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"Posi-Flow" Planting System

by

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SUMMARY:
To meet the needs of crops grown under plastic mulch, the "Posi-Flow" Planting System has been developed. It utilizes progressive dispensing technology, and a system of modular components, useful for many applications. This paper discusses reason for development, early history, theory of operation, achieved results, advantages over past methods, potential impact on the industry, and system limitations.

KEYWORDS:

Injectors, Pneumatics, Singulators, Planters, Progressive Sequencing

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INTRODUCTION

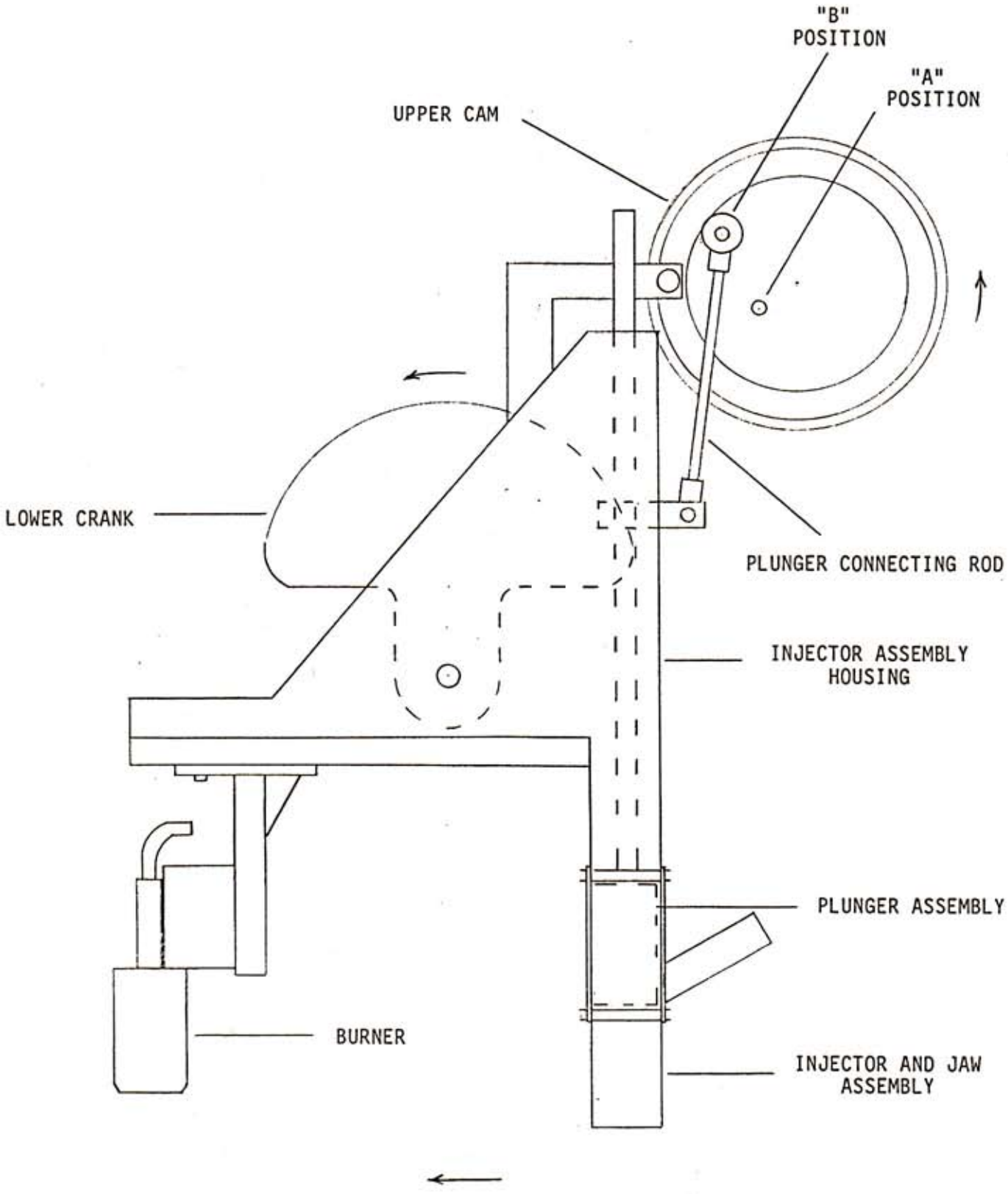
In all sense of the word, to the planting industry, this project would be similar to re-inventing the wheel. Everything previous to this developments, for planting through plastic mulch, involved the use of large diameter wheels with numerous discharge cups for dispensing planting material. Many problems were encountered - many moving parts, material transfer hindered by gravity, difficulty in changing spacing and the inability to perform more than one function. The "Posi-Flow" Planting System utilizes a single injector tool bar concept whereby, many functions are being performed at the same time (i.e. burn holes, plant seed, dispense growing medium, etc.). Because this system uses one injector head, it can be calibrated for many different spacings. Simplicity is one of its key elements - being able to perform many functions with a mechanism that has seven moving parts. Universal is another factor to its uniqueness. It has the ability to add or subtract functions (i.e. burn holes, plant seed, dispense growing medium, etc.) as to the need of the particular region in which it is used.

