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COMPARATIVE AGRICULTURE RESEARCH PROJECT, 1986

by

Mary Ann Klein

THE NATIONAL COLONIAL FARM

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The Author

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"We can build one system only within another. We can have agriculture only within nature, culture only within agriculture. At certain critical points these systems have to conform with one another or destroy one another."

Wendell Berry

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ABSTRACT

1986 was the second year of the Comparative Agriculture Research Project. The project was designed to compare different farming systems which ranged from biological to modern conventional as were outlined in the 1985 research report.[1] We continued with the two separate experiments of Field (Agronomic) Crops and Fresh Vegetable Crops. See Figure 1 for the project layout.

The agronomic crop study maintains four farming systems of four repetitions each or sixteen total plots. According to the preset rotation schedules, all sixteen plots were in field corn for 1986. The four farming systems are as follows:

- (T1) A no-till system with chemical inputs; 3 crop rotation over two years.
- (T2) A conventional modern system with less dependence on synthetic chemicals and some tillage; four crop rotation over two years.
- (T3) A biological system with legumes as part of the rotation for nitrogen; some tillage.
- (T4) Continuous tilled corn, a single crop, high chemical inputs.

See Figure 2 for the fixed plot layout and rotation schedule.

The fresh vegetable crop study maintains three farming systems of four repetitions each or twelve total plots. The three systems are as follows:

- (BIOL) Biological system with legumes as a cover crop source of nitrogen.
- (MAG) A modern conventional system with high synthetic inputs.
- (CON) A no input system for control.

See Figure 3 for the vegetable plot layout. The rotation of crops continued as was outlined in the 1985 report. In other words, sweet corn followed muskmelons, tomatoes followed sweet corn, and muskmelons followed tomatoes.

Four sets of data were collected in 1986: daily temperatures and precipitation; crop and soil characteristics; weed and insect data; and an economic analysis for each farming system. Because this is farming system research, no single factor is expected to be isolated from the study, nor will a particular cause and effect relationship be anticipated.

In the agronomic experiment, corn was raised in all four systems. The biological system performed best on yield and achieved 69.4% of our goal of 100 bu./acre. Continuous Corn had

the least yield at 36.3% of goal.

The vegetable crop experiment was abandoned in July due to losses suffered from drought and weed pests.

The insect pests on corn were high due to the favorably dry conditions. The Black Light Trap and Pheromone Trap monitored pest population and provided data to assess the pressures that these populations had potential to endure.

An outbreak of the weed pest, Dodder, required much attention and concern. We feel the measures taken should bring the pest under control, because it was eradicated at a critical point in its life cycle.

INTRODUCTION

This is the second year of the Comparative Agriculture Research experiment, and a restatement of the project objectives is as follows: to demonstrate the comparative differences or similarities between biological farming systems and modern conventional farming systems; to provide a demonstration site, open to the public, where farmers, agriculture students, and other visitors can observe the experiment in progress; to make our findings available to the public through publication of the research results; and, to demonstrate that other system options are available to American farmers. Our systems approach is representative of reasonable options for grain farmers and fresh market farmers in Southern Maryland and most of the mid-Atlantic seaboard.[2]

This was an unusual crop year for Maryland farmers in general.[3] The spring season began with a moisture deficit, and by early July, there was a 10.64 inch deficit in precipitation. This could be observed in the crops by extreme drought stress. For example, the field corn leaves, in the whorl stage, were folded closely together, and by late afternoon on hot days, they were wilted and crinkled along the margins. The stress was apparent on the vegetable crops in that the sweet corn tassled at the "knee-high" stage, and the tomatoes lost their early blossoms. In addition, the vegetable plot soil was showing signs of a crusted surface and soil compaction well below the plow layer.

The entire experiment was further taxed by an outbreak of the parasitic weed, Dodder (*Cuscuta pentagone*).[4] Although we were experiencing a drought, a few light showers in early June produced enough moisture for the Dodder seed to germinate.

The vegetable plots continued to do poorly; so much so, that an outside consultant was brought in to assess the site of the vegetable crop experiment. Dr. Ray Weil, who designed the field crop experiment, was invited to the Farm in both June and August, 1986. He advised us that the soil in the present site of the vegetable plots was not suitable for vegetable production, nor could its organic matter level be easily build up enough to support the biological system successfully.[5]

On July 25, a decision was made to abandon the vegetable crop experiment for 1986. Moreover, we agreed to hire Dr. Weil as a field consultant to redesign the vegetable crop experiment. A more detailed report on Dr. Weil's recommendations will follow.

MATERIALS AND METHODS

Experimental Design

This twelve year study was initiated in 1985 and will continue through 1996.

Subjects to be addressed through study and research are:

Program and Crop Management
Economics
Integrated Pest Management
Soil Fertility
Plant Nutrition

The two experiments have been laid out in a completely randomized, block design, see Figure 1. Figure 2 illustrates the agronomic plots layout and rotation schedule. Figure 3 illustrates the vegetable plots and sub-plots as they appeared in 1986.

Grassy buffer strips, 10 feet wide between the plots, control possible contamination by pesticides and fertilizer through drift and leaching. Grass road ways, 25 feet wide along the field margins, allow for easy access by vehicles and farm equipment. These buffer strips are now established in a Kentucky fescue and are kept closely clipped to control encroaching weeds.

Location and Climate

The Comparative Agriculture Research Project is located on an alluvial deposit of the Potomac River coastal plain on the National Colonial Farm in Accokeek, Maryland. The Farm is in Prince Georges County in Southern Maryland, approximately 20 miles south of Washington, D.C. The Potomac River lies about 100 feet from the north-west side of the research site, see Figure 1.

The Farm is situated on gradually sloping land surrounded by old and new forests and rural homesites kept in "scenic easements" for historic appearances' sake.

Southern Maryland has a fairly moderate and humid climate. The proximity to the Potomac River alters the weather only slightly if compared to weather data gathered by the United States Weather Service at Glendale Bell Station.[6] The winter is usually short and very mild, and the frost free days average 190 or more. The average annual temperature is 67.5o F., with temperature extremes of 5oF. to 95oF. over the year.

Precipitation averages 43.8 inches annually, and ranges from 2.75 inches to 4.91 inches monthly. Rainfall occurs fairly evenly throughout the year with the heaviest rainfall usually in

July and August. Snowfall averages about 20.4 inches annually.

Beginning with the 1983 growing season, the annual precipitation has been below average. The summer rainfall accumulation continued to be low in 1986. Both May and June were extremely dry with deficits of 3.28 and 3.14 inches of rainfall, respectively. July and August had above average rainfall with accumulations of 4.57 and 8.92 inches, respectively. Spring through summer temperatures averaged above normal until September when daytime temperatures were below normal. See Table 1, for complete weather information for 1986.

A color coded system of marking the plots was initiated in 1986 using wire colored flags at the corners of all 28 plots. A combination of metal and plastic pipe served as the corner markers of each plot with the flags inserted identifying the farming systems. The pipe was driven into the soil so that only 2-3 inches remained above the ground surface. In the field crop experiment red flags were used on the no-till plots, green for biological, blue for conventional and white for continuous corn. In the vegetable crop experiment, green flags were used on the biological plots, blue on the conventional plots and white bordered the central plots.

Field Preparation and Planting

The research project lies on a 7.2 acre field that was previously a lespedeza hay field with little chemical inputs in recent years. On the east lies an alfalfa field and on the west lies a grove of 540 American chestnut trees. Neither of these two crop areas receives any chemical sprays as a part of their routine maintenance programs.

In the late fall of 1985, soil samples were taken on both the vegetable and field test plots. These were bulked and dried, labelled and sent to the Soil Testing Laboratory at the University of Maryland. Summaries of the test results are shown in Tables 2 and 3.

A winter cover crop of rye was seeded at a rate of 120 lbs./acre on the plots of both experiments in the fall of 1985. A legume cover crop of red clover was overseeded on the biological plots of both experiments in December, 1985 at the rate of 10 lb./acre.

On April 24, 1986, fertilizer was applied to the T1, T2, and T4 plots in the following analysis (N-P-K- pounds per acre) 120-138-120. Recommendations by the Soil Test Laboratory at the University of Maryland were followed. See Table 4 for the agronomic plot fertilizer application.

The vegetable plots were fertilized on an individual-by-plot basis according to the Soil Test Laboratory recommendations. Only the MAG plots received granular fertilizer according to the schedule in Table 5.

The Biological (T3) plots of the agronomic experiments and the vegetable crop experiment received the following treatment in place of granular fertilizer. Fish emulsion (Fertrell 1) at the rate of 2 1/2 gallons per acre supplemented with seaweed kelp extract (Folia-grow), 0.5 lb. per acre was applied to the soil in a liquid form. The two products were diluted with 35-40 gallons of water in a tank mix and applied with a pressurized sprayer. A surfactant was used to keep the mix uniform throughout spraying. The spraying operation utilized an "Agritech" sprayer with #8006 flat spray tips moving at approximately 6.4 km/hr (4 mi/hr) with a pressure of 2.1 kg/cm2 (30 psi).

Herbicide was used on the No-Till, Conventional and Continuous Corn agronomic test plots according to the schedule shown in Table 6, Economic Analysis of the Agronomic Crops. No herbicide was used on the Biological (T3) plots.

Herbicides were applied to the MAG sweet corn plots according to the schedule in Table 7, Economic Analysis of the Fresh Vegetable Crops. No herbicides were used on the BIOL or CON plots.

Sowing and planting of the crops began on April 25 with the field corn and were completed on May 22 with the transplanting of the tomatoes. See Tables 8 and 9 for the varieties used and plant spacings.

Because the muskmelons were directly seeded at 12 inch spacing in the row, a thinning to 40 inches between plants was necessary. It was completed by the time they reached the three to four leaf stage of growth. "Gold Star", the variety planted, produces over a long season, and therefore this wide spacing in the row is recommended.

RESEARCH TOPICS

Program and Crop Management

The 1986 Comparative Agriculture Research Project was continued under the guidelines and objectives that were developed in 1985. The conclusion section of the 1985 Report suggested that we ammend our Integrated Pest Management program by using both Black Light Trap and a Pheromone Trap to supplement the field corn and sweet corn IPM. This change has allowed early insect infestation detection. A detailed account on the use of these traps is outlined in the IPM section.

In the agronomic crop experiment all plots were planted in field corn, permitting assessment of comparative differences among the farming sytems.

Cultivation and Weed Survey

Cultivation was used to control weeds in the research project plots. Frequent cultivations were done on the plots before the crops reached a size where tractor tillage became impossible.

