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To the Graduate Council:

I am submitting to you a thesis written by George Cooper Tucker entitled "The Compatibility of Increased Farm Family Earnings with Improved Water Control." (Subtitle: A Case Study of a Farm in the Chestnee Watershed of the East Tennessee Valley.) I recommend that it be accepted for nine quarter hours credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

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c 2

THE COMPATIBILITY OF INCREASED FARM
FAMILY EARNINGS WITH IMPROVED WATER CONTROL

A Case Study of A Farm in the Chestnee Watershed
of The East Tennessee Valley

33

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the Degree of
Master of Science

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by

George Cooper Tucker

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CHAPTER I

THE PROBLEM

Background

A review of historical records reveals that people in every country have at times been plagued by floods and problems of water control. This has been true regardless of the vegetative cover that the land possessed. Some competent critics have questioned whether vegetation offers any appreciable control over water flow, and they find comfort in the fact that floods were noted in America prior to the development of agriculture. Garcilliaso de la Vega, a member of De Soto's exploratory expedition recorded a flood in the lower Mississippi Valley in 1543. La Salle, in about 1680, found the Mississippi in flood. The Mississippi River, as well as most other streams, was able to develop a raging flood when its watershed was relatively free of gullies and possessed the best natural vegetative cover for water control and soils with a possible maximum infiltration capacity.¹

The natural vegetative cover of America was less efficient than the present for producing food and fiber to provide survival for human life. In fact, America furnished the necessities of life for only a few million Indians before the arrival of the white man. The production of food and fiber was greatly increased with the introduction of agriculture.

¹United States Department of Agriculture, The Land in Flood Control, Miscellaneous Publications, 331 (Washington, D. C: Government Printing Office).

During the days of the expanding American frontier, land was quite abundant in relation to labor and capital. The farmer's first concern was the production for his own requirements. Additional production for commercial use was largely determined by available transportation and markets. Cotton, grain and tobacco had an economic advantage over other farm products mainly because they had limited bulk and could be transported great distances without a reduction in quality. These commodities involved intensive crop production which tended to deplete the soil fertility that in many cases was inherently low.

Even though land was abundant the quantity cleared and available for cultivated crops was limited. A pioneer could clear about five acres of forest land per year of which the productivity improved with cultivation for the first few years. With no soil amendments and limited knowledge of soil conservation, the farmer found it more profitable to continue land in cultivation for a number of years and then move on to other virgin land.

With the industrial revolution came railroads and farm machinery, which expanded the area that could profitably produce commodities for export and enabled great increases in land cultivated per worker. Introduction of soil amendments in some areas of the East enabled farmers to cultivate land profitably for longer periods of time. The results were greater soil erosion and increased requirements of soil amendments to maintain productivity.

A good portion of the floors of our valleys are covered with alluvial material, resulting from erosion and laid down by flood waters. Soil scientists point out that the deposits of the preagricultural era

developed under moderate overflows. The theory is based on differences in soil profile. The underlying material has prevailing finer texture with a more uniform composition. Recent deposits not only contain coarser material, but more diverse with respect to texture composition and color characteristics through the profile.² With the development of agriculture in this country soil erosion and runoff of surface water increased; rich valley soil was covered with material coarser in texture and sometimes lower in fertility. Furthermore, many streams have changed from slow clear ones with a channel depth of several feet to swift muddy streams with a channel that is shallow and obstructed with drifts and logs. This condition has not only obstructed water transportation, but has resulted in increased flood damage and, in some areas, necessitated the construction of many miles of flood levees.

The above phenomena have arisen as a consequence of the systems of farming that have come to prevail in most hilly areas. Many small farms are located on rolling land of low fertility. Under existing farming systems there is much surface water runoff and soil erosion, resulting in conditions discussed above in regard to erosion and flood damage. Actions to prevent or ameliorate these conditions would have involved varying amounts of capital investments. Farmers were not aware of the advantages to be gained from these investments, or rightly or wrongly rationalized that such investments would not be to their advantage.

In the early 1900's the American people became somewhat concerned

²Ibid., p. 9.

about the flood control problem. The first act of Congress pertaining to vegetal covering of land was in 1911, the Weeks Forest Purchase Act; it authorized the Secretary of Agriculture to take certain steps regulating the flow of navigable streams. Additional flood control interest was developed as a result of the great Mississippi flood of 1927. In 1928, Congress passed acts which authorized a study of ways in which forestry might aid in control of Mississippi River floods, and an investigation to determine methods of reducing soil erosion and controlling water flow.

It was during the 1930's depression years that this country really undertook flood control work. The plan of attack that was started then is divided into two parts. First comes the control of water in the river channels, This is the control that is more publicized and spectacular. It involves great engineering structures as dams, reservoirs and levees. The greatest experiment and work in mechanical flood control is carried out by the Tennessee Valley Authority, which was authorized by Congress in 1933. A network of dams throughout the head water area of East Tennessee as well as along the Tennessee River channel has enabled the accomplishment of three objectives, namely, provide security against floods, provide navigation and develop water power. These dams were built of sufficient height and have adequate reservoir capacity to eliminate immediate danger of being filled with silt. However, this does not eliminate the second part of flood control - the control of water on the land. It is this second part that takes time to accomplish, and involves both individual and cooperative action of thousands of land owners.

The importance of this control of water on land should not be

minimized just because the contribution of each individual land operator is small. Flood damage resulting from insufficient water control on the land has probably been as great as the damage from river channel floods. In fact, the control of water on the land will to a certain extent affect the river channel floods. It is the water problem above the river channel that determines the soil erosion of hill land, the kind of soil deposited in valleys and the damage to farm and industrial activity.

In 1935 Congress authorized the establishment of Soil Conservation Service with a primary objective of providing for control and reduction of soil erosion and thereby conserve natural resources and control floods. The Soil Conservation Service provides assistance and means that enable farmers to cooperatively attack the erosion problem. The plan of attack has been to control surface runoff through engineering and vegetative methods. There are a number of other public programs dealing with soil conservation. The approaches used involve research, education and incentive programs.

Statement of Problem

This study is directed towards the problems confronting individual farmers of the humid Southeast, particularly those of the East Tennessee Valley, and the public with regard to water control.

First an attempt has been made to formulate a rational procedure for bringing erosion into consideration in the selection of farming systems³

³Farming system is defined to include the selection of commodities to be produced, the techniques for producing such commodities, and the quantities of such commodities to be produced.

by individual farmers, under simplifying assumptions with regard to relative prices and control of individual farmers over economic resources. It was assumed that relative prices would be unchanged by the decisions of the individual farmer. Thus, his plans will be made upon a predicated pattern of relative prices, a pattern which is not expected to change as a result of his actions. Further, it was assumed that the individual farmer owns an equity in a certain area of land (the land having certain physical properties) and in certain other productive agents. It was assumed that the farmer controlled a given force of labor including managerial ability. In addition it was assumed that the individual's equity in wealth provides collateral for acquiring credit for production and/or consumption purposes. It was also assumed that the individual's knowledge (beliefs) regarding production functions include soil erosion. The farm was considered to be a going concern.

In some way similar to the solution of simultaneous equations in mathematics the individual farmer must decide among other things: (1) what to produce? (2) how to produce these commodities? (3) what quantities of various commodities to produce? and (4) what quantities of credit to use and for what purposes? That is, the farmer must decide the combination and quantities to produce, the combination and quantities of resources to use and the manner in which to use them. The decision as to quantities of commodities to produce determines the relative size of each enterprise and the aggregate size of the farm. The quantity of credit used must be within limits of availability. Knowledge is so inadequate that a maximum return allocation of resources can not be estimated by the simultaneous solution of equations. Present available data

are the result of observing specific conditions and must be adjusted to fit desired situations. Maximum income for a specific farm must be arrived at through a combination of maximizing process and trial and error.

