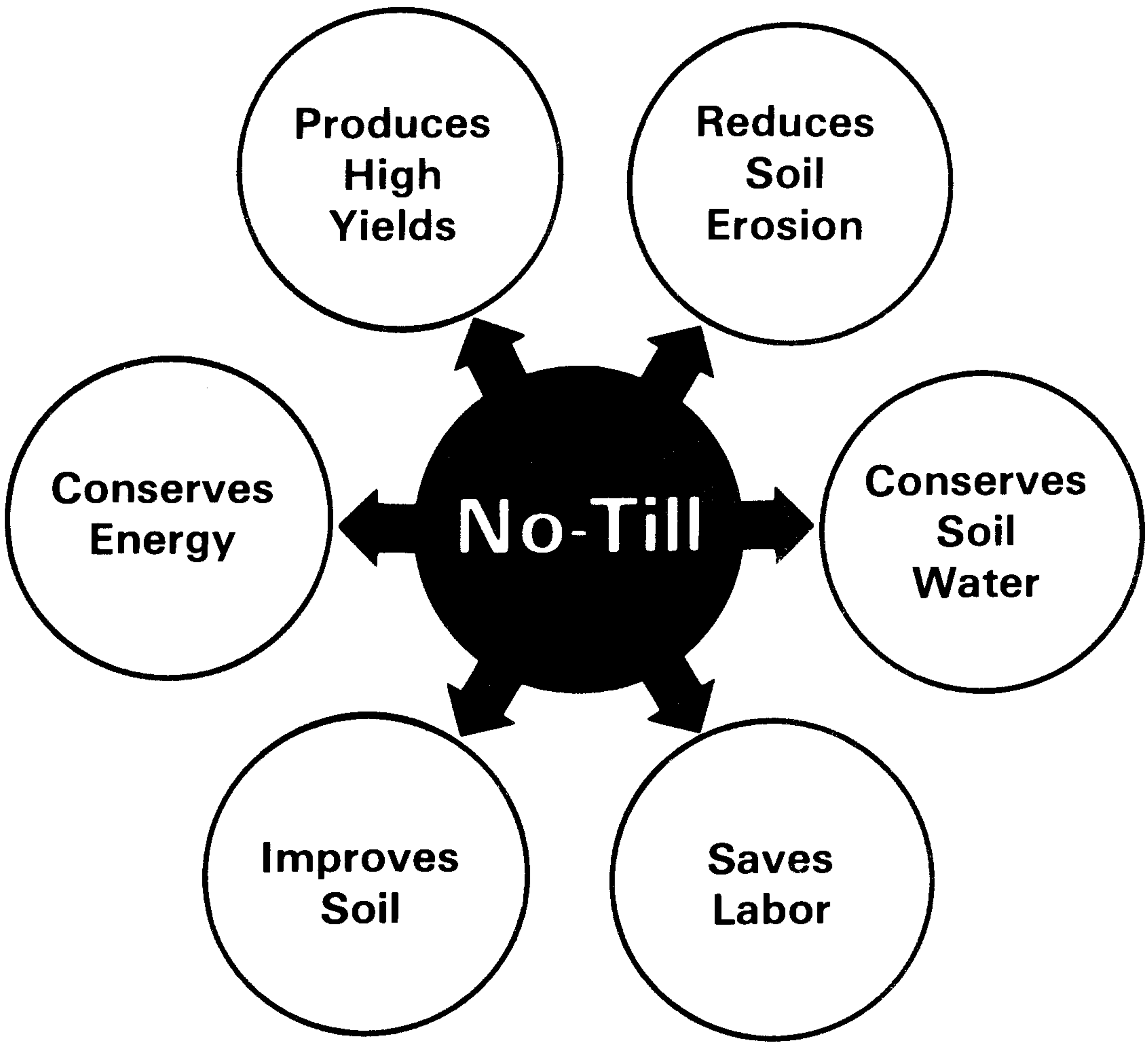
Proceedings of the Sixth Annual Southeastern No-Till Systems Conference

University of Tennessee
Institute of Agriculture

Edited by John Jared, Fred Tompkins, and Randy Miles



Milan, Tennessee
July 21, 1983

SIXTH ANNUAL SOUTHEASTERN NO-TILL SYSTEMS CONFERENCE

SPONSORED BY

The University of Tennessee
Institute of Agriculture

IN COOPERATION WITH

Land-Grant Universities in Alabama, Florida, Georgia,
Kentucky, North Carolina and South Carolina

And

The Soil Conservation Service,
U. S. Department of Agriculture

Chevron Chemical Company also made significant contributions to the Conference. This support has been most helpful and is greatly appreciated.

ACKNOWLEDGEMENT

The Sixth Annual Southeastern No–Ti11 Systems Conference gratefully acknowledgesthelate MR. TOM McCUTCHEN for his unsurpassed service and contributions to no–till research and its application. Mr. McCutchen served as Superintendent of the Milan Experiment Station from 1963 until his untimely death on June 3, 1983. Under his leadership, the Milan Station became one of the pioneer research centers in the nation for collecting scientific information on no–till crop production and soil erosion control. In 1982, approximately five thousand people from Tennessee and surrounding states attended the Annual Milan Experiment Station Field Day.

Tom's expertise and enthusiasm in no-till work were widely recognized and appreciated. He authored numerous articles and publications, presented research papers at professional meetings and regularly prepared timely articles for popular farm publications. In addition, he was very instrumental in forming and promoting the West Tennessee No–Till Association.

Much of the success of this year's conference must be attributed to Tom's aspiring efforts and dedicated spirit as he pursued the goal of successful no-ti1l farming.

CONTENTS

Page

WELCOME.. 1

CONSERVATION TILLAGE: A NATIONAL VIEWPOINT........................ 2

THE STATUS OF NO-TILL IN THE SOUTHEAST

ALABAMA.. 6

FLORIDA.. 8

GEORGIA.. 10

KENTUCKY.. 12

NORTH CAROLINA.. 16

SOUTH CAROLINA.. 19

TENNESSEE.. 21

NO-TILL WEED PROBLEMS AND CHALLENGES IN THE LOWER SOUTH............. 23

NO-TILL WEED PROBLEMS AND CHALLENGES IN THE UPPER SOUTH............. 26

FERTILIZER AND LIME PROBLEMS IN THE LOWER SOUTH.................... 30

FERTILIZER AND LIME PROBLEMS IN UPPER SOUTH........................ 34

DISEASE AND NEMATODE PROBLEMS IN NO-TILL SOYBEANS................... 38

MULCHES. COVER CROPS. CROP RESIDUES. N-FIXING LEGUMES. ETC.......... 43

INNOVATIONS IN NO-TILL PLANTING AND SPRAYING EQUIPMENT.............. 47

NO-TILL FORAGE CROPS.. 51

CONSERVATION CROPPING SYSTEMS FOR PRODUCTION AND SOIL EROSION
CONTROL IN THE SOUTH.. 56

NO-TILL WORKS ON THE FARM.. 62

NO-TILL: IT WORKS ON THE FARM...................................... 64

NO-TILL OF THE FUTURE.. 66

RESEARCH PRESENTED DURING MILAN NO-TILL FIELD DAY.................. 71

CONFERENCE COMMITTEES.. 73

WELCOME TO THE SIXTH ANNUAL SOUTHEASTERN NO-TILL SYSTEMS CONFERENCE

Joseph E. Johnson

It is a real pleasure for me to have this opportunity to welcome farmers, professional agricultural workers, and friends to the Sixth Annual Southeastern No-Till Systems Conference, to Tennessee, and especially to Milan.

Milan is the location of the Milan Experiment Station, the Milan Arsenal, and the parental home of Dr. Andy Holt, former President of the University of Tennessee having retired in 1969.

The Milan Experiment Station and the Buford Ellington 4-H Training Center were a part of the Milan Arsenal. They were established by The University of Tennessee in 1963.

A large amount of the Experiment Station's no-till research has been conducted at the Milan Experiment Station under the direction of the late Tom McCutchen, Superintendent of the Milan Experiment Station. As you saw yesterday on the tours of the field research, a tremendous number of experiments dealing with no-till and conventional crop production methods have been developed by the Experiment Station faculty and implemented at the Milan Station. Mr. McCutchen also provided leadership and motivation for no-till crop production throughout Tennessee.

The University of Tennessee Agricultural Experiment Station has nine locations off campus where agronomic research is conducted with four of those being in West Tennessee – Ames Plantation, Grand Junction; West Tennessee Experiment Station, Jackson; Martin Experiment Station, Martin; and Milan Experiment Station here in Milan. This network of research centers provides an opportunity for field testing under different soil and climatic conditions to serve agriculture here in Tennessee. The College of Agriculture, The Agricultural Experiment Station and The Agricultural Extension Service are very important segments of The University of Tennessee, the Land-Grant University. Our total job is to teach students, conduct research, and then provide research information to farmers, consumers, and the general public.

The concern for efficient crop production and soil and water conservation has been shared by the Soil Conservation Service, Tennessee Valley Authority and other agencies as well as county, state and federal governments and local organizations. Last year the West Tennessee No-Till Association was formed to promote the adoption of no-till crop production.

Finally, let me formally welcome you to Tennessee, to Milan, one of the many locations in the state where The University of Tennessee is providing services to the public. We are delighted you are here and we know that there are many interesting and informative topics which will be discussed here today, and thank you for inviting me to play this traditional role on your program.

Joseph E. Johnson is Executive Vice President and Vice President for Development, The University of Tennessee, Knoxville, Tennessee.

CONSERVATION TILLAGE: A NATIONAL VIEWPOINT

PETER C. MYERS

Conservation tillage is a key feature of the National Conservation Program, a fresh approach to the U.S. Department of Agriculture's conservation assistance programs that President Reagan sent to Congress last December.

It is is the spotlight as an important part of today's farming systems for several reasons.

First, it is one of the most cost-effective conservation ideas. The current financial plight of many farmers does not leave room for the installation of expensive conservation practices. Whatever the virtues of soil conservation, we are not going to be able to sell farmers on the basis of resource protection alone. At least some of the conservation alternatives we recommend have got to be cost-effective, and they must include reliable data on costs and benefits.

To help obtain this kind of information, the Soil Conservation Service has contracted with the University of Illinois to develop a computer program to show farmers the relative cost or savings--and the amount of soil saved--through the use of various conservation practices, singly and in combination. The program is called SOILEC. When it is completed in the fall of 1983, we will be able to furnish farmers with schematic diagrams on the costs and benefits of alternative practices. For most soils, SOILEC printouts will show savings in dollars and soil for the farmer who substitutes conservation tillage for conventional tillage.

Second, conservation tillage is already popular with farmers and becoming more widely accepted every cropping season. Just how fast it is growing in use is subject to some disagreement. I travel over much of the country and talk with thousands of farmers, and I see first-hand that reduced tillage, ridge tillage, no-till, and all the rest are increasing fast. No-Till Farmer estimates that 100 million acres were under some form of conservation tillage last year and that 1983's conservation tillage acreage will be up by more than 10 percent. The Farm Journal sets the 1983 figure at nearly 97 million acres--not enough difference to quibble about. The important thing is that conservation tillage in all its variations is expanding fast because it is cost-effective and because, with proper management, it works.

There also is persuasive evidence that once farmers have tried conservation tillage, they stick with it. A new study of farmer attitudes in 15 States conducted by Pioneer Hi-Bred International found that 96 percent of farmers using conservation tillage are either moderately satisfied or highly satisfied with results. Two-thirds of the farmers cited reduced soil erosion as a reason for satisfaction.

Peter C. Myers is Chief, USDA Soil Conservation Service, Washington, DC.

Third, there are several efforts underway to find out how to adapt conservation tillage to more kinds of soil, more kinds of weeds, and more kinds of farmers. Farmers do need the help of scientific researchers, both public and private, to help them overcome remaining roadblocks to fuller acceptance of conservation tillage. In the spring of 1983, SCS came up with 11 priority needs from the scientific community. The list has been sent to all Federal and State research stations and to many private facilities. Priority need number two called for research to deal with several problems that have been slowing the adoption of Conservation tillage.

Farmers answering the Pioneer survey listed inadequate weed control as their leading reservation about conservation tillage. In particular, farmers need practical, safe, and inexpensive methods to control a number of deep-rooted grasses as well as certain broadleafed weeds that continue to plague us. There are several of these persistent pests in every part of the country, in every climatic zone.

Part of the impetus for further research as well as information and education about conservation tillage comes from the Agriculture and Food Act of 1981. In Title XIV, it called for expanded research to develop more cost-effective and practical conservation technologies, including conservation tillage. In Title XV, it authorized a research program to resolve questions on advantages and disadvantages of conservation tillage compared with other soil conservation practices. It also urged the Secretary to direct the attention of farmers to costs and benefits of conservation tillage for controlling soil erosion and improving profitability. The Act indicated that conservation tillage practices may reduce soil erosion by 50 to 90 percent while also resulting in better yields, greater land use flexibility, decreased fuel, use, decreased labor and equipment costs, increased retention of soil moisture, and more productive land than conventional farming practices.

Not all serious soil erosion will be reduced by conservation tillage, of course. There are problems with it, for example, in parts of the Southern Coastal Plain and in the arid West. Conservation tillage alone is not a universal panacea, and we need to keep looking for other cost-effective farming systems that perform well with conservation tillage. And, on some land being cropped today, there is no satisfactory answer to erosion control except to switch the land out of crops and into grass or trees--permanently.

Fourth, the Department's new Payment-In-Kind Program represents a tremendous opportunity for increasing soil and water conservation on the more than 80 million acres that will be idled for a year or more. The Agricultural Stabilization and Conservation Service estimates that as much as 3 tons of soil per acre could be saved on the diverted cropland through the required conservation management. The plant cover and crop residues also will hold more moisture on the land as well as adding nutrients to the soil. Farmers also are being encouraged to consider improving wildlife habitat.

Another welcome provision of PIK is that eligible land devoted to a permanent vegetative conservation practice can be designated as a conservation use acreage in any future diversion program through 1985--further incentive to seed diverted land to permanent cover, particularly on fragile, erosive soils.

Where the land will be coming back into crop production within a year or two, this is an excellent time for the farmers concerned to consider installing permanent conservation practices on the more erosive acres. Terraces, grassed waterways, windbreaks, and other enduring practices can be installed now without interrupting cash crops. It also is an excellent time for farmers to plan ways to fit no-till or other conservation tillage methods into their operatione.

I am convinced that the single most important element in making a success of conservation tillage is the desire of the farmer to make it work. Problems always arise in switching to any new system. The determined farmer will solve his problems and make conservation tillage fit his operation. PIK and other acreage-reduction programs may give him the chance to figure out how best to do that.

Fifth, we are making determined efforts to help and encourage farmers and to answer their questions about conservation tillage. Renewed emphasis is being given to information and education in this area, not only by SCS soil conservationists but also by Extension people, conservation district leaders, and industry representatives. It is truly a cooperative effort.

Extension has been an excellent conservation partner because of its close ties with State agricultural experiment stations; a dedicated corps of soil and water management specialists; agents in every county who have the truet and confidence of many farers and ranchers; well-established lines of communication through radio, television, newspapers, and other media; and experience in organizing successful meetings, demonstrations, and other educational events.

We in SCS look forward to increasing and strengthening our activities with Extension as well as ASCS in order to reach more land users and other citizens; to motivate them toward natural resource improvements including conservation tillage, and to help them make conservation cost-effective.

Conservation districts and their National Association of Conservation Districts deserve a great deal of credit for leadership in promoting conservation tillage, and particularly for helping create the Conservation Tillage Information Center, in cooperation with the agribusiness community and USDA. The Center is gathering and spreading information that will encourage a better Understanding and more effective use of conservation tillage on American farms. A monthly newsletter already is being issued. Other parts of the Center's Information network will include literature and research reviews; a speaker's bureau, demonstration project reviews, a telephone referral service; and liaison with industry, government agencies, universities, organizations, associations, farm groups and individual conservation districts.

Finally, conservation tillage will receive priority attention from the Federal government because it is an excellent way of accomplishing soil and water conservation while holding down the growth of Federal expenditures. We do spend a great deal of money in USDA to support soil and water conservation--about a billion dollars for all programs last year. But, as Secretary Block has said, "There's no way we're going to solve all the conservation problems by buying terraces on all the land that could use terraces, or building structures everywhere that we could build structures, because there isn't that much money in the Federal government or in the States.

"The real solution to erosion is going to be provided by the farmer-on his land. He's going to do it once he becomes fully convinced that conservation tillage and other improved tillage techniques are in his best interest. It will be in his interest because it keeps his land in place for his children. Or because if he wants to sell the land it's going to sell for more. Or because he can make more money by using conservation tillage."

It has been estimated that it would cost USDA some $21 billion just to cost-share the construction of terraces on all the "problem" acres--about $150 for each of the 140 million acres that erodes at a rate of more than 5 tons an acre each year.

We still need terraces, and many other practices as well, based on the conditions and opportunities on each parcel of land. But conservation tillage can either do the same job for less or it can enhance the usefulness or effective life of these other practices when combined with them.

The need to curtail Federal spending remains urgent. The national debt, the result of accumulated Federal deficits, has passed the $1 trillion mark. That represents almost $5,000 for each man, woman, and child in the United States. By mortgaging our future in this way, we are narrowing our options for the future.

The steadily increasing use of conservation tillage by farmers who voluntarily want to improve their natural resources and protect their land's productivity can help us all meet economic and environmental aims at the same time.

NO-TILL CROP PRODUCTION IN ALABAMA

TED WHITWELL

Acreage of no-till planted crops has increased over the past five years in Alabama. Corn is the only major crop that the no-till acreage has declined Table 1). Soybeans and sorghum has had the largest increase in no-till acreage. Cotton and peanut no-till acreage is still very small.

Table 1 No-Ti11 Acres For Alabama In 1977-1982

Crop	1977 Total Acres	1977 No-Till Acres	1982 Total Acres	1982 No-Till Acres
Soybeans	1,600,000	43,000	2,100,000	285,200
Corn	840,000	55,000	530,000	45,000
Sorghum	75,000	3,000	100,000	30,300
Cotton	395,000	800	285,000	3,400
Peanuts	215,000	0	222,000	1,100

Future increases in no-till acreage will be slowed in the next year if the government Payment In Kind program continues. Less wheat will be planted thereby limiting the successful doublecropping system of soybeans or grain sorghum after wheat harvest. However, awareness of soil conservation and seeking higher production efficiency will spur more producers to try a no-till crop production system. Failures in stand establishment and weed control are still too common. Cover crop management becomes extremely important in crops such as cotton.

In the coastal plain region of Alabama, no-till crops have been more successful using an in-row subsoiler at or prior to planting. In other areas standard no-till planters are used without the in-row subsoiler. In corn, paraquat plus atrazine are used to kill green vegetation and Lasso or Dual are added for annual grass control. Mulch for corn usually consist of rye-vetch or old crop residue. Fertilizer is normally broadcast applied prior to planting with additional nitrogen applied as a sidedressing. No-till sorghum productions practices are similar to those for corn.

No-till soybeans are either planted after wheat harvest or into crop residue from last year. Herbicides used would include paraquat plus a broadleaf herbicide (ex.-Sencor) for better control of green vegetation. Grass herbicides such as Lasso or Dual may be added for annual grass control. Fertilizers are applied to the wheat in the fall or broadcast in the crop residue.

No-till cotton production system include a legume cover crop (vetch or clover) which should be killed two weeks prior to planting with paraquat. Herbicides used for residual weed control are Cotoran plus Prowl. Fertilizers are applied broadcast with no nitrogen used. Peanuts are planted no-till into rye or crop residue. Paraquat plus Lasso will be used for vegetation control and grass control. Cracking and postemergence herbicides are used for additional weed control.

Ted Whitwell is Weed Scientist for Auburn University, located in North Alabama

New practices being employed by producers are strip killing clovers along the corn row for reseeding of the clover in the middles. Starter fertilizers are also being used in corn and grain sorghum. Killing of cover crops early before planting gives an advantage when planting no-till cotton.

Research at Auburn University has investigated starter fertilizer type and placement in cotton, corn and soybeans. Production systems for no-till cotton is also being determined by evaluating cover crops, cotton varieties, planting methods, nitrogen requirements and weed control. Nitrogen management for cotton grown in legume cover crop mulch is also being determined. Effects of tillage on wheat production and production systems for no-till peanuts are also being investigated.