A weed survey was completed on June 2 and 5 on the vegetable and field crop experiments, respectively,. Tables 10 and 11 document the results of those surveys. As was noted last year, there was much variance over the agronomic and vegetable crop studies.

In the vegetable crop weed survey, significant numbers of each weed species (40 or more in 20 row feet) were found in six of the BIOL plots and five of the CON plots. Three of the MAG plots also had weeds at the significant level. Plots A9 (BIOL), A10 (CON) and A11 (MAG) were completely overgrown with weeds. The most prevalent annual weed species were: Lamb's Quarters in five plots, Morning Glory in six plots, Crab Grass in two plots, and Pigweed in two plots. The most prevalent perennial weed species was Bermuda Grass in three plots. The outbreak of Dodder occurred in June, and the population level was high enough in the vegetable plots to warrant hand pulling of both weeds and the parasitic plants on June 6 and 9. We completely removed the trash from the plots in plastic bags to avoid a reoccurrence during the season. Dodder grows quickly, but only early buds were seen on the parasites, and no seed heads were formed.

Dodder was found on the all agronomic plots as well. We utilized the herbicide Roundup, spraying along the field margins where the parasite was concentrated. The rate of application was two pints per acre, and the spray was directed on weeds and Dodder, and away from the crop plants. Some hand pulling was necessary.

Annual weed species were found in the agronomic plots at above significant numbers on one No-Till (T1) plot and one Biological (T3) plot. Significant levels of perennial weed species were observed on one each of the Biological (T3) plots and Continuous Corn (T4) plots. The most common annual weed species was Lamb's Quarters followed by Morning Glory. Another common perennial was Nightshade.

Except for the Dodder outbreak, and heavy weeds in vegetable plots 9, 10, and 11, our findings are similar to those we observed in 1985.

Harvest and Yields

Fresh Vegetable Crops

There is no harvest data to report for the Fresh Vegetable Crops. The experiment was considered a loss due to the long drought and the further aggravation by weeds and Dodder.

The project is being relocated in 1987, so that irrigation can be provided to the crops. These changes are discussed at length in the Results and Discussion section.

Agronomic Crops

The agronomic corn plots were hand picked on September 27, 1986. Two central rows of each plot were harvested in 14 of the 16 plots and were bundled and labelled and brought under cover for drying. The yields are reported in Table 12. Our goal was (100 bu/a) 6,725 kg/ha.

The average yields were as follows:

No-Till T1	= 3,607.72 kg/ha,	53.65 bu/a
Conv. T2	= 2,890.32 kg/ha,	42.98 bu/a
Biol. T3	= 4,664.98 kg/ha,	69.37 bu/a
Cont. Corn T4	= 2,437.59 kg/ha,	36.25 bu/a

Some of the yield loss was due to crow damage, although this was less than last year since the harvest was taken about a month earlier.

<u>Soil Fertility and Plant Nutrition</u>

Soil samples were collected from the agronomic and vegetable plots in December, 1985 and sent to the University of Maryland Soil Test Laboratory for analysis. See Tables 2 and 3 for the test results of the field and vegetable plots respectively.

In comparing the soil test results to those of 1985, the agronomic plot soils returned the macronutrients of Nitrogen, Phosphorous, and Potash in variable amounts. Boron, a soil micronutrient, was low. All four systems on the average showed an increase over the 1985 pre-season Phosphate levels, ranging between a 19.8% increase for Continuous Corn (T4) to 84.7% for the Conventional (T2). Residual Nitrates varied from an increase of 73.7% for Conventional (T2) to a decrease of 60% for Continuous Corn (T4). Potash levels expressed as K O pounds per acre, increased on the T1 and T2 plots by 24.3% and 8.2%, respectively; and decreased on the T3 and T4 plots by 9.6% and 8.1%, respectively.

The Cation Exchange Capacity, expressed as milliequivalents per 100 grams of soil, was reduced on the average in all four systems. Th C.E.C. range for fine sandy loams is 5-10 meq/100 gm soil. The averages for the agronomic systems soils range between 4.7 and 5.3. Similarly, the organic matter percent was reduced on all but the No-Till (T1) plots. Organic matter is difficult to build up on sandy soils, and the soil tests showed the normal amounts for this type of soil.

The vegetable crop soil tests show similar changes overall on the macro and micro-nutrients. A discussion is not included here because that portion of the experiment is being relocated in 1987.

Leaf tissue testing was again part of the Plant Nutrition Analysis for the field crop experiment in 1986. On June 4, 20 leaves of at least 20" in length were gathered from each of the sixteen agronomic crop plots. These were dried, packaged and sent to the University of Maryland Tissue Laboratory. See Table 13 for the test results. The corn was in the late whorl stage, above knee-high in height.

The four agronomic systems averaged below the sufficiency levels in nutrient uptake overall. On an overall rating of nutrient uptake, the No-Till plots were the most efficient followed by the Conventional Biological and Continuous Corn. For example, the nitrogen uptake on the No-Till plots was 23% below sufficiency levels and 8% below on the Continuous Corn plots.

The pH levels of the agronomic plot soil remained relatively stable. The system average was 6.1 for No-Till to 6.35 for Continuous Corn. The slight drop from last year is logical due to the drop in the calcium content which can be noted in Table 2 (Soil Test of Field Plot Soils).

Calcium and magnesium uptake was below sufficiency levels in nearly all cases. A lime application would be beneficial to the agronomic crop experiment.

Integrated Pest Management

The data we collected in the 1986 growing season was limited to insect pest populations and the weed surveys previously outlined in the "Cultivation and Weed Survey" section.

No disease problems were experienced on the agronomic crop systems. Therefore, no surveys were compiled this growing season. Because the vegetable plots were abandoned in July, no disease surveys were completed this summer although drought symptoms were readily apparent on all three vegetable crops.

Insect Pest Surveys

Agronomic Crops - Field Corn

Scouting for European Corn Borer was conducted on June 12 and 13. The guidelines that were provided by the University of Maryland Cooperative Extension Service were quite different this year than in 1985. A formula designed to make decisions based on the economic risk was the basis for our spray program on both field and sweet corn. In Table 14, "Insect Scouting, Field Corn", the "Benefit per Acre" was projected from the estimated population level. In all, twelve out of the sixteen plots were sprayed using Diple/4L at the rate of 2 pints/acre. This brought the pest under control, and no other sprays were needed on the field corn in 1986.

We participated in the University of Maryland's Black Light Trap and Pheromone Trap surveys this season. This consisted of having both an ultraviolet light trap and a pheromone trap installed by a field entomologist on April 3, 1986. The U.V. light trap collects insects that fly at night and population levels are tallied on certain insect species of economic importance to both field and sweet corn growers. The pheromone traps are designed to attract and catch male moths of the European Corn Borer and the Corn Earworm.

From data gathered at individual sites, statewide averages are compiled by region and state, and a printout is mailed monthly to individual sites. Using population levels, spray schedules are designed by the state entomologist and printed in the Integrated Pest Management Newsletter. A separate analysis is mailed to the trap operators on a monthly basis.

Because these surveys are a direct count of the adult population, and the real pest to the corn is the larvae stages, the caterpillar population is not directly observed. Therefore, it is well to conduct the field survey on the corn stand in addition to the trap counts, in order to verify the actual amount of apparent damage.

Corn Earworm activity was extremely high in July and the recommended spray schedule on sweet corn was a 3-5 day interval throughout the state. Because field corn can withstand greater earworm damage without suffering an economic loss, we did not spray the field corn for this pest.

Table 15 (Black Light Trap Data) compares the European Corn Borer and Corn Earworm population levels of the Accokeek trap data to the regional lower central Maryland average. The Farm's trap detected two separate broods of the Corn Earworm with the second moths emerging the week of June 26 - July 2. The lower central region's average showed a later emergence of the second brood at mid-July.

In the case of the European Corn Borer, the populations and broods were more closely correlated. If we had sweet corn in the vegetable plots, it is certain there would have been a substantial loss due to the high population levels of these pests. The State Entomologist recommended that all sweet corn growers should spray their corn "that was in silk during July, at the first silking after the first moth is captured in the region." According to the number of moths captured per day, spraying would have continued on a 2-6 day interval.

The actual counts of Corn Earworm Moths rose to over 52 per night the week of August 14-20. The highest counts for European Corn Borer Moths occurred in mid-July with nearly 10 per night. (With this much moth activity we would have been spraying every two to three days throughout the summer.)

The success of these two corn pest species was due to the dry conditions for much of the summer. The diseases and other natural biological controls are favored by wet conditions rather than dry.[7] Moth activity was 3-4 times higher than average as compared to the thirteen year period that the Black Light Trap data has been collected in Maryland. [8]

Fresh Vegetables

Tomatoes

Scouting for the Colorado Potato Beetle was begun on June 3, approximately two weeks after transplanting. See Table 16. At that time the population levels were above threshhold on one BIOL and two CON plots. Threshhold levels are 20 adults and/or larvae on 10 plants. Rotenone (82 fl.oz./acre) was sprayed on the one BIOL plot on June 4. Follow-up scouting was conducted on June 10, at which time, three of the MAG plots were above threshhold. The drought conditions were causing high levels of larvae deaths, so that very few adult beetles arose from the first brood.[9] The three MAG plots were sprayed on June 11. No other scouting or spraying was necessary in 1986, due to the continued drought, and the termination of the vegetable experiment in July.

Sweet Corn

The sweet corn was scouted for European Corn Borer on June 24. Both the number of larvae found was small and leaf damage was light. No sprays were needed or applied to the sweet corn in 1986. See Table 17.

Muskmelons

There was no formal insect scouting conducted on the muskmelons in 1986. The plants were of very small stature, only in the three to four leaf stage by late June. In our field observations thereafter, we detected no Spotted or Striped Cucumber beetles on the plants. Therefore, scouting was not needed on this crop. Because we terminated the vegetable experiment in July, no further information is available to report.

To make this a complete report, two more tables are included here for identification of insect and weed pests. Table 18 is Common and Scientific Names of Insect Pests and their host crops, and Table 19 is Common and Scientific Names of Common Weeds.

Economic Analysis

The Economic Analysis of the agronomic crop experiment reflected that the Biological system (T3) was the least expensive to produce of the four farming systems. Biological (T3) Corn cost $92.84 per acre, Conventional (T2) and Continuous Corn (T4) cost $157.74 per acre and No-Till (T1), $180.84 per acre. The difference in cost was the amount of herbicide and fertilizer applied. See Table 6, Economic Analysis of Agronomic Crops.