The idea has long prevailed among agronomy and soil scientists that the problem is one of finding which farming systems will give the greatest degree of erosion control and then choosing from among them on the basis of earnings. Although they have admitted that it might be desirable under certain price conditions to follow farming systems which would deplete soil, they very largely continue to deny that it can ever be desirable to allow erosion to occur, except in the rare case where no income (satisfaction) can be earned without some erosion occurring. It seems that this position is due to the failure to discount incomes that are likely to be earned in the future. In other words they fail to recognize that, except to the extent that soil fertility is valued per se, depreciation of land is merely another cost of production. It is similar in all respects to depreciation on a tractor except as to the capital agent. Except for the psychic cost for those who love the land for its own sake, the erosion cost of one year's production, using a farming system that allows erosion, is equal to the decline in land value that results consequent to the year's production. Except to the extent that land is valued on the basis of fertility per se, rather than on the basis of its money income producing ability, this cost will approximate losses in future money income discounted to the present.

For the relatively well to do farmers (those who have acquired

wealth status which allows them to be worrying about their children's inheritance rather than how to feed and educate them in the present), the discount rate will tend to equal some market rate of interest. That is they will have access to all the credit they desire for both production and consumption purposes and thus, will have no reason for discounting the future by more than the market rate of interest. They will not be under pressure to follow a farming system which gives a large immediate income but which causes so much erosion as to give lower than maximum present value for future incomes discounted by the market rate of interest. Instead they will likely choose one that gives a maximum present value for future incomes discounted at the market rate. Among the relatively poor farmers, as contrasted with the relatively wealthy, the credit that is made available through their ownership of resources is more likely to be used for consumption rather than for production purposes. Thus conservation practices which might return earnings greater than costs (charging at the market rate of interest) may not be employed because the necessary credit is used for consumption and not production purposes.

Under conditions of credit rationing and aversion to the use of credit by individuals expected incomes in the more distant future are likely to be greatly discounted (probably even using a higher discount rate than the market rates of interest); thus, it is reasoned that farming systems giving the greatest immediate promise of income will very likely be those chosen by the individual farmer, especially in areas of low average economic status.

Farmers must visualize alternative farming systems and the income streams that will result from such alternatives. Consideration must be given to the costs of erosion that would occur with each alternative. However, insufficient empirical data are available to properly appraise the costs of soil erosion or the value of soil improvements resulting from various farming systems. Empirical data in regard to the amount and rate of surface runoff are available. However, there are missing links which prevent a complete analysis of the problem. From the individual farmer's point of view these missing links are the effect of surface run-off (occurring with alternative farming systems) on soil erosion and the effect of soil erosion on future land earnings.

The water control problem is not limited to each individual farmer's point of view in regard to his own farm. Insufficient water control and the resulting soil erosion on one farm may cause damage to other land through deposits of infertile material on good soil or erosion of fertile soil. Inadequate water control may also impair navigation, fill power and flood reservoirs with silt, and produce flood peaks that cause loss of life and considerable property damage. Thus, water control becomes a problem from the public point of view, which is largely concerned with the general welfare of the country. Expected earnings in the future for the public are probably discounted at a lower rate than for an individual. The public is concerned with maintaining resources for production of an adequate supply to meet both present and future needs; since the public has prospects for a longer life than do individuals, uncertainty becomes less than for an individual. Adequate empirical data that would enable a complete analysis from the public point of view are non-existent. The

missing links again include a hookup between water control and soil erosion to give the desired insight into the resulting effect on the natural resources. Another link is the hookup between water control on an individual farm and flood damage outside the boundary of this farm.

Objectives

The major objectives of this study are to:

- (1) To examine alternative farming systems with regard to family earnings (ignoring erosion costs because empirical data necessary for bringing erosion costs into consideration in any refined manner are non-existent) and infiltration rates, which are believed to be highly related to erosion. This will allow us to judge whether or not those farming systems which promise large immediate earnings (disregarding erosion costs) are those which will give greater or lesser degree of water and erosion control.
- (2) To demonstrate how erosion costs are fitted into the decisions of individual farmers in selecting farming systems that will give them maximum satisfaction, given their beliefs, preferences and economic status.
- (3) To examine the probable need for public policy designed to encourage farming systems that farmers under status quo condition are not likely to choose.
- (4) To point out the missing links in experimental data that must be filled in before any more refined empirical analysis of the problem (either from the private or public point of view) can be made.

General Procedure

The study was designed for exploratory purposes in gaining insight into the compatibility of increasing earnings and water control in the East Tennessee Valley. The procedure used was influenced by the available data and time limitations. A case study farm of 121 acres (located in Monroe County) was used as a frame within which the problem was analyzed. The farm was about average commercial size in land area and located in a section on which there were available data in regard to water infiltration rates. It was necessary to make certain assumptions to eliminate the variability of some of the productive factors and gain the desired insight into the problem. It was assumed that the amount of land and labor would remain fixed at the present level. This abstracts somewhat from reality, as the average size farm in the area is gradually increasing, but was necessary for simplification purposes and to make alternative farming systems comparable. Productive factors other than land and labor were allowed to vary so that different farming systems could be developed.

The measure of earnings used was family earnings (net returns to family labor including management.) This measure is quite applicable for comparison between different farming systems with fixed land and labor. However, it carries the underlying assumption that returns to capital investments are equal to the interest on investment determined by a given rate. The rate assumed was 5 per cent, which was a compromise rate between the short-term rate of local banks, rate used by government agencies and the rate farmers could expect from an investment.

To estimate family earnings for different systems, assumptions were made in regard to price level and production functions. It was assumed that prices would remain fixed at the 1947-51 average level, and that changes in commodities produced by individual farmers would not influence changes in the relative prices. The production functions were based on present available data which are the result of observations made under specific conditions; on the basis of judgements made by informed people these data were adjusted to conditions prevailing on the case farm.

It was assumed that the rate at which water infiltrates in the soil provides a measure of water control and soil erosion. Thus, family earnings (ignoring erosion costs) of different farming systems were related to water control. Through such relationships the inadequacy of the data was pointed out as well as the missing links to make a refined analysis from both the private and public point of view.

CHAPTER II

INCREASING FARM FAMILY EARNINGS

In visualizing a farming system that would increase family earnings, a combination of the maximizing process and trial and error was used. The available input-output data are insufficient for developing production functions that can be used in simultaneously allocating resources to the desired systems. Present available data are the result of observations made under specific conditions and much interpolation (often without much empirical basis) was necessary. Such was the case with maximization of earnings in this study.

For maximum earnings owed capital funds must be invested so as to equalize marginal returns in all uses. This may be accomplished either by using these funds in the individual's own business or by lending them to others. Where such funds are already invested in land, buildings, equipment, livestock and supplies, such productive agents must be allocated so as to equalize the marginal returns from each of the various types in all potential uses, including renting or selling such agents to other people. The various types of family labor must be allocated among the various enterprises on the farm or to non-farm work so as to equalize marginal earning in all uses. Credit must be used until the marginal returns equals the marginal cost and be allocated to different potential uses so that the marginal returns from all uses are equated. In a situation of external capital rationing, credit sources, except by unlawful means such as bank hold up, etc. are closed to the farmer before the point of equation between marginal costs and marginal returns is reached.

In cases of internal rationing psychic costs bring about equality between marginal costs and returns before monetary costs and returns are equated.

For the empirical analysis that follows the land area and labor force were assumed fixed, and credit was assumed to be limited only by prospects for being profitable. The above assumptions plus an additional limitation in the scope of enterprises to those commonly selected by farmers in the area must be largely justified by simplification purposes. However, the land area for farms in general can not increase except with a net out migration of farm people. The enterprise limitation was quite broad in providing consideration of corn, burley tobacco, oats, alfalfa, lespedeza, pasture, dairy cattle, swine and beef cattle.

A farm program may be considered to be made up of interrelated business enterprises which have certain complementary and competitive relationships. Any analysis on an enterprise basis will be meaningful only where the relationships (costs and returns) between one enterprise and another enterprise within the farming system are considered. When these inter-relationships are considered, enterprise analysis gives indication of what adjustments in the farming system would give increased returns.

A cost and return analysis of enterprises considered in this study under present scale of production, good farming techniques and 1947-51 price level reveals that most crops return greater earnings per unit of labor than livestock. When different conditions of scale, mechanization and management are considered, there are shifts in the rate of earnings for different enterprises as well as in the relative difference between enterprises. Generally, crops with low labor utilization per acre return

higher earnings per unit of labor than crops with high labor requirements. A similar analysis of livestock production indicates the returns per hour of labor for swine production were much higher, excepting "grade A" milk production, than those for dairying, and the returns from dairying higher than for beef production. These relationships are in agreement with those revealed by a study made in Southeastern Indiana during 1948.⁴

Again it is recalled that the selection for maximum family earnings must be made on basis of the entire farm program. It is meaningless to say that each unit of labor used in the corn enterprise gives higher returns than in the tobacco enterprise, when the farm planted to corn would only use one-half of the fixed labor force, and might give lower total returns to the fixed costs. However, it is remembered that the value of additional leisure time and preference for certain type of work may prescribe a different farming system than for maximum earnings.

