EXECUTIVE SUMMARY FOR SARE PROJECT FNE 94-57

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REPORT FOR: EVALUATION OF WATER RETAINING SOIL AMENDMENT CROPPING SYSTEMS AND AN ALTERNATIVE LABOR SOURCE FOR VEGETABLE PRODUCTION.

1) The use of emotionally challenged individual for transplant and harvest labor proved impractical because of low production rates, the need for constant supervision and a lack of reliability.

2) The use of seasonal creeks for supplemental irrigation of small acreages appears practical and can provide significant increases in yield, quality and grower profit. Projected yield of bell peppers was increased approximately 73% using "when available" water from the seasonal creek in a low tech gravity fed trickle irrigation system.

3) The addition of the water retaining soil amendment at rate of 2 to 4 lbs/1000 square feet gave projected yield increases for bell peppers of 11 to 38% over conventionally mulched and irrigated culture with a 20% reduction in initial nitrogen applied and reduced water consumption compared to the conventional mulched and irrigated system. Use of the polymer also significantly increased transplant survival of bare rooted pepper transplants.

4) Some refinement of fertility programs and irrigation tape is required however, based on one year data for bell peppers and an estimated cost amortized over a 5 year lifetime, the net gain for the grower would be approximately $2,400 to $4,120 per acre, annually based on yield increases of 92% to 139% over conventional bare ground culture.

5) It likewise appears that a system utilizing water from seasonal creeks, the low cost irrigation system and the water retaining soil amendment is extremely cost effective while reducing fertilizer and water inputs.

ALTERNATIVE LABOR STUDY

Background

A lack of planting and harvest labor is a major limitation to small, family operated vegetable producers in our area. Although the larger growers recruit migrant labor, it is impractical for small growers because of the housing and other government requirements.

An "underground" labor force willing to work for unreported cash does exist however a grower not only puts himself at a legal risk but also cannot claim the wages as an expense.

Family labor also has limitations because frequently the children have little interest in farming and the children and spouse may have other employment.

The labor situation will not improve when the agricultural worker safety laws which require certification of worker's safety training is implemented in 1995.

This study was undertaken to evaluate the possible use of emotionally challenged individuals enrolled in a state sponsored counseling and rehabilitation program. Worker performance was evaluated by comparison with other available labor.

Limitations

TEC (Transitional Employment Consultants) coordinates the program for the challenged individuals providing counseling and placement in temporary, seasonal or part-time jobs with an objective of phasing the clients back into the mainstream workforce. Because of a budget shortfall, TEC was prohibited from adding any new individual to the program until after the start of the new fiscal year in July, 1994. This limited the number of candidates we could screen because all new TEC clients must undergo testing, initial counseling and an evaluation to determine whether they are ready to participate in the work therapy portion of the program.

Despite high unemployment in our area (Western Pennsylvania and West Virginia Panhandle), we were unable to secure local labor willing to work for $5/hr reported income. We were approached by four individuals willing to work for under-the-table cash. This was declined.

My wife works full time and my eldest son (16) worked full time during the summer at a bank in Pittsburgh. My younger son (14) attended advanced classes at the Allegheny Community College throughout the summer and suffered a

broken collarbone during harvest season. These three individuals along with my younger brother (41), reluctantly served as local labor. A major portion of the funds in the grant allocated for local labor were not used.

Results

In general, the use of the contract "challenged" labor was unacceptable and cost rather than generated revenue. Production rates were substantially lower, product loss was high, the level of supervision required was high and the dependability variable.

A considerable effort was made by the counseling staff to secure acceptable workers and to correct obvious deficiencies. Frequently, "coaches" familiar with the individuals, accompanied the workers and worked with them on a one-to-one basis. In one instance, a team approach was tried with 5 counselors supervising a crew of approximately 12 workers.

The staff was professional, creative in their approaches, pragmatic and patient. Their efforts were commendable.

A range of individual from new, actively counseled to "inactive" standby clients were tried. The most frequently encountered problems were:

Learning dysfunctions -

* Inability to stay focused on the task, and a lack of concentration
* Difficulty in following/remembering directions particularly with sequential or multiple tasks, i.e., tomatoes should be pink or higher in color,and the stems should be removed, and ripe tomatoes should not go on the bottom
* Physical limitation - many of the workers appeared to have been involved in accidents with a loss of flexibility. Some lacked strength, many lacked stamina to work more than 2 hours at a reasonable pace. Medication also limited ability to work under temperatures evenly moderately warm or under full sun.
* Motivation/attitude. This is perhaps the most frustrating obstacle in our use of the emotionally challenged workers. Contrary to expectations, we found the majority of the clients were poorly motivated. Our experience suggested that many of the individuals had developed and refined defense mechanisms which help them "get-by"

Another trait common in the majority of the clients was an increased effort to work and please the counselor/coach as long as present with a corresponding

almost immediate, decline in effort upon the counselors' departure.

The clients' primary motivation appeared to be projecting an acceptable image to the counseling staff.

In feed back from the TEC offices, it was pointed out that lack of focus, limitations in understanding and following instructions are prevalent in individuals with persistent mental illness. It is also an effect of medications used to treat cognitive disabilities. Medication may also cause fatigue and reduce the ability to function at a rapid or steady pace.

In a review of the clients by TEC, it was determined that a number of them had suffered physical trauma from accidents and had lingering physical problems.

Overall, it was our feeling that the outdoor environment and work were probably therapeutic for the client workers however training on proper harvesting is not readily assimilated by this workforce and the expertise required in dealing with the individual emotional problems and identifying motivational shortcomings are more appropriately dealt with by the professional staff. A combination program training the individual on proper techniques of vegetable/greenhouse production in conjunction with their regular counseling could prove worthwhile particularly if the growing operation were an integrated and essentially self sustaining unit within the existing rehabilitation unit. Although the number of non-owner agricultural positions paying significantly more the $6-7/hr may be limited, this could change with the implementation of the newly mandated agricultural worker safety law. Additionally, from my conversation with the "inactive" rehab clients, the majority of the jobs taken by this workforce are around minimum wage and frequently non-permanent.

Regardless, in this study the use of "challenged" labor proved to be counter productive and economically impractical because we failed to find any individuals who were reliable, consistent and who could perform at a rate which would generate a profit for the grower without continuous supervision.

A sampling of comparative productivity and worker experience is attached in Table 1.

SAMPLING OF WORKER PERFORMANCE AT VARIOUS TASKS ASSOCIATED WITH SMALL FARM VEGETABLE PRODUCTION

TABLE 1

TASK	LOCAL LABOR	CONTRACT LABOR	COMMENTS
Hand transplant cell grown peppers into prepunched plastic mulch.	Short Term = 350/hr Sustained = 225-250/hr	Highest rate 92.5/h	Had to have consultant supervision to maintain this rate. One individual resorted to transplanting in a prone position. 30 to 40% of the plants had to be reset.
Harvest 400 foot row unstaked fresh mkt pink tomatoes.	5 Bu./2hr with 27 saleable chip bskts.	2 Bu. /1 hr 2.5 saleable chips	Contract labor left 3 3/4 Bu. in the row vs. 5 lbs for local labor. Contract labor picked unsaleable product and also damaged saleable product during harvest. Unsupervised this individual was found asleep after picking 1 Bu. in 2 1/2 hrs, and later failed to call in, failed to show.
Drive stakes for staked tomatoes.	50-60/Hr.	50/hr.	Acceptable.
String Florida weave for tomatoes.	15 min./100 ft row	20 min/100 ft row 30 min/100 ft row	Initial performance good, third stringing not completed, loose. Plants had to be positioned in weave later. Individual failed to call or show up for work next 2 dates. "Personal Problems".