In the vegetable crop experiment, the Biological system was less expensive to plant than the modern agriculture system. Again, this was due to the amount of fertilizer and pesticide applied to the modern plants. The cost of the control plots per acre were sweet corn, $37.29; tomatoes, $43.99; and muskmelon $284.91. The Biological plots averaged 197% over the cost of the control plots, whereas the modern agriculture plots averaged 292% over control. See Table 7, Economic Analysis of Fresh Vegetables.

RESULTS AND DISCUSSION

A comparison of the agronomic crop systems shows that the Biological (T3) system averaged the best yield at 69.37 bu/acre (4,665 kg/ha.) This is comparable to the average yield in 1985 on the Continuous Corn (T4) system. The order of highest to least yields in 1986 were Biological (T3), No-Till (T1), Conventional (T2), and Continuous Corn (T4). Refer to Table 12 (Harvest of Agronomic Crops, 1986).

Two of the sixteen field plots had no yield this season. There was a close correlation between their weed populations and the low production on these plots, as well as damage by local fauna.

The long drought was expresed as a two-fold problem to the field corn: suppressed yields due to the lack of moisture, and increased plant damage due to the record population levels of the Corn Earworm and the European Corn Borer. The pressure of these insect populations required that three of the four plots in each system receive a spray treatment when the field was in the late whorl stage. In 1985, no sprays were needed on either the field corn or the sweet corn sub-plots. The later sowing date of the sweet corn in 1986 may have been the reason no sprays were required.

Two broods of Corn Earworm were noted and documented from the Accokeek Foundation's participation in Blacklight Trap Data Collection. Two peaks in the population level occurred; one, the third week of August, and another, the second week of September. There were four broods of European Corn Borers, and the maximum population level occurred the second week of July.

No yields are given for the vegetable crops this season. The project was terminated in late June due to the drought and its associated problems.

Again, as in 1985, the cultivation practices used on both the agronomic and vegetable plots were similar except that a roto-tiller was used on all the vegetable plots in mid-June. In the agronomic experiment, the No-Till plots were an exception in that herbicides were used instead of cultivation.

Pre-emergence herbicides were used on the MAG vegetable plots of tomatoes, sweet corn and muskmelons. Pre-emergence herbicides were used on the Conventional and Continuous Corn agronomic plots. Pre-emergence plus post-emergence herbicides were applied to the No-Till plots.

In the vegetable plots, weed control was sufficient in the MAG Sweet Corn plots. There was a localized area in plots 19-BIOL, 10-CON, and 11-MAG where weeds were too numerous to count. Pigweed and crabgrass were the two most difficult weeds to control.

Dodder was found in all the plots of both experiments. Roundup was found to be an effective herbicide in controlling Dodder. No new outbreaks occurred in those plots where it was used.

In the agronomic test plots, there was effective control of weeds in the Conventional Corn plots and poor control in the Continuous Corn plots. The most difficult weeds to control were Bermuda Grass, Morning Glory, and Nightshade. The most prevalent species was Bermuda Grass followed by Lamb's Quarters.

In the vegetable plots, granular fertilizer was used on the MAG plots. Fish emulsion and seaweed kelp were used on the BIOL plot.

In the agronomic experiment, granular fertilizer was used on the No-Till, Conventional and Continuous Corn. Fish emulsion and seaweed kelp were used in combination on Biol plots. The Biological field corn plants showed classical nitrate deficiency in their leaves, but the yields were above average for a dry year.

Plant nutrition was again assayed using dry leaf tissue analysis on the field corn. Nitrogen uptake was highest in the Conventional plots, followed by No-Till and Continuous Corn. Phosphorous uptake was highest in the No-Till plots, followed by Conventional and Biological. Potash uptake was highest in the Conventional plots, followed by No-Till and Biological. All four systems were deficient in calcium and magnesium uptake. The assays for 1985 showed adequate magnesium and calcium uptake.

The soil samples of the field crop plots showed a drop in both calcium and magnesium content. Lime may be needed as a soil amendment in 1987.

Integrated Pest Management was used on the two experiments again in 1986. No disease problems were encountered except for the Dodder pest.

The field corn was surveyed for European Corn Borer and spraying was conducted on most of the plots when the corn was in the late whorl stage. The highest insect counts were collected from the Continuous Corn plots, followed by the Conventional and No-Till. The fewest were collected from the Biological plots.

Significant pest levels occurred on the tomato plots in all three systems. Among these were one Biological plot, two control plots and three modern agriculture plots. One spraying of Rotenone brought the population under control.

No threshhold levels were reached on either the sweet corn or muskmelons and no sprays were used.

The Economic Analysis of the field crops showed that the No-Till (T1) system was the most costly per acre; followed by the Conventional (T2) and Continuous Corn (T4) and lastly the Biological system (T3). On the No-Till system, herbicides accounted for 22.5% of the cost per acre. Fertilizer was another significant cost on the No-Till at 51.2% of the cost per acre.

RECOMMENDATIONS

In an experiment of this type where comparison systems are being demonstrated, it is of tantamount importance that the site of the experiment be chosen carefully, if favorable conditions are to be duplicated from year to year. In this light, our goals and objectives have proven to be correct, but the site chosen for the vegetable crop experiment has proven to be wrong. Because of the less-than-adequate rainfall in both 1985 and 1986, the vegetable crop experiment is being relocated to a site on the Farm within the range of the existing irrigation system. The site of the vegetable crop experiment in 1986 became extremely dry and hard packed by mid-June, and this was more extreme in the subsoil layers. The new site of the vegetable crop experiment is a field adjacent to the employees parking lot. In moving the vegetable crop experiment to an area where irrigation can be applied, the vegetables produced will be of a higher and more consistent quality. The costs of using irrigation can be offset by higher yields.

If Dodder should become a pest problem again, the pre-emergence herbicide (Dacthal) is highly recommended by the Maryland Cooperative Extension Service for its control.[10]

Because the tissue analysis of the field corn showed low uptake of the macronutrients and some micronutrients, close attention should be given to the soil test analysis and fertilizer recommendations for 1987. On the Biological plots initial fertilization can be supplemented with a foliar treatment of the Fertrel and Foliagrow or similar, organically-produced fertilizers may be used as a side dressing.

On the Biological plots, the legume cover crops of hairy vetch or clover should be sown in the early fall to assure good germination and hardy growth before the first frosts.

Table 10.-- Weed Survey, Agronomic Crops, June 5, 1986
(number of weeds in 20 row feet)

Crop System/ Weed	PLOT ID			
	REP. I	REP. II	REP. III	REP. IV
NO-TILL (T1)				
Bermuda Grass			2	
Lamb's Quarters				15
Morning Glory	31	18	8	25
Night Shade	53	8	39	4
Pigweed				2
Smartweed	4		3	1
Trumpet Vine	2	16	4	2
Misc. Others	3		1	6
CONVENTIONAL (T2)				
Bermuda Grass			1	
Lamb's Quarters				
Morning Glory	11	1		3
Night Shade	1	5	12	
Pigweed				
Smartweed			4	
Trumpet Vine	4	4	5	2
Misc. Others	3		1	3
BIOLOGICAL (T3)				
Bermuda Grass	10		[*]	4
Lamb's Quarters		2	[*]	3
Morning Glory	16	7		12
Nightshade		3		
Pigweed	19		4	1
Smartweed	6		7	11
Trumpet Vine		3	6	3
Misc. Others	8	2	4	
CONTINUOUS CORN (T4)				
Bermuda Grass	*	2	2	3
Lamb's Quarters				4
Morning Glory	4	13		15
Nightshade	14	7	3	9
Pigweed				2
Smartweed		1		
Trumpet Vine	9	23	14	9
Misc. Others	7	3		

[*] Too large to count.

Table 11.--Weed Survey, Vegetable Crops, June 2, 1986
(Number of Weeds in 20 row feet)

Crop and Weeds	Plot ID/ System			
	A1/BIOL.	A5/BIOL.	A9/BIOL [1]	A12/BIOL.
Muskmelons				
Bermuda Grass	5	9	overgrown	
Crab Grass	192		with	33
Lambs Quarters	120	13	weeds	25
Morning Glory	18	59	"	
Nightshade	13	6	"	22
Pigweed	10	54	"	
Smartweed		7	"	1
Trumpetvine	6	7	"	2
Witch Grass				
Sweet Corn				
Bermuda Grass	7	23	"	
Crab Grass			"	32
Lambs Quarter	160	88	"	1
Morning Glory	25	33	"	5
Night Shade	10	2	"	1
Pigweed	17	78	"	
Trumpet Vine	5	2	"	5
Tomatoes				
Bermuda Grass	57		"	
Lambs Quarters		9	"	15
Morning Glory	2	20	"	7
Night Shade			"	
Pigweed	2		"	
Smartweed		19	"	5
Trumpet Vine	5		"	
Witch Grass			"	
Misc. Others	6	2	"	

(1) The underlined data entries represent significant weed species levels as noted in the text.

The following rcommendations were taken from a written report prepared by Dr. Ray Weil in August, 1986 following his field consultation on August 15, 1986. The accompanying figures and crop rotation schedule were a part of his report and are included here:

The site adjacent to the staff parking lot was chosen as the new location for the Horticulture Experiment. The soil is Elkton Silt Loam and is a clayey mixed mesic. The A horizon is a gray-brown silt loam. Under the plow layer is a lighter silt loam with yellow-brown mottles. The mottling indicates wet season water logging. At 12 inches the texture is a silty clay loam, and at 18 inches it is a silty clay.

Drainage is not ideal either internally or on the surface. The soil is friable and easily tilled at the proper moisture content. Deep tillage should be avoided due to the heavier sub-soil.

Poor drainage is the main soil limitation. Significant levels of improved drainage exist at the upper end of the field, 160 feet up from the gravel road. It is recommended that only the upper portion of the field be used for fresh vegetable production.

To improve crop growth on sensitive crops, the practice of soil ridging (to 10") should be used. The ridging would allow for better aeration to the root zone. Ridging could be tried on one of the replications the first year of the experiment as a test.

Use grassed alley ways between plots for tractor and foot traffic.

Preliminary Experimental Design

"The experiment is designed to demonstrate to the Southern Maryland farmer the feasibility and profitability of growing horticultural crops in as sustainable, and ecologically-sound manner as possible."[11] Three cropping systems are proposed for comparison:

1. Conventional (C) - A modern agriculture chemical intensive system.

2. Organic (O) - A farming system dependent on purchased, non-synthetic inputs.

3. Natural (N) - A farming system based on self-sufficiency and minimal interference with the natural soil-plant community.

Comparisons will not be based on single factors nor will they be isolated in the classical "cause and effect" sense. Furthermore, not all systems will produce the same crops at a given time. See Figure 4. Each system will be replicated three times. Within each experimental plot, sub-plots will be defined to contain separate crops as outlined in the Cropping System Plan, Figure 5.

