The effect of contour tillage on yields is further shown by Table 8 data and results when two row directions are compared at Marcellus, New York, on an 8 percent slope (27).

TABLE 8

Corn Yields (Bu/A) Comparing Two Row Directions

YEAR	DIRECTION Up and Down	CONTOURED	DIFFERENCE (% YIELD)
1942	52.9	56.2	6.2
1946	74.6	77.4	3.8
1950	68.5	84.8	23.8
1953	88.7	112.0	26.3
AVERAGE:	71.2	82.6	16.0

Measurements of rainfall and runoff amounts were made in the Southern Piedmont Conservation Research Center, Watkinsville, GA on a Cecil sandy loam to compare row directions. These results appear in Table 9 and indicate a 3.5 inch reduction in runoff in the cotton plots and a 2.5 inch reduction in the corn plots (28). Assuming that 70% of this reduction from runoff was due to contouring was effective in additional yields, one could expect from 50 to 55 more pounds of cotton per acre. Since many factors would influence the exact expected yield, one can only generalize about the increase. However, in other research work at Clarinda, Iowa, contour cultivation increased annual infiltration by 2.3 inches and increased corn yields 12 bushels per acre

(29). In 1966, a detailed summary of runoff and erosion research in 24 states and Puerto Rico concluded runoff losses were reduced more than 15 percent by contour tillage (30).

TABLE 9

Average Annual Rainfall and Runoff By Row Direction and Slope

CROP TREATMENT	SLOPE (%)	ROW DIRECTION	RAINFALL (Inches)	RUNOFF (INCHES %)
Cotton	7	Contour	55.7	6.33 11.4%
Cotton	7	Up-Down Hill	55.7	9.84 17.7%
Corn	7	Contour	55.7	4.54 8.2%
Corn	7	Up-Down Hill	55.7	7.03 12.6%

B. TERRACES

Graded terraces are built on sloping land to catch and direct runoff water into a protected waterway, thus controlling erosion. Level terraces, not presently used in North Carolina, are designed to catch runoff water and gives it an opportunity to infiltrate into the soil. Level terraces are frequently ridged at the ends or at intervals along their length and thus serve as catch basins. The tile outlet terrace, used only at a few specific sites in this state, is primarily for erosion control, but will provide additional infiltration near the inlet of the tile.

The slight delay of runoff water in the channel of the graded terrace gives time for some slight increases of water infiltration into the soil. On land with an impervious subsoil, the amount of infiltration in the channel will be slight, while on deep, open soil an appreciable water savings is possible.

At Bethany, Missouri, (31) with an annual precipitation of 37 inches, conventional terraces permitted 21 percent of the water to run off, while on land not terraced, 27 percent of the precipitation ran off the land. This is a savings of 6 percent or more than 2 inches of water due to terracing. Similar results were obtained at Guthrie, Oklahoma, where the average annual precipitation is 32 inches per year. Here, terraced land permitted 17 percent of the rainfall to run off, while land not terraced allowed 23 percent to run off. Again, terracing reduced runoff nearly 2 inches or 6 percent (32).

C. STRIPCROPPING

Contoured strips tend to slow down the rate of water flow and allow opportunity for a larger volume of the precipitation to be absorbed by the soil. However, the true effectiveness of stripcropping is difficult to evaluate. It is more realistically a resource management system comprised of several good water management practices such as crop rotations, grass in rotations, crop residue management, contouring, cover crops, and in many enterprises, no till. When one combines the effects of each of these practices along with the effect of various strip widths and soil textures, it is virtually impossible to predict an average increase in soil infiltration. However, research supports that stripcropping is a more effective practice than contouring or most of the other practices evaluated singularly.

Experiments at La Crosse, Wisconsin, from 1941 to 1951 on 11 percent slopes planted to a 4 year rotation of corn, oats, and two years of hay, showed only 3 percent more reduction than contouring alone (33). At Blacksburg, Virginia, a 5.4 acre field planted in corn, up and down hill cultivation had an average 10.1 percent runoff of surface water from 1939 through 1942. After stripcropping in 1943, the surface runoff was reduced to an average of 6.9 percent for the period of 1943 until 1950 (34).

D. SUBSOILING AND DEEP TILLAGE

Deep tillage can have a significant effect on the rate of infiltration while the effects on water storage capacity are less substantiated by research. However, one would normally expect some benefits from extension of storage depth and reduction in plant root zone restrictions. Subsoiling or deep tillage to shatter or disrupt water restricting subsurface horizons may reduce runoff losses on many soils. The overall effectiveness of subsoiling is influenced by whether the restricted layer is due to a tight, fine textured subsoil or a distinct plowpan found in loamy or sandy loamy soils. During 1952 at the Wheatland Conservation Experiment Station near Cherokee, Oklahoma, a chisel was used to break a plow pan in a fine-textured soil. The chisel-plowed treatment reduced runoff from three storms in 1953. During the second year, runoff from seven storms was still substantially less on the deep-tilled land than on the untreated. In each of the two seasons, runoff from the deep-tilled plots was approximately one-half that from the untreated area (35).