TABLE I (continued)

TASK	LOCAL LABOR	CONTRACT LABOR	COMMENTS
Hand weeding between mulched rows.			Individual found wandering between rows. Described this as "randomly" weeding. Later broke off tops of weeds because he had to "keep my clothes clean". Took a 1 hour break while a delivery was being made to "avoid sun stroke".
Plant miniature & Ornamental corns w/ precision seeder.			Clean, cut hard worker apparently motivated. Became confused and planted corn in double rows 1" apart. Became confused in laying out area. Created 6 intersecting rows (X) rather than 8 straight rows. Left opened bags of seed in field during rainstorm. Broke seeder. Did not communicate.
"Strip Pick" Peppers.	4 1/4 Bu/hr w/ 4 Bu saleable	4 Bu/3 hr w/ 2 Bu saleable	Plants are cut down & taken to picker. Individual tried hard but could not maintain pace, could not simultaneously select for both size & color & had difficulty disregarding fruit which would be acceptable in his own garden.

IRRIGATION & SOIL AMENDMENT STUDY

Background

Irrigation in vegetable crops can significantly increase yield, fruit quality and income for the grower. However, many small growers cannot afford the substantial capital investment required for pond or deep well construction and irrigation equipment. Many of the soils in Appalachia also have severe limitations for pond construction. Additionally, adequate water may simply not be available.

One possible source of water is in the abundant streams flowing through the hills. Although some of these streams cannot be utilized because of trout or other fish populations, seasonal creeks frequently have limited fish numbers because of wide fluctuations in water level.

Another possible approach to optimizing utilization of water would be the use of water retaining polymers as soil amendments to extend water holding capacity. These polymers are used successfully in commercial greenhouse production but their high cost and current projected rates for field use make them cost prohibitive.

The intent of this portion of the research project was to investigate several low cost systems which could possibly provide alternatives to the current, standard methods of irrigation. In particular, the use of water retaining polymers at reduced rates either by themselves or in conjunction with supplemental and reduced irrigation, was evaluated.

Two crops, staked fresh market pink tomatoes and green bell peppers were used for the study.

General

The spring of 1994 in Western Pennsylvania was cold and wet with frost warnings issued up to 5/27/94. This delayed field preparation and transplanting. Soils were officially classified as saturated by 5/26. Although pepper plants for the plots were acceptable, the tomato plants had been held in the greenhouse, were spindly and between 8" and 10" tall.

Although the soil in the test area is classified in the SCS soil survey as a Glenford silt loam with a 3 to 8% slope, there is a distinct break in soil appearance midway through this field and the plot area is closer in appearance to Guernsey silt loam. Both of these are described as deep, moderately well drained with slow to moderately slow permeability and a high available water capacity.

The plot area was limed, plowed and disced. Fertilizer

was then applied by hand at the recommended broadcast rate per the soil test and the specified crop (fresh market pink tomatoes or sweet bell peppers) with the exception that rows which were to contain the soil amendment had nitrogen applications reduced 20%. Rows were marked with a light application of lime and furrows were cut 10 - 12" deep in those rows requiring the soil amendment. Granules of the water retaining soil amendment (trade name Water Works) were diluted with processed peanut hull granules (AgTech Ag Form) to provide sufficient volume for uniform distribution. The check in each row(plot #3) received no soil amendment or diluent granules. The granular products were then mixed in the furrow using 24" and 10" rotary tillers to produce treated trenches 2" wide and 10 - 12" deep. Herbicide (Devrinol 50 DF @ 2 lbs ai/A) was applied to the specified rows. The field was then disced in one direction and leveled with a spring tooth harrow. Irrigation tape was laid. Rows with the soil amendment were watered with the equivalent of 1/2" of water on 5/21/94.

Rainfall of 0.33" fell 5/24. Designated tomato and pepper rows were covered with black, biodegradable plastic mulch on 5/25. A severe wind and hail storm on 6/20/94 damaged plants but the plants did recover.

The original test design was to set all transplants with 1 pint of water, thereafter, no water was to be applied to any bare ground or non-irrigated plants. The conventionally trickle irrigated control was to receive 3/4" to 1" of water per week up to the appearance of the first pink fruit on tomatoes and throughout the growing season for the peppers. The polymer amended, irrigated treatments were to receive 1" of water for one week after transplanting, 1/2" to 3/4" during initial flowering and 3/4" to 1" during fruit development. This would result in a projected water savings of 25 to 30%

As covered in more detail under the Results section of the irrigation system portion of the study, severe problems were encountered with the use of the standard Irragrow irrigation tape. Frequent leaks, shutdowns and repair resulted in an inability to hold to the irrigation schedule and a premature termination of irrigation to the bell peppers.

IRRIGATION SYSTEM DESIGN

The original design of this study was to pump water from the seasonal creek immediately adjacent to the field into a 1600 poly tank situated in the test plot area. Another tank located 200' north and approximately 100' east of the first was situated in the corner of the field as close as possible to a second and larger creek. The second creek was 300' from the second tank. The intent was to use the second tank as a temporary, staging tank and transfer water from the larger creek to the staging tank then to the main tank when the seasonal creek could no longer supply enough water.

Permission was obtained from the regulatory agencies (PA Dams & Waterways and the PA Fish Commissions) to tap the two streams with the following stipulations:

1) No pools could be drained dry or reduced to a level which endangered fish populations particularly when the flow in the seasonal creek ceased.
2) The installation could not be permanent or permitting and an impact study would be required.
3) The definition of permanent would include any basin built to contain water for pumping and any installation of a pump as a more or less permanent fixture.

An attempt was made to shorten the distance from the staging tank to the larger creek by obtaining permission from local authorities to run the hose/pipe through a culvert adjacent to the field and/or run hose/pipe over a township road. This idea proved impractical because the hose or pipe would be considered an unwanted obstruction in the culvert, hose or pipe across the road would hinder traffic and burying a pipe beneath the road would be cost prohibitive, requiring a permit and an impact study.

The field and creek elevations were determined by a survey conducted by the USDA Soil Conservation Service. A copy is enclosed for reference.

At our own expense, it was decided to extend the irrigation system beyond the test plot area to expand the study and attempt to approximate how much area could be at least partially irrigated using the seasonal water flow from the small creek.

The system as used consisted of a portable 5 HP centrifical pump with suction hose and strainer which was transported and connected each time the tank was filled. Water was pulled from a natural small rock lined hole in the creek. Water was pumped through flexible, 2" diameter discharge hose a distance of approximately 300' and an elevation of 47' into the poly holding tank in the middle

of the plot area. Water was gravity fed via a 2" valve and a 2' section of flexible fire hose into 88' (10' sections) of standard schedule 40, 2" PVC pipe which divided each 400 foot row in the test area into 2, 200 foot sections. Holes were drilled into the PVC for each row to be irrigated and tube fittings to accommodate the irrigation tape installed. The prelaid irrigation tape, already covered with mulch, was then cut and connected.