It is often difficult to make abrupt changes in a farming program. Capital invested in buildings, equipment and livestock for one system may not be costlessly convertible to an alternative system. It takes time to change from one cropping program to another; consequently, consideration should be given to the present facilities and operation to develop a system for increasing earnings in both short-run and long-run. The immediate desire and availability of credit may prescribe an entirely

⁴ Elmer C. Davis and Ronald H. Bauman, Livestock Costs and Returns in Southeastern Indiana, (Lafayette, Indiana: Purdue University Agriculture Experiment Station, Bulletin 550, 1950).

different farming system for the short-run than for the long-run. For example, costs of scrapping facilities as a dairy barn will retard changes to other farming systems. Also the loss of income during pasture establishment retards changes to the production of forage consuming livestock.

Present Farm Facilities and Operation

Ownership of the 121 acre farm selected for study was acquired in 1943 through the aid of the Tenant Purchase Program. The land was part of a tract that had proved to be unprofitable property for a loan company.

The topography of the land is rolling with a slope range of 2 to 25 per cent. A branch runs through the farm and provides a good drainage system for the slopes to each side. The lay of the land is such that the use of terraces is not practical for controlling erosion. On some areas it is even difficult to keep rows on the contour.

Soils of both limestone and acid shale origin are present; however, those of limestone origin predominate. The Dewey, Farragut, Decatur, Emory, and Sequoia soil series make up most of the land. When slope and degree of erosion are considered and land classified by soil type, the resulting areas become small and of irregular shape, see Figure 1. This presents a difficult problem in laying out fields of efficient size and uniform soil type. The present field layout reflects the owner's approach to establishing crop rotations long enough to be suitable for the lower quality soils, see Figure 2. The fields are not uniform in size and cause considerable fluctuation in crops produced.

Figure 1. Soil Map of 121 Acre Farm, Monroe County, 1952 (continued)

Legend

Soil Symbol*

Soil Name

Class 3 Soils

18CP	Dewey silty clay loam, severely eroded rolling phase
18DN	Dewey silty clay loam, eroded hilly phase
19CP	Decatur silty clay loam, severely eroded rolling phase
19DN	Decatur silty clay loam, eroded hilly phase
43CL	Sequoia silt loam, rolling phase
43CN	Sequoia silty clay loam, eroded rolling phase

Class 4 Soils

18DP	Dewey silty clay loam, severely eroded hilly phase
19DP	Decatur silty clay loam, severely eroded hilly phase
22CP	Farragut silty clay loam, severely eroded rolling phase
43CP	Sequoia silty clay loam, severely eroded rolling phase
43DL	Sequoia silt loam, hilly phase
43DN	Silty clay loam, eroded hilly phase

Class 5 Soils

21D	Rockland (limestone material)
22DP	Farragut silty clay loam severely eroded hilly phase
37D	Rough gullied land (acid shale material)
43DP	Sequoia silty clay loam, severely eroded hilly phase
67DP	Litz shaly silt loam, severely eroded hilly phase
77D	Rough gullied land (limestone material)

*Slope Classification

A:	0 to 2 per cent
B:	2 to 5 per cent
C:	12 to 25 per cent

Erosion Classification

L:	Virtually uneroded
N:	Moderately eroded
P:	Severely eroded

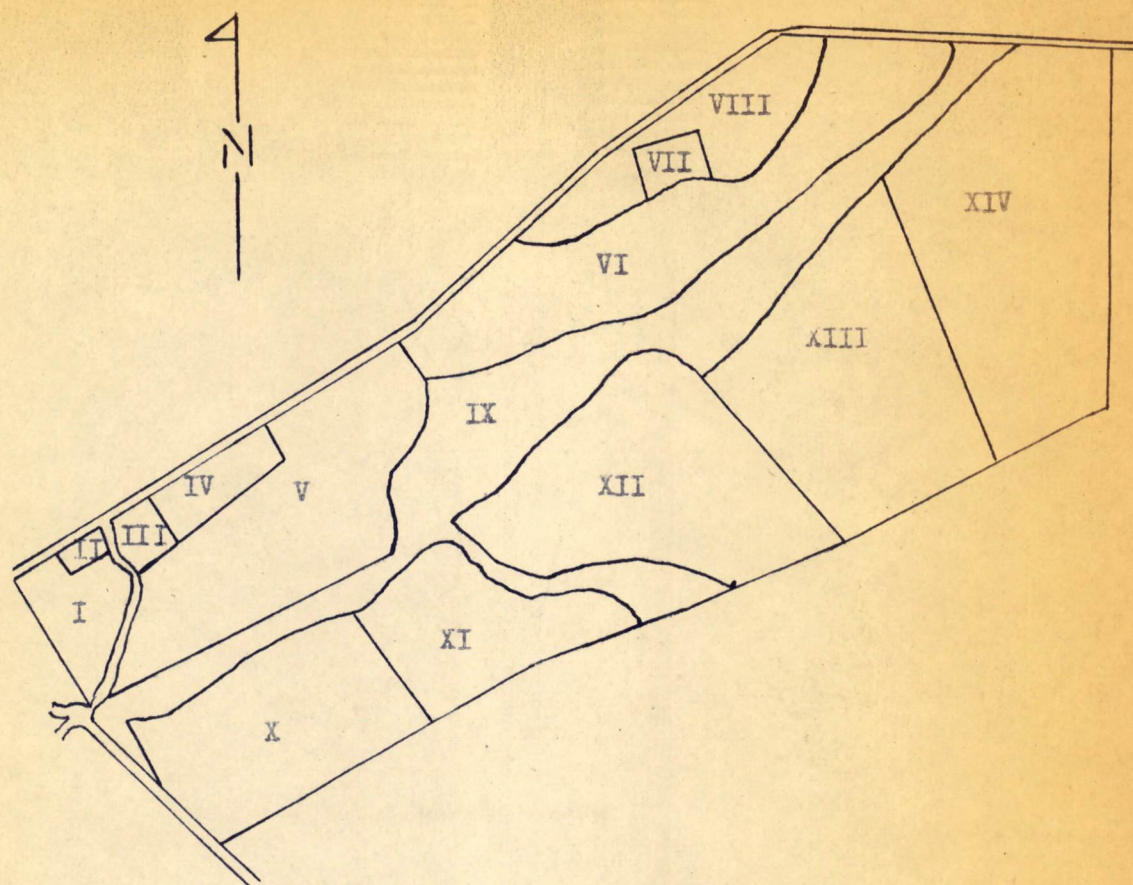


Figure 2. Present Field Layout and Cropping Plan
of a 121 Acre Farm, Monroe County

Field Number	Size in Acres	Land Use
I	2.7	Barren pasture
II	0.2	Garden
III	0.6	Homestead
IV	1.6	Permanent pasture
V	12.8	Corn, oats, 4 year's pasture
VI	14.0	Corn, oats, 4 year's pasture
VII	0.9	Tobacco with crimson clover cover crop
VIII	6.6	Woodland
IX	18.0	Permanent pasture
X	10.0	Corn, oats, alfalfa
XI	6.7	Corn, oats, alfalfa
XII	14.5	Corn, oats, 4 year's pasture
XIII	14.5	Corn, oats, 4 year's pasture
XIV	17.7	Corn, oats, 4 year's pasture

There are about 90 acres of land occasionally row cropped. The crop rotation used on most of the land includes corn, oats and four years of orchard grass, rye grass and lespedeza. The corn is harvested for grain and followed with fall seeded oats, which are usually harvested for grain. The rye grass is seeded in the fall with the oats, while the orchard grass and lespedeza are seeded the following spring. Most of the hay is produced from a corn, oats and alfalfa rotation. The tobacco is continued year after year on one track of land with a crimson clover cover crop.

