Placing sound bilbs in crates or mesh bags on a slope and erecting a simple tunnel of bamboo supports for the polythyene cover for approximately 4 - 5 hours before removing the "cured" bulbs to a storage should be of interest when compared to field dried non-cured bulbs.

2. The farmer may wish to label the cured bags or crates so storage comparisons can be made later.

5. <u>Assessing Value of sorting on Keeping Quality</u>

A). <u>Objectives</u> : Demonstration

1. To demonstrate the value of sorting and removal of bruised, rotted or sun burned bulbs, from the sound bulbs.

2. To compare a small lot (or bin) of sorted sound bulbs with a small lot of non-sorted field-run bulbs at various dates in storage.

B). <u>Suggested Approaches</u>

1. Most of the onion growers we have talked with keep fairly good records, so this exercise should be quite easy if the sample size is kept small.

2. If growers could start with multiples of 100 bulbs the discard rate of each sampling date could provide strong support from this valuable practice.

6. EVALUATION OF TRADITIONAL AND PHOTOPERIOD BASED PRODUCTION SYSTEMS

A. Objectives

Notes: The photoperiod based program may need to be compared with YALA plantings only as both utilize the early part of the calendar, require well drained soil and preventative disease control programs. It appears that traditional culture of bulb onions is based on a 90 day maturity from transplanting, but the PB program would need much longer to fully mature the larger bulbs

1. To examine the broad implication fo cost benefit, farmer acceptance and technology requirements of both programs.

B. Suggested Approaches

Research

Comprehensive research involving horticulture - ecnomics and post harvest may be justified in the future based on the preliminary trials suggested in this overview. A more complex experimental design could help partition the contribution of the new practices on extended shelf lefe.

Demonstration

Perhaps 1 or more farmers associated with an agro-well district would try the photoperiod based program (all or in part) and their market records could be compared with years and results of farmers near by who followed the traditional methods.

Table 4 Tentative Research and Demonstration Plans 93-94.

1. <u>DATES OF PLANTING STUDIES</u>

   a. RESEARCH STATION : ANGLOPLESSA
      (ALSO VARIETY EVALUATION)

   b. DEMONSTRATIONS
      SOUTHERN PROVINCE
      2 FARMERS ASSOCIATION SITES

2. <u>INFLUENCE OF TRANSPLANT SIZE</u>

   a. DEMONSTRATION
      SOUTHERN PROVINCE
      1 FARMERS ASSOCIATION NURSERY, 2 FARMS

3. <u>RATE AND TIMING OF SPROUT SUPPRESSANT</u>

   a. RESEARCH DEPT HORTICULTURE UNIV PERADENIYA

4. <u>INFLUENCE OF CURING ON SHELF LIFE</u>

   a. RESEARCH DEPT HORTICULTURE UNIV PERADENIA
   b. RESEARCH STATION, MAKANDURA REGIONAL CENTER

5. VALUE OF SORTING IN PRE STORAGE AND STORAGE

   a. DEMONSTRATION
      FARMERS ASSOCIATION NORTH WEST PROVINCE

6. COMPARISON OF TRADITIONAL AND PHOTOPERIOD BASED PRODUCTION SYSTEMS
   a. RESEARCH STATION - ANGLOPHESSA
   b. DEMONSTRATION
      HIGHLAND LOCATION (MATALE WITH AGRO WELLS)