Because these are farming systems, it is expected that cropping practices will change due to experience. From the outset the principles and goals defining each system will serve as guidelines for future years.

To be specific, the three systems are set apart by the following factors.

1. The Conventional System will use petrochemicals for weed and insect control. Soluble fertilizers will supply plant nutrients. Plastic mulches, but not organic, may be used. No winter cover crop, fall plowing. Spaces between rows should be weed free and bare.

2. Organic System will have the same crops as the Conventional System, but a winter cover crop of a small grain plus clover will be grown. No petrochemicals will be used. Weeds will be controlled by cultivation and will be as weed free as possible. Only organic materials and methods will be used to control insect and disease pests. Manure and purchased non-synthetic fertilizers will be used for plant nutrition. In short, much tillage and purchased organic inputs are the by-words for this system.

3. The Natural system aims to produce a complex and interactive ecosystem, while at the same time, to produce reasonable quantities of marketable produce. Marketability of the produce will be determined by organic buyers, not commercial, conventional markets. Tillage and purchased off farm (off plot) inputs will be minimized. No petrochemicals or soluble synthetic fertilizers will be used. Closely spaced crop plantings, cover crops and mulch will be used to control weeds. Mulch materials may be cut from one sub-plot and used on another sub-plot within the same plot.

Further guide lines for the Natural System include intercropping of mixed plantings and possible reseeding of cover crops. Also, transplants may be set into existing cover crops after mowing. Rock fertilizers may be used, but the overall aim is to recycle plant nutrients back into the soil.

TABLES

Table 1.--Comparative Weather Conditions, 1985 and 1986
National Colonial Farm and Glendale Bell Station

Month and Station	Max. °F.	Min. °F.	Mean °F.	Precip. Total, in.
January				
NCF, 1985	40.11	25.1	32.6	2.36
NCF, 1986	44.52	26.58	35.55	2.39
Glendale Bell	44.0	22.4	33.2	3.06
Departure	0.52	4.18	2.35	0.67
February				
NCF, 1985	48.39	30.07	39.23	3.33
NCF, 1986	43.46	32.57	38.07	2.66
Glendale Bell	47.1	23.8	35.4	2.75
Departure	(-3.64)	8.77	2.67	(-.09)
March				
NCF, 1985	58.77	39.07	48.9	1.90
NCF, 1986	60.35	36.68	48.52	1.14
Glendale Bell	56.6	31.1	43.9	3.70
Departure	3.75	5.58	4.62	(-2.56)
April				
NCF, 1985	75.0	49.70	62.35	0.31
NCF, 1986	69.23	46.63	56.93	1.945
Glendale Bell	68.2	40.3	54.2	3.52
Departure	1.03	6.33	2.73	(-1.57)
May				
NCF, 1985	79.0	58.96	68.98	3.025
NCF, 1986	84.33	57.2	70.77	0.655
Glendale Bell	76.9	49.9	63.4	3.94
Departure	7.43	7.3	7.37	(-3.29)
June				
NCF, 1985	83.86	64.36	74.11	1.59
NCF, 1986	91.63	66.40	79.02	0.73
Glendale Bell	84.2	58.2	71.2	3.87
Departure	7.43	8.2	7.82	(-3.14)
July				
NCF, 1985	86.67	69.61	78.29	1.88
NCF, 1986	94.03	71.97	83.00	4.57
Glendale Bell	88.1	62.9	75.6	4.31
Departure	5.93	9.07	7.4	0.26

Table 1 -- Comparative Weather Conditions, 1985 and 1986

	Max. °F.	Min. °F.	Mean °F.	Precip. Total, in.
August				
NCF, 1985	85.51	68.12	76.81	3.07
NCF, 1986	85.35	64.68	75.02	8.92
Glendale Bell	86.9	62.1	74.5	4.91
Departure	(-1.55)	2.58	0.52	4.01
September				
NCF, 1985	81.17	62.87	72.02	2.53
NCF, 1986	82.40	61.33	71.87	1.21
Glendale Bell	80.9	55.1	68.0	3.66
Departure	1.5	6.23	3.87	(-2.45)
October				
NCF, 1985	70.0	53.0	61.5	4.51
NCF, 1986	72.87	51.71	62.29	1.75
Glendale Bell	70.1	43.0	56.6	3.30
Departure	2.86	8.71	5.66	(-1.45)
November				
NCF, 1985	63.43	48.50	55.96	3.30
NCF, 1986	56.5	38.4	47.45	3.77
Glendale Bell	58.4	34.1	46.3	3.34
Departure	(-1.9)	4.3	1.15	0.43
December				
NCF, 1985	54.30	34.07	44.18	3.47
NCF, 1986	47.21	30.38	38.79	5.70
Glendale Bell	47.3	25.9	36.7	3.39
Departure	(-0.09)	4.48	2.09	2.31
Annual totals				
NCF, 1985	68.85	50.29	59.57	32.88
NCF, 1986	69.32	48.71	59.01	35.44
Glendale Bell	67.4	42.4	54.9	43.75
Departure	1.92	6.31	4.11	(-8.31)

Table 2 -- Soil Analysis, Agronomic Crops[1] 1986
Soil Depth 0-15 cm (0-6 in.)
Units = Pounds/Acre unless otherwise stated

Chemical Analysis	Plot ID and Crop Farming System				
	IT1/NT	IIT1/NT	IIIT1/NT	IVT1/NT	AVE./NT
pH	6.1	6.1	6.4	5.8	6.1
Magnesium	201	211	219	169	200
Phosphate,	44	28	51	47	42.5
Potash,	87	108	102	164	115.25
Ash, %	2.6	3.0	2.8	2.8	2.8
Boron	1.12	0.91	0.78	1.05	0.97
Calcium	880	860	1080	640	865
Cation Exchange	--	--	--	--	--
Capacity, meq.	4.7	4.6	5.0	4.4	4.7
Copper	1.2	0.9	0.7	0.8	0.9
Manganese	23	35	26	38	30.5
H_2O %	0.6	0.6	0.4	0.6	0.55
Nitrates	12.0	26.3	14.7	18.8	17.8
Organic Matter %	1.5	1.8	1.2	1.9	1.6
Zinc	2.3	2.1	2.2	2.6	2.3

	IT2/CONV	IIT2CONV	IIIT2/CONV	IVT2/CONV	AVE./CONV
pH	6.1	6.1	6.4	6.1	6.2
Magnesium	214	233	219	185	213
Phosphate	51	44	51	59	51.25
Potash,	84	102	102	120	102
Ash, %	2.6	2.9	2.8	2.4	2.7
Boron	0.98	1.11	0.78	0.72	0.90
Calcium	740	940	1080	740	875
Cation Exchange	--	--	--	--	--
Capacity, meq.	4.3	5.2	5.0	4.4	4.7
Copper	1.0	1.0	0.7	0.7	0.85
Manganese	23	31	26	27	26.8
H_2O %	0.6	0.6	0.4	0.4	0.5
Nitrates	28	24.5	14.7	11.7	19.7
Organic Matter,%	1.5	1.6	1.3	1.3	1.43
Zinc	2.3	2.3	1.7	4.0	2.6

Table 2 - Soil Analysis-Agronomic Crops-Continued

Chemical Analysis	Plot ID and Crop/Farming System IT3/BIOL	IIT3/BIOL	IIIT3/BIOL	IVT3/BIOL	AVE./BIOL
pH	6.5	6.4	6.3	6.2	6.35
Magnesium	189	232	240	186	212
Phosphate,	31	29	59	35	41
Potash,	83	75	122	107	97
Ash, %	2.4	2.7	3.0	2.4	2.6
Boron	1.05	0.98	0.97	0.69	0.92
Calcium	1000	1200	1340	920	1115
Cation Exchange	--	--	--	--	--
Capacity, meq.	4.6	5.6	6.1	4.8	5.3
Copper	0.9	0.9	0.8	0.8	0.85
Manganese	19	21	32	38	27.5
H_2O %	0.4	0.8	0.4	0.6	0.55
Nitrates	16.7	15.8	7.9	18.8	14.8
Organic Matter,%	1.4	1.4	1.7	1.5	1.5
Zinc	1.5	1.6	2.4	1.5	1.8

Chemical Analysis	IT4/C.C.	IIT3/C.C.	IIIT3/C.C.	IVT3/C.C.	AVE./C.C.
pH	6.4	6.4	6.3	6.0	6.3
Magnesium	187	228	203	190	202
Phosphate,	29	37	29	82	44.25
Potash,	114	68	61	131	93.5
Ash, %	2.6	2.8	2.8	2.8	2.75
Boron	0.81	0.85	0.81	0.77	0.81
Calcium	960	1120	840	840	940
Cation Exchange	--	--	--	--	--
Capacity, meq.	4.7	5.3	4.4	5.1	4.9
Copper	0.8	0.9	0.8	0.6	0.775
Manganese	21	25	19	35	25
H_2O %	0.6	0.6	0.8	0.6	0.65
Nitrates	6.3	3.8	4.5	5.3	5.0
Organic Matter, %	1.4	1.4	1.1	1.7	1.4
Zinc	1.5	1.6	1.3	3.1	1.9

[1] All field test plots will be in field corn, 1986

Key
- NT = no till
- CC = Continuous Corn
- CONV = Conventional
- BIOL = Biological

Table 3. - Soil Analysis, Vegetable Crops, 1986
Soil Depth 0-15 cm (0-6 in.)
Unit = Pounds/Acre

	Plot ID and Crop/Farming System				
Chemical Analysis	A1/BIOL	A5/BIOL	A9/BIOL	A12/BIOL	AVE./BIOL
pH	6.6	6.5	7.0	6.8	6.7
Magnesium	201	227	296	160	221
Phosphate,	75	36	89	77	69
Potash,	167	106	165	102	135
Boron	0.92	0.63	0.65	0.72	0.73
Calcium	940	980	1620	860	1100
Cation Exchange	--	--	--	--	--
Capacity, meq.	4.4	4.8	6.4	3.8	4.85
Nitrates	26.9	11.6	12.8	6.0	14.3
Organic Matter %	1.5	1.3	1.4	1.2	1.35
	A2/MAG	A6/MAG	A8/MAG	A11/MAG	AVE./MAG
pH	6.4	6.3	6.6	6.8	6.5
Magnesium	246	210	186	160	200.5
Phosphate	123	35	65	77	75
Potash	197	81	151	102	133
Boron	1.16	0.70	0.76	0.72	0.84
Calcium		1140	860	1000	860
Cation Exchange	--	--	--	--	--
Capacity, meq.	5.5	4.6	4.6	3.8	4.6
Nitrates	3.0	9.3	11.4	6.0	7.5
Organic Matter %	1.3	1.3	1.3	1.2	1.275
	A3/CON	A4/CON	A7/CON	A10/CON	AVE./CON
pH	6.7	6.8	6.6	6.8	6.7
Magnesium	237	258	221	251	242
Phophate,	31	38	40	94	51
Potash	85	102	110	166	116
Boron	0.49	0.93	1.01	0.86	0.82
Calcium	1020	1180	1080	1500	1195
Cation Exchange	--	--	--	--	--
Capacity, meq.	4.7	5.2	4.9	6.1	5.2
Nitrates	8.0	4.1	16.0	25.5	13.4
Organic Matter %	0.9	1.3	1.4	1.6	1.3

