AN APPROACH TO PLANT PROPAGATION

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Every generation has a need to state things in its own way. Let us look at some examples: "It is well, in fact it is necessary, that the seasons be considered (for grafting and budding) in which new growths are generally made, namely fall, spring, and the period of the Dog Star." Describe time by the Dog Star, and you are not in the 20th century of scientific writing unless you are an astronomer. "The following is a good method of grafting olives, figs, pears, or apples: Cut the end of the branch you are going to graft, slope it a bit so that the water will run off, and in cutting be careful not to tear the bark. Get a hard stick and sharpen the end and split a Greek willow. Mix clay or chalk, a little sand and cattle dung, and knead them thoroughly so as to make a very sticky mass." This description goes on to state how the bark grafting is done and how to protect the newly made graft from rain and cold. Because of the unique substance used to seal the graft, you know this is not 20th century writing. "In Italy, a widely used method is to bark graft small seedlings (of olive) in the nursery row in the spring. The stocks are cut off several inches above ground, and one small scion is inserted in each seedling, followed by tying and waxing." This last quote is more like the terminology of modern day.

The first quote comes from Robert E. Dengler's translation of Theophrastus: De Causis Planitarium, Book I. The second quote is from Marcus Porcius Cato On Agriculture, written around 160 BC. The last is from the third edition of *Plant Propagation* by Hartmann and Kester.

These quotes point out that even with technological development, a lot about plant propagation has remained constant. Instead of cattle dung and clay, we use beeswax and resin or asphalt and water. Instead of split Greek willow for tying the graft, we use rubber bands or plastic ties or sticky tape. Yet the method for bark grafting has not changed much. "Take your split willow and tie it around the cut branch to keep the bark from splitting. When you have done this, drive the sharpened stick between the bark and the wood two fingertips deep. Then, take your shoot, whatever variety you wish to graft, and sharpen the end obliquely for a distance of two fingertips; take out the dry stick which you have driven in and drive in the shoot you wish to graft. Fit bark to bark, and drive it in to the end of the slope. Wrap the Greek willow thicker, smear the stock with the kneaded mixture three fingers deep . . ." In 160 BC, this is the way they grafted olives in the spring in Italy. How different is it from the procedures used today?

If procedures have remained fairly constant, aside from exchanging beeswax for cattle dung, what has changed over the centuries? We like to think that we have a more fundamental understanding about plants and plant propagation and that we can describe the phenomenons in chemical and physical mathematical terms, that we can put our formulas and numbers into computers and analyze complex relationships, that we can use the marvels of microprocessors to monitor environments and control processes and that we more fully understand the relationships of seemingly isolated occurrences.

The Holistic Approach. Each generation likes to think that it is applying the latest technology and that it is considering holistically all of the ramifications of the separate processes. In the main, each generation is.

The system approach is an holistic approach. By examining the relationships, we will concentrate on those areas where improvements will have large payoffs. It will also help to understand why different systems are essential.

The payoffs — where are they and why? First, we must consider how we are to judge payoff. This leads one to answering the question — why are you propagating plants?

To expand our understanding in chemical or mathematical terms and write a paper about it is payoff to the scientist. It means we look for an interesting or intriguing phenomena to study and describe. For example, crown gall bacteria causes proliferation of undifferentiated cells. What are the chemicals and how do they act? Can this information be used to increase callus growth for propagation by tissue culture? Here we are involved with information to more fully understand the biological system involved in plant propagation.

On the other hand, if we are studying plant propagation because our livelihood depends upon profit from it, then the *system* involves biological, human, mechanical, and environmental considerations. The payoffs would be in terms of dollar returns and profitability. Rearranging work stations may have a larger payoff then instituting a procedure that increases rooting percentage by a small number. Controlled atmosphere storage of rooted cuttings or seedlings may be more profitable than increasing the size of the propagation facilities. Rather than studying a biological phenomena alone, we study the man, machine, and biological interactions.

Developing New Systems. Analyzing a system and developing replacements is one of the great values of a systems approach. By this, I refer not to simply replacing cattle dung with beeswax, but rather to developing an entirely new system. Take field budding of roses — there must be a better way, and there is. True, each plant must be handled one at a time, and each plant will probably be handled by a human with mechanical aids. But there is a better way than squatting or lying in the hot sun hour after hour and hoping that nature does not play tricks.

The commercially used procedure goes somewhat as follows:

1. Stock blocks may be maintained for understock and for the budwood. This is especially true where virus-free plant materials are used. Otherwise, the necessary cuttings are harvested from plants to be dug for market.