TABLE 5

EXAMPLE OF BULB ONION PRODUCTION SCHEDULE
BASED ON PHOTOPERIOD BASED PLANTING

DATE OF INITIATION	GERM AND SEEDLING	ACTIVE LEAF DEVEL.	BULB DEVELOP	BULB MATURATION	HARVEST, CURING	MARKETING AND STORAGE PERIOD
DAYS	403	35	50	25	2	0 - 90
NUMBER LVS.	3	4	5	2	PROBABLE	NUMBER 14-16 LEAVES
SEPT.10	OCT.20	NOV.24	JAN.14	FEB 8	FEB 10	FEB 10 - MAY 10
* 254	294	329	379	404	406	406 - 496
SEPT. 20	OCT 30	DEC 7	JAN. 24	FEB 18	FEB 20	FEB 20 - MAY 20
264	304	339	389	414	416	416 - 506
SEPT. 30	9 NOV	DEC 14	FEB 3	FEB 28	MAR 1	MAR 1 MAY 30
274	314	349	399	424	426	426 - 516
OCT. 10	19 NOV.	DEC. 24	FEB 13	MAR 9	MAR 11	MAR 11 - JUN 9
284	324	359	409	434	436	436 - 526

* TO FACILITATE COMPUTER CALCULATION OF PHENOLOGICAL EVENTS, A CALENDAR ASSIGNING A NUMBER DAY FOR EACH DATE STARTING WITH 1 JANUARY AS NODA 1, 1 NARCH AS NODA61 ETC IS USED. FOR NODA GREATER THAN 365, APPROPRIATE SUBTRACTION IS REQUIRED.

TABLE 5 - B PROVIDES A NUMBERED DAY CALENDAR FOR THE RECORD.

TABLE 6.
DAY CALENDAR USEFUL TO CROP SCHEDULING
IN ANNUAL CROPS

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	32	61	92	122	153	183	214	245	275	306	336
2	33	62	93	123	154	184	215	246	276	307	337
3	34	63	94	124	155	185	216	247	277	308	338
4	35	64	95	125	156	186	217	248	278	309	339
5	36	65	96	126	157	187	218	249	279	310	340
6	37	66	97	127	158	188	219	250	280	311	341
7	38	67	98	128	159	189	220	251	281	312	342
8	39	68	99	129	160	190	221	252	282	313	343
9	40	69	100	130	161	191	222	253	283	314	344
10	41	70	101	131	162	192	223	254	284	315	345
11	42	71	102	132	163	193	224	255	285	316	346
12	43	72	103	133	164	194	225	256	286	317	347
13	44	73	104	134	165	195	226	257	287	318	348
14	45	74	105	135	166	196	227	258	288	319	349
15	46	75	106	136	167	197	228	259	289	320	350
16	47	76	107	137	168	198	229	260	290	321	351
17	48	77	108	138	169	199	230	261	291	322	352
18	49	78	109	139	170	200	231	262	292	323	353
19	50	79	110	140	171	201	232	263	293	324	354
20	51	80	111	141	172	202	233	264	294	325	355
21	52	81	112	142	173	203	234	265	295	326	356
22	53	82	113	143	174	204	235	266	296	327	357
23	54	83	114	144	175	205	236	267	297	328	358
24	55	84	115	145	176	206	237	268	298	329	359
25	56	85	116	146	177	207	238	269	299	330	360
26	57	86	117	147	178	208	239	270	300	331	361
27	58	87	118	148	179	209	240	271	301	332	362
28	59	88	119	149	180	210	241	272	302	333	363
29	60	89	120	150	181	211	242	273	303	334	364
30		90	121	151	182	212	243	274	304	335	365
31		91		152		213	244		305		366

TABLE 7

EFFECTIVE DAYLENGTH HOURS
COLOMBO, SRI LANKA
7· NORTH LATITUDE
SRI LANKA METEOROLOGICAL SERVICE, 20 YEAR RECORD

MONTH	HOURS	MINUTES	HOURS, DECIMAL
JAN	11	46	11.77
FEB	11	54	11.90
MAR	12	04	12.07
APR	12	15	12.25
MAY	12	25	12.42
JUN	12	31	12.52
			11.99
AVE			
JUL	12	29	12.48
AUG	12	21	12.35
SEP	12	10	12.17
OCT	12	01	12.02
NOV	11	48	11.80
DEC	11	43	11.72
			12.09
YEARLY MEAN			12.04

Table 8 Characteristics of staked, mulched tomatoes (Variety Duke)
(From : Marlowe G.A. 1983. Proc Fla State, Hort Soc 96:103-107)