Soil tests indicate that the land is rather low in phosphorus, medium to high in potassium and needs some lime. The corn yields average about 40 bushels per acre with open-pollinated varieties and 300 pounds of 3-9-6 fertilizer. Oat yields are 30 bushels per acre with 300 pounds of 3-9-6 fertilizer. There is no nitrate "side or top dressing" applied to either grain crop. The tobacco receives about 1000 pounds of 3-9-6 fertilizer per acre with an application of manure and yields 1600 pounds of leaf tobacco. Pastures receive little or no annual application of fertilizer, and are grazed continuously. The management and selection of pasture plants are such that at times there is little vegetative cover.

The building facilities consist of a tobacco-livestock barn 48' by 70' with a 14' by 48' end shed, two machine sheds 20' by 20', a combination corn crib and machine shed, poultry house, hog house and smoke house. There is a steel hay track and carriage installed in the barn to aid hay storage.

The water supply is limited to cisterns, ponds and a branch during wet weather. Attempts to establish wells in the community indicates a deep water table and high risk in establishing a well with a good water supply.

Current farm equipment includes a two row tractor, tandem disk harrow, bush and bog disk, sub-soiler, grain drill plus a fairly complete outfit of horse drawn equipment. Both tractor and horses are maintained for power. This condition appears to be the result of a gradual change to tractor equipment.

Estimated costs and returns of the present farm program is shown in Table I. The family earnings of \$1951.00 from this program are not exceptionally high. The estimated labor to carry out the program including time for repairs and upkeep of facilities is 355 10 hour days. In actual practice the tobacco crop is rented to a neighbor. However, in this study the whole farm program is considered as one unit so that alternative systems will be comparable.

A number of weaknesses in the present farm program are a result of the techniques used. For example, increases in corn yields could be made by using an adapted hybrid variety instead of Thompson's Prolific. The addition of nitrate "side or top" dressing on grain crops would normally prove economically sound. Pastures could be greatly improved on a well prepared seed bed following the oat crop. Both the pasture and soil fertility could be improved by adding a perennial clover and increasing the addition of phosphate fertilizer. Evidence of over grazing was quite apparent. There is no question but what increased livestock production could be secured by utilizing improved feeding practices, and improved practices

TABLE I

COSTS AND RETURNS OF PRESENT FARMING
PROGRAM, 1947-51, PRICE LEVEL

A. Expected Expenses

1. Direct Cash Crop Expenses

<u>Kind of Crop</u>	<u>Acres</u>	<u>Cost Per Acre</u>	<u>Total Cost</u>
Corn	15.0	\$ 6.02	\$ 90.30
Oats	15.0	12.86	192.90
Tobacco	.9	53.42	48.08
Alfalfa (4 yrs.)	10.0	15.39	153.90
Crimson Clover	(.9)	5.65	5.08
Rotational Pasture (4 yrs.)	45.0	4.28	192.60
Hog Lot Pasture	1.6	7.77	12.43
Permanent Pasture	12.5		
Garden	.2		15.00
Other	15.6		
Total Direct Cash Costs for Crops			<u>710.29</u>

2. Direct Cash Costs for Livestock

<u>Kind of Livestock</u>	<u>Number</u>	<u>Cost Per Animal</u>	<u>Total Cost</u>
Dairy Cows	12	\$ 8.92	\$ 107.04
Other Cattle	5		
Sows	2	5.50	11.00
Hogs Raised	17	2.50	42.50
Horses	2		
Hens	40		15.00
Chicks Raised	100	.402	40.20
Total Direct Cash Costs for Livestock			<u>215.74</u>

3. Other Cash and Fixed Farm Expenses

<u>Item</u>	
Auto, Electricity and Hauling (farm share)	\$ 300.00
Equipment Repair and Depreciation	578.56
Building and Fence Repair and Depreciation	337.75
Tractor Operating Expenses 200 hrs.	70.00
Taxes	55.00
Insurance (general farm)	25.00
Interest on Annual Investment (\$14,809.87 @ 5%)	
Land (\$6000.00)	300.00
Buildings and Fences (\$3235.50) ^a	161.76
Equipment (\$2307.50) ^b	134.12
Livestock (\$2500.00)	125.00
Feed Supply (\$767.12)	38.36
Total Other Farm Expenses	<u>2125.55</u>
Total All Farm Expenses	<u>3051.58</u>

COSTS AND RETURNS OF PRESENT FARMING
PROGRAM, 1947-51, PRICE LEVEL (continued)

B. Expected Receipts

1. Cash Receipts

Item	Amount	Rate	Value
Tobacco	11,440 lbs.	.484 lb.	\$ 696.96
Slaughter Hogs	15 (225 lbs.)	22.50 cwt.	750.30
Milk (Grade C)	38,000 lbs.	4.10 cwt.	1558.00
Veal Calves	10 (200 lbs.)	29.98 cwt.	599.60
Cows	3 (800 lbs.)	16.04 cwt.	384.96
Eggs	220 doz.	.43 doz.	94.60
Poultry	150 lbs.	.24 lb.	36.60
Total Cash Receipts			4130.02

2. Other Farm Receipts

Perquisites			
Dwelling			183.93
Slaughter Hogs			
Sow	1 (350 lb.)	19.46 cwt.	68.11
Gilts or Barrows	2 (225 lbs.)	22.50 cwt.	101.24
Milk	5000 lbs.	3.60 cwt.	180.00
Eggs	220 doz.	.43 doz.	94.60
Garden			45.00
AAA Payment			200.00
Total Other Farm Receipts			872.88
Total Receipts Plus Perquisites			5002.90
Family Earnings			1951.32

^aBuildings and fences include dwelling, barn, poultry house, garage, smoke house, machine shed, combination machine shed and corn crib, hog house, 760 rods woven wire fence and 680 rods of three strand barbed wire fence.

^bEquipment includes all horse-drawn equipment included in Table XIV plus two-row tractor, tandem disk harrow, bush and bog disk, sub-soiler, 12 hole grain drill, hay-loader, trailer wagon, manure spreader, chicken brooder, milk cans, and miscellaneous equipment.

in caring for livestock. Production costs were high due to the maintenance of two sources of power and the small scale of operation for some equipment.

Alternative System for Maximizing Family Earnings

In developing an alternative system for maximum earnings one is confronted with a large number of variable factors. It is quite possible to conceive of two or more farming systems that would produce equally high family earnings. The question has often been raised as to whether crops or livestock should be basic in developing farming systems. Soils people would tend to place more emphasis on the selection and techniques used in crop production while animal husbandrymen would be inclined to favor livestock production. From an economic point of view neither is basic and importance should be given to determining the combination that will return the greatest earnings from the given resources.

The farmer attempts to allocate available resources, within the limitation of his ability and knowledge (beliefs) to provide maximum satisfaction. For the lack of a better measure of satisfaction, this analysis is based upon the assumption that there are no non-monetary costs and returns.

To develop a farming system for maximum earnings with given land and labor (labor equal to that with the present farming system) certain assumptions in regard to farming techniques, relative prices and rates of production were necessary to determine family earnings. Farming techniques assumed in this analysis were based on recommendations derived

from research. The relative prices selected were those that prevailed during 1947-51, and the production functions assumed were based upon research data and the hunches of informed people.

At first, in developing a system for maximum earnings (within the framework of given assumptions) through the allocation process, it is most profitable to allocate land and labor to grain and hogs. When this allocation was pressed to the assumed limits of land or labor, it was found that a part of the land would be unused unless other enterprises with lower labor to land requirements were used. Trial and error methods indicated that the marginal returns from using part of the labor and land in low labor intensive enterprises (beef and pasture) would become higher than the marginal returns from using all of the labor on grain and hogs and leaving part of the land unused. The maximum earnings are obtained by allocating the fixed land and labor to the selected enterprises so that the labor and land used with each potential enterprise produces equal marginal returns after considering erosion costs. (The erosion costs were not taken into consideration in this analysis because of the lack of data.) Furthermore, capital (for which we have assumed credit to be unlimited except by the prospects for profitability) must be used until the costs of the last unit equals the returns from the last unit. In addition, this capital must be allocated among the various enterprises to equate the marginal returns from each enterprise. These marginal conditions of maximization had to be approximated by trial and error methods because of the crudeness of empirical data with regard to production functions.