The irrigation tape used was 5/8" "IRRIGRO-S" supplied by International Irrigation Systems. This tape differs from standard "T" tape in that it is constructed of TYVEK, is porous its' entire length and operates at pressures of 3-5 psi making a gravity fed system possible. A gravity fed system was chosen because of an anticipated reduction in labor, and a lower projected cost.

When necessary, the lines were closed off using either binder clips or spring loaded clothes pins. Approximately 4400' row feet or 0.6 acres were mulched and irrigated including the bell pepper and tomato area used in the soil amendment study. A breakdown of components and costs is attached.

Limitations - The first water pick up point was relocated to the south east corner of the field because of difficulty carrying a 50 lb pump and suction hose up and down a steep, brush covered creek bank with a 40'+ elevation. The final location chosen could be accessed from a township road and had a natural hole.

This subsequently became the permanent pick up point because it became apparent that it would be extremely impractical to uncoil and coil 300' of 2" flexible hose through the overgrown creek bank each time the tank needed to be refilled even when the hose was broken down into 3, 100' sections with quick disconnect fittings. Also, it never became necessary to pull from the larger creek and the second or "staging" tank was never used after plants were set.

As will be discussed in more detail, punctures, splits, leaks in the "Irrigro S" tape were a major problem. With repair units priced at 65¢ each, duct tape was substituted for repair work. Likewise, the standard irrigation tape to header pipe connections were difficult to work with and leaked. In most cases, the barbed section was modified and the fitting glued into place with PVC cement.

Two treatments of household bleach were required to clean the holding tank of algae during the season.

Although we did not install one, a hand operated valve would be advantageous because 300' of 2" hose and a 47' drop generates considerable pressure when the hose is removed from the pump.

RESULTS : IRRIGATION SYSTEM CONCEPT & SYSTEM COMPONENTS

The system concept of using a seasonal creek for irrigation proved extremely successful and is probably one of the most worthwhile findings of this research project.Approximately 0.6A was irrigated on a more or less regular basis. I estimated that this can be more than doubled even without a water retaining amendment if a water management program addressing the system limitations were incorporated.

1) It became apparent that running a temporary line to the second creek would be impractical and unnecessary. The second or "staging" tank was used only once and this was for testing only. The seasonal water supply must be in close proximity to the field to be irrigated.

2) Fluctuating water levels were a minor problem but could become critical if not watched. Surprisingly, high water was more of a problem than low water. Water level rose rapidly after thunderstorms. Access to the creek became difficult or impossible. Floating or suspended debris would strike the suction hose jarring the pump, occasionally cause loss of the prime and restrict flow by blocking the strainer. Low water may limit the amount or more frequently the rate at which water can be pulled. It should be noted that this creek is so small that no flow data has ever been collected, it has no tributaries and is not even listed as a Class I stream. Despite this, a minimal flow adequate enough to prevent water level from dropping more than 2" in the pool was maintained even during a 3 week period (5/26 - 6/18)when no appreciable rain fell and both our well and spring ran dry.

Over 63,000 gallons of water were taken from this stream. At no time was a pool drained, flow stopped or fish population threatened. The most practical approach in managing creek water level was to wait 24-36 hours following a heavy rain before pulling water. During low water periods, either interrupting the filling process or filling the tank to less than full capacity proved to be the most efficient.

A crop mix (such as tomatoes and peppers) in which water demand is reduced going into dryer weather would be another worthwhile technique.

3) Storage capacity is important. Approximately half an hour was required to fill the tank to 1500 gallons. Of this, approximately half the time was spent in set-up and later dismantling the pumping station. Additional storage capacity would have decreased the work load. Moving the second or "staging" tank into the field could have accomplished this but would have been impossible without damage to the crop once the transplants had been set.

4) Limited 'fertigation' is possible with this system and proved to be a time saver compared to side dressing nitrogen with dry product. We were somewhat handicapped by having a single tank with different crops and varieties requiring different N rates and timing. We have since learned of two possible sources of small capacity (250-300 gal.) recyclable poly tanks originally used to transport water soluble pigments and soybean oil based ink. This may be a solution.

5) One mechanical component, the irrigation tape, has serious shortcomings.

System Components

With the notable exception of the Irrigrow 'Standard' 5/8" irrigation tape, all components of the irrigation system, with some minor modification, worked well.

The 2" PVC pipe was originally friction fit to facilitate dismantling at the end of the season. Deer moving through the field at night would bump into the header pipe loosening the fittings and causing leaks. The couplings were changed to glued screw fittings.

The plastic header pipe to irrigation tape connections were difficult to insert into the header pipe and leaked. The connectors were remounted using PVC cement.

The basket strainer on the pump suction hose proved inadequate in keeping debris out of the pump. A section of panty hose stretched over the strainer solved the problem.

The 5HP pump was able to move water up the 40+ foot creek bank through 300' of discharge hose at a fairly constant rate of 80 to 100 gallons/minute. The pump needed to be close to the creeks water level and the suction hose filled prior to starting or it was difficult to prime.

Irrigation Tape

Irrigrow 'Standard' in the 5/8" width was selected because it operates at low pressure (3-5psi) and can be gravity fed. The tape is constructed of TYVEK and is a "sweat" or "weep" tube as opposed to the "trickle" or 'T' tape. It is easy to handle and simple to install.

A major problem developed with leaks in the tape after it was installed. Initially, the irrigation rate was approximately 150 to 170 gallons/400' row/24 hours. At times, this rate climbed up to 436 gallons/400' row/24 hours. A leakage problem could sometimes be detected by monitoring the discharge from the storage tank. Other times, wet spots, water on the plastic or plants falling over were

the indications of a problem. The normal methods for locating the leaks would be to walk the row listening for the sound of water against the plastic. The plastic was then slit and the repair made. Detailed records were not maintained throughout the entire growing season, however, more than 86 leaks were noted as being repaired in the 4,400 row foot of tape over a 2 1/2 month period. During one 7 day period, 47 leaks were repaired.

On 8/9, 4 1/2 hours was spent repairing leaks in the tape. On 8/12/94, leaks were again noted. The entire system had to be shut down prematurely on 8/20/94. The leaks wee causing plants tc be washed out and fruit was developing rot from laying in standing water on top of the mulch. It was impossible to keep up with the repairs as well the other routine field work.

Shutdowns for repair made it difficult to adhere to the original irrigation schedule.

There is a likelihood that excess water from leaks and reduced water as a result of drops in line pressure below leaks or restrictions in the line caused by repairs caused non uniform irrigation in the tomato and bell pepper soil amendment study area.

It is difficult to determine how much impact this had on the test results.

Samples of the recovered tape were sent to the manufacturer (and to Penn State) for examination. Dr. M. Orzolek, Dept. of Horticulture, conducted a microscopic examination of 3 samples in November. In his professional opinion, the samples displayed none of the characteristics associated with rodent or insect damange. The leaks appear to be the result of structural defects in the tape itself.