2. Understock is harvested in the late fall. Canes are cut to lengths and the lower buds are removed. Fungicide and other chemical treatments are applied.

3. Understock is stored under refrigeration until they are lined out in the field during the winter.

4. Meanwhile, budwood is collected, treated, wrapped in moist newspaper, and stored at slightly below freezing.

5. Understock is irrigated as necessary.

6. In the late spring, the budding process begins. Budwood is removed from the storage as needed, and the budder inserts each bud, one at a time, into the understock. The buds are tied in by the budder or by another person.

7. Water, fertilizer, and other cultural practices are applied on a continuing basis.

8. Once callusing has occurred, various steps such as bending over the top of the understock are undertaken. The exact step depends upon the type of rose being produced. By type, we refer to greenhouse started eye, two-year garden roses, etc.

Is there another way to arrive at the same end point — a #1 rose plant ready for the world gardens? The system developed must take into consideration these necessary parts:

1. An understock and a scion must be joined by some grafting or budding procedure.

2. Optimum yield of #1 roses is necessary.

3. Costs must be such that the profitability is equal to or better than the present system.

4. People must be able to control the system.

5. Suitable machinery is available or can be developed.

Some possible systems suggest themselves — they should be developed:

Possible System 1. Dormant scion buds are chip-budded upon dormant understock. Suitable machinery can be used. These are then placed through a series of physical environments to effect healing of the bud union and initiation of roots in the understock.

A few years ago, Don Luvisi, a Farm Advisor in Kern County, California, and I chip-budded dormant rose scion buds on rose understock. These were coated with grafting wax, then lined out in the field. Some of these buds took and grew into budded plants.

Possible System 2. Rather then chip bud, one-eye scions and grafting machines might be used. These grafts then would be subjected to various environments for union to occur and for rooting to be initiated.

This system is applying the information on propagation of grapes to another crop. It should be relatively simple to make the procedure pay off handsomely.

Possible System 3. Understock and scion stock plants are maintained in controlled environment conditions, i.e. greenhouse, so that vegetative growth can be maintained around the year. The buds or grafts are made each day — possibly microbudding, or some similar procedure can be used. Callusing of the graft and initiation of roots is stimulated. The grafts are then stored in controlled atmosphere storage until all are transplanted (lined out) into the field. Lining out occurs during one optimum period.

There are other possible systems to explore. These alternative systems maintain the essential parts, remove much of the chance element, and put the work into more pleasant surroundings. These descriptions are in broad strokes — many details must be inserted, investigated, and many procedures must be tested and adapted. However, the process comes into focus — the area where payoff would be greatest begins to appear. For example, of the three possible alternative systems, I am drawn to the third because the work load is spread out over the year, permitting maintenance of a capable staff. The other suggested systems require a lot of concentrated effort in the winter when harvesting, packaging, and shipping stretches the management ability of the company to the limit.

Many possibilities begin to appear as we anticipate problems and develop alternative solutions. Perhaps the understock and the budwood should be stored until after the shipping season. Still the work could be highly seasonal, but it overcomes the major problem of too many important tasks all at once.

Could understock and budwood be stored all year and taken out for budding and callusing, then returned to storage to be then lined out all at the same time?

A lot has remained constant, until now. As long as we continue to make grafts or buds outdoors or to stick cuttings into rooting media, not much will change over the years. However, an holistic approach and a lot will change. Propagation by tissue culture is a good example. Other examples will come. We have just begun ----.

THE DEVELOPMENT OF FOAM PROPAGATING SYSTEMS

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INTRODUCTION

Propagating systems continue to evolve from the introduction of Jiffy-Pots in 1954 (1). These and other peat pots are made in round and square shapes, in a range of sizes for the propagation and growing on of individual units. Propagators familar with peat properties find few difficulties in growing plants in these biodegradable units and buyers like the concept of planting pot and all. While others less familar with peat technology, encounter difficulties in watering procedures and observe restricted root development. We see the "wicking action" problem when plants are set a bit high in the final container. Individual peat pots tend to fall over on the propagation bench. They are difficult to efficiently handle during packing and shipping processes.

The buyer of plants rooted in these pots must also deal with single units which can be difficult for him to manage. From the individual peat pot or plastic pot we see the development of Jiffy-Strips and a whole array of vacuum-formed plastic "packs". These thin walled plastic "packs" are low cost and adequately do the job for the propagator. They allow for multiple unit handling, ease of handling during propagation and packing, but getting a rooted plant to the customer in one piece can still be a shipping problem.

POLYSTYRENE FOAM TRAYS

The California Rooting Tray developed by Paul Ecke Poinsettias in the early 1970's was a further improvement in low