Larger allocations of land and labor to grain and hogs will undoubtedly increase erosion cost and reduce probably future yields. Yet, available data are insufficient to determine costs due to erosion, and the point at which erosion costs equal additional returns that may be gained by producing soil eroding crops. In this analysis it was necessary to make a more or less arbitrary decision as to the maximum grain to produce. The land area allocated to grain production was 28 acres, or 23 per cent of the total acres for corn which would be followed with oats. This production was obtained by using a two-year rotation of corn, oats with lespedeza hay and a green manure crop of crimson clover on the best land. A four-year rotation of corn, oats and two years of either sweet clover and orchard grass pasture or ladino clover, alfalfa and orchard grass pasture was used on the other land in the grain rotation. More erosive systems were not considered as this system is considerably more erosive than the one presently in use. Fertilization of crops was based on recommendations based on current soil tests. A rapid turn over of crops fertilized on this basis will probably leave some residual material in the soil (unless removed by erosion) which over time would reduce the fertilizer requirements.

The assumed grain production balanced with hog production leaves some land and labor to be allocated for other production. Some of the possibilities include purchasing additional grain and making further increases in hog production or including additional enterprises. The alternative of purchasing additional grain for hogs was not considered because of the disease control problem for larger hog numbers.

Beef production is apparently the most profitable complementary

enterprise (complementary to grain and hogs). Such an enterprise provides for utilization of permanent pasture and forage crops in the grain rotation. A cow-calf production plan would be most profitable with the calves being marketed in the fall to eliminate grain requirements. Further additions of burley tobacco, production of perquisites and general upkeep of the farm complete the allocation of fixed land and labor. Details of the land allocation are shown in Figure 3.

A cost and return analysis of the grain and hog system (excluding soil erosion costs) is shown in Table II. The family earnings (net returns to labor and entrepreneurship) from this system greatly exceed any other combination of the selected enterprises within the frame of underlying assumptions. In comparison with the present system, it required an additional average investment of \$5116.00 and additional cash expenditures of \$2400.00 to increase the family earnings by \$2185.00 (not considering erosion costs).

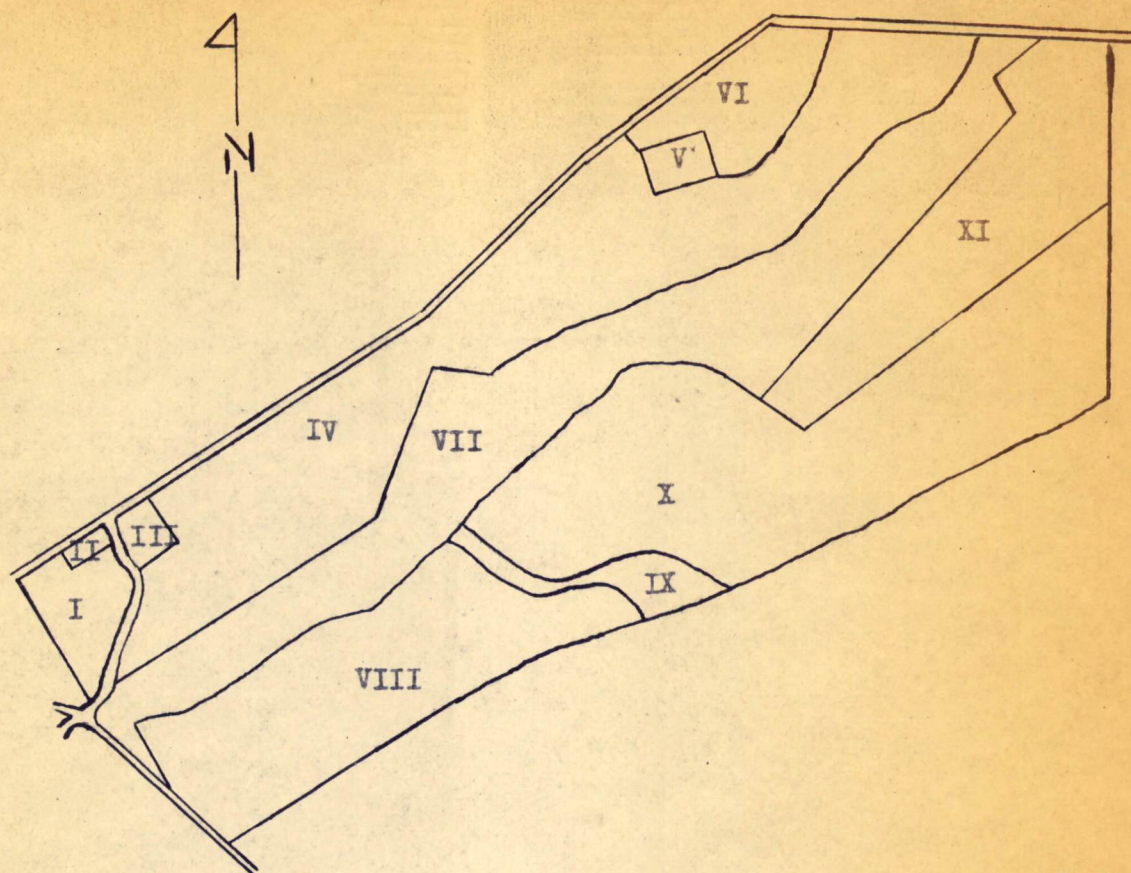


Figure 3. Field Layout and Cropping Plan for Grain and Hog
Alternative System, 121 Acre Farm, Monroe County

Field Number	Size in Acres	Land Use
I	2.7	Barnyard pasture
II	0.2	Garden
III	0.6	Homestead
IV	28.7	Corn, oats, 2 year's pasture
V	0.9	Tobacco with crimson clover cover crop
VI	4.5	Woodland
VII	24.5	Permanent pasture
VIII	16.7	Corn, oats, lespedeza, crimson clover cover crop
IX	2.0	Woodland
X	28.0	Corn, oats, 2 year's pasture
XI	12.0	Corn, oats, lespedeza, crimson clover cover crop

TABLE II^a

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COSTS AND RETURNS OF GRAIN-HOG AND BEEF CATTLE
ALTERNATIVE, 1947-51, PRICE LEVEL

A. Expected Expenses

1. Direct Cash Crop Expenses

<u>Kind of Crop</u>	<u>Acre</u>	<u>Cost Per Acre</u>	<u>Total Cost</u>
Corn	28.0	\$ 13.66	\$ 382.48
Oats	28.0	21.97	517.16
Burley Tobacco	.9	54.42	48.98
Lespedeza	(14.0)	5.30	74.20
Cover Crop	(14.9)	7.83	116.67
Rotational (2 yrs.)	28.0	19.72	52.16
Pasture			
Permanent Pasture	20.1	4.20	84.42
Garden	.2		15.00
Other	15.6		
Total Direct Cash Costs for Crops			1791.07

2. Direct Cash Costs for Livestock

<u>Kind of Livestock</u>	<u>Number</u>	<u>Cost Per Animal</u>	
Sows	10	\$ 9.08	\$ 90.80
Slaughter hogs	130	4.81	625.30
Boar	1	36.38	36.38
Beef Cows and Calves	15	5.08	76.20
Beef Heifers for Replacement to 2 yrs.	3	18.11	54.33
Dairy Cow	1	23.78	23.78
Bull	1	80.08	80.08
Hens	15	2.79	41.85
Chicks Raised	50	.805	40.25
Marketing Livestock			212.97
Total Cash Costs for Livestock			1311.94

3. Other Cash and Fixed Expenses

<u>Item</u>	
Auto (farm share)	\$ 200.00
Electricity (farm share)	18.00
Equipment and Repair and Depreciation	693.22
Building and Fencing Repair and Depreciation	377.55
Tractor Operating Expense (830 hrs.)	290.50
Taxes	65.00
Insurance (general farm)	50.00
Interest on Investment (\$20,326.53 @ 5%)	
Land (\$6000.00)	300.00
Building and Fences (\$3536.50) ^b	176.79
Equipment (\$2713.50) ^c	160.96
Livestock (\$3668.75)	183.44
Feed Supplies (\$2170.28)	108.51
Total Other Expenses	2623.97
Total All Expenses	5726.98