In the opinion of the manufacturer, the leaks were the result of "... a severe infestation of some type of voracious ant or cricket..." Their recommendation is to maintain pressure (at least 1 psi) at all times or to apply insecticide at low concentrations in the irrigation water.

Regardless of the course,as it stands now, the use of the standard tape cannot be recommended for this application. Buried tape, a heavier construction or an alternative tape may provide a solution.

Miscellaneous

One component of both the irrigation and growing systems used which has not been discussed is the biodegradable, black plastic mulch. This was our first large scale experience using plastic mulch. Approximately 12,000'

of 120 day mulch was laid using a pan type mulch layer. Originally the mulch layer was set up for use on the tractor draw bar. This was converted to a 3 point hitch. Considerable problems were experienced in laying the mulch.

It was difficult to adjust the mulch layer to track true and to cover the edges of the plastic. The mulch layers are designed for use on flat, level ground and the sloping ground in our field would cause the machine to drift with the slope. This resulted in rows which were not always on 6 foot centers and necessitated some hand shoveling to cover the edges of the mulch. A portion of one test treatment (bell peppers, mulched but not irrigated with soil polymer at the 2 lb rate) appeared to be slightly off center from the 2 foot wide polymer prepared bed as some plants on the west side of the double row showed a stronger response than those on the east.

As evidenced by the data on the peppers and tomatoes, the mulch hastened plant maturity and gave an earlier harvest. The mulch also kept the fruit cleaner so that less time was required for pack out. The mulch was not entirely successful in suppressing weed growth. Perennial weeds such as multifloral rose, brambles, poke weed and nutsedge perforated the plastic. Deer also punctured the plastic allowing weeds to come up. Other holes from setting transplants or irrigation repair likewise let weeds come through.

Even through the mulch was laid in late May, as of 11/1/94, it had not become brittle or begun the decomposition process. The rows were shallowly disced at the end of the season in a attempt to hasten breakdown. Problems could be encountered in the spring if breakdown has not occurred.

Tomatoes

Locally grown 60 count cell pack tomato transplants (var. "Empire") were set 2 ft apart on 6 ft centers 6/1/94. Four foot hardwood stakes were set 6/13/94 and 3 stringings (Florida weave) were run on 6/14-15, 6/23 and 7/2-3. Plants were moderately pruned of suckers once prior to the first stringing. A rescue treatment of Round-UP + Sencor between the rows and handweeding were required because of inadequate weed control of horsenettle, purple nightshade and ragweed. Aphids and Colorado Potato Beetle were not a problem and no insecticide was required (CPB preferentially attacked the adjoining eggplant and the horsenettle.) One application of Bravo 720 (1 oz./1000 ft) was made on 8/7/94. Nitrogen was applied at 9 lb/A, 25.5 lb/A and 25.5 lb/A on 7/18/94, 7/23/94 and 7/29/94 using ammonium nitrate in the first application and calcium nitrate in the remaining two. The nitrogen was applied through the irrigation system for mulched irrigated rows and as granular product in the conventional bare ground row.) Irrigation to the tomatoes was stopped on 8/9/ 94 when the first tomatoes reached the breaker stage.

A comparison of staked versus unstaked tomato harvest rate and quality with associated costs was also planned. Locally grown 60 count cell pack tomato transplants (var. "Pilgrim") were set as described above into two non-irrigated, black plastic mulched 50 foot rows, one staked, one unstaked.

Limitations

Theft and vandalism were a factor in the project itself and in the interpolation of data. Unstaked tomatoes in the area which was to provide a comparison of harvest rates for staked versus unstaked tomatoes were stolen 6/22/94. The plastic mulch was also torn and split when the plants were removed and no comparison could be made for staked versus unstaked with the same variety. Theft also affected yield data and was hard to detect in tomatoes unless fruit were dropped or plants damaged.

The final stringing was poorly done and plants had to be placed into the weave after the stringing which resulted in some breakage. For this variety, 4' stakes were marginal. It would have been advantageous to run a fourth string and to prune the plants more heavily. Theft and vandalism occurred on 6/22, 8/1, 8/21, 8/26 and 9/23. Tomatoes were stolen on at least two of these dates (8/24 & 8/26) which would bias data.

Some plants were lost to hail on 6/20/94. Raccoons and opossums were a problem particularly on the staked tomatoes

as they would pull both the fruit and the plant.

A rain of 1.5" on 8/28 and other factors caused the majority of the plot tomatoes to split making a harvest economically impractical until the later setting fruit had sized and begun to ripen. By the time this occurred, a second hail storm on 9/25/94 destroyed the remainder of the crop. Data on tomatoes in this trial is limited and the value may be questionable because of human and animal theft.

Sweet Bell Peppers

Bare rooted, southern grown transplants of bell peppers (var. "Jupiter") were air freighted 5/26 and transplanted 5/27-28. The plants were in excellent condition. Because of the extended dry spell between 5/26 and 6/12, the bare ground conventionally grown transplants were given 1 pt of additional water per plant on 6/7/94. It was feared that no plants would survive to provide base line yield data. The plants were also damaged by hail on 6/20/94 but not as severely as the tomatoes. A rescue treatment of Round-Up + Devrinol or Round-Up alone was required between the rows particularly the no herbicide treatments because of inadequate or complete lack of control of ragweed. Purple nightshade and horsenettle were a secondary problem. Hand weeding in the rows was required. Plants were sprayed with Sevin for corn borer control of 7/16. Orthene was applied for aphid and corn borer control on 7/28, 8/8 and 8/29. No fungicides were used. Peppers were stolen on 8/21 and 8/26. Supplemental nitrogen was applied at 9 lbs/A using ammonium nitrate on 7/18/94 and at 25.5 lbs (7/29/94) and 9.25 lbs (8/11/94) using calcium nitrate.

Limitations

On 5/27/94, after half the transplants had been set it appeared that thieves removed one box (approximately 500 plants) from our storage area. This required some adjustment in row lengths for the conventional bare ground and bare ground with polymer treatments. It was later discovered that only 100 to 150 plants had been stolen but that the vandals had mixed Hungarian Hot wax peppers shipped with same order with the bell peppers. These hot peppers were subsequently removed from the test area and adjustment made in the calculations to equate all yields to 100 row foot equivalents.

Theft also affected recorded yield data. Unlike tomatoes, pepper theft was fairly easy to detect because we normally harvest by cutting fruit to minimize damage to the plant and reduce bruising during pack out. Stolen peppers were normally snapped off. Theft occurred generally on the outside rows and treatment closest to the field edges and least visible. The only data lost from a "control" treatment was the first harvest done for fruit size distribution from

the conventional, mulched and irrigated row.

Treatment 3/2 (mulched, reduced fertility with polymer at 2 lbs) was off center with portions of the east row of the double row of peppers outside the polymer bed. Differences in plant appearance and yield were visibly obvious.

The earliest date (first two harvests) is the most reliable and does indicate trends.

Although more data was collected on peppers compared to tomatoes, the hail storm crop loss did not allow collection of the final yield data.