NO-TILLAGE REPORT FROM FLORIDA

D. L. WRIGHT

INTRODUCTION

No tillage or minimum tillage production of crops has become an excepted practice with many growers in Florida. Deep tillage or in row subsoiling has long been known to result in increased crop yields in the Southeast Coastal Plain. Most of the no-till planters that were on the market early, only opened up a slot for the seed and did no additional tillage. Since it was known that deep tillage was necessary for optimum yields in the Southeast, no-tillage was slow to be introduced. In the period around 1976 to 1977 a no-till planter plus in row subsoiler was developed for use in no-tillage conditions. This planter resulted in yields similar to what could be expected with deep tillage planting under conventional conditions. At that time only fifteen to twenty thousand acres of wheat were being grown in Florida to be doublecropped with. However, as much as 200,000 acres of rye was being grown for grazing. This opened up opportunities in Florida for no-till planting. In many cases, wheat was followed with row crops while rye had either row crops or summer pasture following it. No more than 2,000 to 5,000 acres were used as no-till mulch. By 1982, with the introduction of adapted wheat varieties, approximately 155,000 acres of land was planted to wheat for grain. Another 250,000 acres were planted to either oats or rye for grazing. This led to the use of more no-till planting. Improved no-till equipment with in row subsoiling resulted in an increased acreage planted no-till. About 300,000 acres are now in conservation tillage in Florida.

In Florida, corn, soybeans, and grain sorghum were planted into small grain stubble or grazed winter pasture. These cover crops could be killed with an application of Paraquat at planting time. Rye was often more difficult to kill than wheat with one Paraquat application early in the season. Therefore split applications of Paraquat at lower rates have often been used successfully since that time. Soybeans are normally planted after wheat or other small grains are harvested. The grain crops generally are not competitive with the soybeans. However, weeds are often emerging and must be killed with Paraquat or Roundup or other suitable material. Recent data has shown that use of legumes such as crimson clover and vetch make excellent cover crops to plant corn or grain sorghum into. Besides providing protection from water and wind, these legumes provide nitrogen for the following grain crop. Corn planted early in the season (late February or early March) will need an additional 100 pounds of nitrogen after the corn reaches about knee high. Grain sorghum may be grown in legumes under dryland conditions without any additional nitrogen. Killing legumes early in the season is often not an easy task with Paraquat alone. Best results with crimson clover has been to apply a mixture of 112 pint/A Banvel with 1 pint/A of Paraquat plus surfactant or Paraquat with Atrazine about 10 days before planting followed by a pint of Paraquat plus

D. L. Wright is Extension Agronomist, University of Florida, Agricultural Research and Education Center, Quincy, Florida.

surfactant immediately after planting if necessary. However, an application of Paraquat plus Banvel just prior to planting or immediately after planting or Paraquat plus Atrazine gives adequate kill on crimson clover. The vetches may be killed with 2, 4-D, Banvel, Paraquat and other herbicides in a single application. Weed control from vetch residue has not been as good as with crimson clover residue.

Most of the herbicides used on corn such as Lasso, Aatrex and Dual are applied after emergence. This allows longer season control of weeds than if herbicides were put down at planting. Grain sorghum often needs Lasso or other grass type materials put down at planting since it is planted during a warmer season and grasses are emerging more readily. Herbicides are normally applied immediately after planting in no-till conditions with soybeans.

Fertilizers are either banded near the row or put down below the row on a subsoiler shank to prevent injury to the seedling but yet to get a "pop-up" affect from the fertilizer. Broadcasting fertilizers under no-till conditions generally increases weed pressures and results in about a weeks delay in maturity of corn and grain sorghum.

Several other crops not normally considered for no-till production have been researched to a limited extent. Peanuts have been planted no-till immediately after wheat harvest. Yields have been very similar to peanuts planted under conventional conditions. However, weed control is one of the main problems. New "over the top" herbicides are making no-till peanuts more practical.

Other crops plantedno-till include wheat and other small grains immediately behind soybean harvest. Where soybeans were subsoiled, little yield difference may be noted between wheat planted under conventional conditions and no-till wheat. However, the root system of wheat is more restricted in the compacted surface layer where a tillage operation is not done. This may lead to lower yields in dry years. Wheat has also been planted into bermudagrass in the late fall resulting in 50-60 bushels of grain per acre. Much work still needs to be done in these areas to perfect the management necessary for high yields.

Research emphasis in Florida has been in trying to minimize production costs. This includes row placement of fertilizers under no-till conditions including anhydrous ammonia. Use of legumes for nitrogen fixation for such crops as corn and grain sorghum and possibly wheat, and also in the areas of overseeding permanent pastures with a grain crop such as wheat. Additional research still needs to be done on planting dates and crops that may be successful. Previous crop residue has been shown to delay maturity and harvest unless the planting date is moved up.

Cooperative research is being conducted between several southeast states along with no-till meetings and conferences that has spread the advancement of knowledge on management practices to growers. It is expected that in the next ten years, that over 50% of the row crop acreage in Florida will be planted under no-till conditions.

NO-TILLAGE CROP PRODUCTION IN GEORGIA

W.L. HARGROVE and J.E. HELM

No-tillage crop production has escalated in Georgia from 26,000 acres in 1973 to 405,000 acres in 1982. However, it is still a relatively small fraction (10 to 15%) of the total acreage of corn, soybeans, and grain sorghum produced in Georgia. The no-till acreage for corn, soybeans, and grain sorghum has increased substantially over the past ten years (Table 1). No-till soybeans dramatically increased from 11,000 acres in 1973 to 320,000 acres in 1982. The large increase in no-till soybeans in the past five years is directly related to a large increase in the small grain acreage and to the successful adoption of doublecropping practices. The trend towards increased no-till soybeans will likely continue as long as there is a significant acreage of small grains. If suitable markets are developed, no-till grain sorghum will probably increase since it can also be double-cropped with small grains. No-till corn production probably will not increase significantly over the next few years.

The no-tillage system that is currently most popular in Georgia is the wheat-soybean doublecrop system. Generally, fall tillage is completed before establishing the wheat, but soybeans are planted without tillage following wheat harvest. In much of the Coastal Plain region of Georgia the soybeans would be planted with in-row subsoiling. In the Piedmont and Mountain regions of the state a fluted coulter planter is generally used. With doublecropping systems, lime as well as P and K fertilizers are commonly broadcast-applied in the fall for both crops.

Other no-tillage production systems currently in use include corn or soybeans planted in killed rye, and grain sorghum double-cropped with small grains. However, the acreage of these systems is small compared to the wheat-soybean system.

New practices in no-tillage production include no-till cotton production and no-till peanut production. However, these are limited to a few growers in the state. Additional research on no-tillage production of these crops is needed. Another new practice which has received considerable interest from growers is corn or grain sorghum no-till planted into legume cover crops. The most common legume used is crimson clover; however, arrowleaf clover, subterranean clover, hairy vetch, improved common vetches, and lupines are also being used. Research results indicate that a legume cover crop can provide 80 to 100 lbs N/A for a subsequent crop. At the same time, soil erosion can be reduced substantially with these crop/tillage systems.

W.L. Hargrove is Assistant Professor, Agronomy Dept., Georgia Agric. Expt. Stn. Experiment, GA 30212. J.E. Helm is Resource Conservationist, USDA-SCS, Athens, GA 30613.

Research emphasis on no-tillage in Georgia focuses on:

1) The long-term influence of no-tillage on soil properties and crop production.

2) The problem of soil acidity under no-tillage management and its effect on crop production.

3) Nitrogen fertilizer efficiency in no-tillage production.

4) Legume cover crops in no-tillage production systems.

5) Relationships between soil erosion and soil productivity.

6) Pest management and control in no-tillage systems.

Although no-tillage has gained substantial popularity in the past few years, more row-crop acreage in Georgia needs to be in no-tillage production due to excessive soil erosion. Continued research and extension efforts, especially in weed control, should enable the amount of no-till production to continue to increase.

Table 1. GEORGIA NO-TILL ACREAGE CORN, SOYBEANS, AND GRAIN SORGHUM

	Corn	Soybeans	Grain Sorghum	Total No-Tillage	Total Corn, Soybeans, Sorghum
	Acres				Millions of Acres
1973	12,000	11,000	3,000	26,000	-
1974	18,000	22,000	3,000	43,000	-
1975	23,500	42,200	9,300	75,000	3.09
1976	27,310	38,755	9,925	75,990	3.08
1977	25,697	41,371	6,460	73,528	2.11
1978	35,000	85,000	10,000	130,000	3.22
1979	35,000	110,000	6,000	151,000	3.70
1980	53,955	170,293	26,297	250,545	3.52
1981	58,450	215,300	32,200	305,950	3.30
1982	50,000	320,000	35,000	405,000	3.70

Source: USDA-SCS, Athens, Georgia

STATUS OF NO-TILL PLANTING IN KENTUCKY, 1977 AND 1982

K. L. WELLS
EXTENSION SOILS SPECIALIST, UNIVERSITY OF KENTUCKY

NO-TILL ACREAGE ESTIMATES

Until the Kentucky Crop and Livestock Reporting Service (KCLRS) conducted a survey in 1981, there were few reliable data available on no-till acreages in Kentucky. Reports prior to 1981 were based on estimates made by various organizations, and were not always made on the same basis. One reason for variations in no-till acreage estimates has been due to differences in what is defined as "no-till planting". This particularly affects the size of no-till acreage of forages and small grains since grassland renovation by sowing forage legume seeds directly onto undisturbed soil surfaces and aerial seeding of small grains are sometimes included in "acreage of no-tilled crops". Because of this it is somewhat confusing in trying to determine the status of no-till acreage actually planted with the no-till planting technology developed during the 1960's and 1970's which involves use of specially designed planters to open a small slit in soil, drop a seed into it, and press soil around the seed. No-till planters are now widely available for planting corn, soybeans, grain sorghum, and forage species. Acreages reported here for Kentucky are estimates for no-till planting of crops only by use of a no-till planter. Acreages were estimated as follows:

CORN: The 1977 estimate was based on observations and opinions of University of Kentucky agronomists. It was based on increasing the 18.8 percent determined by the KCLRS in 1981 to 20 percent for 1982.

SOYBEANS: The 1977 estimate was based on observations and opinions of University of Kentucky agronomists and the 1982 estimate was based on increasing the 33.5 percent determined by the KCLRS in 1981 to 35 percent €or 1982.

GRAIN SORGHUM: Both 1977 and 1982 estimates are based on observations and opinions of University of Kentucky agronomists that 25 percent of the acreage was no-till planted.

SMALL GRAINS: Both 1977 and 1982 estimates are based on observations and opinions of University of Kentucky Agronomists that none was planted with a no-till drill in 1977 and 5% in 1982.

FORAGES: Both 1977 and 1982 estimates are based on observations and opinions of University of Kentucky Agronomists that there were no more than 60 no-till renovators in Kentucky in 1977 and 100 in 1982, and that each no-till renovator was used on *200* acres.

Table 1. Estimated Acres of Crops Planted in Kentucky with No-Till Planters

Year	Crop (000 acres) Corn	Soybeans	Grain Sorghum	Small Grains	Forages	Total
1977	248	338	10	0	12	608
1982	336	595	12	46	20	1009

TRENDS

By the mid-1970's no-till acreage of corn and soybeans in Kentucky had increased greatly, with an estimated 26 percent of the corn and 30 percent of the beans being no-till planted in 1974. No-till acreage dropped from that point to an estimated low of 10 percent of the corn and 21 percent of the beans in 1978. Agronomists at the University of Kentucky attribute this decline to weed control problems, especially johnsongrass, which had intensified during the previous 6 years of no-till planting. Additionally, the market impetus of the mid-1970's encouraged expansion of corn and beans, most of which was clean cultivated. By 1978 the herbicide Roundup was available and use of it was begun to control johnsongrass. This herbicide was particularly effective in postemergence applications on johnsongrass in beans using wipers or recirculating sprayers. As a result, together with a dramatically increased planting of wheat during the fall of 1980, no-till planting of beans increased to 35 percent of the crop in 1982. No-till corn acreage didn't increase as fast but has more than doubled since 1977, making up 20 percent of the acreage in 1982.

We don't have good statistics for use of no-till planters in seeding other crops. Following introduction of the first commercial model of a no-till pasture drill in the mid-l970's, there has been a slow increase in the number of such planters in Kentucky. We estimate there may have been as many as 60 such planters in 1977 and there may be as many as 100 now. By arbitrarily assuming that each planter would be used on 200 acres per year, we estimate that 12,000 acres of grasslands were renovated by use of no-till planters in 1977, and that 20,000 acres were renovated with no-till planters in 1982.

Since it's doubtful there were any no-till small grain drills in the state in 1977, we concluded no small grains were seeded with a no-till drill then. However, since 1977 there has been considerable interest in no-till grain drills and there are several around now. We've estimated that 5 percent of the small grain acreage was planted with no-till drills in the fall of 1981, but that's probably too high.

We don't have much basis for estimating acres of grain sorghum planted with no-till planters, so we arhitrarily estimated 25 percent for 1977 and 1982, which may be too low.

NO-TILL PRACTICES IN KENTUCKY

CORN: The most obvious change in practice which has taken place with no-till corn is the type of residue into which planting is done. Since much of the grassland acreage suitable for no-till corn has been used, about the only sod available for no-till planting now, is that which is in rotation with red clover and alfalfa. Most no-till corn in Kentucky is now being planted into residues from the previous year's crop... usually corn or soybeans...or into a winter cover crop, mostly wheat with lesser acreages of rye. Use of winter annual legumes for no-till cover currently is minimal, and since planting of corn will usually be delayed in order to get enough legume growth to fix substantial amounts of nitrogen, it's unlikely that this will become a major practice unless it is used on those soils on which delayed planting is a usual occurrence.

Paraquat is still by far the dominant contact herbicide used, although farmers are slowly becoming more sophisticated in deciding on what residual herbicides to use. Even though atrazine is still probably the dominant residual herbicide used, mixtures with other herbicides to provide broader spectrum control is more widespread now than 1977.

Nearly all fertilizer continues to be broadcast onto the soil surface, although high fertilizer prices have prompted some corn growers to go back to banded fertilizer since rates of needed phosphate and potash can be reduced by banding. Delayed application (4-8 weeks after planting) of part or all nitrogen with ground-driven equipment is now a common practice. Row application of insecticides is still a common practice, but probably not to the extent it was 2 or 3 years ago. With the stress prices received for corn during the past few years, soil insecticide use has been one major area where growers have cut back on expenses. With the second generation of commercial no-till corn planters now widely available, it appears in Kentucky that most no-till corn growers have settled on planters with a double-disk furrow opener running behind a coulter which now is more commonly a ripple coulter rather than a fluted coulter. Lack of good seed coverage continues as a problem for many growers. Although there is currently a variety of covering mechanisms in use, it would appear there is a trend toward use of either small covering disks running just in front of wide packer wheels or use of dual small diameter packer wheels which "squeeze" the seed slit closed.

SOYBEANS: No-till soybeans are nearly all double-cropped with wheat and to a lesser extent barley. They are seeded directly into small grain stubble using paraquat as the dominant contact herbicide, mixed with various other residual herbicides chosen for target weeds. Postemergence application of Roundup with a wiper has become a common practice to kill johnsongrass. Planting no-till beans normally involves use of double-disk openers running behind 1 or 2 coulters.

Although there is much interest in thc newly developed multi-crop no-till drills which would make narrow-row planting of no-till beans easier, most no-till beans are still planted in Kentucky with the standard no-till planters, with the units being narrowed down to 20-inch or less spacing. Most fertilizer is applied the previous fall at the time small grains are seeded, although some growers continue to make band applications when planting beans.

FORAGES: Commercial development of no-till planters capable of planting small-seeded forage species into an undisturbed seedbed during the latter half of the 1970's and continuing to the present, has made seeding of forage legumes directly into an undisturbed sod a reality. This is a growing practice in Kentucky at the current time, but represents only a small fraction of total grassland renovation. We estimate that about half the acreage renovated with no-till drills is not treated with a contact herbicide, while about half is treated...either totally or in narrow strips centered over each furrow...with a contact herbicide, dominately paraquat.

NEW PRACTICES IN NO-TILL

Since the original technical components became available in the late 1960's to make no-till planting of corn and beans practically feasible, few changes in that technology have developed which have resulted in new practices for no-till. Most changes which have taken place represent a fine-tuning of the original major technical components designed for the practice rather than changes in components. Several of the "fine-tuning" changes, however, are noteworthy. Much more attention is now given to the surface pH of no-till corn since research during the 1970's showed this to be so important on residual activity of the triazine herbicides. The practice of delayed nitrogen applications has also become commonplace. The labelling of Roundup in the late 1970's was a major breakthrough for johnsongrass control in no-till beans and postemergence applications of Roundup, mostly with wipers, has become a common practice. A wider selection of herbicides for use on target weeds has made use of multi-component herbicide mixtures a common practice. No-till planting has also made a major contribution to erosion control and has added more flexibility in developing more profitable cropping systems.

NO-TILL RESEARCH IN KENTUCKY

Major research emphasis on no-till at the University of Kentucky is concentrated in the areas of herbicides and weed control programs, insecticides and insect control, seed vigor, soil moisture and temperature relationships, fertilizer efficiency, cover crops, and use of the practice in developing more profitable cropping systems.

NO-TILLAGE IN NORTH CAROLINA

W. M. LEWIS

No-Till Acreage in North Carolina

Crop	1977	1982
	--- Acres ---	
Corn	140,000	225,000
Soybeans	160,000	250,000
Grain sorghum	3,000	5,000
Forages	20	1,000

Prior to the 1982 and 1983 planting seasons, considerable educational effort was undertaken by the extension service, soil conservation service and agri-business interests. There seemed to be an increased awareness of the conservation and labor-saving aspects of no-till and other reduced tillage systems among farmers. Fuel shortages also increased interest in no-till. Most of our no-till soybeans are double-cropped behind small grains, particularly wheat. One of our largest wheat crops was planted in the fall of 1981 culminating a three-fold increase in wheat acreage during the previous five years. Therefore, the acres of no-till soybeans planted in North Carolina directly relate to small grain plantings.

The acreage of no-till corn and probably soybeans will be down in 1983 due to the PIK program. In the Piedmont for 1983, no-till planted acres increased in percent of the total corn acreage planted. The johnsongrass-infested acres which require incorporated herbicides were set-aside. With present technology we expect only slight future increases in no-till corn acreage. No-till double-cropped soybean acreage should continue to increase in the future. A breakthrough such as preemergence or postemergence control of johnsongrass in corn or a vigorous legume cover crop which can be easily and economically established could provide a real boost to no-till corn production.

NO-TILL PRACTICES

General practices for no-till corn production in North Carolina

Planting time: when early morning soil temperature at seeding depth is 50°F
Variety selection: Similar to conventional planted corn
Seeding rate: 10% above that for conventional tillage

W. M. Lewis is Professor, Crop Science Department, North Carolina State University, Raleigh, North Carolina.

Cover crop or residue: Majority of no-till planting in soybean or corn refuse of the previous year. On More sloping land it is planted into wheat or rye mulch.

Row width: 30 to 36-inch rows

Herbicides:

Control of existing vegetation: Paraquat for annual weeds and small grain cover crops. Roundup for control of annual grasses over 3 inches tall, legume cover crops, smartweed and horseweed and slight infestations of perennial weeds. 2,4-D for only broadleaf weeds.

Residual herbicides:

AAtrex + Princep
Lasso + Atrazine or Bladex
Dual + AAtrex

Planters: Fluted, serrated or notched coulter in front of double disk seed opener, ribbed press wheel common, increase in units with wheels firming soil from the side. In-row subsoiling practiced by a few farmers in the Coastal Plains on soils subject to hardpans. Not effective in Piedmont soils.

Fertilizer: Complete fertilizer applied broadcast is most common. Some applied as starter fertilizer in a band or within furrow. Additional nitrogen sidedressed.

Insecticides: Furadan or Counter in the furrow or Lorsban banded.

General practices for no-till soybean production in North Carolina

Planting time: Double cropped as soon as possible after small grain harvest

Variety selection: Medium to late maturing varieties

Row width: 18 to 20 inches

Seeding rate: 5 to 7 seeds per foot of row

Herbicides:

Control of existing vegetation: Paraquat or Roundup

Residual herbicides:

Dual + Lorox or Lexone or Sencor
Lasso + Lorox or Lexone or Sencor
Surflan + Lorox or Lexone or Sencor

Postemergence herbicides: Basagran, Blazer, Poast, and Fusilade

Fertilizer: P and K applied broadcast. If high soil test levels have been maintained in the preceding crops, usually no fertilizer is applied.

NO-TILL RESEARCH EMPHASIS

Weed scientists have gathered considerable evidence that Roundup at 1.5 to 2.0 qt/A has economically increased yields in no-till corn planted into a green small grain cover crop and in soybeans if planted into weeds. Work is currently being done on evaluating lower rates of Roundup with additional surfactant and reduced carrier volume. The allelopathic effects of wheat and rye straw on the germination of broadleaf weed seeds are being examined. Reduced germination of morningglory, prickly sida, pigweed and lambsquarters has been confirmed and

and several phytotoxic chemicals isolated and identified. The contribution of chemicals leaching from mulches and not disturbing the soil with tillage on suppression of certain broadleaf weeds in no-till crops is being closely examined. Weed population shifts are being evaluated in long term herbicide studies under no-till. New experimental herbicides are being evaluated for control of existing vegetation at planting time as well as the role of the new postemergence herbicides applied over-top for annual grass control and johnsongrass control in no-till soybeans. The potential and techniques of no-till flue-cured and burley tobacco production in a killed cover crop are being studied including effects on soil erosion and quality and yield of tobacco.