REASON FOR DEVELOPMENT

Being a short-line manufacturer, specializing in agricultural machinery, our first experience with planters came about in 1984 when growers approached us with their mechanical-type cup planters. They asked us to redesign this equipment to meet their particular need. What they needed was a method of placing a metered rate of pre-mixed seed and plug mix under plastic mulch covered beds. We were quite successful with the conversion of this planter system. We added a rotary-type plug mix feeder to feed the plug mix into the rotating cups. We designed a system for burning holes through the plastic mulch. These planters were configured in various row centers and in-row spacings as needed. In its time, this planter reduced planting cost drastically by off-setting large amounts of labor used in hand planting.

But like any piece of machinery, it soon could not meet the needs of the future. This planting system contained certain inherent limitations that led to its demise. The first, and most pronounced limitation, is by its own nature of being a wheel concept. In-row plant spacing is determined by the center distance between the dispensing cups around the circumference of the wheel. To change spacing, cups had to be added or subtracted to the circumference. This was a major project when done in field conditions. The second limitation is the need for a large number of cups spaced around the circumference which resulted in a high number of moving parts. Because of the proximity to the soil, the moving parts were prone to early failure. Naturally, any accessories added (burner and plug feeder systems) involved more moving parts, and more potential for component failure. The accessories had to be timed accurately to the action of the planter cups. In the situation when in-row spacing was changed, the drive ratios of the feeders had to be changed to match the number of the dispensing cups used. These planters were a big advantage for the grower to off-set the cost of hand labor, but as the needs to perform more operations were being presented, this planting system was turning into a nightmare of complexity.

FIGURE #1
INJECTOR ASSEMBLY



The growers were requesting planters with metered seeding to off-set the large seed waste incurred when pre-mixing seed into plug mix. The need for a faster, more accurate, more reliable, simpler design with adaptability to regional conditions were the goals in developing a new type of planting system for plastic mulch culture.

EARLY HISTORY

Through experience from working with the mechanical-type cup planter, work began on developing a new planting system that could meet the needs of the future.

In the fall of 1986, development of the first prototype began. After some time, a system using one ground-engaging injector was developed and tested. To accurately meter seed into the injector was the primary objective of the project at this point. Commercially available seed singulators were researched and tested. None were found to have the accuracy needed to fulfill the needed requirements.

Having reached an impasse, a decision was made to develop our own singulator, making it compatible to the positive pressure pneumatic system used with the plug mix feeder. Designing and building a pneumatic seed singulator proved to be quite a challenge. Ironically, it proved to be an asset to the project. The singulator was designed for full automatic operation with no need for adjustable seed wipers for doubles and triples, and no need to manually set singulator PSI. These two features greatly reduced the operator's involvement in obtaining accurate seed singulation.