Results: Growing Systems/Polymer Soil Amendment Study

Tomatoes

At 59 days after transplanting, there appeared to be no significant difference in survival rates among treatments with tomato transplants with the possible exception of slightly reduced survival of non-irrigated plants under mulch with the polymer. Plants height as measured relative to the stakes showed increasing height in the order of conventional bare ground < bare ground + polymer < plastic mulch + polymer < plastic mulch + reduced irrigation + polymer = conventional plastic mulch + irrigation.

Height differences within each general category (bare ground, mulched, mulched + irrigated) were readily apparent but did not seen to be polymer rate related. Plants grown with polymer were fuller with more extensive foliage and at the 4 lb rate were darker green.

Yield Date

The first harvest of tomatoes occurred 8/10/94. Yield was low (45 fruit at breaker stage or higher in 1600 row foot) and data was insufficient to identify any trends except: 1) not a single harvestable tomato was found in any bare ground plantings, 2) the highest yield in fruit number and weight came from the conventional mulched and irrigated treatment, 3) over 60% of the fruit were unsaleable primarily because of cracking.

The second harvest on 8/15 yielded better numbers however one treatment harvest (mulched + 2 lbs polymer) was left in the field by the laborer and eaten by raccoons. Data was also collected on fruit defects which made them unsaleable. The data showed that:

1) again more than 50% of the crop was unsaleable primarily because of cracking
2) the highest percentage of cracking (71%) occurred in the conventional bare ground planting.

3) blossom end rot occurred only in the conventional bare ground, conventional mulched/irrigated treatments and in the bare ground + 0 polymer treatment
4) the conventional mulched irrigated treatment had twice the total yield of the traditional bare ground culture and almost 16 times the yield in saleable fruit by weight
5) mulching increased size and saleable yield
6) irrigation increased size and saleable yield

On 8/20, four plants chosen at random from each treatment were harvested for saleable fruit only. The data is of limited value because of the low percentage of saleable fruit and because the harvest was stopped before

the conventional irrigated plot was picked due to a rain of 1.75". This area was ransacked by thieves early on 8/21/94 before tomatoes could be collected.

On 8/30/94, a harvest of the total plot area was done. No data could be collected for a variety of reasons including post harvest damage from dropping baskets and punctured fruit because of failure to remove stems. Filled baskets were also left in the field and treatments lost.

No additional data was collected prior to the hailstorm which destroyed the crop.

The data collected on tomatoes is of marginal value. Although the data supports the position that mulching provides an earlier and larger yield and that irrigation will increase total yield and fruit size, this has been documented previously on numerous occasions. The trial provided some evidence that the soil amendment polymer did produce more vigorous plants however conclusive evidence that this translates into improved yields and profits was not obtained.

Although the variety "Empire" was only one of more than six varieties which showed cracking, the problem appeared to be most severe in the plot tomatoes. After discussions with Dr. Orzolek, several explanations are plausible.

1) A combination of soil profile/permeability and the extremes of rainfall during the season probably contributed or caused the cracking. This is normally corrected by going to raised beds to improve drainage and utilizing plastic mulch and trickle irrigation to provide better water control. This does not however completely explain the problem in the mulched rows.

2) A total of 60 Lbs of nitrogen/A was applied as side dressing. Although this is not considered extreme, nitrogen can contribute to cracking. Nitrogen applied too closely to the time of fruit ripening can soften fruit and lead to cracking. This is both a rate and timing problem. Two of our customers remarked that these tomatoes were not as firm as our previous crops and bruised more readily. Also, the data suggests a possible excess of vegetative growth at the expense of fruit production. This is indicative of excess nitrogen. Based on these observations, it is likely that side dressed nitrogen, particularly with the polymer amended plantings, needs to be reduced further and application made closer to fruit set.

Herbicide usage could have been reduced but not eliminated if the weed population could be better controlled between the mulched rows. It was of interest that fungicide and insecticide applications for some reason were considerably below normal.

Bell Peppers

Under conditions of little or no rainfall for almost three weeks following transplanting, significant differences in plant survival were noted. The conventional, bare ground plot averaged only 72% survival with some sections near 50% mortality. This was despite the emergency application of water to the bare ground plants, the high available water capacity of the silt loam soil and the near saturation at transplanting. All other treatments, including the lowest rates of polymer showed improved survival with a range of 88 to 98.5%.

One bare ground treatment without polymer (row 2,plot 3) did have a 95% survival rate, although the plants were severely stunted. This location received unrecorded water from line breaks in the header pipe which was finally corrected on 6/7/94 and also approximately 100 - 150 gallons on 6/16/94 when the fill pipe overflowed from the storage tank.

This difference in survival rates which was not seen in tomatoes may be related to the transplants being bare rooted stock.

All mulched plants appeared to have a fuller appearance with more foliage than bare ground plantings. All bare ground plants without the polymer amendment appeared stunted at this rating date. One treatment (mulched, reduced fertilizer, reduced irrigation and no polymer) developed a pale green color in both the fruit and foliage until the supplemental nitrogen was applied. This suggests that the initial nitrogen rate applied was marginal for plant development when the crop is irrigated. One possible explanation for the lack of similar symptoms in the other treatment in the row would be the ability of the polymer to reduce leaching of the soluble nitrogen and/or concentrate it in the root zone of the plant. Supporting this theory is the incidence of blossom end rot in non polymer amended soil. Although not of economically significant magnitude, some blossom end rot (normally associated with calcium deficiency and water inbalance) did occur in both peppers and tomatoes despite liming but was confined to the non amended plots.

Based on the first data, possible trends were suggested for bare rooted transplants:

1) Increased survival with increasing rate of polymer in bare ground culture and under mulch with reduced irrigation.

2) Although possibly not significant, increased survival of mulched plants with polymer and reduced irrigation compared to conventionally mulched and irrigated

culture.

3) Decreased survival with increasing polymer rates under mulch without irrigation.

4) Increased plant vigor for mulched plants.

5) Increased plant vigor with polymer amended beds even with reduced nitrogen.

Crop Yield

In mentally examining the yield data, certain considerations should be factored in.

1) Reduced yield, particularly in the conventional bare ground treatment is proportional to stand loss

2) Treatment 3/2 (mulched, reduced fertilizer, polymer @ 2 lbs) is off center with some plants growing outside the polymer bed

3) Treatments with the earliest maturity (mulched) have an advantage in early yield

4) Treatments with the earliest maturity have an understated yield in the last harvest because partially mature (suntan) and red, ripe peppers were not harvested due to crop loss from hail

5) Theft. Certain portions of the test plot area were systematically raided. Those treatments with the earliest maturity, largest fruit and least visibility were hit.

Treatment 5/1, (conventional mulched & irrigated) was hit early and the theft is reflected in size /distribution data, however a second 100 foot row block situated closer to the road had been planted. Data collection was switched to the second replicate.

Treatments 4/1, 4/3, 4/2 & 4/4 (mulched, reduced fertility, reduced irrigation with polymer from 0 to 4 lbs.) Treatment 4/1 was hit prior to the second harvest, all others prior to the 3rd harvest.

Treatment 3/4 (mulched, reduced fertility, polymer @ 4 lbs) was hit prior to the 3rd harvest.