COSTS AND RETURNS OF GRAIN-HOG AND BEEF
CATTLE ALTERNATIVE, 1947-51, PRICE LEVEL (continued)

B. Expected Receipts

1. Expected Cash Receipts

Item	Amount	Rate	Total Value
Tobacco	11440 lbs.	.484 lb.	\$ 696.96
Sows	4 (350)	19.46 cwt.	272.44
Slaughter hogs	123 (225)	22.50 cwt.	6226.88
Beef Cows	3 (800 lbs.)	17.97 cwt.	431.28
Beef Calves	12 (400 lbs.)	25.64 cwt.	1230.72
Bull (average yearly sale)			100.00
Boar (average yearly sale)			50.00
AAA Payment			45.00
			<u>9053.28</u>

2. Perquisites

Dwelling			183.93
Slaughter Hogs	3 (225)	22.50 cwt.	151.86
Milk	5000 lbs.	3.60 cwt.	180.00
Eggs	221 doz.	.43 doz.	94.60
Garden			200.00
Total Perquisites			<u>810.39</u>

Total Income Plus Perquisites 9863.67

Family Earnings 4136.69

Increase in Investment Over Present Farming System 5516.66

Increase in Family Earnings Over Present Farming System 2185.37

^aMaterial included in this table is derived from Tables X-XVII.

^bBuildings and fences include dwelling, barn, poultry house, garage, smoke house, machine shed, combination machine shed and corn crib, five hog houses.

^cEquipment includes two-row tractor, two-bottom plow, tandem disk harrow, bush and bog disk, sub-soiler, cultipacker, two-row cultivator, two-row planter, section harrow, grain drill, mower, side delivery rake, hay loader wagon, manure spreader, hammer mill, chick brooder, two hog feeders and miscellaneous equipment.

CHAPTER III

IMPROVING WATER CONTROL

Importance of Water Control

The problem of water control for the upland farmer, from his point of view, is largely that of controlling soil erosion or damage to his specific farm. He really isn't too concerned with the resulting effect that surface water runoff from his farm may have on property and people down stream. It is easy for the farmer to rationalize that any flood damage down stream was due to an act of God or nature and that the surface runoff from his farm was so small that it really didn't make any difference. However, the soil erosion aspect affects him either immediately or in the future. Where his credit needs are of an immediate nature, he discounts the value of conserving the soil for future production more than the market discounts it.

From the public point of view damage of soil erosion on the upland farms or of floods down stream may represent a loss to the general welfare. This loss may be offset by additional immediate production that may be gained with actions that contribute to the flood damage. The public also discounts the future, but probably to a lesser degree than an individual. The public point of view is quite necessary to bring a system of order to the water control problem where individual's self interests are in conflict. Empirical data for determining erosion costs to the individual farmer and flood and erosion damage to the general welfare are limited. In this study it was necessary to use the rate water infiltrates into the soil as

a measure of water control offered by different farming systems. Available data did not permit establishing the connection between runoff and costs of runoff.

Factors Affecting Surface Water Runoff and Soil Erosion

Runoff results from gravitational force and the fluid nature of water. It includes all water that drains from land areas, and may be divided into two parts, surface runoff and ground water runoff. Surface runoff is the residual water from rain, sleet and snow that is not evaporated or infiltrated into the soil. Ground water runoff comes from the subterranean storage which is supplied by water infiltrated into the soil. Some increase in water control may be gained by a shift in the quantity of surface runoff to the quantity of steady ground water runoff.

The amount of surface runoff is governed by certain physical attributes of the land, as climate, topography, vegetative covering, soil type, tillage and grazing practices. The detrimental effects to the upland farmer are soil erosion, reduced crop yields and increased production costs; to the public they are (in addition to the above) erosion on other farms, silting out of valley farms, silting out of navigation channels and flood control reservoirs and floods.

The major climatic factors that affect surface runoff are precipitation, temperature and wind. Temperature determines whether the precipitation will be in the form of rain, snow or sleet, and to a certain extent, the viscosity of water and the absorptive condition of the soil. Wind

can influence the angle and impact of rain drops which effect the condition of surface soil. In the Tennessee Valley, it is largely the amount, intensity and distribution of rainfall that determines the amount and velocity of surface runoff from a given soil.

The erosion of soil by water is due to the dispersive action and transporting power of water. Intense rainfall tends to break down soil aggregates, and, unless the soil is covered with vegetative growth, a muddy splash results. The smaller soil aggregates reduce the size of soil pores and cause a reduction in infiltration and additional surface runoff. The resulting increase in surface runoff has more transporting power for soil erosion.

The distribution of rainfall influences the amount of rain that may occur before surface runoff and erosion result. For example, a dry soil may receive considerable rainfall with little or no surface runoff. Hence, crops may be selected with their vulnerable point when a limited amount of adverse rainfall normally occurs.

The topographic factor includes the length and degree of slope. Soil type and the amount and intensity of rainfall governs the effect that length of slope has on surface runoff. When the soil is of low permeability or the rainfall of high intensity the surface runoff increases with slope length. Opposite conditions present a decrease in surface runoff with increases in slope length. Most experimental data indicate that the degree of slope has little effect on the percentage of surface runoff.⁵

⁵L. D. Baver, Soil Physics (New York: John Wiley and Sons, Inc., 1948), p. 358.

The vegetative covering on the soil intercepts the rainfall and absorbs the impact. Thus, it reduces the break down of soil aggregates, soil dispersion and the resulting reduction in pore size. Some water will be evaporated directly from the leaves and stems without ever reaching the soil and contributing to surface runoff. Any slowing down of surface runoff due to vegetal covering will give more time for infiltration and prevent rapid concentration of water which would increase erosion. The transpiration effect of vegetative growth removes considerable water from the soil, and improves the condition for infiltration. Vegetative growth may also protect the soil from freezing and maintain conditions for infiltration. The roots influence granulation and greater porosity as well as binding influences that reduce erodibility. The plant residue furnishes food for insects, fungi and bacterial life and in decomposition passes through a stage called humus, which improves soil tilth and increases the capacity of infiltration. The action of insects, earthworms and plant roots leave the soil with many large passages that accelerate infiltration of water.

The effect of soil properties on surface runoff is influenced by the permeability of the profile, condition of soil surface and moisture content. Once a soil becomes saturated the percolation rate, determined by the permeability of the least pervious profile, regulates further water absorption. Permeability varies with different soil types and may be somewhat changed by growing deep rooted crops or subsoiling where the impervious layer is near the surface.

The condition of soil surface is a key factor in determining the infiltration capacity⁶ of soils. It varies with vegetal cover, climate and

⁶Infiltration capacity refers to the maximum rate at which soil in a given condition, can absorb water.

tillage practices. Vegetative and climatic factors have been discussed above. Tillage practices may involve soil loosening or compacting action. The loosening action increases infiltration capacity while compaction reduces it. The infiltration capacity of a dry soil is greater than for a saturated soil. Hence, the moisture content of a given soil governs the amount of absorption to effect a reduction in infiltration capacity.

Decisions as to the kind of vegetative cover, tillage, fertility level and engineering devices can greatly influence surface runoff. The effect of vegetal cover and tillage has been discussed. A high fertility level influences a good vegetative growth for crops selected, and presents conditions for a granular, porous soil with high infiltration capacity. Engineering devices refer to soil barriers which impede the downward flow of water. Thus, there is more time for infiltration and less soil erosion which depletes soil fertility.

A major problem in determining the effect of different farming systems on water control is the development of a method of measure, applicable to different soils and farming conditions. There are three methods, in general use, for measuring the infiltration rate of soils, namely, (1) by means of a lysimeter, (2) by a device known as an infiltrometer and, (3) by analyzing stream flow hydrographs and rainfall pluviographs.⁷ The lysimeter is essentially a container which holds a quantity of soil to which a known quantity of water is applied and the infiltrated water measured.