In December of 1987, a one-unit prototype was sent to the Jupiter, Florida area. Here was the first test in commercial field conditions. This test was not without its problems, but the theories and principles were successful. The main problems revolved around the demanding conditions to which the injector components were exposed. With the vast array of space age materials available, it was a fairly simple matter of finding the right materials for the conditions. Testing continued through the winter under various field conditions. Finally, that following spring, the planter was sent home for evaluation. From the knowledge obtained in the field testing program, two production planters were built and sold to a large pepper grower near Boynton Beach, Florida.

With the success of this planting system, a second model was developed and released for production in the summer of 1990. This second model utilized all the same ground-engaging components as the first model. However, the plug mix feeder option is not available on the second model. Many growers do not need to use the plug mix system on plastic mulch. By developing a second model, the selling price of this planter was reduced, making it more cost effective for the smaller acreage growers.

THEORY OF OPERATION

The "Posi-Flow" Planting System utilizes a single discharge injector as shown in Figure #1. The injector assembly follows a rotating motion in relationship to the ground.

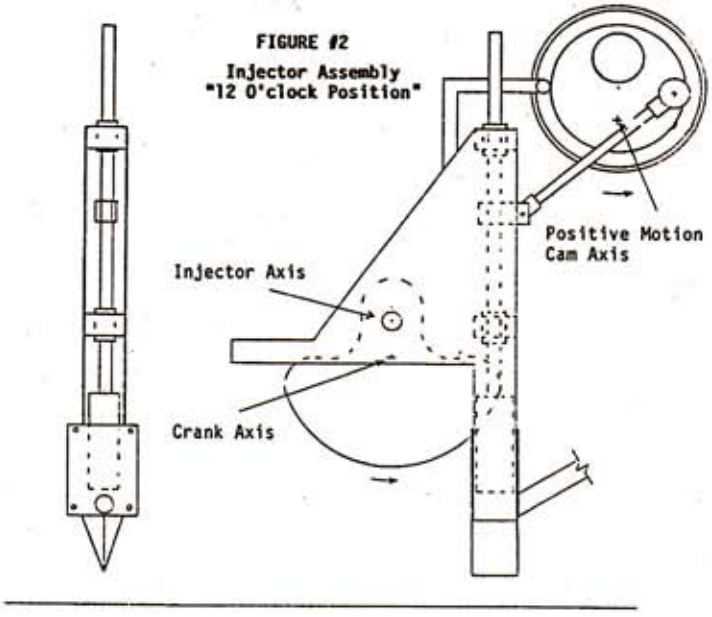


FIGURE #2
Injector Assembly
"12 O'clock Position"
Positive Motion
Cam Axis
Injector Axis
Crank Axis

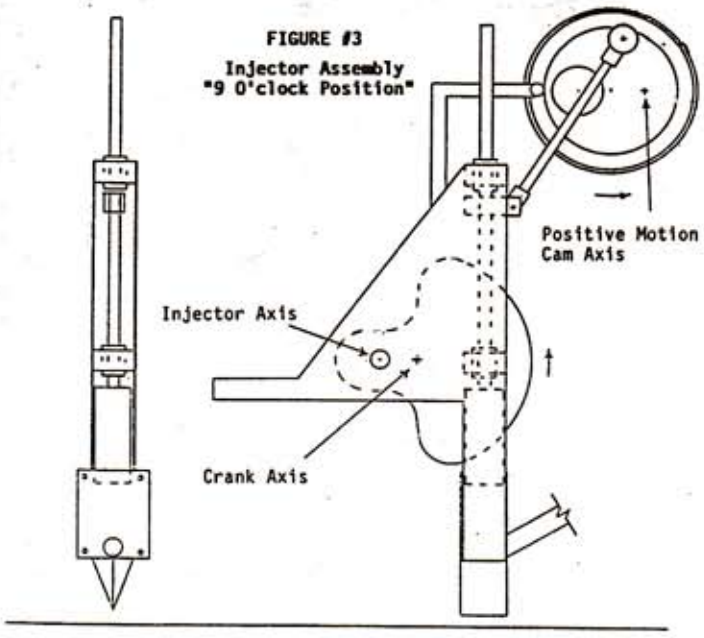


FIGURE #3
Injector Assembly
"9 O'clock Position"
Positive Motion
Cam Axis
Injector Axis
Crank Axis