Legume cover crops and their establishment for nitrogen production in no-till corn are being studied by crop science extension specialists. Soil scientists are continuing their research on reduced tillage systems including in-row subsoiling and recently new research personnel will study soil structure, moisture, temperature, and various aspects of no-till systems. Entomologists are evaluating the importance of starter or pop-up fertilizer in corn to reduce the susceptibility to early postemergence insect damage. Plant pathologists are investigating nematode control in no-till corn and the effects of no-till on nematode populations.

NO-TILLAGE CROPING SYSTEMS IN SOUTH CAROLINA

J. H. PAI.MER

INTRODUCTION

No-tillage (no-till) is defined as a planting method in which a narrow seedbed (1 to 3 inches) is prepared by a coulter or similar tool. The idea is to disturb the soil very little as an aid in reducing erosion and possibly lowering the costs of establishing a crop.

In South Carolina, no-till has met with limited success. In 1983, an estimated 150,000 out of 2.3 million row crop acres have been planted no-till. However, there were 500,OOO+ additional acres planted with minimum tillage in which crop residues were either disced lightly or otherwise treated (e.g., burning) before planting. The potential by 1990 is for 1 million no-till acres of row crops in South Carolina.

NO-TILL CROPPING SYSTEMS

The major no-till cropping system in South Carolina involves soybeans planted in small grain stubble. In 1983, there were over 600,000 acres of soybeans planted in small grain stubble (primarily wheat), of which approximately 120,000 acres were no-till. Much of the remaining 480,000 acres were planted with minimum tillage following the burning of the grain stubble. Burning remains the most widely accepted type of residue management in reduced-tillage systems involving double cropping with small grain.

For growers who wish to utilize them for livestock feed, etc., cover crops offer much potential. However, the establishment of cover crops exclusively for erosion control has not gained wide acceptance. Legume cover crops grown for their contribution of nitrogen to succeeding crops such as corn or grain sorghum, appears to be gaining favor among certain innovative growers.

Due to heavy crop concentrations in the lighter Coastal Plain soils, most no-till planting systems in South Carolina involve planters with a double disc opener following a row subsoiler. This, of course, increases the energy requirement per row by about 50%, compared to coulter-planter systems. Many new no-till planters are now commercially available for use in sandy soils which form hardpans, but virtually all involve some type of chisel for deep tillage (usually 8 to 15 inches).

Row spacings for over 95% of the no-till row crops in South Carolina remain 30 to 40 inches. The primary reasons for this include: 1) some row treatment of insecticide-nematicides is practiced, particularly for corn and grain sorghum; 2) most planters equipped with chisels for deep tillage have difficulty with row spacings closer than 30 inches; 3) a conventional row width of 30 to 40

J. H. Palmer is Extension Agronomist, Clemson University, Clemson, South Carolina

inches is necessary for many row-oriented directed or shielded sprayers for weed control: and 4) research does not show a yield advantage for corn or soybean rows closer than 30 inches in South Carolina.

NEW PRACTICES IN NO-TILL

The major deterrentsto increased no-till plantings are weed pests, particularly perennial grasses (e.g., johnsongrass) and large-seeded broadleaf weeds (e.g., sicklepod and morningglory). New grass herbicides, such as POAST and FUSILADE, and new herbicide application technology (e.g., shielded sprayers) give growers additional weed management options. Management is the key factor for success with no-till, regardless of the crop(s) involved.

RESEARCH EMPHASIS

A new IPM (Integrated Pest Management) project involving various tillage and crop rotation schemes and their influence on pest populations has been initiated in South Carolina. Several disciplines are involved, but emphasis is given to weed management. Several commercial companies are supporting a phase of the work involving postemergence weed management. Other research by USDA scientists involves planting grass crops such as corn into various legume cover crops. This effort is a part of a new southern regional research project.

THE NO-TILL SITUATION IN TENNESSEE

ELMER L. ASHBURN

In Tennessee, our major no-till production involves soybeans planted into freshly-combined wheat stubble. Some 300,000 acres were planted in this system in 1982 as compared to about 70,000 acres in 1977. Most producers use paraquat to burn down green vegetation and a combination of a broadleaf and a grass herbicide to provide preemergence weed control.

A small percentage of our no-till soybeans are planted into the previous year's corn or soybean stubble. Also, some producers are utilizing a rye or wheat cover crop and no-tilling into the killed small grain cover.

Most no-till planters in our state utilize a cutting or straight coulter, a 1 inch or 2 inch fluted coulter and double disk openers to open and prepare a slit for the seed. Enough phosphorus and potassium for wheat and soybeans is normally applied broadcast to the wheat in the fall. Topical spring applications of N are made to the wheat. However, some producers still apply 130 pounds of 9-23-30 in the row during soybean planting.

Tennessee producers plant about 75,000 acres of corn no-till and this acreage has not changed significantly since 1977. Corn is no-till planted into soybean stubble, killed small grain cover crops, killed perennial sod, or small grain stubble where silage or haylage has been produced.

Most corn producers utilize paraquat in liquid nitrogen to burn down existing vegetation. A combination of atrazine and a preemergence grass herbicide are normally included in the spray mix.

Some fertilizer is usually applied in the row as a pop-up application with the majority of the P and K being broadcast. However, on low testing soils producers apply most of the P and K in the row rather than broadcast. Very few producers apply any fertilizer after planting.

Tennessee fanners planted about 60,000 acres of no-till wheat in 1982. This compares with some 10,000 acres in 1977. No-till wheat is drilled into soybean stubble or aerially applied to soybean fields as leaf drop begins on mature soybeans.

New practices in no-till in our state include: (1) use of narrower (prilled or I-inch fluted) coulters to replace 2 inch coulters, (2) use of 2 in-line straight coulters to cut through heavy surface residues, (3) use of more small grain cover crops as mulch, (4) some increase in post-directed herbicides in no-till soybeans, (5) some shift to Roundup or Bronco as a burndown to improve control of horseweed, goldenrod, smartweed, and established fall panicum, and (6) use of narrower rows.

Elmer L. Ashburn is Professor, Plant and Soil Science, Agricultural Extension Service, The University of Tennessee.

Research emphasis in no-till includes the following: (1) mulch species, (2) mulch or stubble management, (3) nitrogen levels for corn, (4) no-till cotton, (5) no-till grain sorghum, (6) disease control, (7) fertilizer placement, and (8) systems of weed' control.

In summary, Tennessee farmers have embraced no-till as a useful and economical means of crop production. Their innovations and ever-changing methods of crop production should insure a sizable increase in no-till acreage in the future.

NO-TILL WEED PROBLEMS AND CHALLENGES IN THE LOWER SOUTH

P. A. Banks

INTRODUCTION

The majority of the no-till crop production systems in the Piedmont and Coastal Plain of the lower south (Georgia, Florida, Alabama, South Carolina and North Carolina) involves double-cropping where only one of the crops is produced without primary tillage. The most popular double-cropping system for the past several years in this region has been winter small grains (usually wheat) followed by soybeans. Approximately 30% (320,000 acres) of the double-cropped soybeans in Georgia are planted no-till. Other double-cropping combinations include small grains followed by grain sorghum, cotton, sunflowers, or peanuts and in the deep south, corn followed by soybeans or grain sorghum. Vegetable and cole crops may also be double-cropped with any of the previously mentioned crops but generally the no-till concept is not used. Each of these systems poses distinct weed control and herbicide residue problems that must be recognized and solved.

FACTORS THAT AFFECT WEED CONTROL IN NO-TILL CROPS

Several factors exist which affect weed control in no-till double-cropped systems that are not important with conventional tillage. For crops which are established following small grain harvest there is a two to six week delay in the date of planting compared to conventionally produced full season crops. This delay allows both annual and perennial weeds the opportunity to become well established and difficult to control with traditional contact herbicides, such as paraquat. Mid-June through mid-July, the time when most double-cropped soybeans and grain sorghum are planted, is historically the driest period of the year in most of Georgia, Alabama, and South Carolina. Drought stress reduces the effectiveness of the contact herbicides used to control emerged large crabgrass, common ragweed, common lambsquarters, and horseweed. The dry weather and high temperatures also reduce the effectiveness of soil-active preemergence herbicides. Research has shown as much as 50% loss of some preemergence herbicides within 5 days of application if no rainfall is received and sunny, hot conditions are experienced. The higher temperatures and drier conditions also make crop establishment more difficult. Uneven crop densities, even when planted in narrow rows, reduces the effect of crop canopy suppression on late emerging weeds and extends the period of weed control needed to avoid yield and harvest losses.

The presence of wheat straw residue on the soil at the time of herbicide application has been shown to intercept a great deal of the herbicide. At straw levels above 4,000 pounds/A only about 15% or less of the herbicide which is applied will reach the soil surface. That which remains on the straw must be washed into the soil by rainfall or irrigation. Several preemergence herbicides have been shown to have 25 to 75% of the applied herbicide retained on the straw even after 0.5 inch of sprinkle irrigation

---

P. A. Banks is an assistant professor of Agronomy at the University of Georgia, Athens, Georgia.

water was applied immediately after herbicide application. A delay in rainfall or irrigation will further decrease the amount of herbicide received by the soil. These findings would suggest that increased rates of preemergence herbicides should be used when applied to no-till straw-mulched situations or that straw residue levels should be reduced. However, it has been observed that small grain straw residues and extracts from these residues can adversely affect the growth of some weeds. It has also been noted that the presence of wheat straw gives better suppression of certain small seeded annual weeds than herbicides applied for their control in conventionally tilled areas. It is possible that the loss of herbicidal activity due to the presence of straw on the soil at the time of application may be compensated for by the effect of straw on the weeds that were to be controlled.

Another factor that must be considered is the persistence of the soil active herbicides applied in the no-till double-crop. While it is desirable to use a herbicide which provides season-long weed control, the potential for herbicide carry over into the following crop must be recognized. Most producers follow the soybean or grain sorghum crop with small grains again in the fall. The later date of herbicide application in the no-till double-crop reduces the period between herbicide application and planting of the following crop from 6 months to 4 or 5 months. Several herbicides that are currently registered for preemergence use in soybeans have the potential to persist at levels high enough to injure wheat planted after harvest. The factors which affect the persistence of the compounds and alternatives to their use must be investigated.

PROBLEM WEEDS IN NO-TILL FOLLOWING WHEAT

Weed problems in no-till crops planted after wheat harvest can be separated into two categories: 1) those which germinate in the wheat and are present when the soybeans are planted, and 2) those which emerge after soybean planting. The most commonly occurring weeds in category one are common lambsquarters, common ragweed, and horseweed. Large crabgrass may also be present in the wheat, especially if harvest is delayed. These weeds usually germinate in March or April and are not affected by the January and February applications of 2,4-D for broadleaf weed control. Paraquat or glyphosate are commonly used to control the weeds at the time of soybean planting, however, the adverse conditions previously mentioned can decrease the effectiveness of paraquat. Glyphosate has been shown to be somewhat more effective but is also more expensive. The category two weeds can be any of those commonly found in conventionally tilled crops but the most difficult to control are sicklepod, Texas panicum, morningglories, fall panicum, and johnsongrass. Areas heavily infested with sicklepod, Texas panicum, or johnsongrass make it especially difficult to economically produce no-till crops. In the past, the lack of effective herbicides for postemergence control of grass weeds has made no-till farming impractical in many areas. However, the introduction of sethoxydim and fluazifop, for postemergence grass control in broadleaf crops, will alleviate these problems to some extent. With the loss of toxaphene for postemergence sicklepod control, this weed will remain the most troublesome weed in soybeans in the lower south and will severely hamper no-till soybean production.

FUTURE NEEDS FOR NO-TILL CROP PRODUCTION IN THE LOWER SOUTH

Several important factors will affect the future success or failure of weed control in no-till crop production in the lower south. It appears that double-cropping will remain popular and profitable for southern producers, at least in the near future. To improve weed control in the no-till crop, usually soybeans or grain sorghum, improved management, equipment, crop cultivars, and herbicides are needed.

At the present time, few producers own equipment that will efficiently plant crops in no-till situations, especially in the Coastal Plain where in-row subsoiling is necessary to break-up the hard-pan which forms in these soils. Several types of effective planters are available but difficult economic times and the high price of the equipment will hamper the transition from the established conventional tillage practices to no-till. Poor crop stands due to inadequate equipment is many times the difference between acceptable weed control and disaster. Innovative engineering of no-till equipment at affordable prices will make no-till production more of an alternative to southern producers.

At the present time, there are few soybean or grain sorghum cultivars which are adapted or have been specifically developed for the short-season double-cropping system. This is especially true where maturity group VI and VII soybeans are planted late in the growing season. These determinate types of soybeans many times do not develop a full canopy before beginning reproductive growth and therefore do not suppress the growth of emerging weeds. The introduction of indeterminate types of soybeans which are adapted to the southeast will greatly improve this situation. At the present time, a few of these varieties have been introduced but seed supplies are very limited.

Even when better equipment and cultivars become available and are in use there will still be troublesome weeds to contend with. As pointed out earlier, sicklepod, morningglories, johnsongrass, and Texas panicum will be difficult to control. The introduction of new and improved herbicides for their control is necessary. The introduction of the new foliar grass herbicides will solve some of the problems in soybeans, although, solutions are still needed for grass control in grain sorghum. Dependable morningglory control is now available with acifluorfen although proper timing of application and optimum conditions are needed for success. New herbicides must be developed which will selectively control sicklepod in soybeans. Few fields in Georgia, Alabama, or Florida do not have economic levels of sicklepod infestations. Several experimental herbicides show promise for sicklepod control but even if the decision to develop them is made it will be several years before they will become available.

No-till crop production using the double-cropping systems previously described are labor and land efficient and have shown to be benefical in erosion control and soil-water conservation. However, effective weed control is still one of the major stumbling blocks in the minds of many producers. Until effective, dependable weed control systems are available, no-till double-cropping will be difficult to utilize for many producers in the lower south.

NO-TILL WEED PROBLEMS AND CHALLENGES IN THE UPPER SOUTH

R. M. HAYES

INTRODUCTION

Most of the weed problems in no-till systems are also present in conventional systems, however, there are some exceptions. Indeed, it must be understood that the solutions to many of these problems do not lie in strictly conventional-tillage and cultivation. Perhaps if we had expended as much effort on these problems as we have on similar problems in conventional-tillage they would be of only minor consequence today.

The objective of this report is to identify weed problems in the Major no-till systems in the Upper South. As with conventional systems, some major problems are present in rather localized areas that, for reasons of space and scope, will not be mentioned, but this is not intended to infer that they don't exist.

JOHNSONGRASS

Johnsongrass is one of the major weed problems in no-till cropping systems in the Upper South. Most of the cropland in this area is either infested with johnsongrass or potentially can become infested. The best approach to handling this problem in no-till cropping systems is to have near complete control of johnsongrass for at least one year (preferably several years) prior to no-tilling. If this can be achieved the problem is then reduced to seedling johnsongrass which is much easier to control with available herbicides.

Experience in the Upper South has not shown much, if any, advantage of Roundup or Bronco (glyphosate) over Paraquat for rhizome johnsongrass control in early spring plantings of corn. Cool temperatures coupled with reduced susceptibility of very young johnsongrass usually means poor results. Also, much of the johnsongrass has not emerged at the time corn is planted. There are no selective preemergence or postemergence herbicides for rhizome johnsongrass control in corn or grain sorghum. Lasso (alachlor), Dual (metolachlor) or Prowl (pendimethalin) all effectively control seedling johnsongrass. Lasso and Dual can only be used with herbicide safened grain sorghum seed. Prowl is only labeled for postemergence incorporated application in grain sorghum. Dual or Prowl is effective on seedling johnsongrass in no-till cotton, however, compatibility problems exist in tank mixtures of Dual with Cotoran or Lanex (fluometuron).

In no-till soybeans, temperatures are warmer and rhizome johnsongrass is generally at a more susceptible growth stage for control with Roundup or Bronco than with earlier plantings.

Excellent initial rhizome johnsongrass control has been obtained with Bronco compared to Paraquat plus Lasso and this resulted in an 8 bushel per acre higher

---

R. M. Hayes, Associate Professor, Plant and Soil Science Department, University of Tennessee, Jackson, Tennessee.

yield (Table 1). Where Bronco was followed by a single application of Poast (sethoxydim) late season johnsongrass control was more than doubled and yields were improved another 11 bushels per acre. Two applications of Poast following Bronco gave excellent johnsongrass control throughout the season and soybean yields were 10 bushels per acre higher than the comparable treatment following Paraquat plus Lasso.

COVER CROPS

Until very recently, most of the no-till production was in small grain stubble, killed sod, or old crop residue. There is now considerable interest in growing legume cover crops which would provide soil cover and supply some nitrogen. One of the problems encountered with legume cover crops is when and how to kill these covers, especially for no-till corn and cotton. Cool, cloudy weather present at this time coupled with the rank growth of the cover crops often results in slow or incomplete kill. Of the legumes with which we have had experience, alfalfa, subterranean clover, red clover and arrowleaf clover have been the most difficult to control with Paraquat. Fortunately, the two legume covers which appear to be most promising, hairy vetch and crimson clover, are relatively easy to control with either Roundup or Paraquat in combination with residual herbicides such as Aatrex, etc. (atrazine) or Cotoran/Lanex.

HORSEWEED

Horseweed, sometimes and perhaps more appropriately called marestail, is virtually ubiquitious to untilled fields in the Upper South in the early spring. It is often 1 to 2 ft when no-till crops are planted in old crop residues. This weed is difficult to control with contact type herbicides like Paraquat. To be effective, the herbicide must kill all the growing points on the plant. Systemic herbicides like Roundup or 2,4-D are effective on this weed.

PERENNIAL WEEDS

Several perennial weeds are present in no-till cropping systems in the Upper South and are serious problems in localized situations. The more common ones are shown in Table 2.

ANNUAL WEEDS

Among the more serious annual weed problems are the annual grasses, especially fall panicum, giant foxtail, and crabgrass, These are often problems where they are well established at planting and are not killed by the "burndown" herbicide or where sufficient rainfall is not received to "activate" preemergence herbicides, or where excessive rainfall depletes the activity of preemergence herbicides. The recent introduction of Poast and Fusilade (fluazifop-butyl) should help to solve this problem.

Volunteer small grain is often mentioned as a problem in no-till double-cropped soybeans. It seems to be more of a problem as a host for small grain diseases than as a competitive weed.

Smartweed, common ragweed, and cutleaf evening primrose are often present in no-till double-cropped soybeans in wheat stubble. Often much of the leaf surface of these weeds is removed during combining and consequently contact kill of established plants is difficult. Systemic herbicides such as glyphosate provide better control of these weeds under these conditions.

Sicklepod is definitely a serious weed pest in no-till situations, especially in soybeans where herbicide activity is less than for those used in corn, grain sorghum or cotton. At the present time, partial control is attainable with preemergence herbicides such as Dual or Lasso plus Sencor/Lexone (metribuzin). Early overtop application of Attac (toxaphene) and oil concentrate will provide excellent control of sicklepod at the cotyledon stage. This program will provide a height differential for subsequent post-directed application of Paraquat, Sencor/Lexone, or Sencor/Lexone plus 2,4-DB (Table 3). In no-till corn, sicklepod can be effectively controlled with atrazine at 3 to 4 lbs ai/acre. No-till grain sorghum will not tolerate these rates of atrazine. In fact, we have observed more grain sorghum injury from atrazine at 2 lb ai/acre preemergence under no-till than conventional-tillage. This is possibly due to either more feeder roots close to the soil surface or greater movement of atrazine in the zone of root uptake.

Annual ryegrass, wild garlic, wild mustard, and cheat appear to be more prevelant in wheat fields not receiving fall tillage,

SUMMARY

Obviously, it is not within the scope of this paper to discuss all of the weed problems in no-till systems in this region. Similarly, this report does not imply that these problems are only found in no-till systems. These are just some of the more apparent problems. Perhaps the most important problem in weed control in no-till systems is to develop more economical weed control systems, especially where specific problems exist that require postemergence control measures. Secondly, as we continue in no-till systems year after year and both litter and organic matter are increased, we must be prepared to increase herbicide rates. Thirdly, we must not repeatedly rely on the same herbicide program year after year, hut rather develop rotational weed control programs that will allow a better opportunity for control of some of these weed problems.

Table 1. Johnsongrass control and effect on no-till soybean yields as influenced by Bronco or Paraquat plus Lasso alone or followed by one or two applications of Poast.

Treatment[1/]	Percent control 8-2-82	Percent control 9-1-82	Dry wt 9/16	Yield Bu/A [2/]
Bronco	38	24	2110	21.6 e-h
Bronco + Poast	86	12	-	32.4 a-d
Bronco + Poast + Poast	92	9R	-	39.2 a
Paraquat + Laaao	0	15	4453	13.1 h-j
Paraquat + Lasso + Poast	81	44	-	18.0 f-i
Paraquat + Lasso + Poast + Poast	68	91	-	29.4 b-e

1/'Essex' soybeans planted and treated with preemergence herbicides on June 22. Firot application of Poast on July 12 and Recond application on August 4. Bronco 4 qts/A; Paraquat 1 qt/A; Lasso 2.6 qts/A; Poast - first application 1 1/2 pts/A; 1 pt/A second application.