Five Year Sampling Period 1978-1983

A	VEGETATIVE ASPECTS	INDUSTRY, MEAN (N+72)
	Fresh wight of plant, gms	4096.2
	Dry Weight of Plan, gms	526.6
	Number of leaves per plant	170.1
	Number of stemps per plan	5.4
	Number of sub-branches/plant	10.6
	Stem diameter, mms	20.3
	Leaf area, meters square	101.6 sq.ft

B	YIELD ASPECTS	INDUSTRY MEAN PER PLANT (N=72)
	Number of fruit cluster	45.3
	Total fruit set, number	94.3
	Marketable Fruit, number	63.0
	Immature Fruit, number	29.9
	Marketable Fruit/Cluster	1.4
	Total Fruit per Cluster	2.1

C	FRUIT ASPECTS WEIGHT/PLANT		AVE DIAM, MM	NUMBER/PLANT	
	SMALL FRUIT WEIGHT GMS	771.8	53.5	SMALL FRUIT, NUMBER	9.9
	MEDIUM FRUIT, WEIGHT GMS	1679.8	58.2	MEDIUM FRUIT, NUMBER	17.3
	LARGE FRUIT, WEIGHT GMS	2360.7	64.3	LARGE FRUIT, NUMBER	18.9
	EX LARGE FRUIT WEIGHT,GMS	4040.6	71.0	EXTRA LARGE, NUMBER	19.9
	MARKETABLE WEIGHT, GMS	8852.9		MARKETABLE FRUIT NO.	63.0

TABLE 9 SOME ESTABLISHED RESEARCH FINDINGS RELATED TO IMPROVED TOMATO PRODUCTION PRACTICES

A. YIELD RESPONSES MT/HA (From :Sajapongse,AVDC)

	WEED	FREE	PERIOD	DAYS	FROM TRANSPLANTING	
SITUATION	0-14	0-28	0.42	0.56	0-70	O-HARV
WEED FREE	41.9	48.0	58.1	55.7	57.9	63.2 MT/HA
WEED/INFESTED	60.5	59.1	51.4	46.9	39.7	38.3 MT/HA

B. YIELD RESPONSE DUE TO MULCHING (FROM: PERRY, NC STATE UNIV)

		MULCHED	NOT MULCHED
1.	RATE OF DEVELOPMENT		
a.	EARLY YIELD MT/HA	17.4	11.6
b.	TOTAL YIELD MT/HA	40.0	24.6

C. RECOVERY OF APPLIED NITROGEN (LOCASCIO, UNIV FLA AES)

		MULCHED	NOT MULCHED
1.	RECOVERY BY CROP	53%	39%
2.	REMAINING IN SOIL	42%	15%
3.	N LOST	5%	46%

D EFFECT OF PRUNING ON TOMATO YIELD (MANIK, BANGLADESH 88)

TREATMENT		NO FRUITS/PLANT	YIELD MT/HECTARE
1.	PRUNED ONCE	28	100.2
2.	PRUNED TWICE	25	98.0
3.	PRUNED TO SINGLE STEM	15	69.3
4.	NON-PRUNED CONTROL	36	120.0

TABLE 10 **ADVANTAGES AND DISADVANTAGES OF MULCHING**
(FROM : MARLOWE, G.A. 1982, FULL BED MULCHING SYSTEMS UNIV FLA VTC 4905)

A. **ADVANTAGES OF MULCHING**

1. Reduces evaporation of soil moisture
2. Reduces fluctuations in soil moisture
3. Retains soil moisture
4. Reduces fluctuation in soil temperature
5. Provides warmer day time surface temperature
6. Reduces weed growth
7. Reduces compaction of soil
8. Reduces leaching of fertilizer salts
9. Prevents crusting of soil
10. Promotes activity of micro-organisms
11. Reduces soil rot of fruit
12. Increases fumigation efficiency
13. Increases water use efficiency
14. Increases fertilizer use efficiency
15. Increases yield and improves quality
16. Is easy to learn
17. Requires only simple tools
18. Wide range of organic and inorganic materials can be used