A research study in Lincoln, Nebraska, was initiated in 1972 to determine the effect of different tillage systems on moisture use, moisture conservation, and corn yields over a four-year period. Results for locally adoptable tillage methods are contained in Table 10. Slopes ranged from 3 to 8 percent and plot areas were established between and parallel to terraces.

TABLE 10

Moisture Storage, Water Use and Corn Yields for Three Tillage Systems

A.

SYSTEMS	SYSTEM OPERATIONS
1. Moldboard Plow:	Cut stalks, disk, plow in fall; disk, plant in Spring
2. Chisel Plow	Cut stalks, chisel plow in fall; disk, in Spring
3. No-Till	Cut stalks, plant in Spring

B.

Corn Yields (Bu/A)

System No.	1972	1973	1974	1975	AVERAGE
1. Plow	130.0	137.7	8.8	45.2	79.2
2. Chisel Plow	119.9	130.7	8.3	70.9	82.5
No-Till	118.1	130.4	13.1	77.3	83.5

Precipitation during the study ranged form above normal the first two years to below normal the last two years. The annual rainfall in 1974 and 1975 was 28 and 32

Precipitation during the study ranged form above normal the first two years to below normal the last two years. The annual rainfall in 1974 and 1975 was 28 and 32 percent, respectively; below the 22 year average. Runoff losses were low during the four-year period, the highest in 1973 when annual precipitation was 42 percent above normal. Yield differences between treatments were non-significant statistically for the first three years. The fourth year the chisel plow and no-till plot yields were significantly higher than the moldboard plowed for a net difference of 25.7 and 32.1 bushels per acre (36).

Subsoiling was shown to increase water storage at St. Anthony, Idaho. Soil samples in March, 1953, measured 1.4 inches of additional moisture stored in soils that received fall chiseling or subsoiling in comparison with no fall treatment. Subsoiling the previous year had increased profile moisture 3.4 inches (37).

J.C. Harden reported at the 1978 Southeastern No-till systems conference that on his Coastal Plains Alabama farm, in-row subsoiling on highly compacted soil allowed less runoff due to the fact that the subsoil plot acted as a funnel for channeling more water into the subsoil. He said, "We can apply heavy rates of irrigation water at longer intervals. The shattering of the hard pan allows deeper root penetration, up to 7 feet, into the subsoil area which we consider a second reservoir of moisture." (38)

At Tifton Georgia, a 15 to 25 percent yield difference was obtained form subsoiling and irrigation (39). Irrigation was used when plant stress on the treatment area indicated available water shortages. Table 11 summarizes results from this test.

TABLE 11

Effect of Soil Compaction on Yield of Irrigated Sweet Corn, Cucumber, and Southern Pea 1975

	Sweet Corn (Crates/Acre)	Cucumber (Dollars/Acre)	Southern Pea (Pounds/Acre)
Non Compacted	228	317	2409
Compacted	200	244	1873
Percent Decrease	12	23	22

Soils having relatively thin compacted or cemented layers, can benefit from deep tillage and the loosening of the profile. The period of effectiveness varies widely with soil conditions and the total effectiveness is highly dependent upon specific soil characteristics, moisture content, crop management practices, and secondary tillage operations. The time of treatment may also be important in determining effectiveness.