""Values within a column followed by the same letter(s) are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

Table 2. Perennial weeds and no-till crops in which they are a problem.

Weed Problem	No-Till Cropping Situation: Corn	Grain Sorghum	Cotton	Soybeans	Wheat
Johnsongrass	X	X	X	X	
Bermudagrass	X	X	X		
Trumpetcreeper	X	X	X	X	
Honeyvine milkweed	X	X			
Nutsedge	X				
Bigroot morningglory	X	X	X	X	
Smooth groundcherry				X	
Goldenrod			X	X	
Pokeweed	X	X		X	
Wild garlic					X

Table 3. Sicklepod control with postemergence herbicides in no-till 'Essex' soybean at Springhill. Tennessee, 1981.

Treatment[1/]	Application[2/]	% Sicklepod control 8-5-81	% Sicklepod control 9-3-81	Yield Bu/A[3/]
Lorox + 2,4-DB + X-77	POD	65	49	38.9 bc
Paraquat + X-17	POD	15	30	38.0 c
Sencor/Lexone + X-77	POD	80	80	40.1 bc
Sencor/Sexone + 2,4-DB	POD	96	90	45.6 a
Attac + C.O.C.; [4/]	O.T.			
Paraquat + X-77	POD	97	93	41.5 abc
Attac + C.O.C.;	O.T.			
Lorox + 2.4-DB + X-17	POD	95	87	43.6 ab
Attac + C.O.C.;	O.T.			
Sencor/Lexone + X-77	POD	91	93	41.5 abc
Attac + C.O.C.;	O.T.			
Sencor/Lexone + 2.4-DB + X-77	POD	98	94	45.7 s
No postemergence herbicide	-	0	0	33.0 d

1/Entire experiment planted and treated with Dual, Lexone, Paraquat and X-77 at 1.5: 0.5, 0.5 lb ai/acre plus 0.5% volume/volume on June 16, respectively. Rates of other herbicides in lbs ai/acre are as follow: Lorox - 0.5; 2,4-DB - 0.2; Paraquat - 0.125; Sencor/Lexone - 0.5; and Attax - 2.0.

2/O.T. = Overtop postemergence at cotyledon stage on July 1. POD = Post directed in soybeans 12 inches. 3 to 4 trifolates; and sicklepod from cotyledon to 5 inches on July 15.

3/Values within a column followed by the same letter(s) are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

4/C.O.C. = Agridex crop oil concentrate at 0.5% volume/volume.

FERTILIZER AND LIME PROBLEMS IN THE LOWER SOUTH

J. T. Touchton and G. W. Martin[1]

There is no logical reason for a plant's nutritional requirements to vary among tillage systems, but methods of fertilizer and lime applications do vary. In conventional-tillage systems we are working primarily with incorporated lime and fertilizers. In no-tillage systems, we are working almost entirely with surface applications similar to those used with perennial pastures. Data from some studies indicate that root development and growth can vary among tillage systems. Varying root growth patterns and methods of fertilizer applications among tillage systems can result in varying responses to fertilizer and lime.

LIME AND NON-MOBILE NUTRIENTS

Lime and some of the fertilizer nutrients, such as phosphorus, are not mobile in the soil. In no-tillage systems where the soil surface is not mechanically mixed, lime and non mobile nutrients will accumulate in the surface inch or two of soil. There has been some doubt expressed about the availability of surface accumulated nutrients. Data from research conducted during the past few years have indicated, however, that surface fertilizer applications in no-tillage systems, even when the initial soil nutrient levels are low, will result in yields as high or higher than incorporated fertilizers in conventional-tillage systems.

In continuous no-tillage systems, a fairly rapid pH change can occur in the upper inch or two of soil. To accurately detect this pH change, a 0- to 2-inch sampling depth should be used. The common 0- to 6- or 0- to 8-inch sampling depth can result in misleading pH values and lime requirements. If a 0- to 8-inch soil sample is taken, a low pH in the surface 2 inches of soil may not be detected. This situation will most likely occur on soils that nave not been limed for several years, and where high rates of N have been applied. A low pH in the surface inch or two of soil may not be detrimental to plant growth, but it may result in poor herbicide activity and severe weed pressure. If soils have been recently limed, the pH in the upper inch of soil may be much higher than the pH in the 2- to 8-inch soil depth. If a 0- to 8-inch soil sample is taken, the high pH zone at the soil surface may not be detected, which can result in unnecessary lime applications.

MICRONUTRIENTS

High pH and/or P levels can restrict the uptake of some micronutrients, especially zinc (Zn) and copper (Cu). There is a possibility that the surface accumulation of P and high surface pH levels in no-tillage systems can result in induced micronutrient deficiencies on some soils. Data from studies with both soybeans and wheat indicate that Zn and Cu levels in the

[1]Department of Agronomy and Soils, Alabama Agricultural Experiment Station, Auburn University, Alabama.

plant tissue will sometimes be lower in no-tillage than conventional-tillage systems especially if high rates of P fertilizers have been applied. There have not, however, been indications that reduced levels of micronutrients in crops grown in no-tillage systems have resulted in yield reductions.

NITROGEN

Surface applications of N fertilizers probably create the greatest problems associated with fertilizer efficiency in no-tillage systems. The problems center primarily around the use of urea and method of application. If urea is applied to a soil containing surface residue, severe N losses can occur through ammonia volatilization. A key point to remember is that N solutions containing more than 19% N are most likely made from urea or urea-ammonium nitrate combinations. The most common solutions (28, 30, and 32% N) contain approximately 50% urea-N and 50% ammonium-nitrate N. The urea in these solutions is just as susceptible to N losses through ammonia volatilization as is the N in solid urea.

The most inefficient applications probably occur when the urea-containing N solutions are used as a carrier for pre-emergence or post directed herbicides. Data from research conducted in Georgia (Table 1) illustrate the inefficiency of 32% N solution when sprayed on the soil surface. In this study, 80 lb/acre N as ammonium nitrate resulted in approximately 15 bu/acre more corn than a spray application of 32% urea-ammonium nitrate applied at a rate of 240 lb/acre N. With the lower rates of N solution, the surface band application resulted in lower yields than did the injected application, which indicates that some N was being lost from the surface band application.

Table 1. Yield of irrigated corn as affected by nitrogen source and method of application.

Applied nitrogen	Ammonium nitrate	32% N solution		
	Surface band	Injected	Surface band	Broadcast spray
lb/a	corn yield, bu/acre			
80	130	135	120	80
160	160	165	145	100
240	170	160	160	115

J. T. Touchton and W. L. Hargrove. 1982. Agron. J. 74:823.

The data in Table 1 clearly indicate that spray applications of N solutions containing urea should not be used. Reasonable responses to N can most likely be obtained with surface dribble systems, but in some years, the surface dribble system will also result in lower N efficiency than injected N.

STARTER FERTILIZERS

During the first few weeks after planting, it is not uncommon for plants in no-tillage systems to grow more slowly than plants in conventional-tillage systems. Data from recently conducted research indicate that this slow growth may be a fertility problem (primarily N and P) created by the no-tillage system. The data also indicate that the slow growth problem can be corrected with starter fertilizers. Data from several studies conducted in Alabama and Georgia suggest that starter fertilizers (18-46-0, 10-32-0, or 23-26-0) can almost double the growth of no-tillage corn and sorghum during the first few weeks after planting. The improved early growth with the starter fertilizers in no-tillage systems generally results in increased grain yields at maturity as indicated in Tables 2 and 3.

Table 2. Yield of grain sorghum grown on a high P soil as affected by starter fertilizer (120 lb/acre of 10-34-0) and sidedress nitrogen.

		Sidedress N, lb/acre			
Tillage	Starter	0	40	80	120
		---------- grain yield, bu/acre ----------			
No-till	yes	50	72	85	92
	no	39	62	72	76
Tilled	yes	55	73	83	88
	no	44	71	81	81

J. T. Touchton & W. L. Hargrove. 1983. Better Crops With Plant Food. LXVII:3-5.

Table 3. Yield of corn grown on a high P, high K soil as affected by starter fertilizer combinations applied in the in-row subsoil track at planting.

	Tillage	
Starter fertilizer[1]	Conventional	None
	-------------- bu/acre --------------	
none	60	79
N	72	93
P	68	78
K	66	82
N-P	69	97
N-P-K	78	103

[1]Rates were equivalent to 21, 54, and 72 lb/acre of N, P_2O_5, and K_2O, respectively. Sidedress N for all treatments was 200 lb/acre.

The problem with starter fertilizers is that we do not have a definitive fertilizer analysis, rate, or method of application. Probably 100 pounds per acre of 20-20-0 would be sufficient for corn and grain sorghum in most situations. Research on the use of starter fertilizers with soybeans is limited. There are indications that a no-N starter such as 0-10-30 will improve soybean yields.

Method of starter fertilizer applications in no-tillage systems can definitely be a problem. Currently, we do not have data on *2* x *2* fertilizer placements for no-tillage systems. Data in Tables *2* and 3 came from studies in which the crops were planted with an in-row subsoiler. The starter fertilizer was applied deep in the subsoil track at planting. When in-row subsoilers are used, massive root systems often develop, but these roots generally remain within the subsoil channel. The responses resulting from the fertilizer applications may have been due to a placement response rather than to a starter response. In some studies, surface applied starters have been compared with subsoil track applications. The surface applications increased grain yield over that obtained with no starter, but they resulted in lower yields than the subsoil track applications. Since N will move down into the soil and P will not, responses to surface applied starters were probably due to the N fertilizer.

KEY POINTS TO REMEMBER

1. Don't forget to soil test and follow recomnendations.
2. Use shallow soil samples (0 to 2 or 3 inches) for pH determinations and lime requirements in continuous no-tillage systems.
3. Remember that surface applied urea N can be lost through ammonia volatilization. If N solutions contain more than 19% N, they probably contain 50% urea N.
4. DON'T USE SPRAY APPLICATIONS. If urea N is used and can't be injected, use surface dribble applications.
5. Use starter fertilizer in no-tillage systems, especially when planting with an in-row subsoiler.
6. Don't use nitrogen containing starter fertilizers with soybeans.
7. Don't place starter fertilizers in direct contact with seed.

FERTILIZER AND LIME PROBLEMS IN UPPER SOUTH

DON TYLER

Surface application of lime, phosphorus and potassium in continuous no-tillage systems has prompted many questions. Can surface-applied unincorporated lime adequately neutralize soil acidity? Will phosphorus and potassium move into the soil enough to supply adequate plant nutrition? Research has shown that under many no-tillage conditions, the burial of lime, phosphorus, and potassium is an unnecessary undertaking (Singh et al., 1966; Shear and Hoschler, 1969; Triplett and Van Doren, 1969; Moschler et al., 1972; Fink and Wesley, 1974; Kang and Yunusa, 1977; Blevins et al., 1978). However, research on fertilizer placement on low testing soils is continuing. In Tennessee, research is being conducted at Milan comparing N, P and K at various rates and placements including surface broadcast, banding, and injection. Placement and fertilizer for no-till soybeans is also being studied. The placement of P and K may turn out to be of much less importance as compared to methods of applying certain forms of nitrogen in no-tillage systems.

Under certain conditions, gaseous losses of nitrogen from surface-applied ammonium salts, and urea have been large (Terman and Hunt, 1964; Hargrove et al., 1977; Fox and Hoffman, 1981; Bandel et al., 1980). This is illustrated by research results shown in Figure 1 (Charles R. Graves and Donald D. Howard of the Plant and Soil Science Dept., Univ. of Tenn.). A comparison of unincorporated urea and ammonium nitrate at three rates was studied in conventional and no-tillage corn. As shown in Figure 1, 1981 yields in conventional-tillage were significantly lower at the 120 and 160 lbs N/acre rates when urea was the source as compared to ammonium nitrate. In no-tillage the yield differences between sources were much larger and significant at all nitrogen rates. Based on yield response the surface application of urea on the no-tillage wheat residue resulted in much larger losses than the surface application on a conventionally prepared seedbed. After fertilizer application no significant rain occurred for 6 days. As shown in Figure 2, yield differences were much smaller and not significantly different in 1982. However, there was a trend for N source differences to be larger in no-tillage than with conventional-tillage. In this season rainfall occurred within 3 days after fertilization. Volatilization losses of N from urea are minimized if it is soil incorporated. Banding and injection have been beneficial in reducing losses (Mengel et al., 1982; Touchton and Hargrove, 1982). These methods for reducing losses are being investigated in Tennessee.

Nitrogen can also be lost in other ways. Leaching (movement into the soil below the root zone), denitrification (conversion to a gas usually associated with excessively wet conditions), and immobilization (the tie-up of nitrogen in organic matter decomposition processes) are also avenues of nitrogen loss. One way of avoiding these losses is delaying application until the plant is growing and more ready to utilize the nitrogen. With most row crops very little

---

Don Tyler, Associate Professor, Plant and Soil Science Dept., Univ. of Tenn., Jackson, Tennessee.

nitrogen is used in the first 4 to 6 weeks. This is true for corn. Nitrogen application at corn planting in April and May in Tennessee can be followed by periods of heavy, intense rains which can produce considerable nitrogen losses through leaching. Thomas (1980) concluded that these losses could be minimized by delaying the nitrogen application to 4 to 6 weeks after planting. A study comparing five nitrogen rates at two times of application (at planting versus 4 to 6 weeks after planting) for conventional and no-tillage corn production has been in progress at Ames Plantation since 1979. Yield trends averaged across tillage systems are shown in Figure 3. A yield response to delayed application was observed in the wet years of 1979 and 1981. However, in the comparatively dry years of 1980 and 1982 yields were low and differences re+ sulting from when nitrogen was applied were usually small and not significant (Figure 3). Advantages for delayed nitrogen applications will vary across different seasons, soil conditions, and climates. Research should continue since nitrogen is one of the most costly fertilizer inputs in crop production in the Upper South.

As nitrogen costs have risen, interest in using nitrogen-fixing legumes as cover crops has increased. Research is being conducted in the Southeast to evaluate the potential of many species of legume cover crops prior to planting cotton, corn, and grain sorghum. A comparison of no-tillage corn yields in wheat stubble with and without vetch are shown in Figure 4. Note that the yield with vetch at the 0 N rate was not significantly different from the yield at 50 lbs N with wheat as the winter cover. This same trend for equal yields with vetch with 50 lbs less nitrogen was present at the 50 and 100 lb N/acre rates. Yields at 150 lbs N/acre rate were not significantly different with or without vetch. These data from 1982 indicate a N contribution from vetch of about 50 lbs/acre to the following corn crop. Other research is in progress comparing other vetches and clovers for adaptability, nitrogen contribution, and reseeding ability.

Many fertility problems have been solved but research on avoiding nitrogen losses and effectively using nitrogen fixing legumes in cropping systems is still needed.

LITERATURE CITED

Bandel, V.A., Stanislaw Dzienia, and George Stanford, 1980. Comparison of N fertilizers for no-till corn. Agron. J. 72:337-341.

Blevins, R.L., L.W. Murdock, and G.W. Thomas, 1978. Effect of lime application on no-tillage and conventionally tilled corn. Agron. J. 70:322-326.

Fink, R.J. and Dean Wesley. 1974. Corn yield as affected by fertilization and tillage systems. Agron. J. 66:70-71.

Fox, R.H. and L.D. Hoffman. 1981. The effect of N fertilizer source on grain yield, N uptake, soil pH, and lime requirement in no-till corn. Agron. J. 73:891-894.

Hargrove, W.L., D.E. Kissel, and L.B. Fenn. 1977. Field measurements of ammonia volatilization from surface applications of ammonium salts to a calcareous soil. Agron. J. 69~473-476.

Kang, B.T. and M. Yunusa. 1977. Effect of tillage methods and phosphorus fertilization on maize in the humid tropics. Agron. J. 69:291-294.

Mengel, D.B., D.W. Nelson, and D.H. Huber. Placement of nitrogen fertilizers for no-till and conventional till corn. Agron. J. 74:515-518.

Hoschler, W.W., and G.H. Shear, D.C. Martens, G.D. Jones, and R.R. Wilmouth. 1972. Comparative yield and fertilizer efficiency of no-tillage and conventionally tilled corn. Agron. J. 64:229-231.

Shear, C.H. and W.W. Moschler. 1969. Continuous corn by no-tillage and conventional tillage methods: a six-year comparison, Agron. J. 61:524-526.

Singh, T.A., G.W. Thomas, W.W. Moschler and D.C. Martens. 1966. Phosphorus uptake by corn (zea mays L.) under no-tillage and conventional practices. Agron. J. 58:147-148.

Terman, G.L. and C.H. Hunt. 1964. Volatilization losses of nitrogen from surface-applied fertilizers as measured by crop response. Soil Sci. Soc. Am. Proc. 28:667-672.

Thomas, G.W. 1980. Delayed nitrogen application on corn. Soil Sci. News and Views. Vol. 1, No. 1. Dept. of Agron., Univ. of KY. Lexington.

Touchton, J.T. and W.L. Hargrove. 1982. Nitrogen sources and methods of application for no-tillage corn production. Agron. J. 74:823-826.

Triplett, G.B., Jr. and D.H. Van Doren, Jr. 1969. Nitrogen, phosphorus, and potassium fertilization of no-tilled maize. Agron, J, 61:637-639.

Figure 1.

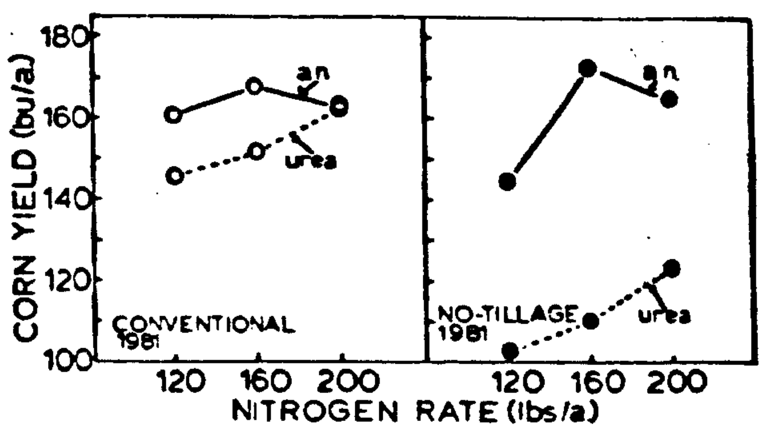


Figure 2.

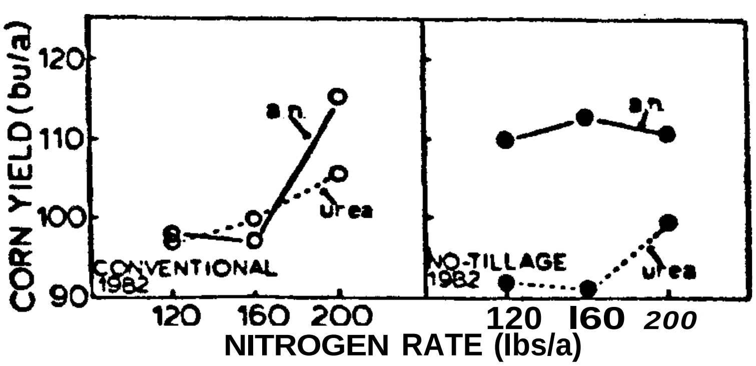


Figure 3.