The infiltrometer essentially consists of a tightly enclosed plot of

⁷Edgar E. Foster, Rainfall and Runoff (New York: The Macmillan Co., 1949), p. 310.

land to which a known rate and quantity of water is applied and the surface runoff measured. It permits a determination of the capacity for infiltration of the soil in its natural condition. The infiltrometer is the best instrument to date in providing an idea of the detail operation of infiltration. It had been found that infiltration capacity varies considerably with different soils and rain conditions. These variations are influenced by surface tillage, crop or crop residue or by repetitions in the application of water.⁸ Hence, only relative estimates of the true infiltration are obtained. In developing estimates to determine a measure of water control, consideration must be given to the quantity, rate and distribution of rainfall as well as the soil type and surface condition. Surface runoff occurs only when there is more than sufficient rain or snowmelt to supply the maximum infiltration rate of the soil at the given time.

The third method of measuring infiltration rate has been utilized by different investigators varying somewhat in the details of the procedure. The general procedure is to determine total rainfall and surface runoff with the difference being due to infiltration and evaporation. Then, by a series of approximations, the infiltration curve can be traced. Relative infiltration rates of different soil types and land use may be obtained by relating the surface runoff of different areas of known soil type and land use. This may be done on the basis of either a particular rain storm as a unit or a season including several storms. The Hydraulic Data Branch of the Tennessee Valley Authority has done considerable work

⁸F. L. Duley and L. L. Kelly, Effect of Soil Type, Slope and Surface Condition on Intake of Water, Research Bulletin 112 (Lincoln, Nebraska: University of Nebraska Agricultural Experiment Station, 1939) p. 16.

along this line.

The infiltration rates employed in this study are based on a system of land use classification and soil type. The system of land use classification was first developed during the study of land use in the upper French Broad watershed.⁹ Land is classified into three broad uses, namely (1) cultivated land, (2) pasture and (3) forest. Each of these broad classes is divided into three or four sub-classes of quality. Although the soils of the Chestnee watershed are quite different from those of the upper French Broad watershed, the same system of land use classification was found applicable, and was used with a sample survey in 1944. The details of this system of land use classification is shown in the Appendix, Table XVIII.

Infiltration rates for each land use classification were determined by experimental studies checked with actual observed data on rainfall and runoff, Table III.

Later studies of the Chestnee watershed have provided detail information on soils, including series, slope and erosion. By assuming different soil conserving techniques with a given soil type, land use classification is possible for the sub-classes of cultivated, pasture and forest cover. An application of this technique is shown in Table IV. In this case "good" management is interpreted as adoption of recommended soil conserving practices developed by research. "Poor" management is interpreted as exploitative farming systems and without regard to conservation practices.

⁹William D. Lee, Land Cover in Relation to Water Control and Utilization in the Upper French Broad River Watershed (Raleigh, North Carolina: North Carolina State Agricultural Experiment Station, 1943), pp. 54, 55, 56.

TABLE III

LAND USE INFILTRATION RATES IN INCHES PER
 HOUR, CHESTNUT WATERSHED^a

Land Use Class	Infiltration Rates	
	Summer	Winter
C ₁	.34	.13
C ₂	.20	.09
C ₃	.11	.07
P ₁	.34	.15
P ₂	.27	.13
P ₃	.22	.12
P ₄	.13	.09
F ₁	.37	.14
F ₂	.32	.13
F ₃	.25	.12
F ₄	.15	.09

^aSource: Tennessee Valley Authority, Report No. O - 3736, Report on Initial Phases Chestnut Watershed Project (Knoxville, Tennessee: Tennessee Valley Authority, 1945), p. 146.

TABLE IV

LAND USE INFILTRATION RATES BY SOIL TYPE, SEASON AND MANAGEMENT LEVEL
IN INCHES PER HOUR, CHESTNUT WATERSHED^a

Soil Type ^b	Infiltration Rates											
	Summer						Winter					
	Good Management			Poor Management			Good Management			Poor Management		
	Cult.	Past.	For.	Cult.	Past.	For.	Cult.	Past.	For.	Cult.	Past.	For.
5B, 5C, 19BN, 22BN, 25BN	.34	.34	.37	.20	.22	.25	.13	.15	.14	.09	.12	.12
18CL, 19CN, 22CN, 18CN,												
25CN	.34	.34	.37	.11	.22	.25	.13	.15	.14	.07	.12	.12
18CP, 19CP, 18DP, 19DP,												
22CP	.20	.27	.25	.11	.13	.15	.09	.13	.12	.07	.09	.09
18DN, 19DN	.20	.34	.32	.11	.13	.15	.09	.15	.13	.07	.09	.09
43CL, 43DL	.20	.27	.32	.11	.13	.15	.09	.13	.13	.07	.09	.09
43CN	.11	.27	.25	.11	.13	.15	.07	.13	.12	.07	.09	.09
43DN	.11	.27	.32	.11	.13	.15	.07	.13	.13	.07	.09	.09
22DP, 43CP, 43DP, 66DP	-	.22	.25	.11	.13	.15	-	.12	.12	.07	.09	.09
21D	-	.13	.15	-	.13	.15	-	.09	.09	-	.09	.09
37D, 77D	-	.11	.11	-	.11	.11	-	.07	.07	-	.07	.07

^aSource: Unpublished data developed by Hydraulic Data Branch of Tennessee Valley Authority.

^bDetail description of soil type shown in Figure 1.

It is again recalled that the infiltration rate varies with soil conditions and that the infiltration rates presented above are a relative measure under saturated conditions. It is assumed that they offer a reasonably good qualitative measure for less than saturated conditions.

An infiltration measure of a farm system may be determined by classifying the land according to the above system of land use classification and calculate the average infiltration rate by weighting the given rates for different sub-classes of land use by appropriate land area. In the case of determining an infiltration measure for proposed alternative farming systems, it becomes necessary to assume a management level as explained above. Then, with the given soil type and farming system the land may be classified into sub-classes of land use and an average infiltration rate determined by a mathematical weighting procedure.

Present Farming System and Water Control

The purpose of determining the average infiltration rate with the present system is to establish a base for comparing increases in water control with various alternative farming systems. This was accomplished by applying the system of land use classification previously discussed. The difficulty encountered was in making a valid appraisal of the use of conservation practices for the unobserved portion of the crop rotation. This required a judgement in determining the effect that a change in land cover, due to crop rotation, will have on land use class of a given area of land.

The current use of conservative practices was neither "good" nor "poor". Observation of the farm and of records of past operation reveal that improvement in soil fertility (as judged by increases in rates of production) is taking place rather than exploitation without regard to conservation. The irregular lay of the land and various other reasons have prevented the utilization of a number of conservation practices. The production of cultivated crops was under a higher level of management than pasture production. Neither corn nor oats were generally grown more than one year out of six on a given area of land. Oats followed the corn for winter cover and both received reasonably liberal use of fertilizer. The pasture did not contain a perennial clover which limited the nitrogen supply. The orchard grass failed to give complete surface coverage, and definitely showed signs of over grazing.

The present use of conservation practices was appraised for each field and for the different land use. Where the management level was considered "good" or "poor" the appropriate infiltration rates by soil type and land use in Table IV were used. In other cases the infiltration data by land use sub-classes were used to determine the rates for intermediate levels of management. The estimated infiltration rates by soil type and land use for the present system of farming are shown in Table V. These rates were averaged by weighting with land area. The entire period of the crop rotation was used to eliminate yearly variations in land use by soil type and land use by area.

The average infiltration rate for the current system of farming was .23 inches per hour during the summer and .12 inches per hour during

TABLE V

ESTIMATED LAND USE INFILTRATION RATES BY SOIL TYPE AND SEASON
IN INCHES PER HOUR, 121 ACRE MONROE COUNTY FARM,
PRESENT FARMING SYSTEM

Soil Type a	Infiltration Rates					
	Summer			Winter		
	Cult.	Past.	For.	Cult.	Past.	For.
5B, 5C, 19BN, 22BN, 25BN	.34	.27	.32	.13	.13	.13
18CL, 18CN, 19CN, 22CN, 25CN	.20	.27	.32	.09	.13	.13
18CP, 19CP, 18DP, 19DP, 22CP	.11	.22	.15	.07	.12	.09
18DN, 19DN	.11	.27	.25	.07	.13	.12
43CL, 43DL, 43CN, 43DN	.11	.22	.25	.07	.12	.12
22DP, 43CP, 43DP, 66DP	.11	.13	.15	.07	.09	.09
21D	-	.13	.15	-	.09	.09
37D, 77D	-	.11	.11	-	.07	.07

^aDetail description of different soil types shown in Figure 1.

the winter. This represents both an average for the farm and an average for storms considered as a unit. Observations of the local area, Middle Creek, in 1944 revealed a summer infiltration rate of .26 and winter rate of .13 inches per hour.¹⁰ However, the whole Middle Creek area had 36.5 per cent in forest on case study farm. The application of land use classification to a single farm may be biased by fringe areas between classes, but are about what was expected.