E. CROP RESIDUE MANAGEMENT

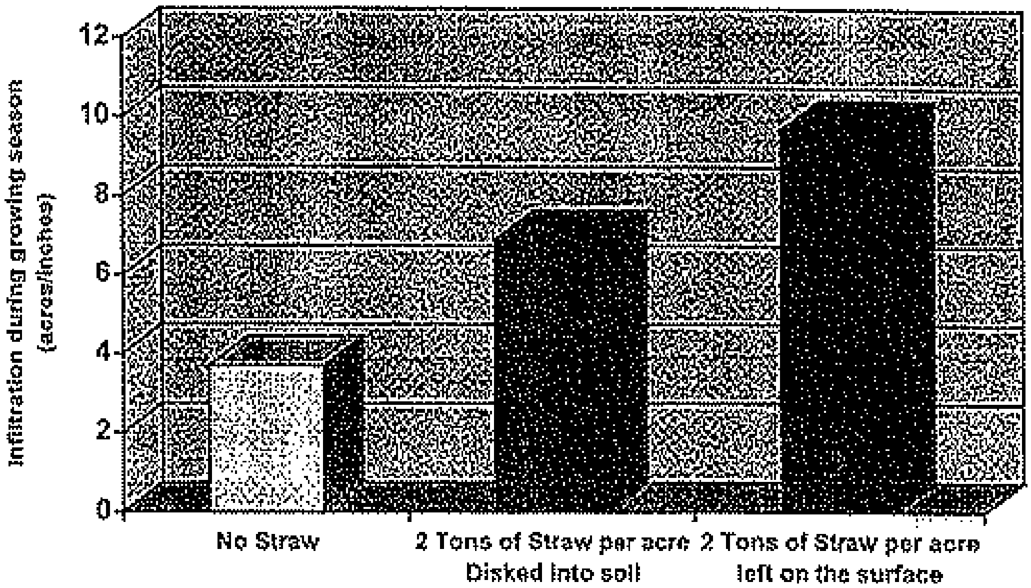
Judicious use of crop residues either incorporated in the soil or maintained on the soil surface can help in maintaining infiltration rates, preventing surface crusting, improving soil aggregation, and modifying the transport and retention of water, heat, and air in the soil. Incorporation, however, is not nearly as effective as leaving residues on the surface.

Baker and Laflen found that soil covered by corn residue at a rate of 1,336 pounds per acre (about the amount left after chisel plowing, 2 diskings, and planting) lost about 0.7 inches of water of 14 percent of the 5 inches applied as runoff, beginning about 30 minutes after application. In this research, the 5 inches of water was applied in a 2 hour period with a rainfall simulator. Check plots began losing water 11 minutes after beginning application and lost 50 percent or 2.5 inches as runoff (40).

In Nebraska, a study was made comparing the difference in infiltration under conditions of no straw, 2 tons of straw disked into the soil, and 2 tons of straw left on the surface. In the plot with no straw, 21 percent of the 17.9 inches of rainfall between April 23 and September 8 was absorbed by the soil; 39 percent of the rainfall soaked into the soil where 2 tons of straw had been disked in; and 54 percent of the rainfall moved into the soil (41) where the straw was left on the surface (Figure 8).

(Refer to Page 35 for Figure 8)

Figure 8. Straw Increases Infiltration of Water



Residue distribution and orientation are as equally important as amount when evaluating water management effectiveness. Standing residue presents a lesser interception area for vertically falling raindrops, and is normally less effective in maintaining infiltration efficiency. Uniform, horizontal distribution has proven to be the most effective placement. Effectiveness of partially incorporated residue varies with percent left on or near the surface. Tillage practices, other than moldboard plowing, will incorporate 10 to 70 percent of the surface residue and reduce infiltration rates due to a fast decline of surface conductivity as rainfall continues. Infiltration is temporarily enhanced when soil shrinks away from pieces of residue near the surface or sticking through the soil surface and allows open channel flow into the soil (42). Residues completely incorporated into the soil would have little or no direct effect on infiltration for surface storage capacity. Should the decomposed products promote greater structural stability, then infiltration would intensify.

Heavy amounts of crop residue on the soil surface will slow the evaporation rate of soil water and is the major water conservation benefit of No-Till. This benefit is especially noticed in double cropped enterprises when planting is necessary during dry-hot periods.

F. CROP ROTATIONS

Different crops have different effects on soil structure. The way soils take in water and permit it to move through the profile depends on the way the soil particles are arranged into granules or aggregates. The storage of water in the soil, use of this water by plants, and the exchange of gasses between the soil pores and the atmosphere also depend on soil structure.

Large pores within the soil mass to provide rapid movement of water, are generally desirable. When a row crop is grown, the stirring of the soil in preparation of the seedbed and cultivation tends to break down the structure of the soil, destroy many of the aggregates or granules, and reduce the proportion of large pores. Because decomposing organic matter provides substances that help to cement soil particles into stable aggregates, the crops that return large amounts of organic residue usually have a beneficial effect on structure and in turn on the moisture of the soil. Table 12 contains data which enables one to relate the moisture absorption for different soil textures and organic matter levels(43).

TABLE 12

Percentage of Moisture Absorbed Due to Organic Matter Content of Different Soil Textures

SOIL TEXTURE	% ORGANIC MATERIAL	% MOISTURE ABSORPTION DUE TO ORGANIC MATTER
Fine Sandy Loam	2.6	23.88
Silt Loam	2.2	20.00
Silty Clay Loam	6.0	25.73
Silty Clay	12.0	39.50

In South Carolina, a study was made to compare the rate at which water moved into two soils, one which had grown continuous cotton, and the other which had been in a rotation of cotton-wheat-lespedeza. Water soaked into the soil that had been in rotation 443 percent faster than through the soil that had grown continuous cotton (44).