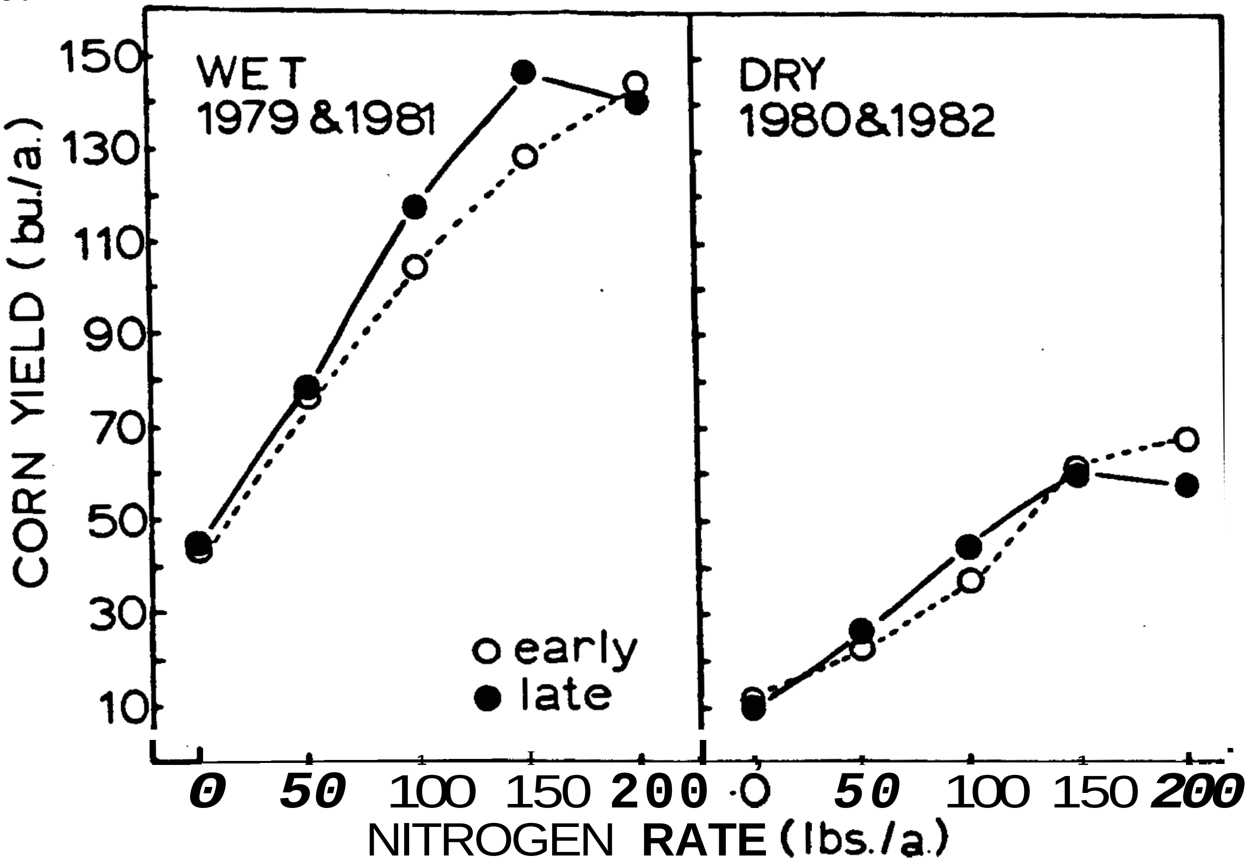
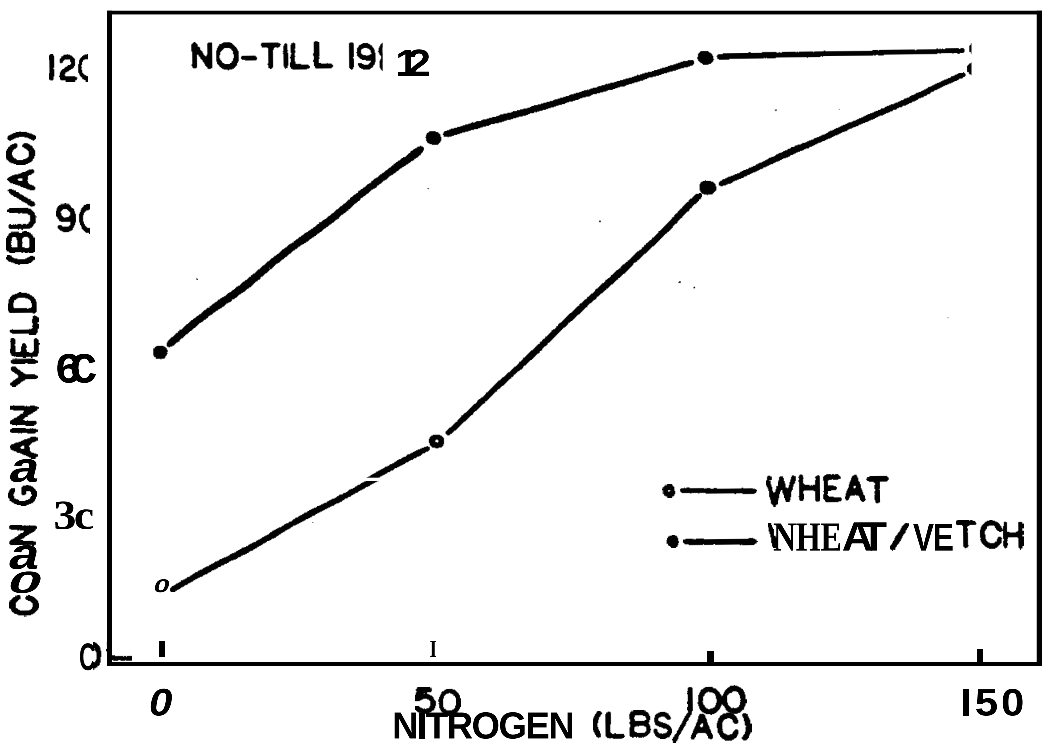


Figure 4.



DISEASE AND NEMATODE PROBLEMS IN NO-TILL SOYBEANS

ALBERT Y. CHAMBERS

INTRODUCTION

One of the unanswered questions related to no-till production of soybeans concerns the probability of increasing disease and nematode problems. Destruction of old plant residue by plowing the soil, especially deep plowing, has long been a fundamental practice for disease control in soybeans and other crops (1, 3). Under no-till production, plant residues remain on the soil surface, and disease severity would be expected to increase if the practice were continued for a number of years,

Much of the soybean acreage in Tennessee is infested with the soybean cyst nematode. Varieties that perform well under no-tillage and comprise a large portion of the acreage are susceptible to either race 4 or to both races 3 and 4 . Growing soybeans continuously also would be expected to increase cyst nematode populations.

Research was initiated in 1979 at the University of Tennessee Milan Experiment Station at Milan designed to study the effects of no-tillage on the incidence of foliar diseases of soybeans. Additional studies were begun in 1980 at Milan to compare population dynamics of the soybean cyst nematode, crop injury, and yields of soybeans double-cropped with wheat under no-tillage and conventional-tillage conditions.

MATERIALS AND METHODS

Plots (13 1/3 x 60 ft., 6 reps) for investigating soybean foliar diseases were established in the fall of 1979 by seeding wheat in plots that were to be double-cropped with soybeans. Soil sampling indicated the plot area to be free of cyst nematodes. 'Essex' soybean was planted by both no-tillage and conventional methods after wheat was harvested in the spring of 1980. A conventional single-crop planting of soybeans (without wheat in the previous winter) was also made. Conventional plantings were made in 40-in, rows; no-till plantings were made in 20-in. rows. Observations were made of foliar diseases throughout the season. Disease ratings were made shortly before harvest when yields were recorded. Wheat was seeded in the fall of 1980 by conventional and no-tillage (simulated aerial seeding) methods. Work was continued without change in 1381 and 1982.

An additional experiment was set up in 1980 on a nematode-infested area to study the effects of no-tillage on cyst nematode populations. A nematode-susceptible variety was planted in the plot area during 1980 to increase the

---

Albert Y. Chambers is Associate Professor, Department of Entomology and Plant Pathology, University of Tennessee Institute of Agriculture, Jackson, TN 38301.
Assistance of the late Tom McCutchen, former Superintendent of the University of Tennessee Milan Experiment Station, and his staff is gratefully acknowledged.

existing nematode population. Wheat was seeded in the fall in plots (13 1/3 x 60 ft., 6 reps) to be double-cropped. 'Essex' soybean was planted in the spring of 1981 using no-tillage and conventional-tillage methods as above. Wheat was seeded in the fall by both methods. Plots were sampled at planting, midseason, and harvest to determine any changes in nematode populations. Plots were harvested to obtain yields. Work was continued similarly in the same plots in 1982. Foliar disease and stem canker ratings were also made in 1982.

RESULTS AND DISCUSSION

Severity of Septoria brown spot was lower in 1980 in no-tillage soybean plots than in conventional-tillage, single-crop plots (Table 1). Brown spot was even less severe in conventional-tillage, double-crop plots possibly due to later planting and hot, dry weather present in 1980. Anthracnose was less severe on pods in no-tillage plantings while more was observed on stems. Yields were slightly higher in double-crop plots, possibly due to late-season rains that came before the later-planted soybeans had matured.

Brown spot severity was lower in no-tillage plots in 1981 and 1982 (Tables 2 and 3). Anthracnose injury was less on pods in no-till plots in 1982 and greater on stems both years. Yields were not significantly different in any of the plantings in 1981. Yields in no-till plots were generally higher than in conventional-tillage plots in 1982.

Soybean cyst nematode levels (cysts) increased three- to six-fold in plots planted conventionally in 1981 while increases ranged from none to two-fold in no-tillage plantings (Table 4). Yields were also significantly higher in no-tillage plots than in conventional-tillage, double-cropped plantings but not higher than in single-crop soybeans. Some of the yield increases may have been due to narrower rows in no-till plantings.

In 1982, cyst levels increased one and one-half to almost three times during the season in conventional-tillage plots while there was no increase in no-tillage plots (Table 5). Yields were again generally higher in no-tillage plantings. Brown spot incidence was lower in no-tillage plots in the nematode experiment while anthracnose injury was less on pods and greater on stems (Table 6). Stem canker symptoms appeared late in the season, but injury, although only moderate, was significantly greater in no-till plots.

Following no-tillage research at the University of Tennessee West Tennessee Experiment Station at Jackson in 1980, Tyler and Overton (2) reported that seed quality was higher and purple stain incidence was lower in soybeans produced in no-till plots compared to those produced in plots of five different variations of conventional-tillage. Soybeans produced in the no-till plots in the present study at Milan were of higher quality and germinated slightly better than those from conventional-tillage plots, especially in the hot, dry season of 1980.

In later work at the West Tennessee Experiment Station at Jackson, brown spot was found to be greatly reduced in no-till soybean plots compared to conventional-tillage plots (D. D. Tyler, Personal Communication). Cyst nematode counts were from three to six times higher in conventional-tillage plots than in no-till plots at the end of the 1982 season. Stem canker appeared in Jackson plots late in the season in 1982 and did not cause severe injury, but

Table 1. Effects of no-tillage on soybean foliar diseases, Milan Experiment Station, Milan, TN, 1980.

Tillage Treatment	Disease Severity (0-9) Leaf	Pod	Stem	Yield, Bu./A.
Soybeans conventional, no wheat in winter	6.3 a	8.5 a	6.8 c	13.5 c
Soybeans conventional, wheat conventional	4.1 c	7.6 b	7.3 b	18.4 ab
Soybeans conventional, wheat no-till	4.3 c	7.8 b	7.4 b	18.9 ab
Soybeans no-till, wheat conventional	5.3 b	7.0 c	8.2 a	18.0 b
Soybeans no-till, wheat no-till	5.1 b	6.6 d	8.5 a	20.9 a

'Essex' planted 5/20 (single-crop) and 6/27 (double-crop); 'McNair 1003' wheat. Leaf ratings were of brown spot; pod and stem ratings were of anthracnose. Soybeans harvested 10/13 and 21.

Table 2. Effects of no-tillage on soybean foliar diseases, Milan Experiment Station, Milan, TN, 1981.

Tillage Treatment	Disease Severity (0-9) Leaf	Pod	Stem	Yield, Bu./A.
Soybeans conventional, no wheat in winter	8.7 a	8.7 a	8.2 b	47.1 a
Soybeans conventional, wheat conventional	8.4 ab	7.8 b	8.4 b	40.5 a
Soybeans conventional, wheat no-till	8.2 b	7.6 b	8.3 b	41.1 a
Soybeans no-till, wheat conventional	7.3 c	7.8 b	9.0 a	44.8 a
Soybeans no-till, wheat no-till	7.3 c	7.7 b	8.8 a	44.3 a

'Essex' planted 5/21 (single-crop) and 6/18 (double-crop); 'McNair 1003' wheat. Leaf ratings were of brown spot; pod and stem ratings were of anthracnose. Soybeans harvested 10/29.

Table 3. Effects of no-tillage on soybean foliar diseases, Milan Experiment Station, Milan, TN, 1982.

Tillage Treatment	Disease Severity (0-9) Leaf	Pod	Stem	Yield, Bu./A.
Soybeans conventional, no wheat in winter	8.8 a	8.2 a	8.4 a	31.8 c
Soybeans conventional, wheat conventional	8.3 b	6.5 b	6.5 c	34.9 bc
Soybeans conventional, wheat no-till	8.1 b	6.4 b	6.7 c	36.9 b
Soybeans no-till, wheat conventional	7.3 c	4.8 c	7.8 b	35.9 b
Soybeans no-till, wheat no-till	6.9 c	4.7 c	7.9 b	41.9 a

'Essex' planted 5/12 (single-crop) and 6/18 (double-crop); 'Arthur' wheat. Leaf ratings were of brown spot; pod and stem ratings were of anthracnose. Soybeans harvested 10/21.

Table 4. Effects of no-tillage on soybean cyst nematode populations, Milan Experiment Station, Milan, TN, 1981.

Tillage Treatment	Cysts/Pt. 6/24	Cysts/Pt. 10/30	Yield, Bu./A.
Soybeans conventional, no wheat in winter	75 a	196 ab	44.9 a
Soybeans conventional, wheat conventional	47 a	285 a	35.1 b
Soybeans conventional, wheat no-till	61 a	196 ab	35.7 b
Soybeans no-till, wheat conventional	112 a	117 b	43.2 a
Soybeans no-till, wheat no-till	75 a	159 b	42.7 a

'Essex' planted 5/21 (single-crop) and 6/18 (double-crop); 'McNair 1003' wheat. Soybeans harvested 10/29.

Table 5. Effects of no-tillage on soybean cyst nematode populations, Milan Experiment Station, Milan, TN, 1982.

Tillage Treatment	Cyst/Pt. 5/21	Cyst/Pt. 10/26	Yield, Bu./A.
Soybeans conventional, no wheat in winter	88 a	138 a	38.4 a
Soybeans conventional, wheat conventional	43 a	115 ab	33.2 b
Soybeans conventional, wheat no-till	63 a	120 ab	38.7 a
Soybeans no-till, wheat conventional	65 a	62 b	42.4 a
Soybeans no-till, wheat no-till	62 a	58 b	41.6 a

'Essex' planted 5/12 (single-crop) and 6/18 (double-crop); 'Arthur' wheat. Soybeans harvested 10/21.

Table 6. Effects of no-tillage on soybean foliar diseases and stem canker, Milan Experiment Station, Milan, TN, 1982.

Tillage Treatment	Disease Severity (0-9) Leaf	Disease Severity (0-9) Pod	Disease Severity (0-9) Stem	Stem Canker Rating (0-5)
Soybeans conventional, no wheat in winter	8.8 a	8.6 a	8.8 a	0.3 d
Soybeans conventional, wheat conventional	7.6 b	7.2 b	6.9 c	1.4 cd
Soybeans conventional, wheat no-till	7.1 c	7.1 b	6.7 c	1.4 c
Soybeans no-till, wheat conventional	6.3 d	4.9 c	8.2 b	1.7 b
Soybeans no-till, wheat no-till	5.8 e	4.8 c	8.0 b	2.2 a

'Essex' planted 5/12 (single-crop) and 6/18 (double-crop); 'Arthur' wheat. Leaf ratings were of brown spot; pod and stem ratings were of anthracnose.

incidence was much higher in no-tillage plots than in conventional-tillage plots. Yields were greatly reduced in plots which were prepared using a moldboard plow and in which nematode counts were highest.

SUMMARY AND CONCLUSIONS

Disease ratings of Septoria brown spot were lower in no-till plots than in conventional-tillage plots in all three seasons (1980-82). Incidence of anthracnose was lower on pods but was slightly higher on stems.

Build-up of cyst nematodes was much less under no-tillage than under conventional-tillage in 1981 and 1982. Stem canker appeared late in the nematode experiment in 1982 but was more severe in the no-tillage plots.

Results obtained from the above experiments indicate that some build-up of disease and nematode problems may be expected in soybeans grown under no-till conditions but that increases will probably be no more rapid, or possibly less rapid, than in conventional-tillage. In the case of brown spot and anthracnose on pods, disease severity was lower under no-tillage. Cyst nematode populations increased more slowly in no-till soybeans. Stem canker may be more severe in no-tillage, but more work is needed before a definite conclusion can be made. Additional work is also needed on other diseases and nematodes.

REFERENCES

1. Soybean Disease Compendium Committee. 1982. Infectious diseases. Pages 3-76 in: Compendium of Soybean Diseases. Second edition. J. B. Sinclair, ed. American Phytopathological Society, St. Paul. 104 pp.

2. Tyler, D. D., and J. R. Overton. 1982. No-tillage advantages for soybean seed quality during drought stress. Agron. J. 74:344-347.

3. Walker, J. C. 1957. Plant Pathology. Second edition. McGraw-Hill, New York. 707 pp.

MULCHES, COVER CROPS, CROP RESIDUES, N-FIXING LEGUMES, ETC.

R. N. GALLAHER

INTRODUCTION

The southern region of the USA has some of the most diversified agricultural production systems in the world. This is brought about, in part because of the relatively long warm growing period and adaptation of a wide range of crops. The warm climate, high annual rainfall and the unique soil geology of the South causes our soils to be highly erodible and infertile under natural conditions. Large inputs of fertilizer are required to maximize production. Although much of the South receives about 50 inches of rainfall annually, distribution is uneven most years and many soils have low water holding capacity causing droughty conditions. Proper amounts and timing of both fertilizer and water applications are required to obtain maximum production on a year-round multicropping basis. The rapid increase in the use of no-tillage and other forms of conservation tillage to plant crops into sod crops, mulch crops, and crop residues has multiplied the problems incurred with fertilizer, cultivar, weed, other pest, and irrigation management.

MULTICROPPING SYSTEMS

Several categories of multicropping systems adapted to the South are in Table 1. Other possibilities exist but those listed illustrate the magnitude of the problem facing agricultural scientists in providing research data on tillage, cropping systems, cultivars, weeds, other pests, water, and fertility management.

Table 1. Categories of Multicropping Systems in the South

Cate-gory	Winter Crops	Summer Crops	Cate-gory	Winter Crops	Summer Crops
1	Forage	Forage	6	Vegetable	Agronomic
2	Forage	Seed	7	Agronomic	Vegetable
3	Cover	Forage/seed	8	Fallow	Agronomics
4	Seed	Forage	9	Fallow	Vegetables
5	Seed	Seed	10	Vegetables	Vegetables

Numerous multicropping systems within each category listed in Table 1 have been practiced in the past, are in production at present, and will by economic necessity increase in the future by farmers in the South. An example of possible double cropping systems in category one include winter crops of wheat, oats, rye, barley, ryegrass, vetch, lupine, alfalfa, crimson clover, red clover, and white clovers for forage. These crops can be

R. N. Gallaher is Professor of Agronomy, University of Florida, Gainesville 32611

succeeded by corn, sorghum, sudax, millet, soybean, tropical grasses, peanuts, and other crops for forage. Eleven winter forages followed by seven Summer forages makes 77 possible multicropping system combinations. Management of these systems make matters even more complicated depending on tillage practice, soil type, type of farm animals produced, selection of cultivars, whether irrigation or natural rainfall is used, and availability of labor, storage facilities, and specialized equipment needed.

In general management becomes more difficult as we go down the categories from one to 10. Over 300 combinations of multicropping systems are possible within the 10 categories. Timing for planting some crops may necessitate using no-tillage for some systems in order to plant early or to utilize crop residues for conservation.

MULTICROPPING MINIMUM TILLAGE PROGRESS

Agricultural Experiment Stations, such as the University of Georgia, Mississippi State University, and North Carolina State University initiated intensive multicropping minimum tillage systems research projects in the early 1970's. Other Land Grant institutions, such as the University of Florida initiated intensive multicropping minimum tillage efforts in research and extension **in** the mid 1970's. By 1981 most all Agricultural Experiment Stations in the South had begun major programs in multicropping and minimum tillage systems.

The Southeastern no-tillage systems conference was initiated in 1978 by the combined efforts of individuals in the Agricultural Experiment Stations along with support from others. This conference has been a major factor in allowing farmers and Scientists to interact within and across state lines in the South. Exchange of ideas played a significant role **in** extending research from the University to the farmer which has helped multicropping minimum tillage systems to be adapted in the South.

Data in Table 2 gives statistics on the major summer and winter crops in the South in 1974 versus 1981. Acreages and yield data were calculated from USDA Crop Production Annual Summary reports. Total acreage increased by 13.5 million for summer crops and by 1.3 million for winter crops in the USA excluding the South. Significant increases occurred for corn, soybeans, and wheat in the nonsouth states. Much of the soybean and wheat acreage occurred in states that border the South, such as Illinois, where double cropping minimum tillage management is on the rise.

The major change in the South was with the eight million acre increase in soybeans and 12.5 million acre increase in wheat during the 8-year period. Most of this increase began in about 1977 with a steady rise through 1981. We know from statistics in Florida that the increase continued in 1982 but many other southern states are in a leveling off period. The multicropping and minimum tillage research, extension, and teaching efforts from Agricultural Experiment Stations in the 1970's paralleled the increased soybean and wheat acreage.