Table 4--Analysis and Amounts of Fertilizers Used on Agronomic Crops, 1986

Date	Crop	System	Fertilizer Type*	Fertilizer Amounts kg/ha	lb/A
4/24	Field Corn	T1,T2,T4	Urea	298.6	266.6
"	"	"	Phosphate	336.0	300.0
"	"	"	Potash	224.0	200.0

Table 5 -- Analysis and Amounts of Fertilizers Used on Vegetable Crops, 1986

Vegetable	System	Plot#	Fertilizer Type*	Fertilizer Amounts kg/ha	lb/a	Date
Sweet Corn	MAG	A2,A6,A8,A11	Urea	298.6	266.6	5/1
" "	"	"	Phosphate	336.0	300.0	"
" "	"	"	Potash	224.0	200.0	"

Tomatoes	MAG	A2	Urea	198.9	177.6	5/22
"	"	"	Phosphate	242.8	216.8	"
"	"	"	Potash	187.3	167.2	"
Tomatoes	MAG	A6	Urea	198.9	177.6	5/22
"	"	"	Phosphate	486.5	434.4	"
"	"	"	Potash	419.5	334.4	"
Tomatoes	MAG	A8	Urea	198.9	177.6	5/22
"	"	"	Phosphate	364.7	325.6	"
"	"	"	Potash	280.4	250.4	"
Tomatoes	MAG	A11	Urea	198.9	177.6	5/22
"	"	"	Phosphate	364.7	325.6	"
"	"	"	Potash	187.3	167.2	"

Muskmelon	MAG	A2	Urea	231.2	206.4	5/7
"	"	"	Phosphate	152.3	136.0	"
"	"	"	Potash	187.3	167.2	"
Muskmelon	MAG	A6	Urea	231.2	206.4	5/7
"	"	"	Phosphate	364.7	325.6	"
"	"	"	Potash	374.5	334.4	"
Muskmelon	MAG	A8	Urea	231.2	206.4	5/7
"	"	"	Phosphate	248.3	221.7	"
"	"	"	Potash	280.4	250.4	"
Muskmelon	MAG	A11	Urea	231.2	206.4	5/7
"	"	"	Phosphate	248.3	221.7	"
"	"	"	Potash	187.3	167.2	"

*N-P-K Percent
Urea 45-0-0
Phosphage 0-46-0
Potash 0-0-60

Table 6.--Economic Analysis, Agronomic Crops
(Cost per Acre Basis)

Item and Crop	Amount/acre	Cost/acre
NO-TILL(T1)/CORN		
Seed------------------	15 lb.	$22.00
Fertilizer------------	766.6 lb.	92.66
Lime------------------	NA	----
Fuel and oil----------	5.9 gal. x 1.10 plus 15%	7.46
Herbicide-------------	2.5 pt. ea of Aatrex & Dual 8E plus 2 pts. Roundup	40.72
Pesticide-------------	2 pts. Dipel 4L	18.00
TOTAL---------------		$180.84
CONV.(T2)/CONTINUOUS CORN (T4)		
Seed------------------	15 lb.	22.00
Fertilizer------------	766.6 lb.	92.66
Lime------------------	NA	----
Fuel and oil----------	5.6 gal. x 1.10 plus 15%	7.08
Herbicide-------------	2.5 pt. ea. Dual 8E & Aatrazine	18.00
Pesticide-------------	2 pt. Dipel 4L	18.00
Total-----------		$157.74
BIOLOGICAL (T3)		
Seed------------------	15 lb.	22.00
Fertilizer------------	2.5 gal. Fertrell I & 0.5 lb. Folia-grow	45.00
Lime------------------	NA	----
Fuel and oil----------	6.2 gal. x 1.10 plus 15%	7.84
Herbicide-------------	NA	----
Pesticide-------------	2 pt. Dipel 4L	18.00
Total-----------		$92.84

NA = Not Applied

Table 7 -- Economic Analysis, Fresh Vegetables
(Cost per acre basis)

	Modern Agriculture		Biological		Control
Crop & Item	Amount	Cost	Amount	Cost	Cost
Sweet Corn:					
Seed---------	12 lb.	$24.64	12 lb.	$24.64	$24.64
Fertilizer---	766.6 lb.	92.66	2.5 Gal Fertrell +0.5 lb. Foliagrow	45.00	-----
Lime---------	NA	----	NA	----	NA
Fuel and oil-	10 gal. x $1.10 + 15%	12.65	10 gal. x $1.10 + 15%	12.65	12.65
Herbicide----	2.5 pts. ea. Dual 8E & Aatrazine	18.00	NA	----	-----
Insecticide--	NA		NA		NA
Total-----		$147.95		$82.29	$37.29
Tomatoes:					
Seed--------	1/2 oz.	$23.50	1/2 oz.	$23.50	23.50
Fertilizer--	733 lb.	88.60	2.5 Gal. Fertrell & 0.5lb. Foliagrow	45.00	
Lime--------	NA	----	NA	----	NA
Fuel & oil--	16.2 gal. x $1.10 + 15%	20.49	16.2 gal. x $1.10 + 15%	20.49	20.49
Herbicide---	NA	----	NA	----	----
Insecticide-	82 fl. oz. Rotenone liq.	22.42	82 fl. oz. Rotenone liq.	22.42	NA
Fungicide---	NA	-----	NA	----	----
Total----		$155.01		$111.41	$43.99
Muskmelons:					
Seed--------	3 lb.	$267.20	3 lb.	$267.20	267.20
Fertilizer--	676 lb.	80.90	0.5 lb. Foliagrow & 2.5 gal. Fertrell I	45.00	-----
Lime--------	NA	----	NA	----	NA
Fuel & oil--	14 gal. x $1.10 + 15%	17.71	14 gal. x $1.10 + 15%	17.71	17.71
Herbicide---	----	----	NA	----	----
Insecticide-	NA	----	NA	----	----
Fungicide---	NA	----	NA	----	----
Total----		$365.81		$329.91	$284.91

NA = Not Applied

Table 8 -- Agronomic Crop Planting Schedule, 1986

SYSTEM	CROP	VARIETY NAME	DATE	SPACING BTW. ROWS	SPACING IN ROWS	POPULATION/ACRE
T1, T2, T3, T4	Field Corn	Pioneer 3358	4/25	30"	9"	23,200

Table 9 -- Vegetable Crop Planting Schedule, 1986

SYSTEM	CROP	VARIETY NAME	DATE	SPACING BETW. ROWS	SPACING IN ROWS	POPULATION ACRE
ALL	Sweet Corn	Bellringer (79)	5/2	30"	10 3/8".	19,700
"	Muskmelon	Gold Star (87)	5/12	42"	40"	3,750
"	Tomatoes	Pick Red (71)	5/22	42"	40"	3,750

Table 10.-- Weed Survey, Agronomic Crops, June 5, 1986
(number of weeds in 20 row feet)

Crop System/ Weed	PLOT ID REP. I	REP. II	REP. III	REP. IV
NO-TILL (T1)				
Bermuda Grass			2	
Lamb's Quarters				15
Morning Glory	31	18	8	25
Night Shade	53	8	39	4
Pigweed				2
Smartweed	4		3	1
Trumpet Vine	2	16	4	2
Misc. Others	3		1	6
CONVENTIONAL (T2)				
Bermuda Grass			1	
Lamb's Quarters				
Morning Glory	11	1		3
Night Shade	1	5	12	
Pigweed				
Smartweed			4	
Trumpet Vine	4	4	5	2
Misc. Others	3		1	3
BIOLOGICAL (T3)				
Bermuda Grass	10		[*]	4
Lamb's Quarters		2	[*]	3
Morning Glory	16	7		12
Nightshade		3		
Pigweed	19		4	1
Smartweed	6		7	11
Trumpet Vine		3	6	3
Misc. Others	8	2	4	
CONTINUOUS CORN (T4)				
Bermuda Grass	*	2	2	3
Lamb's Quarters				4
Morning Glory	4	13		15
Nightshade	14	7	3	9
Pigweed				2
Smartweed		1		
Trumpet Vine	9	23	14	9
Misc. Others	7	3		

[*] Too large to count.

Table 11.--Weed Survey, Vegetable Crops, June 2, 1986
(Number of Weeds in 20 row feet)

Crop and Weeds	Plot ID/ System			
	A1/BIOL.	A5/BIOL.	A9/BIOL [1]	A12/BIOL.
Muskmelons				
Bermuda Grass	5	9	overgrown	
Crab Grass	192		with	33
Lambs Quarters	120	13	weeds	25
Morning Glory	18	59	"	
Nightshade	13	6	"	22
Pigweed	10	54	"	
Smartweed		7	"	1
Trumpetvine	6	7	"	2
Witch Grass				
Sweet Corn				
Bermuda Grass	7	23	"	
Crab Grass			"	32
Lambs Quarter	160	88	"	1
Morning Glory	25	33	"	5
Night Shade	10	2	"	1
Pigweed	17	78	"	
Trumpet Vine	5	2	"	5
Tomatoes				
Bermuda Grass	57		"	
Lambs Quarters		9	"	15
Morning Glory	2	20	"	7
Night Shade			"	
Pigweed	2		"	
Smartweed		19	"	5
Trumpet Vine	5		"	
Witch Grass			"	
Misc. Others	6	2	"	

(1) The underlined data entries represent significant weed species levels as noted in the text.