Organic matter content has long been recognized as an important soil property. Instinctively, early farmers knew that soils with a high organic matter content produced good crops. Today we know that the addition of organic materials to soils adds plant nutrients; improves soil structure; influences soil, water, air, and temperature relations; helps control runoff and erosion; and makes tillage easier.

Growing crops such as peanuts, potatoes, cotton, tobacco, and vegetables is often detrimental to soil structure because these crops require frequent and intense cultivation, return little organic residue to the soil, and generally have small, shallow root systems. On the other hand, corn and grain sorghum are less detrimental to soil structure.

Studies by Van Doren, et al., show corn yields to be less affected by rotations where no-till systems are followed. In Table 13, yield differences were slightly less than 2 bushels per acre when continuous no-till corn was compared to corn-soybean no-till rotation. However, the same rotation when a system of tillage was used resulted in a 5 bushel per acre increase. A comparison of continuous corn-plowed, with a rotation of corn-oats-meadow indicates a significant yield increase, as much as 21 bushels per acre.

TABLE 13

Average Corn Yields (Bu/A) for Five Years Crop Rotations

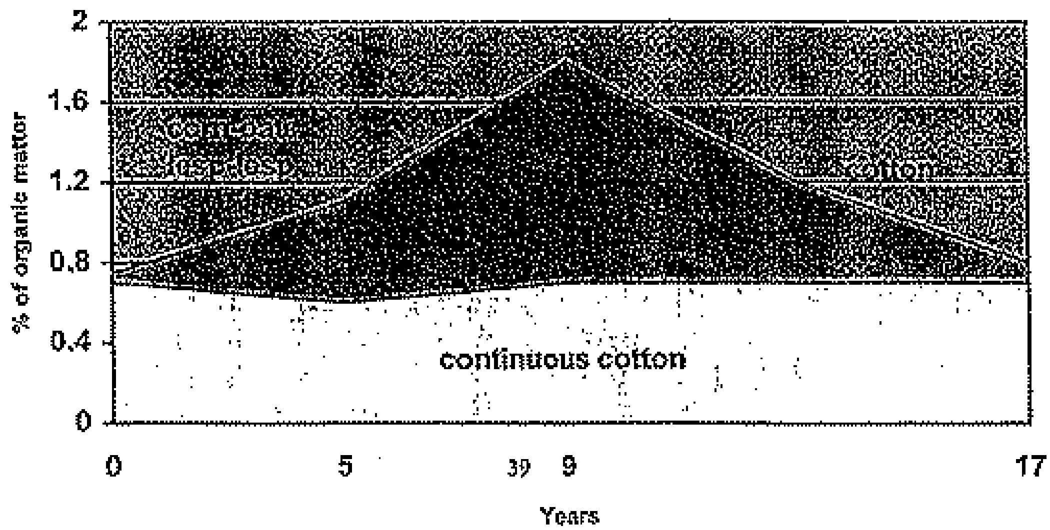
VS.

Tillage Systems (45)

ROTATION	NO-TILL	PLOW
Continuous Corn	149.9	134.3
Corn-Soybeans	151.2	139.0
Corn-Oats-Meadow	166.6	155.0

In 1939, experimental plots with various cropping systems were established on Class IV Cecil clay soil at the Southern Piedmont Soil Conservation Station, Watkinsville, GA. During the 21 year study period, the cropping system was changed from time to time on some plots, while other plots were cropped to continuous cotton. By sampling the soil in 1943, 1948, 1952, and 1960, it was possible to follow the changes in organic matter with the different cropping systems. Shown in Figure 9, there is little change in the amount of soil organic matter when cropped to continuous cotton for 17 years. It should be noted that most of the topsoil from this plot had been eroded away prior to 1943; therefore, the organic matter content was low at the beginning of the study period.

Figure 9. Schematic drawing showing the buildup of organic matter that results from use of crop rotations



With three-year cropping systems that included close-grown crops (corn, oats, lespedeza, lespedeza and cotton-oats, lespedeza, lespedeza) from 1943 to 1952, the soil organic matter increased. Then when continuous cropping to cotton was started on these same plots, the organic matter decreased. In fact, after 7 years of cropping to continuous cotton, the organic matter was almost down to the same level as where cotton had been grown continuously for 17 years (46).

A summary of 50 years' data from Missouri shows the effect of various cropping systems on soil organic matter content.

TABLE 14

Organic Matter of Various Cropping Patterns (47)

CROPPING SYSTEM	ORGANIC MATTER CONTENT (%)
Continuous Corn	1.45
Continuous Wheat	3.40
Continuous Oats	4.08
Corn-Wheat-Red Clover	3.31
Corn-Oats-Wheat-Clover	3.74

The roots of certain crops also affect the structure of the lower horizons. The thick taproots of alfalfa, for example, penetrate some soils to considerable depth. When they die and decompose, they leave a channel or pore through which excess water can drain from the profile and through which the roots of the next crop can grow more easily.