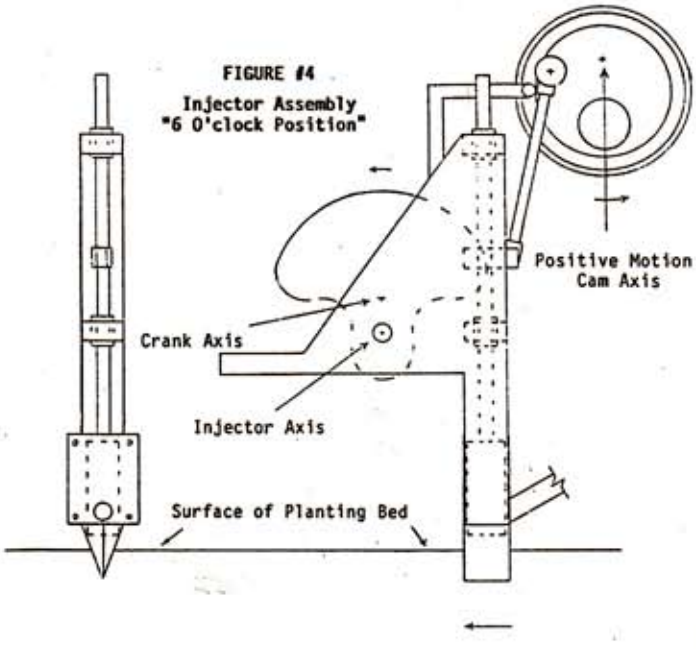


FIGURE #4
Injector Assembly
"6 O'clock Position"
Positive Motion
Cam Axis
Crank Axis
Injector Axis
Surface of Planting Bed

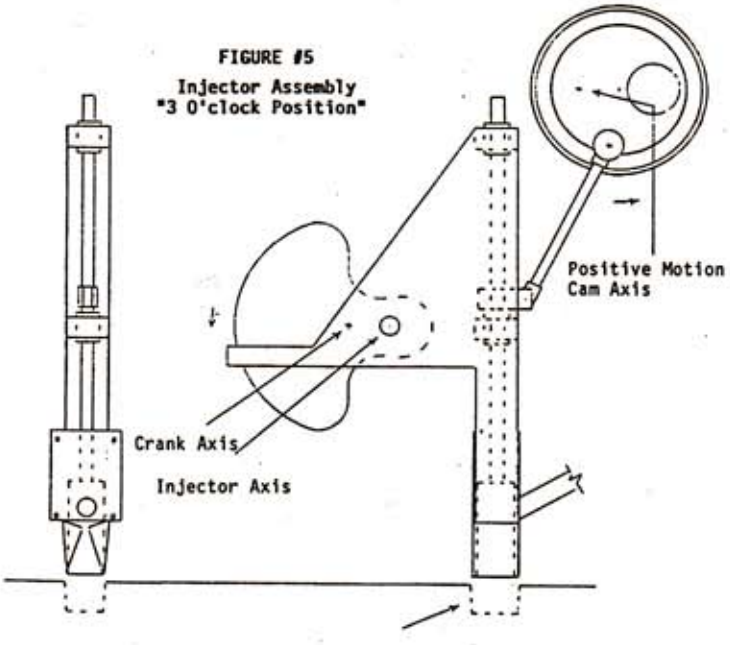


FIGURE #5
Injector Assembly
"3 O'clock Position"
Positive Motion
Cam Axis
Crank Axis
Injector Axis