Table 11 -- Continued

Crop and Weeds	A3/CON	A4/CON	A7/CON	A10/CON
	PLOT ID/SYSTEM			
Muskmelons				
Bermuda Grass	4	78		overgrown
Crab Grass			21	with
Lamb's Quarters	160	3	7	weeds
Morning Glory	45	16	17	"
Night Shade		10		"
Pigweed	9	21		"
Smartweed		1		"
Trumpet Vine	5	1		"
Misc. Others				"
Sweet Corn				
Bermuda Grass	10	5	2	"
Crab Grass	16	3		"
Lamb's Quarters		64	25	"
Morning Glory	24	62	47	"
Night Shade		8	2	"
Pigweed	1	26	25	"
Smartweed	1	5	4	"
Trumpet Vine	1	3	2	"
Witch Grass				"
Misc. Others	3	6	1	"
Tomatoes				
Bermuda Grass		6		"
Lamb's Quarters		2		"
Morning Glory	4	7	3	"
Night Shade		5		"
Pigweed	1	2	8	"
Smartweed		3		"
Trumpet Vine	1	1		"
Misc. Others				"

The underlined data entries represent significant weed species.

Table 11 - Continued

Crop and Weeds	PLOT ID/SYSTEM A2/MAG	A6/MAG	A8/MAG	A11/MAG
Muskmelons				
Bermuda Grass	30	4	2	
Crab Grass	1		1	[2]
Lambs Quarters	10	3	39	4
Morning Glory	128	48	31	14
Night Shade				
Pigweed	2	3	20	1
Smartweed			1	2
Trumpet Vine	4			6
Misc. Others		2		
Sweet Corn				
Bermuda Grass		3		
Crab Grass			1	
Lambs Quarters				
Morning Glory	8	11		
Night Shade		2		
Pigweed				
Trumpet Vine	6	1	1	3
Misc. Others				
Tomatoes				
Bermuda Grass	1			
Crab Grass	1		26	1
Lambs Quarters	1		3	
Morning Glory	7	9		
Night Shade	5			
Pigweed	1			
Trumpet Vine		2	2	2
Misc. Others	1			

The underlined data entries represent significant weed species.

Table 12 -- Harvest of Agronomic Crops, 1986
by Volume and Weight

Plot #	Plot ID [1]	Bu/Acre	lb/acre	kg/ha
		No-Till Field Corn [1]		
15	IT1	-	-	-
9	IIT1	78.15	4689.20	5255.66
7	IIIT1	56.90	3413.89	3826.29
1	IVT1	25.89	1553.56	1741.23
Averages		53.65	3218.88	3607.72
		Conventional Field Corn		
14	IT2	13.76	825.32	925.02
11	IIT2	42.30	2538.09	2538.09
6	IIIT2	47.02	2821.41	2844.69
2	IVT2	68.84	4130.39	4629.34
Averages		42.98	2578.80	2890.32
		Biological Field Corn		
16	IT3 [1]	-	-	-
12	IIT3	56.38	3382.97	3791.63
5	IIIT3	76.76	4605.87	5162.26
3	IVT3	74.96	4497.74	5041.07
Averages		69.37	4162.19	4664.98
		Continuous Corn		
13	IT4	27.10	1625.77	1822.16
10	IIT4	62.20	3732.01	4182.84
8	IIIT4	60.99	3659.42	4101.48
4	IVT4	49.70	2982.26	3342.52
Averages		36.25	2174.87	2437.59

[1] Both #15 and #16 plots were poor stands due to heavy crow damage.
No Yield = No Plot

Table 13--Plant Tissue Analysis, 1986
Agronomic Crops (percent dry weight)

System & Chemical Analysis	Agronomic Corn Rep. I	Rep. II	Rep. III	Rep. IV	Sufficiency (1) Levels
No-Till (T1)					
Nitrogen	2.2	2.0	2.1	2.2	2.76-3.50
Phosphorous	0.27	0.17	0.25	0.21	0.25-0.40
Potash	1.9	1.1	1.6	0.99	1.71-2.25
Calcium	0.17	0.10	0.20	0.33	0.21-0.50
Magnesium	0.16	0.13	0.17	0.25	0.21-0.40
Conventional (T2)					
Nitrogen	2.0	2.2	2.1	2.3	2.76-3.50
Phosphorous	0.19	0.25	0.25	0.19	c 0.25-0.40
Potash	1.1	1.8	1.7	1.2	1.71-2.25
Calcium	0.17	0.17	0.17	0.13	0.21-0.50
Magnesium	0.15	0.15	0.15	0.13	0.21-0.40
Biological (T3)					
Nitrogen	1.9	2.0	1.8	2.3	2.76-3.50
Phosphorous	0.25	0.17	0.21	0.28	0.25-0.40
Potash	1.8	0.73	1.2	1.8	1.71-2.25
Calcium	0.10	0.13	0.17	0.23	0.21-0.50
Magnesium	0.14	0.13	0.20	0.21	0.21-0.40
Continuous Corn (T4)					
Nitrogen	2.0	2.1	2.0	2.1	2.76-3.50
Phosphorous	0.21	0.24	0.20	0.20	0.25-0.40
Potash	1.4	1.8	1.4	1.4	1.71-2.25
Calcium	0.10	0.17	0.13	0.13	0.21-0.50
Magnesium	0.12	0.15	0.13	0.15	0.21-0.40

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(1) Source: Sufficiency Range for Corn--Soil Testing and Plant Analysis, Part II Plant Analysis, 1967. SSSA Spec. Pub. 2. SSSA, Madison, WS.

Table 14 -- Insect Scouting, Agronomic Corn[1]
For European Corn Borer
(Survey = 5 random rows of 20 consecutive plants)

Date	Plot ID	Range of # of Affected Plants/row	Total No. of Live Larvae	% of Affected Plants	Projected # of Larvae Per Plant	Benefit Per Acre	Action Needed[2,3]
6/12	NO-TILL (T1)						
	Rep. I	8-17	16	66	2.36	$26.09	Spray
	II	17-20	14	92	2.56	$28.30	"
	III	16-20	18	87	3.13	$34.60	"
	IV	13-20	5	77	0.70	$ 7.74	none
6/13	CONVENTIONAL (T2)						
	Rep. I	10-15	17	61	2.20	$24.32	Spray
	II	15-20	14	87	2.42	$26.75	"
	III	17-20	22	94	3.9	$43.11	"
	IV	8-16	7	56	0.65	$ 7.19	none
6/12	BIOLOGICAL (T3)						
	Rep. I	10-18	11	71	1.78	$19.68	Spray
	II	9-19	9	69	1.09	$12.05	none
	III	16-19	10	87	1.80	$19.90	Spray
	IV	10-18	11	75	1.80	$19.90	"
6/13	CONTINUOUS CORN (T4)						
	Rep. I	10-12	8	56	0.88	$9.73	none
	II	14-20	23	85	4.2	$46.43	Spray
	III	16-19	13	87	2.86	$31.62	"
	IV	18-20	18	92	3.20	$33.17	"

---

[1] Decision process changed between 1985 and 1986 crop years.

[2] 1985 - Recommendation: Spray if more than 30% of plants are affected as a whorl treatment.

[3] 1986 - Spray whorls if benefit per acre exceeds the cost per acre of spray treatment. We used Dipel 4L at a cost of $18/acre.

Source: 1986 "Integrated Pest Management Report," University of Maryland, College Park, Md., Report #5.

Table 15 -- 1986 Seven Day Summary for Corn Earworms and European Corn Borers, Blacklight Trap Data (Average Number of Moths/Day for Each 7 Day Period)

Dates of 7 Day Interval	Corn Earworm Lower Central Region	Corn Earworm Accokeek	European Corn Borer Lower Central Region	European Corn Borer Accokeek
5/1 - 5/7	0.07	.00	0.28	0.14
5/8 - 5/14	0.10	0.43	0.77	2.57
5/15 - 5/21	0.22	0.29	0.83	1.14
5/22 - 5/28	0.72	0.29	1.17	1.43
5/29 - 6/4	0.37	0.43	0.89	1.00
6/5 - 6/11	0.86	0.14	0.61	2.71
6/12 - 6/18	0.49	0.00	0.35	0.57
6/19 - 6/25	0.31	0.00	0.33	0.43
6/26 - 7/2	0.94	0.29	0.11	0.14
7/3 - 7/9	0.30	0.14	1.22	0.71
7/10 - 7/16	0.60	0.14	1.81	9.86
7/17 - 7/23	0.98	0.29	2.27	4.14
7/24 - 7/30	7.37	2.86	1.83	4.14
7/31 - 8/6	17.19	11.00	0.83	1.43
8/7 - 8/13	22.02	18.43	2.17	2.14
8/14 - 8/20	28.36	52.29	4.78	7.14
8/21 - 8/27	24.32	38.57	7.27	0.43
8/28 - 9/3	10.33	3.00	3.34	2.86
9/4 - 9/10	10.80	3.86	3.27	2.29
9/11 - 9/17	11.81	11.43	4.08	4.89
9/18 - 9/24	12.09	4.86	2.08	2.56
9/25 - 10/1	12.36	5.14	1.52	.86
10/2 - 10/7	4.68	1.71	0.28	0.43
10/8 - 10/15	1.26	N/A	0.19	N/A

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1 Source: University of Maryland Cooperative Extension Service Blacklight Trap Report, 1986.

2 The Lower Central Region was chosen for comparison due to a closer correlation of data than the Southern Region.

N/A - not available.

Table 16.--Insect Scouting, Tomatoes for Colorado Potato Beetle
Threshhold = 20 adults and/or larvae/10 plants

Date & Plot ID	Adults	Eggs	Newly Hatched	Small Larvae	Large Larvae	Totals	Recommended Action *
6/3/86							
BIOL							
1	1	2	31	123	9	164	Spray
5	--	6	--	--	--	--	--
9	--	2	3	8		11	--
12	1	1	--	--	--	1	--
MAG							
2	--	--	1	3	--	4	--
6	--	5	--	--	--	--	--
8	--	1	20	--	--	20	--
11	--	--	--	--	--	--	--
CON							
3	--	6	31	23	--	54	n/a
4	1	5	--	--	--	--	n/a
7	1	12	92	--	--	92	n/a
10	--	2	--	--	--	--	n/a
6/10/86							
BIOL							
1	--	--	--	1	--	--	--
5	--	--	--	2	--	2	--
9	--	--	--	1	--	1	--
12	--	5	29	--	--	--	--
MAG							
2	--	--	--	11	10	21	spray
6	--	--	--	57	13	70	"
8	--	--	--	23	--	23	"
11	--	--	--	12	--	12	--
CON							
3	--	--	10	--	5	5	n/a
4	--	--	--	--	13	13	n/a
7	--	--	--	7	--	7	n/a
10	--	--	--	19	17	36	n/a

*Sprayed plot one on 6/4/86 with Rotenone, and plots two, six, and eight on 6/11/86 with Rotenone.