G. SOD-COVER CROPS

Although landusers may not fully understand what sods technically do for their land, they explain it in their own words. "Soil feels soft and spongy--full of life--it doesn't crust over and the rain soaks in. Crops do not suffer as severely during droughts--weeds aren't a problem--and maybe most important is the increase in yield."

Studies show that benefits from sod crops start when the grass or legume seedling first emerges. These early effects on the soil include: (1) Protection from the beating and sealing forces of the raindrop, (2) Improved infiltration and reduced runoff, and (3) development of roots into deeper soil profiles. All these effects continue for some time when the perennial grass sod or legume is turned under for succeeding row crops.

The amount of organic matter returned to the soil through the extensive root systems of sod crops and plowed under top growth are greater for perennial sod crops than for annuals. As high as 16 tons of oven-dry residue per acre has been obtained from a crop of tall fescue or 8 to 12 tons per acre of common and coastal Bermuda grass or Pensacola Bahia have also been obtained (48). Therefore, perennials can be expected to do more to improve soil structure than annual crops discussed in crop rotations.

The soil is not cultivated by tillage implements while perennial sods are being grown, and therefore, aggregates and pores, once developed, tend to persist for a longer period. Plots in which alfalfa and bluegrass were grown for a 10 year period on Marshall silt loam near Clarinda, Iowa, were found to have 50and 58 percent greater aggregation, respectively, than plots on which corn had been grown annually (49). The improvement in aggregation on the plots formerly in alfalfa and bluegrass was still evident when these plots had been cropped to corn for three years.

The information in Table 15 shows the degrees of stability imparted to soil aggregates following three years of various sod crops and the decline in stability when the sod was turned and the land was row cropped (50). At the conclusion of the final year in sod, aggregates under the fescue were more stable than those from either of the other sods, thus suggesting that fescue probably offers the greatest benefits in soil structure improvement of locally grown sod-crops.

TABLE 15

Effect of Tillage on the Percentage of Water Stable Aggregates in Soils Following Various Sods

CROP	FINAL YEAR SOD (%)	FIRST YEAR ROW CROP (%)	SECOND YEAR ROW CROP (%)
Fescue	78	72	62
Coastal	59	50	33
Alfalfa	45	43	24
AVERAGE	61	55	40

All over the state, and especially in the Piedmont and Mountains, we can observe the superior physical condition of soil under sod. Where sod has been turned for corn or tobacco, more rapid infiltration and percolation and less runoff and erosion occur. Microbial activity and aeration are greater than where corn and much greater than where tobacco have been grown annually. In research comparisons of runoff from grassland and cornland, runoff from cornland was 162 percent greater in Wisconsin, 329 percent greater in Ohio, and 700 percent greater in Virginia than it was from companion plots of grass (51).

A 7 year summary of research on the effects of cropping systems at Watkinsville reports that sod crops control runoff on sloping land and that beneficial effects extended well beyond the first row crop where row crops followed sod crops on the land. Table 16 summarizes this research with different cropping treatments (52) on a Cecil sandy loam soil.

(Refer to page 44 for Table 16)

TABLE 16

Average annual Rainfall and Runoff From Different Cropping Treatments 1961-1967

CROPPING TREATMENT	LAND SLOPE %	RAINFALL INCHES	RUNOFF (in) WITH SLOPE	RUNOFF (in) ACROSS SLOPE
Cotton Continuously	7	55.7	9.84	6.33
Corn Continuously	7	55.7	7.03	4.54
3 Year Rotation (avg.)	7	--	--	2.66
1—Coastal Bermuda				
After Corn	--	54.8	2.42	2.25
2—Coastal Bermuda				
Second Year		54.8	1.78	2.74
3 Year Rotation (Avg.)	7	--	--	4.16
1—Tall Fescue				
After Corn	56.7			5.42
2—Tall Fescue				
Second Year		56.7		2.80
3—Corn		56.7		4.56

Using land year after year for cultivated crops with little or no grasses and legumes uses up the organic matter and causes the soil to become hard and dense. A crust will form over the surface. Laboratory studies show that water moves through a curst only one-third to one-fifth as fast as it does through the soil just below the crust.

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H. NO-TILL

No-till provides economically sound tillage methods, and optimum plant environment, and conservation of soil and water resources. It also assures efficient use of stored water during short-time droughts, particularly in many coarse-textured North Carolina coastal plain soils, which frequently have low water storage capacities and hardpan (54).