Based on plant damage, treatments 4/4 and 3/4 located in the furthest back portion of the field suffered the most theft.

Despite the crop losses, significant trends can be identified particularly by examining data collected from the first two harvest prior to the major occurrence of theft.

1) Early maturity and yield are demonstrated for mulched treatments.

2) Significant yield increases are attainable with irrigation compared to bare ground treatments.

3) A trend towards smaller fruit and lower yield with increasing polymer rate is suggested for bare ground culture.

4) A trend towards larger fruit and increased yield with increasing polymer rate is suggested for mulched, irrigated culture even with reduced fertility.

5) Data is inconclusive on the use of polymer under mulch without irrigation but suggests that total water stored prior to mulching regardless of polymer rate is a limiting factor.

6) Based on the first two harvests, the most productive method of culture for green bell peppers would be mulched, reduced nitrogen fertility with reduced irrigation and polymer amendment at 2-4 lbs/1000 ft^2 ft.

7) Based on incomplete green bell pepper harvest, an estimate of theft loss and an estimate of red ripe and partially ripe peppers remaining in the field, a conservative projection would be crop value increases of 75% and 25% for the mulched, reduced nitrogen, reduced irrigation and polymer at 2-4 lbs/1000 ft^2 program compared to conventional bare ground and conventional mulched, irrigated programs respectively.

Recommendations

1) This study needs to be duplicated under more controlled conditions preferably on a larger scale not only because of the data gaps caused by crop loss but because of time and labor involved in proper data collection and analysis. The rates projected for polymer usage here are only 2 to 5% of those currently being discussed in designs such as the Hydrosource/DeWitt Sunbelt Dryland Water Catchment System. With polymer costs at $3 to $6/lb, current designs would run $6,600 to $13,300 per mulched acre (6 ft centers) initial polymer cost, while this design if successful would run only $130 to $533. This polymer cost would be spread out over the life of the polymer estimated at 5 - 10 years.

2) Polymer bed design should be changed to a wider width i.e., 30" to 36" to facilitate laying mulch on slope ground and I feel the polymer should be incorporated shallower perhaps at 6" to 10" rather than 10" to 12".

3) It would be advantageous for growers to incorporate the polymer in their greenhouse growing mix or to dampen bare rooted plants with the polymer to increase transplant survival.

4) It is likely that rates of polymer may vary depending upon the natural water holding capacity of the soil, the crop requirement and the amount of supplemental irrigation available. Because the system concept involves the construction of semi-permanent beds with buried irrigation and possibly permanent living mulch between the rows, it is critical to determine an optimum rate of polymer. Although the 2-4 lb rate maybe optimum here based on the field trials, it would be impractical to do trials on a farm by farm basis. A soil and/or horticultural research scientist with a stronger knowledge of soil kinetics would be in a better position to project rates for other soil types.

5) A worthwhile project for an ag engineering study may be the design of a mulch layer more adapted to sloping contours.

6) It appears that a more biodegradable mulch is required or labor to remove the plastic manually will increase grower costs.

7) More communication is required with the manufacturer of the irrigation tape to determine what construction or design would lend itself to a semi permanent, more maintenance free installation.

8) It would be beneficial to small growers if the cost of this type of water utilization and conservation system including pump, storage tank and hose to allow pulling from seasonal

creeks could be considered for cost sharing under the Farm Service Agency (formerly ASCS) ACP Program. Likewise, a policy decision at the state level by the appropriate agencies on the utilization of seasonal or low flow waterways would streamline securing permission to tap these water sources by the grower.

9) Additional trials or work needs to be done with tomatoes particularly investigating further reductions in nitrogen fertility.

10) Alternative labor sources need to be identified.

ADDITIONAL RESEARCH

Two observational trials were run outside of this project. With the encouragement of Allan Mathews, a SARE recipient, 1 acre of pumpkins was planted with reduced tillage using Prefar + Round UP as herbicide. Unfortunately, a serious infestation of ragweed provided cover for groundhogs. Nine burrows were found in the field at harvest time. The previous year, we harvested nearly 4.5 tons of Baby Pam pie pumpkins from 1/2 A. In 1994, our yield was 97 pumpkins undamaged by woodchucks.

New potatoes were ground under three cultural systems to evaluate possible labor reductions in harvest. These were conventional bare ground, in hay mulch and laid directly under black plastic mulch. The plastic mulch had the earliest and most vigorous plants however rips and holes in the plastic from perennial weeks and animals caused many of the tubers to be "sunburned" and unsaleable. Although a high percentage of the potatoes were above ground, many still required digging.

The hay mulch had the latest yield and the cleanest tubers. Weeds were a major problem especially growing from the mulch itself. Harvest was comparatively easy although some tubers still were below the ground.

Yields appeared lower for the mulched rows.

APPROXIMATE MAN HOURS EXPENDED ON IRRIGATION SYSTEM PRIOR TO START UP

Field survey for elevations (SCS)	3 MH
Planning	8 MH
Sourcing parts	5 MH
Laying irrigation tape by hand (4400 row feet)	2.5 MH
Assembly, testing, initial fill	6.0 MH
Adjustments	0.5 MH
Preparation of beds with water absorbing polymer (2400 row feet)	13.25 MH
Saturating polymer	8.5 MH

Manhours after start-up:

Fill time	20.75 MH
Fertigation & chlorine treatments	1.1 MH
Line repairs	24.0 MH

Does not include time for laying mulch because of equipment problems.

IRRIGATION & RAINFALL DATA - GREEN BELL PEPPERS

WEEK OF	RAINFALL "	IRRIGATION	REDUCED IRRIGATION	COMMENTS
June 1-4/94	0	0.68	0.68	
June 5-11/94	0	0.425	0.425	
June 12-18/94	0.2	1.21	0.85	
June 19-25/94	3.5+	0.57	0.2	Chlorine treatment 6/19
June 26-July 2/94	0.55	0.23	0	Major repairs till 7/2
July 3-9/94	0.45	0.99	0.57	
July 10-16/94	0.75	1.22	0.79	
July 17-23/94	0.6	0.2	0.2	7/18 NH_4NO_3, Chlorine 7/20 major repairs 7/23
July 24-30/94	2	1.08	1.08	7/29, $CaNo_3$ major repairs, 7/29
July 31-Aug 6/94	1.1	0.78	0.78	
Aug 7-13/94	0	0.27	0.27	$CaNo_3$, 8/11 major repairs, 8/9
Aug 14-20/94	1.45	1.25	1.25	
Aug 21-27/94	1.75+		SYSTEM SHUTOFF	cannot maintain repairs
Aug 28-Sept 3/94	1.7			
Sept 4-10/94	0			
Sept 11-17/94	0.3			
Sept 18-24/94	1.3			
Sept 25/94	2.4 Hailstorm			
TOTALS	18.05+"	8.905"	7.095"	

Plants set May 27-28/94. Polymer treatments watered in with 0.5" on May 21/94. Rainfall May 24-25/94 0.63" brought soil to saturation. Plastic laid May 25/94. One pint of water per plant applied to conventional bare ground plot only on June 7/94.