As much a8 75% of the increased soybean and wheat acreage was likely in various multicropping systems and a large portion of one or both crops were planted with minimum tillage. Minimum tillage acreage has also increased

Table 2, Acreage, Yield, and Estimated Value of Major Crops Grown in the *South* in 1974 Versus 1981

CHANGE IN ACREAGE OF SUMMER CROPS IN THE USA EXCLUDING THE SOUTH

CROP	1974	1981	CHANGE
	ACRES (X 1000)		
CORN	65,154	71,947	+ 6,793
SOYBEAN	32,237	38,435	+ 6,198
SORGHUM	8,955	9,034	+ 79
COTTON	2,414	2,928	+ 514
PEANUT	129	104	- 25
TOTAL	108,889	122,448	+13,559

CHANGE IN ACREAGE OF WINTER CROPS IN THE USA EXCLUDING THE SOUTH

CROP	1974	1981	CHANGE
	ACRES (X 1000)		
WHEAT	65,409	70,229	+ 4,020
OATS	14,770	11,157	- 3,613
RYE	2,194	1,477	- 717
BARLEY	8,563	9,406	+ 843
TOTAL	90,936	92,269	+ 1,333

CHANGE IN ACREAGE OF SUMMER CROPS IN THE SOUTH

CROP	1974	1981	CHANGE
	ACRES (X 1000)		
CORN	12,633	12,206	- 427
SOYBEAN	21,270	29,565	+ 8,295
SORGHUM	8,721	6,990	- 1,731
COTTON	11,285	11,291	+ 106
PEANUT	1,391	1,409	+ 18
TOTAL	55,300	61,561	+ 6,261

CHANGE IN ACREAGE OF WINTER CROPS IN THE SOUTH

CROP	1974	1981	CHANGE
	ACRES (X 1000)		
WHEAT	5,945	18,635	+12,690
OATS	3,197	2,409	- 788
RYE	1,006	1,117	+ 111
BARLEY	431	335	- 96
TOTAL	10,579	22,576	+11,997

CHANGE IN YIELD OF SUMMER CROPS IN THE SOUTH

CROP	1974	1981	CHANGE
	BU/A (LB/A-COTTON & PEANUT)		
CORN	60.5	76	+ 15.5
SOYBEAN	23.5	24	+ 0.5
SORGHUM	45	51	+ 6.0
COTTON	394	492	+ 98
PEANUT	2,309	2,596	+ 287

CHANGE IN YIELD OF WINTER CROPS IN THE SOUTH

CROP	1974	1981	CHANGE
	BU/A		
WHEAT	26	40	+ 14.0
OATS	34	52	+ 18.0
RYE	18.5	24	+ 5.5
BARLEY	37	53	+ 16.0

CHANGE IN VALUE OF SUMMER CROPS IN THE SOUTH

CROP	1974	1981	CHANGE
	MILLIONS OF DOLLARS		
CORN 1	2,293	2,783	+ 490
SOYBEAN 2	3,499	4,967	+ 1,468
SORGHUM 3	981	891	- 90
COTTON 4	4,446	5,604	+ 1,158
PEANUT 5	771	878	+ 107
TOTAL	11,990	15,123	+ 3,133

1=$3/BU, 2=$7/BU, 3=$2.5/BU, 4=$1/LB, 5=$.24/LB

CHANGE IN VALUE OF WINTER CROPS IN THE SOUTH

CROP	1974	1981	CHANGE
	MILLIONS OF DOLLARS		
WHEAT 1	580	2,795	+ 2,215
OATS 2	179	214	+ 35
RYE 3	65	94	+ 29
BARLEY 4	48	53	+ 5
TOTAL	872	3,156	+ 2,284

1=$3.75/BU, 2=$1.65/BU, 3=$3.50/BU, 4=$3.00/BU dramatically from the mid 1970's through 1982. According to "No-Tillage Farmer" magazine survey report, about 60% of the approximately **12** million acres of no-tillage in the USA is practiced in the South. The evidence indicate that the Land Grant Colleges in the South are doing a good job in research, Teaching, and extension efforts. They are providing information to southern farmers on the long growing season rnulticropping advantages and how minimum tillage is an excellent management tool to aid in multicropping success while saving soil and other costly resources at the same time.

Table 2 data indicate that southern farmers are adapting better management derived from experiment stations in all categories of research. Note that yield per acre increased by all crops during the 8-year period and that gross value of both summer and winter crops increased by 5.5 billion dollars in 1981 over 1974. Increased wheat and soybeans that were grown predominantly in multicropping minimum tillage systems in 1981 contributed over 3.5 billion dollars to the gross value over 1974.

An example of some multicropping minimum tillage systems adapted to the deep South are given in Table **3.** Sunflower and corn were planted in late February followed by sunflower, grain sorghum, and soybeans planted in late July in a minimum of three acre blocks in research verification farm plots. Note that not only choice of cropping system is important in maximizing production and profit but that the multiplicity of genetic cultivars complicate the management decisions. Sixty-three combination of choices are shown but the most profit under these conditions would be Pioneer brand **3320** corn followed by Cobb soybeans in the same warm season. Thousands of multicropping minimum tillage system management choices are available to our farmers in the South that include the use of mulches, cover crops, crop residues, and N-fixing legumes. The scientists of the Agricultural Experiment Stations and Cooperative Extension Service will continue to provide the answers as support is made available from various sources in society.

Table 3, Yield, Gross Sales, and Estimated Profits from Warm Season Double-Cropping No-Tillage Systems on the Parash Farn in Alachua County, Florida in 1982 by R. N. Gallaher.

Crop Sequence	Cultivar	Yield	Gross Sales	Profit After Cost of: Variable	Profit After Cost of: Total
Sunflowers					
1 st.	DG 164	1455 #/a	$138.23	$ 25.48	$ -16.43
1 st.	D0 843	1861 #/a	176.80	64.05	22.14
1 st.	DO 705	2238 #/a	212.61	99.86	57.95
Corn					
1 st.	P-B-3320	135 bu/a	398.25	268.08	226.17
1 st.	GK 748	132 bu/a	389.40	259.23	217.32
1 st.	DK XL71	123 bu/a	362.85	232.68	190.77
1 st.	ASG 777	116 bu/a	342.20	212.03	170.12
1 st.	CKR 19	112 bu/a	330.40	200.23	158.32
1 st.	F-4507A	109 bu/a	321.55	191.38	149.47

Crop Sequence	Cultivar	Yield	Crass Sales	ProfitAlter Cost of: Variable	ProfitAlter Cost of: Total
Sunflowers					
2 nd.	DO 705	520 #/a	$ 49.40	$ -21.60	$ -37.25
Grain Sorghum					
2 nd.	F-G522DR	67 bu/a	134.00	48.52	30.70
2 nd.	DK BR64	69 bu/a	138.01	52.52	34.70
2 nd.	GK 8020	76 bu/a	152.00	66.52	48.70
-.%&=mi					
2 nd.	Bragg	31 bu/a	151.91	51.24	31.14
2 nd.	Coker 488	33 bu/a	161.71	61.01	40.94
2 nd.	Cobb	40 bu/a	196.00	95.34	75.21

F=Funks, DK=DeKalb, GK=Gold Kist, CKR=Coker, P-B=Pioneer Brand, ASG=Asgrow.

INNOVATIONS IN NO-TILL PLANTING AND SPRAYING EQUIPMENT

F. D. TOMPKINS

INTRODUCTION

The summary of a farmer survey published recently in a popular agricultural chemical magazine indicated that conservation tillage practioners, including no-till producers, were apparently quite satisfied with field results obtained using these reduced tillage cultural practices. Sixty-four percent said that they were very satisfied, and an additional 32 percent said they were at least moderately satisfied. However, the same survey noted that the three most important reasons farmers gave for opposing conservation tillage production practices were inadequate weed control, higher chemical costs, and lack of proper equipment. Both researchers and manufacturers have been aware of the need for improvements in each of the areas of expressed concern, and some of the recent innovations in planting and spraying equipment either directly or indirectly address these perceived problem areas.

PLANTING EQUIPMENT

The line of row-crop planters and drills designed specifically for seeding in previously untilled soil continues to expand. Perhaps of greater importance to the individual farmer is the growing array of available planter component options which may provide the flexibility of making a given machine adaptable to a particular set of planting conditions.

The essential functions which must be performed by the planter include opening the furrow to the desired seeding depth, metering the seed and placing them in the furrow in an acceptable pattern, and closing the furrow and compacting the soil around the seed to insure seed-soil contact necessary for germination. Most current no-tillage planters employ a special attachment ahead of the planter opener to cut through the surface residue and to penetrate the soil to at least the depth of seed placement. Fluted, ripple, and plain rolling coulters are all used extensively because they handle surface trash well and leave the planting surface smooth. Ripple coulters are increasing in popularity in Tennessee because they require less down pressure to penetrate the soil than fluted coulters and generally cut through crop residue more easily. To accommodate uneven ground across the width of the planter, individual coulters attached to the planter mainframe are generally equipped with down pressure springs to insure uniform depth of soil penetration. Ballast required to achieve coulter penetration in tough soil conditions is placed on the planter mainframe which has been designed to accept the necessary additional weight.

The double-disk planter opener is widely used to open the furrow in the track created by the rolling coulter, although a runner-type opener is used on some models. At least one model employs an offset double-disk planter opener to

---

F. D. Tompkins is an Associate Professor in the Department of Agricultural Engineering, The University of Tennessee, Knoxville, Tennessee.

penetrate untilled soil without benefit of a leading coulter to reduce the soil strength. A depth control device is essential to insure uniform seeding depth, and several effective models are available.

The difficulty of closing the furrow behind the planter opener depends upon the characteristics of the soil, especially the moisture content. The number of types of soil firming wheels, or presswheels, and other furrow closing accessories available for no-tillage planters has increased substantially. The furrow should be closed completely burying the seed, but excessive compaction of the soil directly above the seed is not desirable. Thus, several of the new firming wheels operate in pairs, one on either side of the furrow, and are oriented at an angle to the vertical so as to apply pressure to the sides of the furrow, forcing it to close. In tests evaluating the performance of commercial no-tillage planting units used for seeding soybeans in wheat stubble at Milan in 1982, a planter equipped with a pneumatic center-rib presswheel operated in Calloway silt loam soil at 21 percent moisture (db) failed to adequately close the furrows leaving an average of 28 percent of the seeds exposed. A similarly equipped planter operated in Memphis silt loam at 20 percent moisture achieved complete furrow closure and excellent seed coverage. This situation vividly illustrates the importance of carefully matching planter components to operating conditions.

SPRAYING EQUIPMENT

The low-volume (LV) chemical application concept has long allured farmers, researchers, and product developers with the potential advantage of eliminating much of the water hauling associated with conventional hydraulic spraying using several gallons of liquid per acre. If chemicals are to be applied directly to the soil as in a preplant incorporated spray, there are research data indicating that volume of carrier and application technique are of little importance as long as a uniform distribution over the ground surface is obtained. However, other factors become important if good weed control is to be assured for crops no-till planted in the stubble of previous crops. For example, sprays applied at planting should thoroughly cover the foliage of existing vegetation to effect post emergence control and uniformly penetrate the stubble enroute to the soil surface to establish preemergence control. Accomplishing these two things with an LV system is the challenge.

Rotary atomizers known as controlled droplet applicators (CDA) are currently being widely marketed as LV applicators. The CDA produces spray droplets fairly uniform in size with the characteristic size being determined by the liquid flow rate through the spinner, the disk rotational speed, and the physical properties of the liquid being sprayed. By contrast, any flat fan hydraulic nozzle produces a broad spectrum of droplet sizes, some quite small and others relatively large. Gebhardt and Webber of Missouri compared the droplets produced with a CDA applying three gallons per acre to those produced by a flat fan nozzle applying 20 gallons per acre. They noted that the CDA produced few very small droplets (less than 100 micrometers in diameter) compared to the flat fan nozzle. To assure reasonably thorough coverage of plant foliage with LV, the liquid must be broken into small droplets: the CDA can accomplish this task.

Two problems have consistently been identified by researchers using CDA for LV application of contact herbicides for post emergence weed control. They are (1) swath displacement by cross winds and (2) lack of canopy penetration desirable for thorough foliar coverage of target weeds. Since the droplets formed for LV foliar application are necessarily small, wind can displace virtually the entire swath down range. Therefore, exercise caution when using contact materials near susceptible crops. Droplets are discharged radially outward from the CDA spinner in a horizontal plane above the target plant. Thus, the only force acting to deposit the droplets on the plant foliage is gravity, unless wind adds a lateral driving force. Studies have shown that foliage penetration can be enhanced by tilting the atomizer at an angle of up to 45 degrees.

Use of crop oil as a pesticide carrier or diluent has generated considerable interest in the past two or three years. This interest has generally coincided with the distribution and adoption of LV applicators, particularly the CDA. Crop oils used with LV applicators offer, among others, the following reported advantages:

1. Reduced evaporation. Small droplets of water carrier evaporate rapidly under certain weather conditions. This evaporation creates even smaller droplets more easily moved away from the target surface by wind. Since crop oil carriers are much less volatile, the droplet will remain essentially the same size throughout its flight.

2. Increased spread factor. When a droplet impacts on a plant surface, the material spreads to cover an area greater than the diameter of the original droplet. The spread factor of a vegetable oil droplet is three to four times that of water. This phenomenon may be of especial importance in control of weeds with contact herbicides using LV applicators.

3. Resists washoff. Tests indicate that oil droplets deposited on plant tissue form a film after a period of time. When this film has been established, the chemical is not readily removed by rainfall.

4. Better plant penetration. Some evidence has been presented to show that oil penetrates plant tissues better than water. Research studies have also indicated that oil seemed to boost the activity of some herbicides to produce better weed control than the same herbicide carried in water.

An investigation is currently underway at Milan which focuses upon comparing LV application with conventional application rates for both preemergence and post emergence herbicides in no-till soybeans planted in wheat stubble. LV applications are being made with both CDA and low capacity hydraulic flat fan nozzles. Both water and crop oil-in-water carriers are used in each system.

Progress is being made in ultra low-volume chemical application technology. Commercially promising prototype machines which generate fluid droplets each carrying an individual electrical charge are currently being used to apply foliar pesticides at rates of less than one-half pint total solution per acre. Electrostatic charging helps create very small droplets which are necessary to assure thorough foliar coverage at such low application rates. The small droplets are then in turn attracted to oppositely charged biological targets (plant foliage) so that drift and waste of pesticide are minimized. A tractor-mounted electrostatic sprayer model is currently being used in Milan for application of a post emergence over-the-top grass herbicide in no-tillage soybeans. A hand-held electrostatic sprayer unit is being used similarly with emphasis upon Johnsongrass control.

There is renewed interest in post emergence directed sprayers for use in no-till soybeans. There already exist preemergence soil surface-applied herbicides which effectively control a broad spectrum of weeds. These have been recently complemented with some highly acclaimed over-the-top post emergence herbicides. However, from the standpoint of total cost of herbicides necessary to produce a crop, post emergent directed spraying may offer an economically attractive alternative. Accordingly, a study is currently in progress at Milan to evaluate seven commercial and experimental directed spray applicators operated in soybeans planted with 20-inch row spacing. Each of the sprayers features devices for shielding the soybean plants from the spray being applied between the rows. Nozzles recommended by the various manufacturers range from flood-type to flat fan and even spray.

A CLOSING COMMENT

Recall the three most frequently mentioned reasons for opposing no-tillage or conservation tillage production practices in general. Equipment innovations and technique refinements in the areas of planting and chemical application for no-tillage production will surely go far to negate these arguments against no-tillage farming.

PERTINENT LITERATURE

1. Akesson, N. B., K. Haq, and W. E. Yates. 1983. Pesticide spray drop spectra correlated with fluid physical properties. ASAE Paper No. 83-1014. American Society of Agricultural Engineers, St. Joseph, MI.

2. Bode, L. E., B. J. Butler, S. L. Pearson, and L. F. Bouse. 1982. Characteristics and operating parameter of CDA applicators. ASAE Paper No. 82-1002. American Society of Agricultural Engineers, St. Joseph, MI.

3. Gebhardt, M. R. and C. L. Webber, III. 1982. Controlled droplet applicator operation. 1982 Report Agronomy Research Center, University of Missouri, Columbia. pp. 35-37.

4. Matthews, E. J. and C. Lincoln. 1982. Electrostatic application of herbicides and insecticides. ASAE Paper No. 82-1003. American Society of Agricultural Engineers, St. Joseph, MI.

NO-TILL FORAGE CROPS

J. KENNETH EVANS

INTRODUCTION

Sod planting of corn has developed into a widespread practice in Kentucky and many other states in the past 10 years. Sod seeding of small seeded legumes is a much older practice with reports in the literature as early as 1910 of seedings made in 1879 at Cornell University, In fact, broadcast seeding of clover on snow or frozen soil in late winter has been a widely used farm practice in Kentucky for probably over 100 years. Although this method of seeding has been most common in stands of small grains seeded the previous fall, many farmers also broadcast clover seed on the surface of fields containing perennial cool-season grasses. Historically some alfalfa seedings were made into small grain stands, but very little has been seeded broadcast into perennial cool-season grasses.

Prior to the early 1950's research was very limited on no-tillage or minimum tillage methods of seeding any forage species. Consequently, most farmers felt it was necessary to plow and prepare a fine seedbed if stands were to be obtained. Since much of the forage acreage in the eastern United States is quite susceptible to erosion, plowing and preparing seedbeds resulted not only in considerable expenditure of time and money but also unacceptable soil losses.

Considerable research efforts over the past 30 years have been devoted to establishment or re-establishment of desirable forage species with minimum disturbance of vegetative cover and soil. Today I want to state some ecological principles which must be satisfied if any sod seeding is to be successful. Next, I will discuss some research results and report some observations and experiences which illustrate how these principles may be satisfied.

STATEMENT OF ECOLOGICAL PRINCIPLES

Some ecological principles must, of necessity, be considered if any no-till forage seeding is to be successful. These are: (1) the existing vegetation must be controlled; (2) lime and fertilizer must be applied to satisfy needs of the species to be seeded; (3) seed must be covered; and (4) pests must be controlled.

CONTROL OF EXISTING VEGETATION

No-tilling small seeded species into heavy layers of thatch or into tall vegetation is inviting failure. Control or removal of the thatch must be

---

J. KENNETH EVANS is an Extension Specialist in Forages, University of Kentucky, Lexington, Kentucky.

accomplished to avoid damping off diseases and to remove hiding places for insects and slugs which will attack the new seedlings. Burning may be acceptable in some areas and unacceptable in other areas, but it works. Tall vegetation will provide excessive shade for some types of seedlings, but may be more acceptable for others. In our experiences, we would rank species such as crownvetch and birdsfoot trefoil as extremely susceptible *to* early seedling competition and red clover and white clover least susceptible to shading with alfalfa intermediate between these species.

It is highly desirable *to* have a pasture or grass field closely grazed before making no-till seedings. This is difficult to do if there are no fences or if the fields are located some distances from the cattle. It is also difficult to achieve close grazing by lactating dairy cows without limiting milk production, especially in late summer for autumn or early fall seedings. In cases where close grazing after seeding cannot be achieved or where the vegetative regrowth cannot be controlled by mowing, chemicals such as Paraquat or Roundup may be used prior to seeding to reduce the competition of existing vegetation for new seedlings. Ohio State University recommends a spraying with *2,4-D* to control broadleaved species followed by a waiting period and Paraquat spraying to control the grass growth prior to seeding small seeded legumes. Tennessee has recommended strip spraying with Paraquat prior to seeding simply by rotating nozzles on the spray boom to get the desired coverage. Many Kentucky farmers have successfully used this method to establish legumes in grass when seeding was done in late winter.

We have been consistently successful in our experimental plots in establishing both red clover and alfalfa in either bluegrass or fescue by drilling seed into closely clipped sod and mowing the grass above seedlings of these species. Many farmers in Kentucky successfully renovate without tillage and without chemicals by using the grazing animal to control competition for the seedlings. Generally, we find that since alfalfa is more sensitive to seedling competition, it is desirable to spray a closely grazed or clipped sod with Paraquat (if suppression is desired) or Roundup (if more kill is desired) prior *to* seeding. It should also be pointed out that most farmers are very busy and will not observe newly seeded fields as frequenly as researchers. Therefore more competition may be developed for the seedlings before it is observed and after it is too late to do anything about it without injuring the seedlings. If this is the case it is probably desirable to use chemicals in the control of existing vegetation. Selection of chemicals and combinations of grazing and clipping should be tailored to fit the vegetation to be controlled and the species to be seeded.

We have successfully established summer annual grasses into cool-season grass sods by drilling with no-till drills and band spraying Paraquat in 9" bands over the rows. Best production on these seedings can be obtained when nitrogen fertilizer is placed in bands 4" from the row. However, this is difficult to do at seeding if the drill has no fertilizer box. It is probably impractical to accomplish anything other than broadcast nitrogen applications after the first cutting or grazing of these species.

LIME AND FERTILIZE FOR THE SPECIES TO BE SEEDED

The most critical need for lime is obviously for species that have a higher pH requirement such as alfalfa. Seeding alfalfa or clovers into fields with a pH of less than 6.2 can, on some soils in the eastern United States, result in molybdenum deficiencies which reduce nodulation and nitrogen fixation. Also, proper liming facilitates phosphate availability and reduces quantities of toxic elements such as iron, manganese and aluminum which are in the soil solution.