B. **DISADVANTAGES OF MULCHING**

1. Requires special knowledge for use on crop
2. Requires more labor than non-mulched crop

TABLE 11 HIGHLIGHTS OF TOMATO FRUIT DEVELOPMENT USEFUL TO IMPROVED HANDLING AND MARKETING (20-25° c DAYS, 12-16°C NIGHTS)

	TIME PERIOD	EVENT
A.	FLOWER ASPECTS	
	1. 0-50 HOURS	POLLEN TUBE GROWTH PERIOD
	2. 44 HRS AFTER FERTILIZATION	2 CELLED EMBRYO STAGE
	3. 110 HRS " "	4 CELLED EMBRYO STAGE
	4. 130 HRS " "	EMBRYO DIFFERENTIATED
	5. 224 HRS " "	PRIMARY TISSUES DIFFERENTIATED
	6. 18 DAYS " "	PRIMARY ROOT & COTYLEDONS FORMED IN EMBRYO
B.	FRUIT ASPECTS	
	1. 14-20 DAYS AFTER FERTILIZATION	FRUIT 12,7 MM
	2. 20-32 " " "	FRUIT 25.4 MM
	3. 40-50 " " "	FRUIT MATURE GREEN
	4. 2-3 DAYS FROM MATURE GREEN	BLOSSOM END COLOUR
	5. 4-5 " " " "	TURNING COLOUR ENTIRE
	6. 5-7 " " " "	PINK MATURE
	7. 8-10 " " " "	HARD RIPE
	8. 10-12 " " " "	RED RIPE
	9. 13-14 " " " "	SOFT RED RIPE

C.	TIME ASPECTS	INDETERMINATE	DETERMINATE
		INDET.	DETERM.
	1. DAYS PLANTING TO 5 LEAF SEEDLING	21- 32	21-28
	2. DAYS TRANSPLANTING TO FIRST HARVEST	70- 90	65-80
	3. DAYS TRANSPLANTING TO FINAL HARVEST	70-120	80-95

TABLE 12 SOME GENERALISED RESPONSES INFLUENCING TOMATO PRODUCTION IN THE TROPICS

A. RESPONSES DECREASED BY INCREASES IN TEMPERATURE

NUMBER OF FLOWERS	FLOWERS PER CLUSTER	FRUIT FIRMNESS
SIZE OF FLOWERS	FRUIT PUFFINESS	DRY MATTER OF FRUIT
NUMBER OF FRUIT SET		RED JELLY IN FRUIT
POLLEN PRODUCTION		GREEN JELLY IN FRUIT
FRUIT WEIGHT		FRUIT REDNESS

B. RESPONSES INCREASED BY INCREASES IN TEMPERATURE

FLOWER OPENING	POLLEN DESTRUCTION	FLOWER DROP
POLLEN SHEDDING	GRAY WALL OF FRUIT	UNDERDEVELOP OVARIES
EMBRYO SAC ABORTION	GERMINATION OF SEED	DARK SEEDS
OVULE DAMAGE	SUNSCALD OF FRUIT	SENSITIVITY TO
ASCORBIC ACID OF FRUIT		BRUISING OF FRUIT

C. RESPONSES INCREASED WITH DECREASES IN TEMPERATURE

FRUIT PITTING	DELAYED COLORATION	EARLY YIELD
FRUIT SHRIVELLING	FRUIT DEFORMITIES	NUMBER LEAVES TO
BLOTCHY RIPENING	TOTAL ACIDITY FRUIT	FIRST CLUSTER

TABLE 13 RESEARCH AND DEMONSTRATION SUPPORT OPPORTUNITIES FOR THE AGENT PROJECT

A. RESEARCH SUGGESTIONS

1. AGENT ASSISTED DEPT AGRICULTURE TOMATO VARIETY STUDIES (GONORRARA)

a. OBJECTIVES

1. To assess All available germplasm carrying multiple disease resistance and heat tolerance for use as fresh market tomatoes in Sri Lanka.