BELL PEPPER (var. "JUPITER") TRANSPLANT SURVIVAL RATE @ 63 DAYS

TREATMENT	SURVIVAL	COMMENTS
		Additional water (1pt./PLT) applied 6/7/94 to CONV. BG only
CONV. BG	71.6	Erratic, some areas below 50% survival
CONV. MI	95.5	
BG RF P0	95.1	Stunted plants. Recv'd unrecorded water from pipe leak and tank overflow
" " P1	91.7	
" " P2	94.7	
" " P4	97.7	
M RF P0	94.5	Some Hungarian peppers
" " P1	94.7	
" " P2	88	Some Hungarian Peppers. Mulch is off center Some plants outside polymer bed
" " P4	91	Some Hungarian Peppers.
M RF RI P0	93.2	
" " " P1	96.2	
" " " P2	98.5	
" " " P4	97	

NOTE: Plants were bare rooted, southern grown transplants. All mulched plants were taller and fuller than bare ground treatments. Polymer amended plots had 20% less nitrogen in initial fertilizer application.

YIELD MATRIX

FIRST TWO HARVESTS BELL PEPPERS GROWN UNDER FIVE CULTURAL SYSTEMS

	CONV. BG		BG RF		M. RF		M RF RI		CONV. MI	
	#	Fruit Wt (lbs)	#	Fruit Wt (lbs)	#	Fruit Wt (lbs)	#	Fruit Wt (lbs)	#	Fruit Wt (
Polymer rate lbs/1000 sq ft										
0	35**	17.4	44.3	22	34	16.4	55	29.2	59	30
1	NA	NA	47.1	22.8	59	29.8	53T	26.3T	NA	N
2	NA	NA	32	15.7	32.9*	14.8*	67	34.3	NA	N
4	NA	NA	23.3	11.33	52.3	25.3	85	42.5	NA	N

* Treatment M RF P2 has mulch off center with some plants outside the polymer bed.
"T" designates yield loss indicated by theft.
** Conventional bare ground treatment had a lower plant survival rate which is reflected in lowered yield.

FRUIT SIZE DISTRIBUTION GREEN BELL PEPPERS GROWN UNDER FIVE CULTURAL SYSTEMS

Treatment	Total Fruit	Total Wt Fruit (oz)	Ave. Wt Fruit (oz)	Size Distribution % ** <2 1/2"	2 1/2" - 3 1/4	3 1/4"
Conv. BG	65	188	2.89	74	23	3
" , M,I*	66	146	2.21	82	17	1
BG RF P0	38	158	4.16	42	58	0
" " P1	55	169	3.07	62	27	11
" " P2	56	145	2.59	77	23	0
" " P4	62	152	2.45	84	16	0
M, RF, P0	59	184	3.12	69	31	0
" " P1	62	172	2.77	74	21	5
" " P2	62	164	2.65	76	23	1
" " P4	54	187	3.46	59	35	6
M RF RI P0	49	160	3.27	73	16	11
" " " P1	71	229	3.23	65	30	5
" " " P2	49	137	2.8	71	20	9
" " " P4	52	176	3.39	60	35	5

* Plants taken by error from row previously hit by theft

** Harvest 8/27/94, five plants/treatment randomly selected

HARVEST DATA: GREEN BELL PEPPERS UNDER FIVE CULTURAL SYSTEMS

		First Harvest			First 2 Harvests			3 Harvests		
Row/Plot	Treatment	Frt.#	Tot.Wt Lbs.	Avg Frt Wt. Lbs	Frt.#	Tot.Wt Lbs.	Avg Frt Wt. Lbs	Fruit #	Total Wt Lbs.	Avg Frt Wt. Lbs
1,1	Conv. B.G.	0	0	0	35	17.425	0.5	385	152.43	0.4
5,1	Conv. M.I.	8	3.65	0.46	59	30.75	0.52	669	266.35	0.4
2,3*	BG.RF.P0	0	0	0	44.34	22.04	0.5	424.34	187	0.44
2,1*	" " P1	0	0	0	47.13	22.79	0.48	307.13	124.69	0.41
2,2	" " P2	0	0	0	32	15.73	0.49	432	157.63	0.36
2,4*	" " P4	0	0	0	23.32	11.33	0.49	323.32	135.73	0.42
3,3	M. RF.P0	3	1.24	0.41	34	16.37	0.48	484	196.37	0.41
3,1	" " P1	5	2.32	0.46	59	29.82	0.51	549	226.72	0.41
3,2**	" " P2	1.5**	0.73**	0.49**	32.92**	14.83**	0.45**	292.92*	141.08*	0.48*
3,4*	" " P4	2.22	1.13	0.51	52.53	25.27	0.48	422.3T	169.67T	0.4
4,3	M.RF.RI.P0	1	0.48	0.48	55	29.23	0.53	205T	86.13T	0.42
4,1	" " " P1	2	0.96	0.48	53T	26.32T	0.5	413	160.72	0.39
4,2	" " " P2	4	1.57	0.39	67	34.32	0.51	457T	197.42T	0.43
4,4	" " " P4	12	5.22	0.44	85	42.47	0.5	325T	136.22T	0.42

* Yields adjusted to 100 row foot.
Harvest dates were 7/29-30/94, 8/27-28/94, 9/2/94. Harvest 9/2/94 yield based on 10' row sample. All others are actual totals. "Suntains are not included in counts. Treatments with a "T" designation indicate evidence of theft or vandalism affecting yield for this harvest. Physical disorders affecting marketable yield were BER in treatments 1,1 and 3,1 and fruit rot in the irrigated rows when fruit were laying in water. Two additional harvest were anticipated including "suntan" and red fruit. Hailstorm on 9/25/94 terminated harvest.

** Treatment 3,2 has mulch off center with some plants outside polymer bed.

3) Code ID: Conv. = Conventional BG = Bare ground M = Mulched
I= Irrigated RF = Reduced fertility RI = Reduced irrigation
P_ = Polymer, Lbs/1000ft

YIELD DATA ON INCOMPLETE HARVEST FOR GREEN BELL PEPPERS
GROWN UNDER FIVE CULTURAL SYSTEMS

ROW/PLOT#	TREATMENT	YIELD	COMMENTS
5	CONV. M.I.	8.5 Bu	100', 3 1/2 Bu in 2nd 100'
2/1	BG, RF P1	5.4 Bu	Notation "No suntans"
2/2	" " P2	4.25 Bu	" "Lots of suntans"
3/1	M, RF P1	6.25 Bu	" "Lots of suntans"
3/2	" " P2	5.2 Bu	
4/1	M, RF, RI, P1	5 Bu	Notation: "Rotted fruit"
4/2	" " " " P2	7 Bu	" " " " "

Harvest for Green Bells only. Ripe red & suntans not harvested.
Harvest 9/22-24/94. Yields adjusted to 100' row.

YIELD MATRIX

ESTIMATED MARKETABLE BUSHELS/ACRE UNDER FIVE CULTURAL SYSTEMS - BELL PEPPERS

		CONV.BG	BG RF	M RF	M RF RI	CONV. MI
Polymer rate						
Lbs/1000 sq ft	0	410	(500)*	525	675	710
	1	NA	450	650	700	NA
	2	NA	417	no estimate	790	NA
	4	NA	360	600	980	NA

* Received additional water inadvertently which increased plant survival & vigor.
Yield estimate based on plant population of 9870 plt/A. and 28 lbs/Bu. weight.