The rearward motion is contacting the ground and the forward motion is jumping ahead for the next penetration. The injector assembly is mounted from two rotating axis in time to each other. The lower rotating axis, through the use of a crank assembly, sets the circumferential travel of the injector (the plant spacing). The upper rotating axis, through use of a positive motion cam, trains the injector assembly for its parallel motion to the ground. Located inside the injector assembly, is the plunger. The plunger follows a linear travel within the injector assembly to facilitate the loading and discharge in each cycle. To create the linear motion of the plunger, a third axis, on the positive motion cam, is connected by linkage to the plunger assembly. This causes a linear motion of varying velocity to facilitate the stroking action. The plunger action is designed to reach bottom dead center approximately 90 degrees after the injector jaws have passed bottom dead center or just as the jaws are leaving the surface of the bed, thus holding down the planting material which allows for high speed cycling. Figures #2 through #5 show the injector assembly in their respective 12, 9, 6, and 3 o'clock positions.

The "Posi-Flow" injector system operates on a one-cycle (one revolution) per plug. The loading portion of the cycle takes place while the injector is withdrawn from the bed and repositioning itself for the next injection. During the injection portion of the cycle, the plunger is forcing the injector jaws open, while pushing the planting material into the bed.

The various materials to be dispensed (seed, plug mix, etc.) are metered from separate feeders located on the planting unit. The transfer from the feeders to the injector is accomplished by fluidizing these materials by pneumatics to cause flow through transfer tubes. The transfer tubes serve two functions. First, as a conduit for planting material. Second, as compensation for the unequal motion between the feeders, which are stationary in relationship to the planter, and the injector, which is moving in relationship to the planter.

The fluidizing material from the feeders is received into a holding chamber located on the injector assembly. The linear action of the plunger creates an on/off valve action over the discharge of the holding chamber. The holding chamber accumulates the steady flow of plug mix until the plunger valve opens to charge the injector. This system does not rely on gravity for the transfer of seed and planting material. Because of the force feed transfer of the material, the system is capable of operating at 7,200 cells per hour when using plug mix and seed; and 14,400 cells per hour when planting seed only. In reality the system can function much faster but bed conditions usually do not allow good seed placement above the rated speed.

The "Posi-Flow" Planting System utilizes a method of progressive sequences for the ground-engaging actions. Accessories are mounted onto tool bar mounts located on the injector assembly. The accessories are located in line with the injector and spaced at the same in-row plant spacing for which the injector assembly is calibrated. In operation, when burning holes, injecting seed, injecting plug mix, and wetting with water, all three functions are being performed during the ground-engaging portion of the cycle at three separate locations. In a progressive sequence, the injector jumps ahead one plant spacing, to perform its functions over the preceding functions. Figure #6 shows a planter unit set up for burning holes, injecting seed, injecting plug mix, and wetting the planted material.

ACHIEVED RESULTS

As explained in U.S. Patent No. 4,941,416, the "Posi-Flow" Planting System has been given the distinction of a new concept in planting under plastic mulch.

The development of the "Posi-Flow" system has led to a fairly simple ground-engaging mechanism consisting of a seven-moving part assembly. The system is built around a series of modular components, with the injector assembly being the heart of the system. All accessories are direct mounted to the injector assembly and follow the same motion as the injector. When operated in a progressive sequence, many operations can be performed without the need of additional ground-engaging mechanisms.

With tens of thousands of acres of experience, this planting system has proven itself in durability and reliability. The system has been operated successfully in all soil conditions (i.e. clay, sand, coral rock, etc.) regardless of moisture content. Figures # 7, 8, and 9 show some of the diverse applications. Figure #10 shows this systems' adaptability to less than ideal conditions.

ADVANTAGES OVER PAST METHODS

In the past, virtually all planting systems used a wheel concept with many cups located around the outer circumference for dispensing seed and planting material into the ground. Many problems were encountered such as:

1. Many moving parts were subject to premature wear.
2. Cups having fixed spacing made it difficult to change in-row spacing.
3. Gravity limits the performance of this type of system.
4. Difficulty in performing other functions (i.e. burn holes, inject water) without utilizing a complex mechanical system.
5. In wet conditions, this type of planter tends to accumulate material in and around the jaw area.