2. To screen Leading processing cultivars known to have multiple disease resistance and heat tolerance for use as processing tomatoes in Sri Lanka.

b. SUGGESTED PROCEDURES

1. Appropriate replicated trials
2. Appropriate screening trials

2. AGENT ASSISTED DEPT AGRICULTURE TOMATO CULTURAL PRACTICES STUDIES (RESEARCH CENTER)

a. OBJECTIVEs

1. To compare various scheduling methods to reduce over supply periods in fresh market tomato production.

2. To assess merits of variety maturity, calendar and character leaf separation methods on market period of fresh market tomatoes.

b. SUGGESTED PROCEDURES

1. Using early medium and late cultivars; calendar interval plantings; based on character leaf method for yield, duration of growing and picking period and fruit quality.

3. AGENT SUPPORTED TOMATO MARKET LIFE STUDIES (POST HARVEST RESEARCH, UNIV PERADENIYA)

a. OBJECTIVES

1. To evaluate the influence of harvesting at mature green, star breaker (blossom and colour break) stage and full pink fruit maturity on shipping and shelf life of fresh market tomatoes.

2. To evaluate the influence of harvest maturity on incidence of field rot, cracking and insect damage (as compared to fruit left on the plant until hard ripe)

b. RESEARCH SUGGESTIONS

1. Using an industry accepted variety and commercial practices typical of the main tomato growing areas all fruit from replicated trials could be removed at mature green; star breaker; (turning), pink mature and hard ripe states of mature for removal from the field to shaded well ventilated holding area.

2. Appropriate curvi-linear relationships via regression curves for each maturity could be related to fruit quality maintenance during holding and advantages to the grower by avoiding on-plant problems such as insect damage, abrasion and fruit cracking.

B. DEMONSTRATION SUGGESTIONS

1. AGENT ASSISTANCE TO FARMERS ASSOCIATION THROUGH COOPERATION OF ADA OR EXTENSION FIELD OFFICERS

a. EVALUATE VALUE OF STAKING ON FRESH MARKET TOMATO CULTURE

1. Compare basket support method with individual plant staking with ground tomatoes on the following :-

a. Cost and labour required.
b. Ease of spraying
c. Ease of harvest
d. Yield and fruit quality
e. Cost/Benefit (Profit)

b. EVALUATE THE VALUE OF THE PRACTICE OF MULCHING ON FRESH MARKET TOMATO

1. Compare bare ground grown tomatoes with raised beds covered with rice straw, banana leaves (or other available organic coverings) on the following :

a. Frequency of watering and weeding
b. Relative growth of tomato vines
c. Yield and fruit quality
d. Cost/Benefit (Profit)

c. COMPARE THE RELATIVE MERITS OF BED GROWN TRANSPLANTS WITH CONTAINERIZED, AIR PRUNED SEEDLINGS ON THE FOLLOWING:

a. Days to harvest, duration of harvest
b. Crop vigor and plant health
c. Yield and quality
d. Cost/Benefit (Profit)

d. COMPARISON OF BEST MANAGEMENT PRACTICES PACKAGE WITH TRADITIONAL PRODUCTION METHODS

NOTE: It is hoped that an entire system comparison can be carried out for use as training and demonstration site; this, may be most appropriate in Mr. Phil Mowbray's linkage with a semi-commercial testing situation sponsored by the AgEnt Project.

An excellent public relations opportunity (as well as effective farmer field day training site) could show the advantage of containerized transplants, crop properly staked on mulched beds over ground non mulched traditional culture.

The benefits on improved pest management, water management, improved harvesting, higher yields and improved fruit quality have achieved global acceptance and should be readily adopted to Sri Lankan small holders. These practices are usually not economically feasible for processing production as the goal of least cost, highest raw product production is used.