IRRIGATION & RAINFALL DATA - TOMATOES

WEEK OF	RAINFALL "	IRRIGATION	REDUCED IRRIGATION	COMMENTS
June 1-4/94	0	0.68	0.68	
June 5-11/94	0	0.425	0.425	
June 12-18/94	0.2	1.21	0.85	
June 19-25/94	3.5+	0.57	0.2	Chlorine Trtmnt, hailstorm
June 26-July 2/94	0.55	0.23	0	
July 3-9/94	0.45	0.99	0.57	
July 10-16/94	0.75	0.79	0.79	
July 17-23/94	0.6	0.42	0.42	NH_4NO_3, 7/18, chlorine, 7/ $CaNo_3$, 7/23
July 24-30/94	2	1.08	1.08	$CaNo_3$, 7/29
July 31-Aug 6/94	1.1	0.78	0.78	
Aug 7-13/94	0	SYSTEM SHUTOFF		
Aug 14-20/94	1.45			
Aug 21-27/94	1.75+			
Aug 28-Sept 3/94	1.7			
Sept 4-10/94	0			
Sept 11-17/94	0.3			
Sept 18-24/94	1.3			
Sept 25/94	2.4 Hailstorm			
TOTALS	18.05+"	7.175"	5.795"	

Plants set June 1/94 with 1 pint water/plant. Polymer treatments watered in with 0.5" on May 21/94. Rainfall May 24-25 0.63". Brought soil to saturation. Plastic laid May 25/94.

TOMATO (var. "EMPIRE") TRANSPLANT SURVIVAL RATE AND VIGOR @ 59 DAYS

TREATMENT	% SURVIVAL	PLANT HEIGHT RELATIVE TO STAKE
CONV. BG	99	-10.5" to -12"
CONV. MI	100	-3" to over stake
BG RF P0	97.4	-10" to -12"
" " P1	100	-4 to -10" (Fuller Plants)
" " P2	98	-8 to 10" (" ")
" " P4	100	-9" (" ")
M RF P0	98	-3" to -12"
" " P1	94	0 to -3" (Fuller Plants)
" " P2	98	0 to -3" (" ")
" " P4	96	0 to -4" (" ", Dark Green Color)
M RF RI P0	100	-3 to over stakes (Full Plants)
" " " P1	100	" " " " (" ")
" " " P2	100	" " " " (" ")
" " " P4	100	" " " " (" ",Dark Green Color)

NOTE: Plants were locally grown, 60 count cell packs. Polymer amended plots had had 20% less nitrogen in initial fertilizer application.

HARVEST DATA: STAKED, FRESH MARKET, PINK TOMATOES UNDER FIVE CULTURAL SYSTEMS

First Harvest 8/10/94

TREATMENT	Total Fruit	Total Wt. (Lbs)	Ave. Wt. (Lbs)	% Saleable By Weight	% Cracked Fruit
CONV MI	8.5	2.9	5.52	80.5	11.8
M RF P0	2	0.63	5.06	32.1	50
" " P1	6	1.75	4.68	0	67
" " P2	2	0.51	4.11	0	100
" " P4	4	1.34	5.34	40.3	50
M RF RI P0	7	2.21	5.03	49.2	28.6
" " " P1	3	1.62	8.63	0	67
" " " P2	2	0.49	3.93	0	100
" " " P4	2	0.69	5.52	100	0

NOTE: Harvestable fruit were found only on mulched treatments. Conventional mulched and irrigated harvest adjusted to 100 row foot from 200 foot harvest. All others are 100 row foot samples

HARVEST DATA: STAKED, FRESH MARKET, PINK TOMATOES UNDER FIVE CULTURAL SYSTEMS

Second harvest 8/15/94 Fruit Defects

TREATMENT	Total Weight Unsaleable (Lbs)	% by Weight Unsaleable	% by Count of Total Harvest		
			BER	CRACK	SCAR/CATFACE
CONV. BG	5.75	90.2	17.6	70.6	0
CONV. MI	4.875	33.2	1.4	35.7	4.3
BG RF P0	1.75	82.4	20	20	40
" " P1	1.06	37.8	0	50	0
" " P2	0.438	30.5	0	0	33
" " P4	0	0	0	0	0
M RF P0	4.375	47.9	0	50	4.2
" " P1	5.688	60.7	0	53.3	10
" " P2	ND	ND	ND	ND	ND
" " P4	ND	ND	0	33.3	0
M RF RI P0	3.3125	32.1	0	50	0
" " " P1	3.75	41.4	0	54.2	0
" " " P2	1.3125	22.1	0	33.3	0
" " " P4	4.5625	54.9	0	52.4	14.3

NOTE: Harvest for M RF P2 was left in the field by laborer. Approximately 27 eaten/partially eaten fruit were found the following day. Weight data for M RF P4 was lost.

HARVEST DATA: STAKED, FRESH MARKET, PINK TOMATOES UNDER FIVE CULTURAL SYSTEMS

Second Harvest 8/15/94

TREATMENT	Total Wt. (Lbs.)	Total Fruit	Ave. Weight	SIZE DISTRIBUTION % 2 1/8"	2 1/8" - 2 5/8"	2 5/8"	% Saleable by weight
CONV. BG	6.375	17	6	5.9	47.1	47	9.8
CONV. MI	14.6875	35	6.7	8.6	15.7	75.7	66.8
BG RF P0	2.125	10	3.4	60	10	30	17.6
" " P1	2.8125	6	7.5	0	16.7	83.3	62.2
" " P2	1.4375	3	7.7	0	0	100	69.5
" " P4	0.625	2	5	0	50	50	100
M RF P0	9.125	24	6.1	16.7	12.5	70.8	52.1
" " P1	9.375	30	5	0	43.3	56.7	39.3
" " P2	ND	27+	ND	ND	ND	ND	ND
" " P4	Incomplete Data	8	ND	0	50	50	ND
M RF RI P0	10.3125	28	5.9	10.7	35.7	53.6	67.9
" " " P1	9.0625	24	6	20.8	20.8	58.3	58.6
" " " P2	5.9375	12	7.9	0	25	75	77.9
" " " P4	8.3125	21	6.3	0	28.6	71.4	45.1

NOTE: Harvest for MRF P2 was left in the field by laborer. Approximately 27 eaten/partially eaten fruit were found the following day. Weight data for MRF P4 was lost.

HARVEST DATA: STAKED, FRESH MARKET, PINK TOMATOES UNDER FIVE CULTURAL SYSTEMS

Harvest on 4 random plants/treatment 8/20/94

TREATMENT	Saleable Yield (Lbs)	Ave. Fruit Wt. (oz.)
CONV. BG	1.25	6.7
CONV. MI	0 (Theft)	0
BG RF P0	0	0
" " P1	2.25	12
" " P2	0	0
" " P4	2	8
M RF P0	3.5	11.2
" " P1	1.75	7
" " P2	0	0
" " P4	2	10.7
M RF RI P0	2.75	8.8
" " " P1	1.75	9.3
" " " P2	1	8
" " " P4	0.75	12