The "Posi-Flow" Planting System uses a single ground-engaging mechanism which carries the planter injector and accessories. The advantages of this system include:

1. This injector system consists of a simplified seven-moving part system constructed with space-age materials and components. One injector can do the work of 6 or 8 cups.
2. A single injector allows easy change of in-row spacing.
3. By pneumatically fluidizing the transfer of seed and mechanically forcing the seed into the bed, all restraints from gravity are eliminated.
4. With the ground-engaging tool bar, many functions can be performed from the same mechanism by simply adding components to that tool bar.
5. With the positive displacement action, the jaw area is cleaned by the plunger on each cycle.

POTENTIAL IMPACT ON THE INDUSTRY

The development of the "Posi-Flow" Planting System brings about a completely new way of utilizing the advantages of plastic mulch. The use of plastic

mulch has been severely hampered with the lack of cost effective methods of planting under plastic. The new hybrid seeds now being introduced, can now be directly sown under plastic economically. This injector system opens the door for many other materials to be injected under plastic, which have been difficult to dispense in the past.

SYSTEM LIMITATIONS

Performance of this system is in direct relationship to the conditions in which it is being used. Soft beds and loose plastic affect seed placement and hole quality. Poor germinating seed can cause many skips if not sown in high enough rates. Planter not being maintained and adjusted properly can lead to poor results. Planting in extreme conditions (i.e. too hot, too cold, too wet, too dry, etc.) can also lead to poor results. Many circumstances above and beyond the planting aspect, enter into determining the end results.

SUMMARY

With the over all trend of crop intensification, plastic mulch is quickly becoming the industry standard for growing high-value crops. The capital outlay for establishing a crop on plastic mulch can be as much as ten time over the cost of bare-ground methods. Growers are resorting to all sorts of techniques to increase their yields and to off-set the large up front investment of growing under plastic mulch. In some areas, a growing medium or plug mix is used to enhance the emergence of seed. Moisture retaining materials are sometimes added to the growing medium in some parts of the country where water control is difficult. Burning a hole through the plastic mulch is probably the single most important operation that is done in common between the different regions. When the flap of plastic mulch is not removed, crops are susceptible to stem damage from the flap of plastic mulch rubbing the stem. In some regions, with high rainfall, the hole size is kept small to limit the amount of rain water entering the bed. In contrast, other regions need a large hole to allow surface heat to escape from the bed before damaging tender young plants in high temperature areas. Some growers are resorting to wetting the seed with water and starter fertilizer immediately after being planted to enhance emergence.

Where the growing season allows, many growers double and triple crop on the same plastic mulch covered bed to help yield more crops from the initial capital investment. In this situation, seed is planted and liquid or granular fertilizer injected for the next crop.

These are only a small sample of the techniques that growers around the country are using on plastic mulch. The "Posi-Flow" system of modular components is an attempt to fill the varying requirements. Meeting the needs of the future is a requirement for which this system was designed.

Planting through plastic mulch has always had two options for the grower from which to choose - seed or transplants. With the completion of the direct seeding aspect of this project, a second phase has been initiated. This is to utilize the "Posi-Flow" ground-engaging components and develop and automatic system of handling transplants.