It is also critical for legumes seeded into grasses that the phosphorus and potassium be brought up to the proper level for the legume species to be seeded. The addition of nitrogen fertilizers when seeding legumes into grasses will simply stimulate grass growth and result in competition for the legumes and necessitates much more careful management to control the existing grass by either grazing or clipping or chemical control prior to seeding.

With the warm season annuals seeded into cool-season species, we learned many years ago that there was excessive competition for both nitrogen and water if corn was no-till planted into cool-season grasses which were not killed. In fact, the first research done by Shirley Phillips on no-till corn into fescue indicated that unless one killed more than 70% of the existing sod, this competition would severely limit corn yields.

COVER THE SEED

We have had several graduate students at the University of Kentucky over the years who have done research involving varius aspects of no-till seedings such as seeding rate, seeding time, herbicides, fertility, and seeding depth. In all of these experiments the one thing which has consistently increased size of seedlings and number of plants per 100 seed planted, is covering seed. It really doesn't matter how the covering is accomplished. For example, in the northeastern United States and as far south as freezing occurs, frost heaving will provide some cover for seed on thin grass stands or stands of small grain; that is seed put on top of the ground will be covered by the frost heaving. As the seeding is done later in the spring, past the time of freezing, it becomes more critical that the seed be actually placed in the ground. Also, the actual precise placement of seed at the desired depth is a much more efficient and consistent way of getting a stand. If we simply control the grass by spraying or grazing or both, and broadcast seed on top of the ground, we can get acceptable stands if the seeding is made in late winter while freezing and thawing is still occurring. If we use one of the no-till planters, we can reduce seeding rates and get equivalent stands. In approximately 25 experiemnts over the years with the no-till seeding equipment, we have found that there is never a need for more than 6 pounds of red clover seed per acre and probably no need for more than 10 pounds of alfalfa seed per acre, however we still use 15 pounds.

CONTROL PESTS

This is a principle which must be satisfied with any type of seeding but it can be more critical in no-till seedings. We have lost stands of seedling plants to weeds, army worms, slugs, diseases, and unknown factors. We know that we have a serious problem in Kentucky with the clover root curculio. This insect is in the soil and is especially bad in some fields where clover or other legumes have been present for a long time. Root and nodule feeding of these insects can do great damage to seedling stands. Dale Wolf and his co-workers in Virginia have found damage to legume seedlings from the seed corn maggot feeding on the roots. In fact, we were shown an experiment in Virginia last year where Furadan had improved seedling stands on any area which had living cover over the winter. We have known for many years that no-till corn planted into a killed sod will shown much more pest damage on both roots and tops, than corn planted on a prepared seedbed.

In some states, 24C labels have been approved for Furadan use on no-till forage seedings, however this is not the case in Kentucky. Our entomologists feel that the label requirement for incorporation of Furadan is not satisfied in the no-till planting. Other states interpret the label to be satisfied if a coulter is incorporating the Furadan in the furrow.

The Integrated Pest Management philosophy of applying only those pesticides which are needed prohibits the application of soil insecticides unless there is an economic level of a known insect population to be controlled. As a practical matter, it is difficult or impossible for a farmer to ascertain the soil insect population until it has already decreased or eliminated his stand. Our experience with no-till corn tells us there is more likelihood of root insect feeding on crops planted by the no-till method into old sods.

We should also recognize that the no-tillage method of planting forages can be no more universally applied than can no-till planting of corn. There are simply some soils and some weed problems in which no-till planting is doomed to failure. We can circumvent some problems by properly timing the planting to favor the seeded species. For example, we can obtain excellent stands of cool-season grasses and legumes in johnsongrass fields by working on johnsongrass control through the summer and doing the new seeding in autumn. The johnsongrass regrowth then frosts back and the cool-season species continues to grow for a period before dormancy is induced. The cool-season species will then begin growth early in the spring and be ahead of the johnsongrass at the time it begins growth.

SUMMARY

Several conclusions appear to be justified by data and experiences collected over the years.

1. Forages can be established without plowing and preparing a seedbed.

2. Some reduction in the competitive advantage of existing vegetation is needed to insure development of seedlings. This can be accomplished by close grazing prior to and after seeding, use of appropriate herbicides or a combination of the two. The value of herbicide appears to be greater in dry years.

3. Covering the seed results not only in better stands but more consistent stands than seeding on the soil surface.

4. Use of a once-over renovator which precision places seed in a furrow permits use of seeding rates which are lower than normally used with conventional seeding techniques.

5. Control of pests which either eat or compete with the newly seeded crop is imperative if successful stands are to be established and maintained.

Conservation Cropping Systems for Production and Soil Erosion Control in the South[1]

G. W. Langdale, A. W. Thomas, and E. L. Robinson[2]

INTRODUCTION

Soil erosion rates associated with conventional tillage of Ultisols and Alfisols in the Southeast usually exceeds T-values (Larson, 1981). Lowdermilk (1953) suggested circa 30 years ago that tillage procedures that permit crop residues to remain at the ground surface is one of the most significant contributions to American agriculture. Since the intense influx of European settlers during the early 1800's or the beginning of the cotton era, southern farmers and researchers have been struggling sporadically with conservation tillage systems. Ruffin (1832) used a crude mulch tillage in Virginia to control soil erosion. Perhaps, this was the first recorded conservation tillage attempt in the South. In a crop rotation system that included clover and the addition of marl plus dunging, Ruffin described the tillage system as troublesome and imperfect. Hilgard (Jenny, 1961) recognized that improved implements of tillage without sound conservation principles were ruining the once productive land of the Southeast. The next recorded conservation tillage event was cited by Lowdermilk (1953) in north Georgia during the mid 1900's. He describes the conservation principles used by a farmer, "Mr. Gowder," for approximately 20 years on land with slopes up to 17%. His principal tillage implement was a 4-inch wide bull-tongue plow used to chisel his topsoil rather than plowing down crop residues. After 20 years, Mr. Gowder was still growing crop on near original topsoil depths, while his ridiculing neighbors were plowing subsoil.

RECENT RESEARCH

Discussion of conservation tillage research will be limited to studies with erosion measurements. Conservation tillage began on the Experiment Stations using cool season green manuring crops (legumes and small grains) in the 1940's. These tillage practices began with the mulch balk methods and evolved the wheel track planting method (Beale, 1950; McAdams and Beale, 1959; Nutt et al., 1943 Beale et al., 1955; and Larson and Beale, 1961). Often several primary tillage procedures (disk, rip, moldboard plow, etc) were required prior to planting. These conservation tillage procedures reduced soil erosion as much as 80% on runoff plots (Table 1), but little adoption by farmers was experienced. Up to this point conservation tillage was confined primarily to the Southern Piedmont in the Southeast.

---

[1]Contribution from Southern Piedmont Conservation Research Center, Watkinsville, GA, 30677, USDA, ARS, in cooperation with the University of Georgia Experiment Station.

[2]Soil Scientist, Agricultural Engineer, and Research Agronomist, USDA, ARS, Watkinsville, GA.

Lister planting equipment, a minimum tillage that required at least one secondary tillage operation, was designed to plow some of the topsoil out of the planting furrow for planting (McAlister, 1962). This tillage pratice experienced some adoption for planting corn in sods and soybeans following small grain harvest in the late 1950's and early 1960's. Unfortunately, this tillage procedure was tested on runoff plots only on silt loam soils of Mississippi (Greer et al., 1976). This tillage approach did not control runoff and soil erosion well in a wheat/soybean cropping system in Mississippi (Table 1). However, this system was given qualitative soil erosion control credit on low silt content Typic Hapludults soils (Hendrickson et al., 1963).

Fluted coulter tillage emerged in the upper South on cool season sods during the late 1960's (Jones et al., 1968; Blevins et al., 1968; Carreker et al., 1972). This breakthrough permitted the first single tillage operation that was capable of reducing soil erosion to rates less than 1.0 ton per acre. Like lister tillage, no runoff studies associated with fluted coulter/cool season sods were conducted. However, one rainulator study (Table 1) was accomplished on live fescue sod that provided some insights with respect to soil erosion control (Barnett et al., 1972). Several runoff studies were published to document the effectiveness of fluted coulter tillage to control soil erosion following grain crop residues on both Alfisols and Ultisols (Table 1 and 2). In all multiple crop modes, soil erosion was reduced below 1.0 ton per acre on rainfed watersheds and runoff plots as well as rainulator plots.

The coulter-inrow chisel practices emerged in the lower South during the late 1970's because of plant root restricting soil layers, especially on coastal plain soils. The inrow chisel practice consistently controls both runoff and soil erosion on the Ultisols (Table 1 and 2). Near 100 year frequency storm energies are required to produce significant runoff with this tillage practice in a double crop mode (Table 1 - Simulated Rainfall). With rainfed conditions, soil erosion on sloping land up to 7.0% is essentially eliminated (Table 2).

Conservation tillage research has evolved slowly during the past 40 years. Most of these conservation cropping systems effectively control soil erosion well below the accepted T-values. However, this research was accomplished on the best land capability classes of Ultisols and Alfisols. Slopes of this landscape were usually less than 8.0%. Uncertainities exist if we stress conservation tillage cropping systems to control soil erosion on marginal farm land with steep slopes during the next few decades.

Table 1. Effect of Tillage/Cropping system on runoff and soil erosion.

Tillage/Cropping Systems	Cover Crop	Soil†	Annual Runoff	Annual Erosion	Reference
			%	Tons Acre^{-1}	
		Natural Rainfall			
Mulch-Corn	Vetch/Rye	Typic Hapludults	2.5‡	0.43‡	(2)
Conventional-Corn	Fallow		16.6‡	2.81‡	(2)
Conventional-Cotton	Fallow		21.2	20.0	(6)
Lister-Soybeans	Wheat	Typic Fragiudalfs	30.0	4.00	(5)
Conventional-Soybeans	Fallow		32.0	4.70	(5)
Coulter-Soybeans	Wheat	Typic Fragiudalfs	23	0.80	(18)
Conventional-Soybeans	Fallow		29	7.80	(18)
Coulter-Corn	Corn residues	Typic Fragiudalfs	26	4.30	(19)
Conventional-Corn	Fallow		31	9.30	(19)
Coulter-Soybean	Wheat	Typic Paleudalfs	545	0.75§	(22)
Conventional-Soybeans	Fallow		27§	5.15§	(22)
Coulter-Soybeans	Barley	Typic Hapludults	4	0.04	(23)
Coulter-Grain sorghum	Barley		5	0.03	(23)
Conventional-Soybeans	Rye (Green manure)		12	1.53	(23)
In-Row Chisel-Soybeans	Wheat	Typic Hapludults	3	0.03	(10, 1
Conventional-Soybeans	Fallow		18	11.70	(10,11)
		Simulater Rainfall			
Conventional	Bare Fallow	Typic Hapludults	78¶	16.74'	(12)
Live Fescue	Fescue		48¶	0.16'	(1)
Coulter	Rye Stubble		57¶	0.04'	(9)
In-Row Chisel	Rye Stubble		8¶	0.08¶	(12)

†Average slopes range from 3 to 8%. ‡ Corn growing season only (April - September);
§Eight selected natural and simulated storms. ¶Five inches of water applied during 2 hours periods to develop ~ 100 EI units (initial rainulator runs).

Table 2. Effect of Cropping/Tillage Systems* on Grain Yield, Runoff, and Sediment Transport.

Crop	Grain Yield	Rainfall	Runoff	Sediment
	Bu acre^{-1}	Inches	%	Tons acre^{-1} year^{-1}
		CONVENTIONAL TILLAGE		
Fallow	--	31	9.0	1.4
Soybeans	19	20	33.0	10.3
		COULTER TILLAGE		
Barley	49	35	8.5	0.06
Grain sorghum	81	14	5.7	0.004
		IN-ROW CHISEL TILLAGE		
Wheat	57	28	2.4	0.013
Soybeans	40	19	2.7	0.0
		IN-ROW CHISEL TILLAGE		
Clover	--	24	1.6	0.002
Grain Sorghum	88	13	0.0	0.0

* Twelve years of research on a 6.7 acre watershed at Watkinsville, Georgia (10, 11).

LITERATURE CITED

1. Barnett, A. P., E. R. Beaty, and A. E. Dooley. 1972. Runoff and soil losses from closely grazed fescue, a new concept in grass management for the Southern Piedmont. J. Soil and Water Cons. 27(4):168-170.

2. Beale, O. W., G. B. Nutt, and T. C. Peele. 1955. The effects of mulch tillage on runoff, erosion, soil properties and crop yield. Soil Sci. Soc. Am. Proc. 19:244-247.

3. Blevins, R. L., L. W. Murdock, and G. W. Thomas. 1978. Effect of lime application on no-tillage and conventionally tilled corn. Agron. J. 70:322-326.

4. Carreker, J. K., J. E. Box, Jr., R. N. Dawson, E. R. Beaty, and H. D. Morris. 1972. No till corn in fescue grass, Agron. J. 64:500-503.

5. Greer, J. D., K. C. McGregor, G. E. Gurley, and B. R. Arnold. 1976. Erosion measured from a lister-till system. pp. 103-109. In Mississippi Water Resources Conf. Proc., Mississippi State, Mississippi.

6. Hendrickson, B. H., A. P. Barnett, and O. W. Beale. 1963. Conservation methods for soils in the Southern Piedmont. USDA. Agric. Inform. Bull. No. 269. 18 pp.

7. Jenny, Hans. 1961. E. W. Hilgard and the birth of modern soil science. Collana Della Revista Agrochimica No. 3. Simposio Internazionale di Agrochimica. Pisa, Italy. 144 p.

8. Jones, J. N., J. E. Moody, G. N. Shear, W. W. Moschler, and J. H. Lillard. 1968. The no-tillage system for corn (Zea mays L). Agron. J. 60:17-20.

9. Langdale, G. W., A. P. Barnett, and J. E. Box, Jr. 1978. Conservation tillage systems on their control of water erosion in the Southern Piedmont. pp. 20-29. In J. T. Touchton and D. G. Gummins (eds.) Proceedings of the first annual southeastern no-till systems conference. GA. Exp. Sta. Spec. Publ. No. 5. 52 pp.

10. Langdale, G. W., A. P. Barnett, R. A. Leonard, and W. G. Fleming. 1979. Reduction of soil erosion by the no-till system in the Southern Piedmont. TRANS of ASAE 22(1):83-86, and 92.

11. Langdale, G. W. and R. A. Leonard. Nutrient and sediment losses associated with conventional and reduced tillage agricultural practices. In R. Todd (ed.) Nutrient Cycling in Agricultural Ecosystems. (In review).

12. Langdale, G. W., H. F. Perkins, A. P. Barnett, J. C. Reardon, and R. L. Wilson, Jr. Reduced soil and nutrient runoff losses associated with in-row chisel planted soybeans (Accepted for publ. in J. Soil and Water Cons.)

13. Larson, W. E. 1981. Protecting the soil resource base. J. Soil and Water Cons. 36(1):13-16.

14. Larson, W. E. and O. W. Beale. 1961. Using crop residues on soils of the humid area. USDA Farmer's Bull. No. 2155. 14 pp.

15. Lowdermilk, W. C. 1953. Conquest of the land through seven thousand years. U.S. Dept. Agr. Inf. Bull. No. 99, 30 p.

16. McAdams, W. N. and O. W. Beale. 1959. Wheel-track planting in mulch and minimum tillage operations. Assoc. Sou. Agr. Workers Proc. 56:55.

17. McAlister, J. T. 1962. Mulch tillage in the southeast. USDA Leaflet No. 512.

18. McGregor, K. C., J. D. Greer, and G. E. Gurley. 1975. Erosion control with no-till cropping practices. TRANS of ASAE 18(5):918-920.

19. McGregor, K. C. and J. D. Greer. 1982. Erosion control with no-till and reduced tilled corn for silage and grain. TRANS of ASAE 25(1): 154-159.

20. Nutt, G. B., W. N. McAdams, and T. C. Peele. 1943. Adapting farm machinery to mulch culture. Am. Soc. Agric. Eng. 24(9):304-305.

21. Ruffin, Edmund. 1832 (ed. by J. Carlyle Sitterson. 1961). An Essay on Calcareous Manures. The Belknap Press of Harvard University. Cambridge, Massachusetts. 200 pp.

22. Shelton, C. H., F. D. Tompkins, and D. D. Tyler. 1982. Soil erosion from five soybean tillage systems in West Tennessee. Tenn. Farm and Home Sci. Progr. Report No. 122 (In press).

23. Thomas, A. W., G. W. Langdale, and E. L. Robinson. 1982. Tillage and double cropped practices on Watershed. pp. 211-218. In E. G. Kruse, C. R. Burdick, and Y. A. Yousef (eds.) Proceedings of the Specialty Conference on Environmentally Sound Water and Soil Management. Am. Soc. Civil Eng. New York, 524 pp.

NO-TILL WORKS ON THE FARM

BILL TANNER

There is no doubt about it. No-till farming is here to stay because it pays. Over the last ten years it has paid off for us in improved soil conservation, reduced expenses, and the production of yields comparable or superior to those produced by conventional methods.

Beans no-tilled in wheat stubble, following two years of conventional corn, has been a real money-maker on level fertile corn land. On rolling ground a shortened rotation of one year of no-till corn followed by wheat and no-till beans has worked well. The wheat straw and chopped bean pomice are left on the ground over winter. Planting no-till corn into this residue in the spring means that with the exception of a brief period to establish wheat in'the fall, the ground is protected year-round. Thus far nematodes have not been a problem. Before either of these rotations can be followed profitably, fields must be free of wild garlic and johnson grass. It may take three or four years, but wild garlic can be eradicated economically through the persistent use of the proper chemicals at the proper time. It appears that the new over-the-top grass killers have reduced the johnson grass problem to a manageable size.

Following corn harvest, lime and fertilizer are applied in quantities sufficient to meet the requirements of both wheat and beans. It is quite important to select an early maturing, short strawed variety of wheat both to accelerate the bean planting date, and to prevent lodging and an excessive mulch of straw which makes accurate seed placement difficult. If straw is forced into the planting trench, the seed is insulated from soil contact, germination is delayed, and valuable growing time is lost. For high yields in double-cropped beans, time is of the essence. A few days can be gained by combining wheat at 18 to 20% moisture, and drying it in the bin. The pLanter should be large enough to stay right behind the combine without having to start planting early in the morning when the straw is tough and difficult to cut through.

Weed control is perhaps the No. 1 problem in no-till beans. It can be made easier by planting the beans in rows twenty inches or less so that middles are shaded early in the season. A good uniform stand of wheat also helps. Because good chemical weed control is ultimately dependent on rainfall to wash herbicides, intercepted by the mulch, down to the soil, a much smaller volume of water is just as satisfactory as the forty or fifty gallons we used to use. It is wise to have a back-up plan in case of a weather related failure of the initially applied herbicides. Skipping two rows behind the tractor wheels greatly facilitates any later use of the spray boom, spot spray, or rub bar which may be required.

The no-tillage concept is just as applicable to forage crops as it is to grains. Looking toward a February seeding of other grasses and clover, a

---

Bill Tanner is a farmer of Obion County, Tennessee.

heavy stand of fescue was sprayed solid with paraquat. Half the acreage was sprayed in mid–November and the remainder a month later. The November spraying was followed by two or three weeks of mild wet weather, and an estimated 75% of the fescue was killed. The December spraying was more effective, with a kill of about 90%. The area was seeded in mid February with a Marliss drill to red clover, ladino, and timothy. The resulting stand is excellent. About three acres was seeded in the same way at the same time to alfalfa with no less successful results. A few spots of common bermuda, which had been sprayed with Roundup the previous summer, were included in the seeding. It is quite important that the old sod be grazed or mowed as closely as possible, and that any excessive clippings be removed. A short period for the grass to recover before spraying with paraquat seemed to increase the kill.

Bill Tanner is a farmer of Obion County, Tennessee,

NO-TILL: IT WORKS ON THE FARM

NEIL WORLEY

INTRODUCTION

The Sam Worley farm, in Maury County, Tennessee, is situated at the extreme western edge of the Nashville Basin in small creek valleys between outlying ridges of the Highland Rim. The open land is mostly of the Dellrose-Mimosa-Armour soil association, with gentle to moderately steep slopes (2–25%) and highly dissected topography. Field size is generally under fifteen acres, often with several soil types in a given field. Much of the farm suffered considerable erosion in the nineteenth and early twentieth centuries, particularly the Mimosa soils (about 1/3 of the cropland), and surface texture ranges from heavy silt loam to silty clay loam with or without chert. Except in small creek bottom areas, soils are well to excessively drained.

During the 1950's and 1960's, much of the marginal cropland was in permanent pasture and hay crops, with the remainder in a two-year barley-grain sorghum-wheat rotation. A small amount of corn silage was grown.

In the 1970s, a two-year wheat-soybeans-corn rotation became more advantageous economically, and some additional land was acquired. In order to implement this new rotation and increase crop acreage, a no-till planter was purchased in 1975. Since 1977, all of the corn and soybeans on the farm have been planted no-till. Wheat is conventionally drilled after a light disking of cornstalks.