A primary advantage of no-till is conservation of soil water. Reduced soil water evaporation and increased infiltration makes more water available for transpiration by plants. For example, evaportation of soil water from a conventionally tilled Maury silt loam (Typic Paleudult) from May through September was 2.4 times greater than from the same soil with no-tillage. This provided 18 percent more water for transpiration by no-till corn compared with conventionally tilled corn (13 versus 11 inches per growing season) (55). Results from tests conducted on North Carolina Piedmont clay soils and displayed in Table 17 have been strongly in favor of no-till planting corn in rye. Lewis

TABLE 17

Corn Yields (Bu/A) in Piedmont Tillage Test

TILLAGE METHOD	CASWELL	STOKES	GRANVILLE	GUILFORD
Conventional	71	141	58	96
No-Till into Rye	94	155	68	99
Net Difference	23	14	10	3

Yields referred to in Table 18 generally support expected results when comparing conventional to no-till systems. This is summarized from research data and on-farm tests from Virginia and Kentucky (57).

TABLE 18

Plot Yields of Corn By

Types of Tillage (Bu/A)

STATE	YEAR	NO-TILL	CONVENTIONAL TILLAGE	NET DIFFERENCE
VIRGINIA	1962	132	115	17
	1963	75	64	11
	1964	126	102	24
	1965	158	151	7
	1962-1967 AVG.	121	105	16
KENTUCKY	1968	132	112	20
	1969	132	121	11
	1970	113	103	10
	1968-1971 AVG.	137	124	13

I. LONG TERM NO-TILL

Long-term continuous no-tillage improves the physical properties of all textures of soils. Eleven years of no-till operation increased soil aggregation, soil moisture retention, and organic matter in the upper 2 inches of soil (58).

Ten years of research at Clemson University has shown that no-till corn planted in vetch and rye mulch averaged 3.11 inches less water runoff per year than that of plowed, un-mulched check (59). Also, the degree of soil aggregation and aggregate stability increased under mulch treatments, but were reduced considerably under the plowed check. The organic matter content increased from 1.5 percent to 2.6 percent under the plowed check.

The concentration of organic matter in no-tilled soils is near the surface, rather than spread throughout the plow layer. Not surprisingly, then, we found a higher concentration of soil micro-organisms are near the surface of no-tilled soil and a lower concentration deeper in the soil, compared with soil that had been tilled. Higher water levels near the surface also contribute to the increased population of microbes. The top 3 inches of no-tilled soil contain 20 to 30 percent more water and organic matter than does plowed soil (60).

A summary (61) of these benefits and conservation of water can be illustrated by studying Figure 10. At this location, average daily rainfall was sufficient to provide moisture above the wilting point for the upper 7 inches of soil through the period from June to August under no-till conditions. Yields increased by 9 bushels of corn per acre even though the moisture level dropped below or approached the wilting point for the upper 7 inches of soil through the period from June to August under no-till conditions.