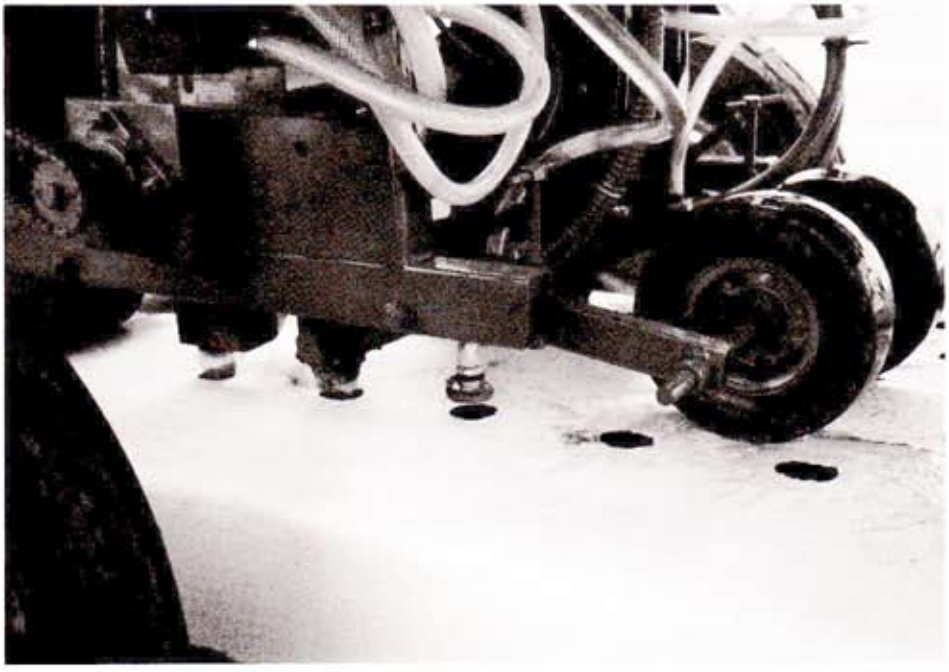


FIGURE #6

Planter Unit Performing Three Functions
In A Progressive Sequence

FIGURE #7

Planter Unit Operating On A Heavy Clay-Based Soil

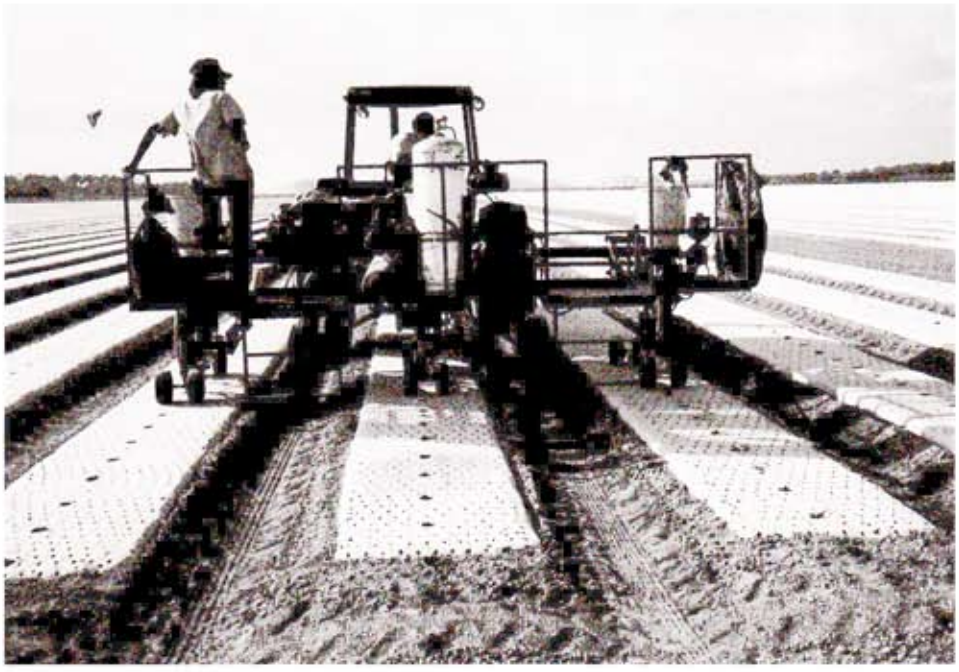


FIGURE #8

A Three-Row Planter Being Operated
On A Coral Rock-Based Soil

FIGURE #9

A One-Row Double Unit Planter
Operating On Pure Sand-Based Soil

FIGURE #10

Second Cropping Being Performed
Over A Depleted Tomato Field