EFFICIENT CROPPING AND CONSERVATION

The primary purpose behind the switch to no-till on the Worley farm was conservation. On steep, irregular slopes modern machinery and contour terraces were incompatible, and only no-till seemed to offer hope of reducing soil erosion to acceptable levels while utilizing the soils reasonably efficiently and intensively. This commitment to both intensive use and conservation requires a drastic change in philosophy: no longer do we consider tillage as a normal practice, but as an obstacle to the natural soil-forming process.

The greatest advantage of this long-term commitment to no-till lies in the cumulative nature of the benefits to the soil. In fields which have been under continuous no-till cropping for several years, soil organic matter has continued to increase over time, with concommitant changes in soil physical condition. Surface and subsurface structure has become stronger, infiltration and permeability have improved; and in some cases internal drainage seems to have improved. Particularly in the cases of some small areas of Egam and Dunning soils (somewhat poorly-drained bottoms), the load bearing capacity of the soil when wet has increased. All of these changes have occurred slowly but seem to be continuing after eight years of no-till cropping.

Neil Worley farms with his father, Sam, and his brother, Stephen, near Hampshire, Tennessee.

When deep tillage is eliminated as an option and even light disking strictly limited, other features in the cropping program must take up the slack in weed and disease control. Experience has shown, however, that combinations of certain crop rotations (or even specific varieties) and herbicide programs can control almost any problem, usually far better than was originally expected. Extension's recommendations have been useful starting points, but considerable experimentation has been necessary to find a suitable prescription for some fields and improvements are still being made.

CROP RESULTS

All of the soil conservation benefits of no-till, even the virtual elimination of erosion, would not bring about its adoption if crops could not be economically produced. On the Worley farm, however, no-till crop yields have been quite satisfactory. Before and after figures are not available, since the crop rotation was changed at about the same time as the planting system, but the current four-year average yield is 101 bu./A of corn and 30.3 bu./A of double-cropped soybeans, on soils which should be expected to yield 70 bu. of corn and 28 bu. of full-season soybeans, according to Bell, et al.[1]. Only wheat yields do not seem to have been improved by the no-till rotation, disease problems having held the four-year average to 34 bu/A

Not only have row crop yields been satisfactory, but lower labor and machinery costs have allowed the total cost of producing a crop to be lower with no-till than with conventional tillage. It has been possible to expand cropped acreage to Class III and IV land and, indeed, the greatest improvement in yield has been on what were considered the poorest soils - eroded, clayey, or poorly drained.

PRACTICAL OBSERVATIONS

I have mentioned only the benefits to the soil, but the list of benefits we have derived from no-till cropping is extensive: timely planting with less fuel and labor, tripled crop acreage with same tractor power, less lodging of corn, etc. After eight years, we would not even consider going back to plowing.

To make no-till work, it is essential to plan ahead: take a unified, whole-system approach, keep fertility high, be aware of potential weed problems early, keep up with new technology. It is particularly vital to scout for and spot treat johnsongrass at levels far below the conventional tillage economic threshhold. Of course, these same factors are well utilized by many in conventional tillage systems, but only no-till develops the full long-term potential of our sloping and fertile soils.

[1] F. F. Bell, G. J. Buntley and Paul Denton. Yield Estimates for the Major Crops Grown on the Soils of Middle and East Tennessee, Univ. of Tenn. Ex~. Sta. Bu. 604, July 1981.

NO-TILL OF THE FUTURE

W. W. FRYE[1]

Naisbitt (6) stated, "The most reliable way to anticipate the future is by understanding the present.'' To understand the present status of no-till, we must know where it is in relation to the past and know whether the trend is up or down. According to estimates from a survey conducted by No-Till Fanner, no-till in row crops increased from about 3.3 to 9.2 million acres, an increase of 179 percent, during the period from 1972 to 1982. The rate of adoption has accelerated in recent years. No-till of row crops increased by about 30 percent in 1981 and 16 percent during 1982.

It seems safe to predict that the upward trend in no-till will continue into the foreseeable future. The U.S.D.A., Office of Planning and Evaluation (9) estimated that 45 percent or 153 million acres of the total U.S. cropland will be under no-till by 2000. An estimated 65 percent of the seven major annual crops (corn, soybeans, sorghum, wheat, oats, barley, and rye) will be grown using no-till by 2000 and 78 percent by 2010. The level to which the use of no-till will rise depends on the future of the many factors affecting it.

This paper examines the major factors that are likely to shape the future of no-till. Factors discussed are (a) use of no-till for erosion control, (b) need for marginal land for production of row crops, (c) supply of fossil fuel energy and the need for its conservation, (d) developments in technology applicable to no-till, (e) governmental programs, and (f) possible environmental restrictions.

No-till for Erosion Control

Concern for soil erosion is not new, but public and farmer interest in the effects of soil erosion may be greater now than ever before. In a survey conducted in Iowa in 1981 by Wallaces Fanner, 91% of the farmers responding listed soil erosion control as a reason for changing to no-till. A survey conducted by the Chevron Company in the Southeast showed that fanners considered erosion control as the primary reason for using no-till.

Farmers are seeking soil erosion control practices that are economical, agronomically sound, and compatible with modern farming methods. No-till fits those requirements in many areas of the U.S. Not since the soil conservation movement of the 1930's has an agricultural practice been so widely acclaimed for its soil erosion control value as has no-till. It appears likely that emphasis on erosion control will continue well into the future. In fact, soil erosion control must be an integral part of soil management on every farm if the quality of our soil resource is to be protected and its productivity maintained.

---

[1]W. W. Frye is Associate Professor of Agronomy, Department of Agronomy, University of Kentucky, Lexington, Kentucky 40546-0091.

Need for Crop Production on Marginal Lands

Faced with surpluses of food and government efforts to decrease production, it may seem absurd to suggest the need to bring additional land into production. But, food surpluses have come and gone in the past, and so will these. World population and people's expectations will continue to increase, especially in developing countries. As we move toward a global economy, demand for food in any part of the world will expand production in our part of the world. As production is expanded, more of the land brought into production will be marginally suited or perhaps unsuited for row crop production under conventional tillage because of erosion hazard. Much of this land can be safely no-tilled in row crops.

Supply and Cost of Fossil Fuel Energy

Our present form of agriculture is highly dependent upon petroleum fuels. As petroleum decreases in abundance, its cost will increase. Farmers can moderate the effects of increasing energy costs by adopting practices that use energy more efficiently. No-till is such a practice. The fossil energy required to bring a crop of corn to the harvest stage (excluding fertilizers) was estimated at 7.7 gallons diesel fuel equivalent (DFE) per acre for conventional tillage and 4.1 for no-till. Offsetting some of the savings in fuel is the energy required for manufacturing the herbicides used, which is estimated at 2.9 gallons per acre DFE for no-till compared to 1.8 for conventional tillage (4).

Technological Developments in No-till

For no-till to continue its upward trend, technological developments must keep pace. Worsham (11) conducted a survey in which he asked Extension personnel in 25 states with the greatest corn acreages to identify areas that need more research to help make no-till corn successful. Areas listed six or more times were weed control (15), nutrient and low-temperature problems (12), insects (ll), adapted hybrids (8), cropping systems (7), and equipment (6).

Weed Control. Crosson (2) concluded that problems of weed control may limit the continued spread of conservation tillage more than any other factor. From a technological standpoint, probably the greatest need in this area is herbicides that can be surface applied and control troublesome weeds. Expansion of no-till and other forms of conservation tillage will create the market incentive to develop new herbicides that are more effective under the specific conditions of no-till. Therefore, progress will continue in new herbicides.

By understanding the life cycle of problem weeds and knowing when they are most vulnerable to herbicides, one can increase the effectiveness of weed control. This points out the need for continued involvement of weed scientists in developing no-till technology.

Soil Temperature. Low soil temperature caused by a mulch with no-till may delay planting in the central and northern U.S. Some delay in planting no-till compared to conventional tillage corn seems not to decrease yields, however, long delays will decrease yields, which will quickly negate any economic advantages of no-till. An optimum balance between the amount of mulch and the soil temperature may be impossible to attain in some areas. Thus, no-till with heavy mulch may not be practical in those areas or on wet soils in areas where no-till is more adaptable.

Soil water contributes to lower soil temperature, so a winter cover crop that is not killed until corn planting time may help warm-up soils that tend to be wet in the spring. Albedo of the mulch can also have a significant affect on soil temperature. Soil is warmer under dark-colored mulch.

Nutrient Problems. Most of the nutrient problems unique to no-till can be traced to four inherent characteristics--presence of mulch, low soil temperature, surface applied soil amendments, and lack of soil mixing. These characteristics are likely to contribute to immobilization of N fertilizer in the mulch layer, ammonia volatilization loss from surface-applied urea, slow mineralization of N and other nutrients, lower efficiency of lime and fertilizer when surface-applied, and accumulation of plant nutrients, organic matter and soil acidity in the surface 2 inches of soil (5). The high acidity may interfere with the activity of herbicides, resulting in poor weed control (8).

To obtain fertilizer efficiency to the extent that will probably be needed in the future, practical techniques for subsurface banding of fertilizers in no-till may be necessary. To avoid problems associated with lack of mixing of the soil, future no-till management may routinely include moldboard plowing every 4 to 6 years. Plowing periodically would also allow the farmer to capitalize on the nitrogen immobilized in organic matter, since plowing increases mineralization of nitrogen (3).

Insect and Disease Problems. Some insect and disease problems are intensified by no-till while others are reduced. Genetic resistance to diseases and insects will remain the most effective and economical control regardless of tillage. Where biological control is not effective, pesticides commonly used in conventional tillage are usually as effective under no-till (7).

Adapted Hybrids. Many crop varieties have been tested under the conditions of no-till, but little has been done to develop varieties with characteristics specifically suited to no-till. To accomplish this would require that plant breeders become involved in no-till research and would require better cooperation between plant breeders and soil management researchers. I believe that plant breeders will become more involved in no-till research programs, similar to the way in which weed scientists, entomologists, and plant pathologists have been involved for several years. Interdisciplinary research has the potential to solve more problems limiting no-till than anything else.

Cropping Systems. No-till has contributed to increased use of several higher intensity cropping systems. Perhaps the best known example of this is the double cropping of wheat and soybeans, which has increased phenomenally in acreage during the past few years and is expected to continue to increase. No-till is required in interseeding soybeans into winter wheat, a practice presently in the developmental stage. The use of legumes in various ways to provide nitrogen for no-till row crops will be an important part of future cropping systems if nitrogen fertilizer prices continue to increase relative to crop prices.

Phillips et al. (7) listed several ways in which no-till enhances high-intensity cropping systems, but the saving of time is probably the most important one. Not to be overlooked, however, is the fact that, under no-till, intensive cropping can be practiced over periods of several years with no apparent deterioration in soil quality (10).

Equipment. Equipment manufacturers have kept pace very well with technological growth in no-till. Developments in no-till planting equipment for corn, soybeans, small grains, and forage crops have been particularly encouraging. In the future, development of no-till planting equipment for other crops can be expected as the demand increases.

With recent and expected future developments in directed-spray equipment and post-herbicides, farmers may use less herbicides or use herbicides with lower residual activity knowing that they have the capability of using a post-directed application in case weed control is being lost. This will diminish two important disadvantages of no-tillage--the need for greater amounts of herbicides and the lack of the option to cultivate.

Other possible future needs include fertilizer placement equipment that will take advantage of the principles of improved fertilizer efficiency now being studied in no-till field experiments. These include improved placement of anhydrous ammonia and subsurface banding of all fertilizers.

Government Programs

Major influences from government on no-till will likely take three forms--incentive programs, research programs, and educational and technical assistance programs. The major incentive program will probably be cost-share payments for the use of conservation tillage to control soil erosion. This is being done to a limited extent in some cases already. Incentive payments to adopt no-till, which is likely to be more profitable than conventional tillage where adaptable, may seem to be a misuse of funds. However, in many cases no-till is far superior to some conservation practices now being supported. Furthermore, risks and uncertainty are likely to be higher for beginners in no-till farming; and, where the need exists but the practice is not as well adapted, incentive payments may be needed to prevent a decrease in income.

The Payment-In-Kind (PIK) program will have some "spin-off" effects on no-till when set-aside land that was planted to a cover crop is returned to row crop production. That will be the most opportune time for PIK participants who are not using no-till to adopt it. Since much set-aside land is erodible, no-till is the most sensible way to return it to crop production.

Possible Environmental Restrictions

The dependence of no-till upon herbicides is the single characteristic that makes it vulnerable to restrictions. Crosson (2) views the potential problems of increased use of herbicides as the greatest threat to the expansion of no-till. He raises the possibility that society through government regulations will limit the use of herbicides, thus restricting the spread of no-till. Society, he claims, will have to weigh the potential problems of increased use of herbicides associated with the spread of conservation tillage against the high social cost of soil erosion that would occur if conservation tillage is restricted.

Phillips et al. (7) stated that most pesticides used in no-till production of corn and soybeans move in the environment mainly by soil erosion. Thus, one would expect less movement of pesticides from no-till fields than from conventionally tilled fields. Furthermore, some herbicides are degraded to harmless products faster under no-till than under conventional tillage (8). Nevertheless, as pointed out by Crosson, there is no ground for complacency about either the excessive use of herbicides or increased soil erosion. Therefore, environmental safety must continue to be a prime consideration in tecnhological developments in the area of herbicides.

Conclusions

No-till is a system of conservation farming that offers many advantages over conventional tillage. It is a system of soil conservation that offers many advantages over several of the conventional soil conservation methods, particularly the earth-moving practices. It is compatible with modern farming practices and trends. It requires less labor, less fuel, and less and smaller machinery, all important considerations for a system of fanning with a future. I believe that history will say that the no-till system of crop production was one of the greatest agricultural developments of the last half of the twentith century.

References

1 Blevins, R. L., G. W. Thomas, M. S. Smith, W. W. Frye, and P. L. Cornelius. 1983. Changes in soil properties after 10 years no-tilled and conventionally tilled corn. Soil and Tillage Research (in press).

2. Crosson, P. R. 1981. Conservation tillage and conventional tillage: A compartive assessment. Soil Conservation Society of America, Ankeny, Iowa.

3. Doran, J. W. 1980. Soil microbial and biochemical changes associated with reduced tillage. Soil Sci. Soc. Am. J. 44:765-771.

4. Frye, W. W., and S. H. Phillips. 1980. How to grow crops with less energy. In Jack Hayes (ed.) Cutting energy costs. The 1980 Yearbook of Agriculture. U.S.D.A., Washington, D.C.

5. Frye, W. W., and G. W. Thomas. The soil fertility environment in reduced tillage systems. 1979 Agron. Abstracts. p. 171.

6. Naisbitt, J. 1982. Megatrends: Ten new directions transforming our lives. Warner Books, Inc. New York.

7. Phillips, R.E., R. L. Blevins, G. W. Thomas, W. W. Frye, and S. H. Phillips. 1980. No-tillage agriculture. Science 208:1108-1113.

8. Slack, C. H., R. L. Blevins, and C. E. Rieck. 1978. Effect of soil pH and tillage on persistence of simazine. Weed Sci. 26:145-148.

9. U.S.D.A., Office of Planning and Evaluation. 1975. Minimum tillage: A preliminary technology assessment. Part I1 of a report for the Committee on Agriculture and Forestry, United States Senate. Government Printing Office, Publ. No. 57-398. Washington, D.C.

10. Wells, K. L., L. W. Murdock, and W. W. Frye. 1983. Intensive cropping effects on physical and chemical conditions of two soils in Kentucky. Comm. in Soil Sci. and Plant Anal. 14:297-307.

11. Worsham, A. D. No-till corn: Its outlook for the 80's. Paper presented at the 35th Annual Corn and Sorghum Industry Research Conference. Chicago, Ill., December 1980.

SCHEDULE OF RESEARCH TOPICS
PRESENTED DURING THE NO-TILL 'FIELD DAY
MILAN EXPERIMENT STATION
July 20, 1983

TOUR A - WEED CONTROL

SYSTEMS FOR NO-TILL WEED CONTROL IN SOYBEANS:
Robert Hayes, Associate Professor, Plant and Soil Science;
John Birch, Graduate Student, Plant and Soil Science

POST-DIRECTED APPLICATORS AND HERBICIDES IN NO-TILL SOYBEANS:
Elmer Ashburn, Professor, Extension Plant and Soil Science;
Wayne Flinchum, Professor, Extension Plant and Soil Science

CROP OIL AS A CARRIER IN CONVENTIONAL AND CDA SPRAYERS FOR WEED CONTROL IN NO-TILL SOYBEANS:
Fred Tompkins, Associate Professor, Agricultural Engineering;
L. R. Wilhelm, Associate Professor, Agricultural Engineering

NEW HERBICIDE EVALUATION IN NO-TILL SOYBEANS:
Larry Jeffery, Professor, Plant and Soil Science;
Reid Evans, Research Assistant, Plant and Soil Science

TOUR B - NO-TILL SOYBEAN PRODUCTION

STUBBLE MANAGEMENT, VARIETIES AND COVER CROPS FOR NO-TILL SOYBEAN PRODUCTION:
George Buntley, Professor, Extension Plant and Soil Science;
John Jared, Associate Professor, Extension Plant and Soil Science

BREEDING SOYBEAN VARIETIES FOR NO-TILL AND DOUBLE CROPPING:
Fred Allen, Associate Professor, Plant and Soil Science;
Robert Miller, Assistant Professor, Plant and Soil Science

WHEAT AND DOUBLE CROPPING SYSTEMS RESEARCH UPDATE:
Charles Graves, Professor, Plant and Soil Science;
Vernon Reich, Associate Professor, Plant and Soil Science

ECONOMIC EVALUATION OF NO-TILLAGE:
Estel Hudson, Professor, Extension Agricultural Economics and Resource Development;
Clark Garland, Professor, Extension Agricultural Economics and Resource Development

TOUR C - NO-TILL SOYBEANS, CORN AND GRAIN SORGHUM PRODUCTION

ARE CYST NEMATODES AND FOLIAR DISEASES WORSE IN NO-TILL SOYBEANS?:
Albert Chambers, Associate Professor, Entomology and Plant Pathology;
Melvin. Newman, Associate Professor, Entomology and Plant Pathology

GRAIN SORGHUM PRODUCTION SYSTEMS:
Bob Hathcock, Associate Professor, Plant and Soil Science;
Don Howard, Associate Professor, Plant and Soil Science

NO-TILL CORN AND SOYBEAN ROTATIONS IN OLD CROP RESIDUES:
Joe Bums, Professor, Extension Plant and Soil Science;
Dennis West, Assistant Professor, Plant and Soil Science

LEGUME COVER CROPS FOR NO-TILL CORN AND GRAIN SORGHUM:
Bob Duck, Professor, Plant and Soil Science;
Don Tyler, Associate Professor, Plant and Soil Science

TOUR D - NO-TILL COTTON PRODUCTION

NO-TILL COTTON - VARIETIES, COVER CROPS, STUBBLE PLANTINGS, AND WHEAT-COTTON DOUBLE-CROPPING SYSTEMS:
P. E. Hoskinson, Associate Professor, Plant and Soil Science;
Paulus Shelby, Assistant Professor, Plant and Soil Science

TOUR E - NO-TILL PLANTING EQUIPMENT AND EROSION CONTROL

NO-TILL PLANTING EQUIPMENT-EVALUATION AND PROGRESS:
David Bell, Graduate Student, Agricultural Engineering;
Bobby Bledsoe, Professor, Agricultural Engineering

FUEL AND POWER REQUIREMENTS FOR NO-TILL CROP PRODUCTION:
Willie Hart, Instructor, Agricultural Engineering;
John Wilkerson, Assistant Professor, Agricultural Engineering

SOIL EROSION CONTROL UNDER VARIOUS CROPPING SYSTEMS:
Curtis Shelton, Professor, Agricultural Engineering;
Robert von Bernuth, Associate Professor, Agricultural Engineering

EROSION CONTROL STRUCTURES - HOW THEY FIT WITH NO-TILL CROP PRODUCTION:
Bill Millsaps, Agricultural Engineer, Soil Conservation Service;
Wilder C. Hudson, Agricultural Engineer, Soil Conservation Service

SIXTH ANNUAL SOUTHEASTERN NO-TILL SYSTEMS CONFERENCE COMMITTEES

Conference Co-chairmen:

Elmer L. Ashburn
Tom C. McCutchen

Program Committee:

Joe D. Burns, Chairman
John Harris
Bobby R. Hathcock
Robert M. Hayes
Joseph R. Overton
Donald O. Tyler
Hugh O. Vaigneur

Local Arrangements Committee:

Paulus P. Shelby, Chairman
Wayne Flinchum
Gene Turner

Proceedings Cover Design: George J. Buntley

Editors: John Jared, Fred Tompkins and Randy Miles

University of Tennessee
P. O. Box 1071
Knoxville, Tennessee 37901-1071
(615) 974-7208