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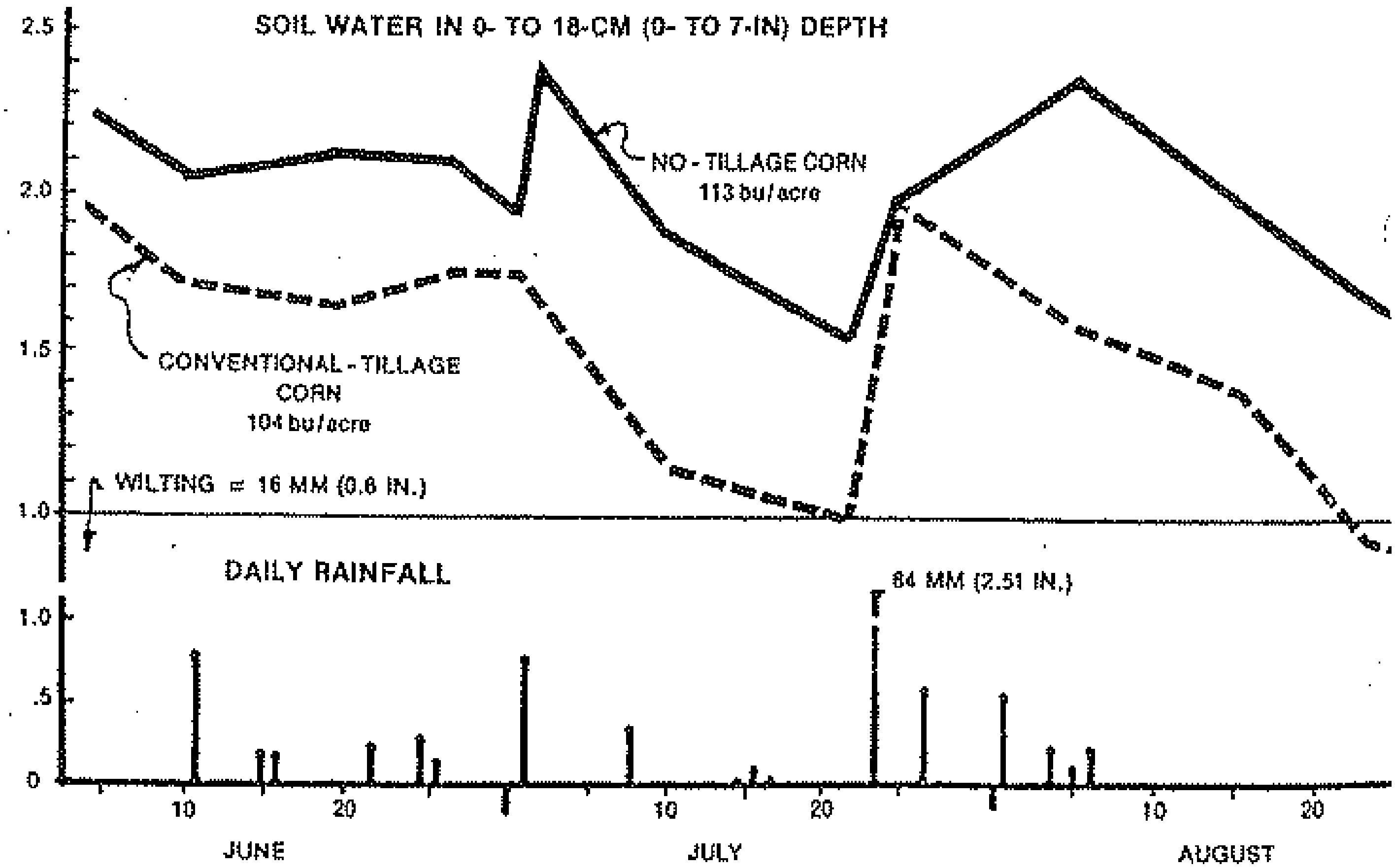
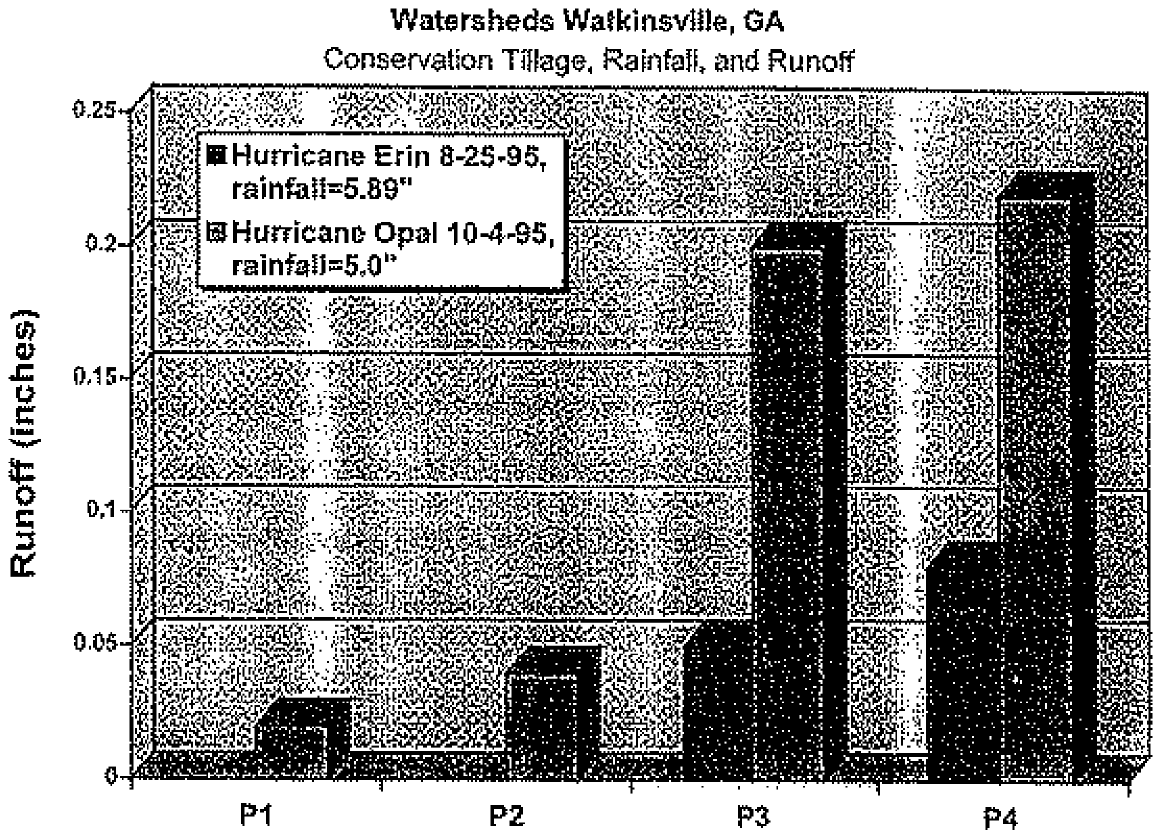