Table 17 --Insect Scouting, Sweet Corn, for European Corn Borer[1]
(Survey: 10 consectutive plants in two rows in each plot)

Date	Plot ID	Plants with apparent damage	Small Larvae	Large Larvae	Action Needed*
6/24	BIOL/A1	5	--	--	none
	BIOL/A5	6	--	--	none
	BIOL/A9	3	1	--	none
	BIOL/A12	4	--	--	none
	MAG/A2	17	4	--	none
	MAG/A6	16	1	--	none
	MAG/A8	8	--	--	none
	MAG/A11	8	--	--	none
	CON/A3	7	1	--	none
	CON/A4	14	1	--	none
	CON/A7	7	--	--	none
	CON/A10	21	--	--	none

*Decision process: if less than 10% of the leaf area is affected = light damage.
1 Crop Stage = Plants were beginning to tassel.
2 1985 "Commercial Vegetable Production Recommendations", Cooperative Extension Service, University of Maryland Extension Bulletin 236 (revised), January, 1985.

Table 18--Common and Scientific Names of Insect Pests And Their Host Crops, 1986

Common Name	Scientific Name	Host Crop
Colorado Potato Beetle	Leptinotarsa decemlineata	Tomato
European Corn Borer	Heliothus zea	Corn
Japanese Beetle	Popillia japonica	Corn, et.al.
Corn Root Worm/ and Spotted Cucumber Beetle	Diabrotica Undecimpunteta Howurdi	Muskmelon, et.al.
Striped Cucumber Beetle	Acalymma vittata	Muskmelon

Table 19 -- Common and Scientific Names of Common Weeds, 1986

Common Name	Scientific Name
Bermuda Grass	Cynondon dactylon
Crab Grass	Digitaria Sanguinalis
Dodder	Cuscuta Pentagona
Lamb's Quarters	Chenopodium album
Morning Glory	Ipomoea spp.
Nightshade	Solanum carolinense
Pigweed	Amaranthus retroflexus
Plantain	Plantago spp.
Queen Anne's Lace	Daucus carota L. Subsp. carota
Smart weed	Polygonum pensylvanicum
Trumpet vine	Campsis radicans
Witch Grass	Panicum dichotomiflorum

FIGURES

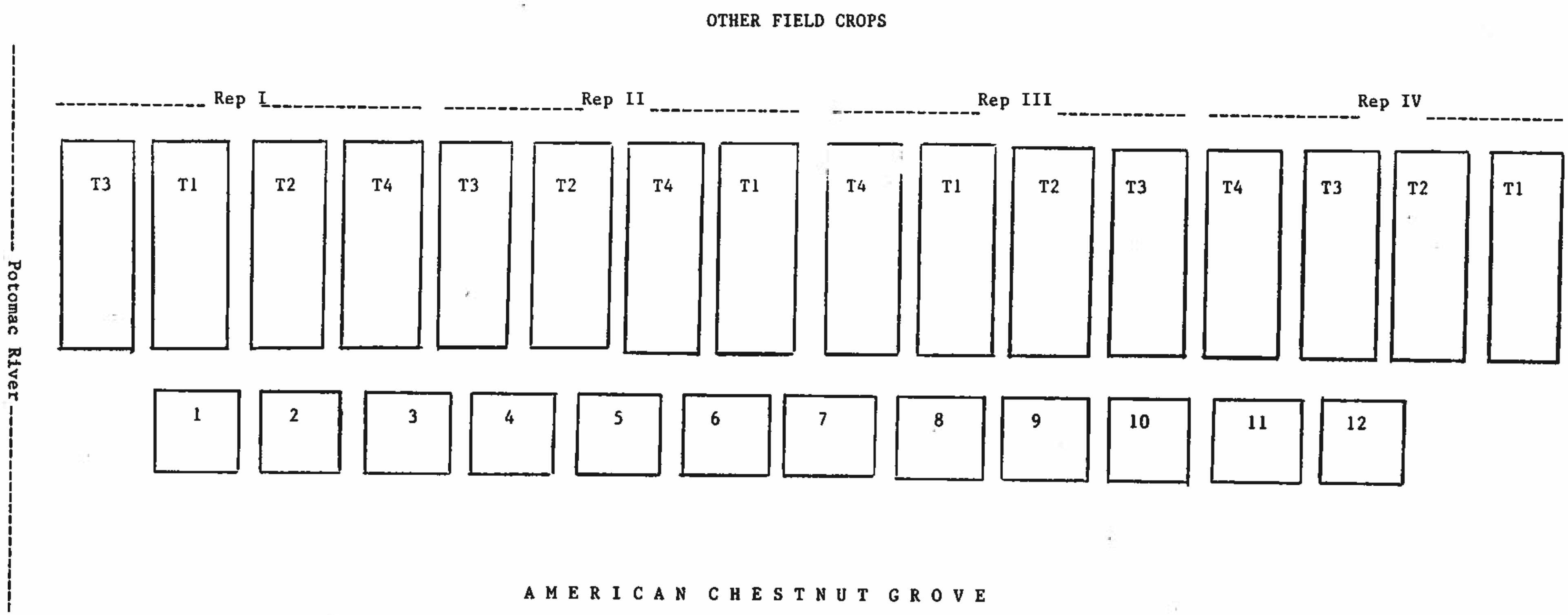
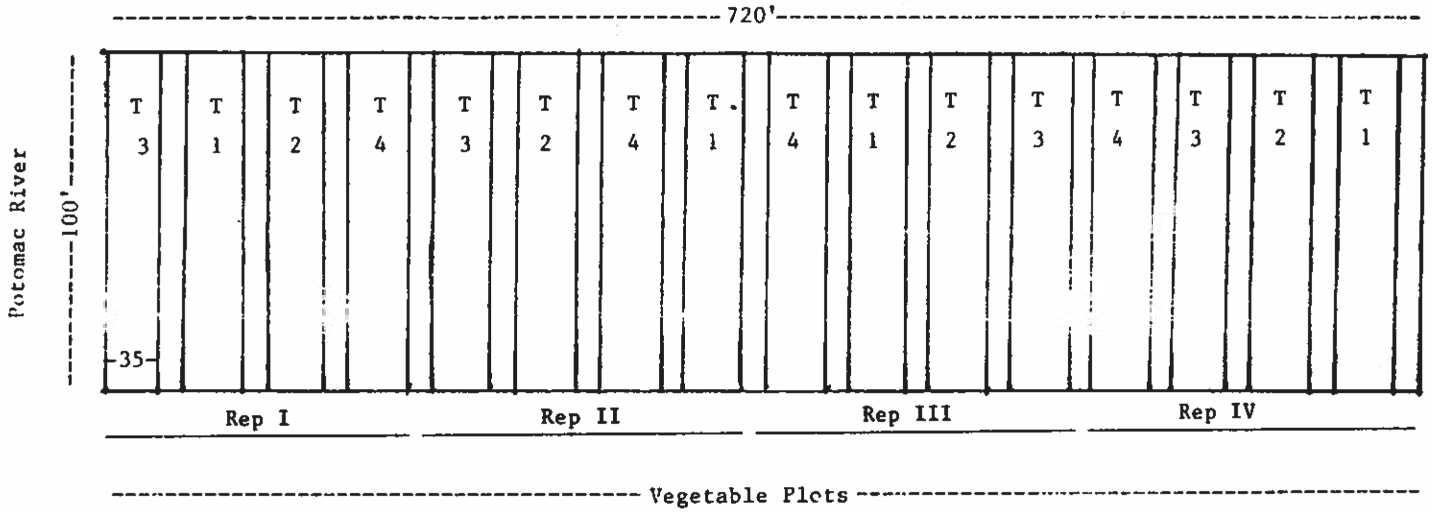


Figure 1. -- Comparative Agriculture Research Project, 1986
Agronomic and Vegetable Plots Layout

Figure 2.--Comparative Agriculture, 1986

Agronomic Plots Layout



Agronomic Crop Rotation Schedule

	1985	1986	1987	1988	1989	1990	1991	1992
T1	FSB	NC	W DSB	NC	W DCB	NC	W DSB	NC
T2	FSB L	TC	W DSB	L TC	W DSB	L TC	W DSB	L TC
T3	M	TC	CC FSB	L TC	W M	TC	CC FSB	L TC
T4	TC	TC	TC	TC	TC	TC	TC	TC

FSB= full season soybeans. NC = no-till corn. W = winter wheat. DSB = double crop soybeans.
L = winter legume. TC = tilled corn. M = meadow/green manure. CC = rye cover crop.