FIGURE 10. AVAILABLE SOIL MOISTURE, RAINFALL BY MONTHS AND CORN YIELDS OF CONVENTIONAL VS. NO-TILL SYSTEMS

Figure 11. Major rainfall events produced little to no runoff from no-till watersheds on piedmont landscapes



YEARS NO-TILLED	21	5	2	2

As the soil bilological activity increases, there is a corresponding decrease of ground cover. The carbon in the biomass serves as the energy for this activity. Therefore, the biological system must be "fed" at every reasonable opportunity.

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J. COVER CROPS

In many production systems, winter cover crops are needed to increase organic matter. Even a temporary increase is helpful, given the tremendous water-holding capacity of organic matter. See table 19 (61). Under no-till systems, cover crops are needed for ground cover requirements after low-residue crops such as tobacco, cotton, and vegetables.

The most commonly used plants are rye, wheat, barley, crimson clover, and hairy vetch. Less frequently used species are Austrian winter pea, buckwheat, sudax, ryegrass, oats, little barley, and soybeans.

Care must be used in cover crop production. Timely planting, adequate seeding rates, proper soil fertility, and attainment of sufficient maturity must be practiced.

TABLE 19

Water-Holding Capacity of Organic Matter and Inorganic Soil Materials

MATERIAL (100 LBS)	WATER HELD (LBS)
Sand	25
Clay	50
Humus or Decaying	
Organic Matter	190

V. SOIL QUALITY IMPROVEMENTS

The condition of a soil's physical, biological, and chemical properties will determine its overall quality. The optimum levels of these properties are heavily influenced by the organic matter content. However, even a soil with the proper physical, biological, and chemical conditions cannot perform without adequate moisture levels. Fortunately, the practices which increase organic matter content will contribute to a better moisture level and a corresponding enhancement of erosion reduction and soil quality improvement.

Soil quality enhancements also bring improvements to water quality (through reduced sediment and its attached riders), air quality (by reduced airborne particles and reduced carbon emission), and wildlife habitat (through better food supply for small game). Better plant health and animal health also result from improved soil quality.

<u>SUMMARY</u>

Water conservation research has been conducted for many years. The principles for water conservation are basically the same whether the water is from precipitation or irrigation. However, the end result may be different. Because precipitation rates, amounts, and times cannot be controlled, producers have very limited control over the amount of water remaining in soil at crop harvest or on percolation, and limited control over evaporation where precipitation supplies the water. Runoff can be controlled to some extent or entirely by suitable techniques. Where irrigation is practiced, controlling the amount, rate, and time of application has a major effect on water remaining in soil and on percolation. It also has an effect on runoff and evaporation.

Practices for conserving water from precipitation have been discussed and are summarized in Table 20. These practices conserve water primarily by minimizing runoff and/or reducing evaporation (conservation tillage).

TABLE 20

Summary of Water Conservation Benefits From Locally Used RMS

PRACTICE	MAJOR BENEFITS
1. Contouring	Up to 40 percent reduction in runoff and yield increase of 12-18 percent
2. Terraces	Runoff reduced 6 to 10 percent
3. Stripcropping	Runoff reduced 30 to 45 percent
4. Subsoiling, Deep Tillage	Increased infiltration
5. Vegetative Residue	Decrease of 30 to 40 percent in runoff
6. Crop Rotations	Yield increases of 10 to 25 percent
7. Sod-Crop	Reduced runoff 35 to 50 percent
8. No-Till	Increases soil moisture 20 to 30 percent and yield increases up to 15 percent
9. Long-Term No-Till	Can nearly eliminate runoff
10. Cover Crops	Organic matter improvements

More questionable, but to some degree effective, are those practices which increase soil water storage. Besides the use of these practices, farmers consider practices which improve water use efficiency such as:

1. Growing crops or crop varieties having growing seasons compatible with water availability patterns.
2. Planting crops at the optimum time.
3. Adopting improved weed control practices.
4. Providing adequate fertilizers, etc.
5. Controlling insects, diseases, and other pests.
6. Breeding crops for prevailing conditions.
7. Adopting cropping systems that integrate the wide range of climatic, biological, mechanical, and management factors.

Technology is available regarding some factors mentioned and research is underway regarding many of the other factors. Further research, however, is needed to identify other practices for further improving the conservation and use of precipitation and irrigation water for greater crop production.

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