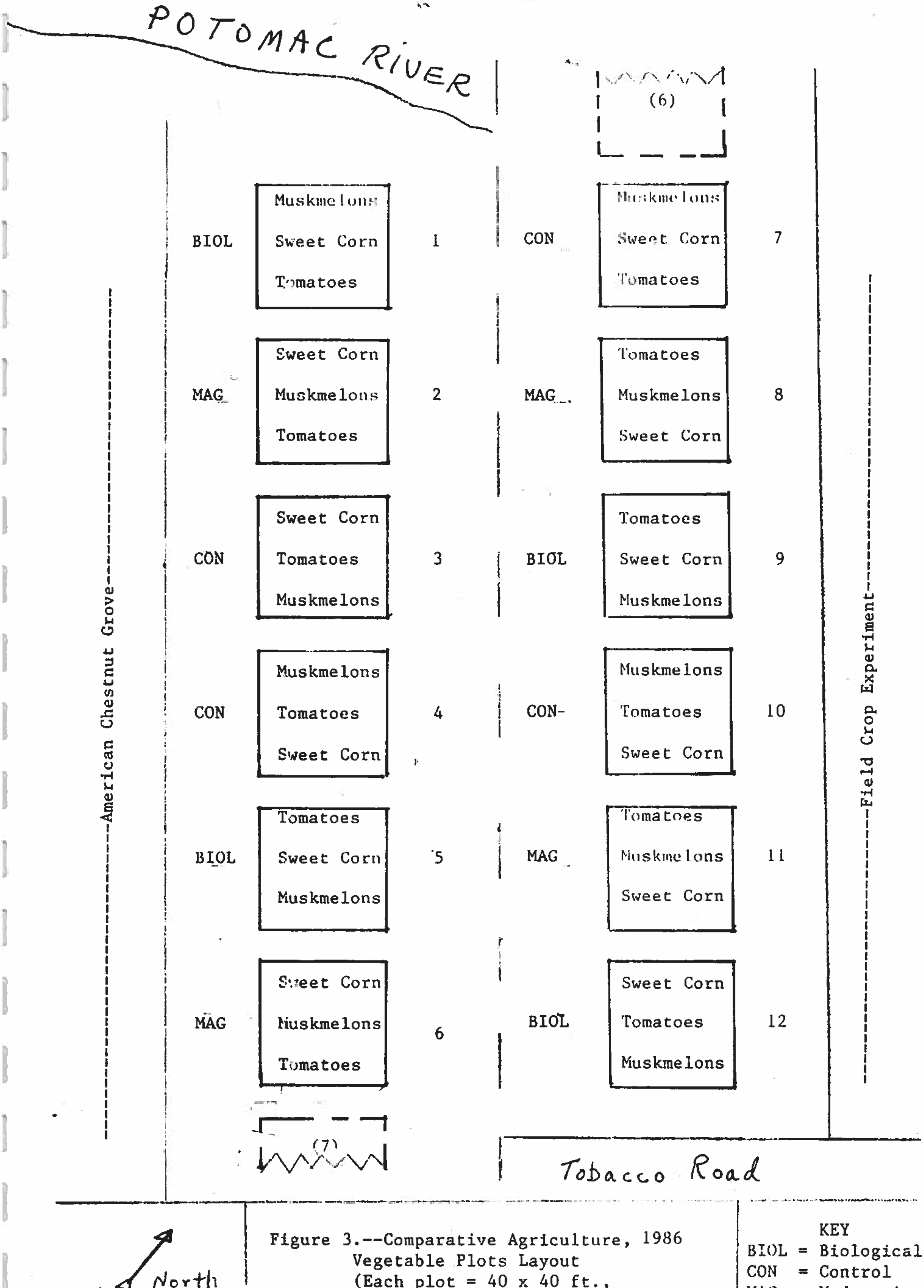


Figure 3.--Comparative Agriculture, 1986
Vegetable Plots Layout
(Each plot = 40 x 40 ft.,
with 10 ft. alleyways)

KEY
BIOL = Biological
CON = Control
MAG = Modern Agriculture

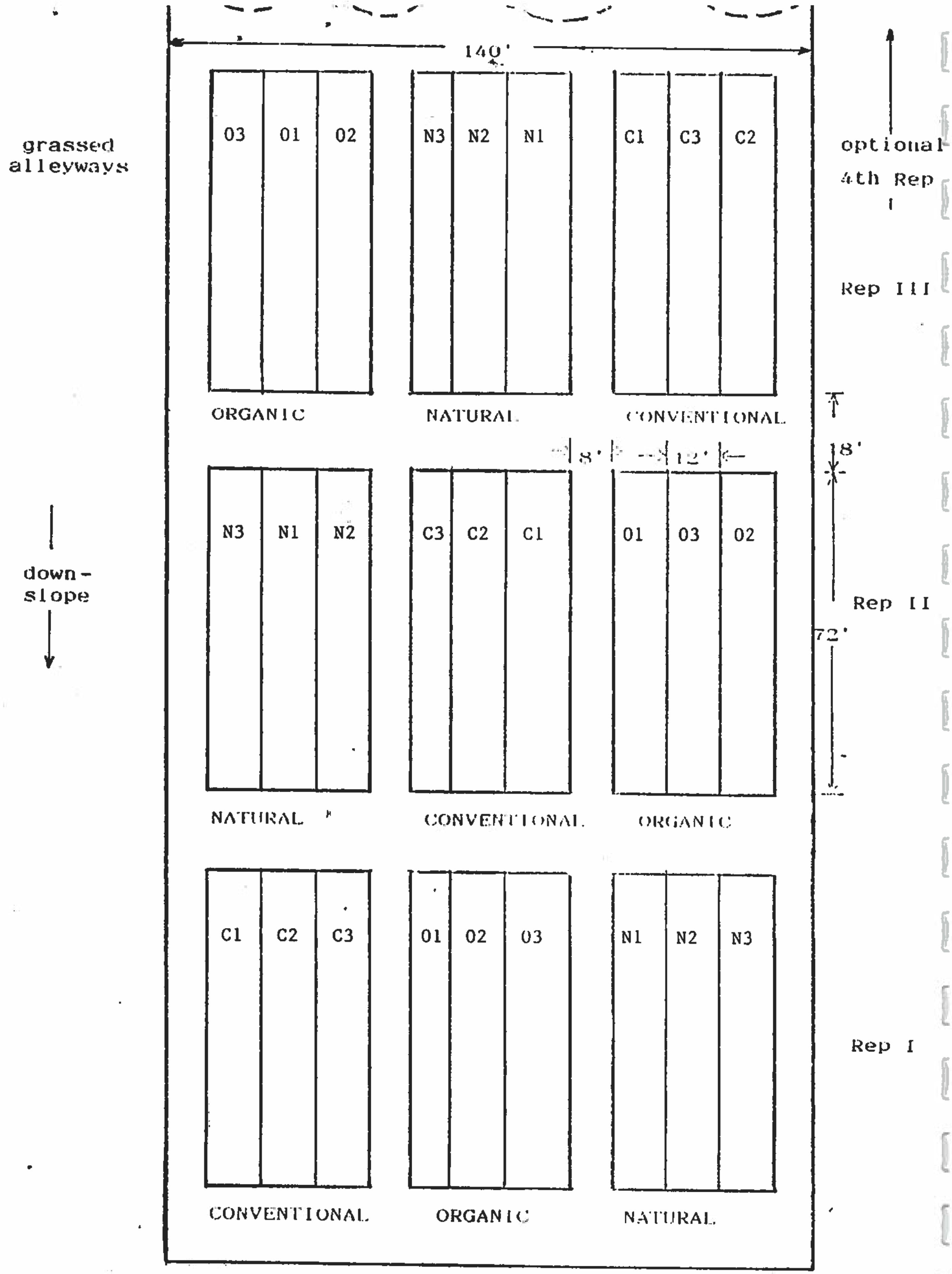
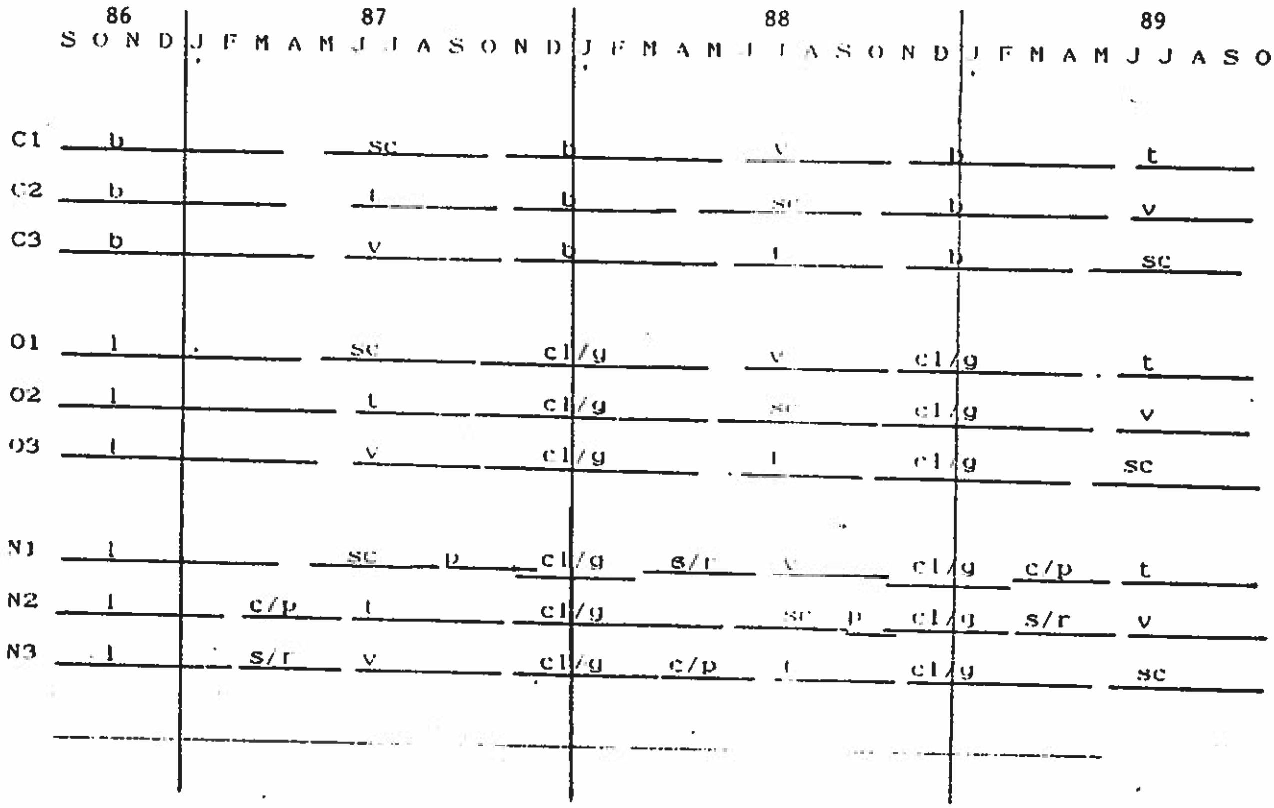


Figure 4 - Field Plan for Horticultural Experiment on Elkton Soil

Figure 5

Preliminary Cropping System Plan
for the Horticulture Experiment
of the Comparative Agriculture Project



Key to Crop Symbols

b = bare ground
c = carrots
cl = clover or vetch
g = grain (rye or barley cover crop)
l = legume such as vetch or winterpea
p = peas (English or snow)

r = radish
s = spinach or similar greens
sc = sweetcorn
t = tomato
v = vine (cantalope or sweetpot.)

C = conventional system, O = organic system, N = natural system

FOOTNOTES

1 Klein, M.A., "Comparative Agriculture Research Report, Initial Year, 1985", p.2.

2 Weil, Ray, letter of October 16, 1984.

3 Ng, Timothy, Ph.D., U. of Maryland, Vegetable Breeding Expert, direct communication, July 10, 1986.

4 McClurg, Charles, Ph.D., U. of Maryland, Vegetable Extension Specialist, direct communication, June 10, 1986.

5 Weil, Ray, Ph.D., U. of Maryland, Soil Microbiologist, direct communication, June 13, 1986.

6 Climatography of the United States, No. 81 (by State) Monthly Normals of Temperature, Precipitation and Heating and Cooling Degree Days, 1951-80, "Maryland and District of Columbia".

7 Blacklight Trap Report, Cooperative Extension Service, U. of Maryland, Report #4, 6/27/86.

8 Integrated Pest Management Newsletter, Cooperative Extension Service, U. of Maryland, #11, 7/31/86.

9 Ibid. #5, 6/6/86.

10 McClurg, Charles, op. cit.

11 Weil, Ray, "Comparative Agriculture Project Consultation on Horticulture Experiment," August 15, 1986, p. 3.

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