Farming System for Maximum Water Control

A farming system for maximum water control in this study is developed within the framework of fixed labor and land. Even though surface runoff is minimized with a well managed forest, this possibility is eliminated by inability to utilize available labor efficiently.

A review of the infiltration rates in Table IV reveals that maximum water control must utilize soil conserving practices. In fact, a small change in the use of conservation practices can influence a change in the sub-class of land use. Pasture use offers almost as much reduction in the amount of surface runoff as forest use with a comparable conservation level. The infiltration rate for high quality land is about as great for cultivated crops using soil conserving practices as pasture use, the biggest difference being during the winter months. There is considerable difference between the infiltration rates of cultivated and pasture use for lower quality land. Alternative systems for maximum water control will generally utilize

¹⁰Tennessee Valley Authority, Report No. O-3736 (Knoxville, Tennessee: Tennessee Valley Authority, 1945), p. 147.

pasture and livestock with a minimum of cultivated crops other than hay crops.

A grassland farming system of good management with present forest land and 1.1 acre in cultivation (garden and tobacco) shows an infiltration rate of .305 inches per hour during summer and .137 during the winter. This compares with a complete forest alternative of .319 inches per hour during the summer and .151 during winter. A complete forest program, over time, would affect a change in soil properties determining soil type, which would influence further increases in infiltration rate. The same would be true with grassland farming that utilizes soil conserving practices.

It should not be overlooked that infiltration rate does not give complete measure for evaluating water control. In many cases a delay in surface runoff may be as beneficial as a reduction in surface runoff. One of the reasons for controlling surface runoff was to aid in the control of soil erosion. Any excessive soil erosion will present a cumulative effect in reducing the infiltration rate of a given soil. Forest and pasture use will generally slow down surface runoff and provide greater erosion control than cultivated use for a given soil. Assuming that infiltration rates give some indication of the slow down in runoff as well as a reduction in runoff, it was determined that a grassland farming system provides maximum water control. It would also reduce soil erosion to a minimum.

CHAPTER IV

ANALYSIS OF SELECTED FARMING SYSTEMS

Selected Farming Systems

Inquiry in Chapters II and III was directed at the development of farming systems for increasing family earnings and increasing water control respectively. To gain additional insight into the problem in this study an analysis was made of selected farming systems, namely, (1) grain and hogs, (2) general diversified, (3) Dairy "ungraded" and (4) dairy "grade A". These systems were developed within the framework of assumptions previously stated, and organized in such a way as to adjust the vegetal covering to the acreage of land, supply of labor and needs of the chosen combination of enterprises, Table VI. Even though there were considerable differences in the crops and livestock selections, the farming techniques and mechanization were maintained at a comparable level.

The cropping plan for the general diversified system differed from the plan shown in Figure 3 for the grain and hog system in that the length of the rotations was doubled, lespedeza replaced with alfalfa for hay and the crimson clover cover crop preceding corn was eliminated. The rotational pasture was increased from two to six years of continuous pasture as a result of the increase in rotation length, and thereby reduced costs and risk in establishing it.

The cropping plan for the dairy "ungraded" differed from the grain and hog system in that land used for crop rotations was limited to pasture

TABLE VI

FARM ORGANIZATION OF SELECTED FARMING SYSTEMS
FOR 121 ACRE MONROE COUNTY FARM

Item	Farming Systems			
	Grain & Hogs	General Diversified	Dairy "Ungraded"	Dairy "Grade A"
A. Crop Selection	Acres	Acres	Acres	Acres
Corn for grain	28.0	14.0	0.0	0.0
Oats for grain	28.0	14.0	0.0	0.0
Burley Tobacco	0.9	0.9	0.9	0.0
Hay:				
Lespedeza	14.0	0.0	0.0	0.0
Alfalfa	0.0	14.0	18.0	16.0
Winter Cover Crops	14.9	0.9	0.9	0.0
Rotational Pasture				
2 yrs. pasture	28.0	0.0	0.0	0.0
6 yrs. pasture	0.0	42.0	66.0	68.0
Permanent pasture	20.1	20.1	20.1	20.1
Garden	0.2	0.2	0.2	0.2
Other	15.6	15.6	15.6	15.6
B. Livestock Selection	Number	Number	Number	Number
Sows	10	4	0	0
Hogs raised	130	56	3	3
Boar	1	0	0	0
Beef cows and calves	15	15	15	0
Beef heifers for replacement	3	3	3	0
Dairy cows	1	11	18	25
Dairy heifers for replacement	0	3	4	5
Bull	1	1	1	1
Hens	15	15	15	15
Chicks Raised	50	50	50	50

and alfalfa hay. The pasture was to be re-established every six years and alfalfa rotated with pasture on land in fields VIII, X, and XI, Figure 3.

The cropping plan for the dairy "grade A" system differs from the dairy "ungraded" system in area used for alfalfa hay and in changing land used for tobacco to pasture.

The systems present varying degrees of intensity of the cropping program. It is expected that soil erosion will occur with the grain and hog system while soil improvement will likely take place with the two dairy systems. The general diversified system will likely have an intermediate effect on the soil (possibly some soil erosion or maybe soil improvement). There are no empirical data available for predicting how much soil erosion or soil improvement will likely take place with each system.

Costs and Returns with Selected Farming Systems

The estimated costs and returns with alternative farming systems are largely governed by assumed prices, production functions and soil erosion costs or soil improvement values. Rather accurate price data can be secured from the market place. In this analysis the 1947-51 price level was used as it represents the most recent period of five years generally considered normal. Price data used came from Tennessee markets (in so far as possible) or from other area markets that had been found comparable. Production functions were based on available empirical data and hunches of informed people.

The big problem in determining accurate costs and returns is in

the evaluation of the soil erosion costs of different farming systems. The soil erosion costs are not readily determined in the market place. There are no historical records of the amount of soil erosion occurring under various conditions or the effect it has on crop production and flood damage. Cost and returns of the selected farming systems in this analysis excludes erosion costs for lack of adequate data. The estimated costs and returns on this basis are shown in Table VII. The systems with family earnings in order of size are (1) grain and hogs with \$4136.00, (2) dairy "grade A" with \$3328.00, (3) general diversified with \$3271.00 and (4) dairy "ungraded" with \$1995.00.

With budgetary analysis the judgment as to the significance of the difference in family earnings between the selected farming systems must be made without the aid of statistical tools; this "boils down" to judgment concerning the validity of the assumptions upon which the analysis was based.

Some general tests may be made by determining how much the price of certain commodities must change before the family earnings of different systems are equated. That is, it is possible to determine the increase or reduction in price of certain commodities necessary to equate the earnings from two different systems. For example, a decrease in the price of hogs of \$2.92 per hundred pounds or an increase in the price of "grade A" milk of \$0.557 per hundred pounds would equate the family earnings from the grain and hog system with those from the dairy "grade A" system. Secondly, the two systems may also be appraised by changes in the rate of production to bring about equal family earnings. In comparing the grain and hog system with dairy "grade A" it was found that an increase of 570 pounds

TABLE VII

FINANCIAL SUMMARY OF SELECTED FARMING SYSTEMS FOR
121ACRE MONROE COUNTY FARM, 1947-51 PRICE LEVEL

Item	Farming Systems			
	Grain & Hog	General Diversified	Dairy "ungraded"	Dairy "grade A"
Cash Income				
Crops	\$ 696.96	\$ 696.96	\$ 696.96	
Livestock	8311.32	7462.06	6666.28	\$ 9203.10
Other	45.00	45.00	45.00	45.00
Total Cash Income	9053.28	8204.02	7408.24	9248.10
Perquisites	810.39	810.39	810.39	810.39
Total Income plus Perquisites	9863.67	9014.41	8218.63	10058.49
Cash Expenses				
Crops	1791.20	1605.35	1508.97	1388.84
Livestock	1311.94	1459.22	2320.95	2766.23
Other	1106.50	1090.97	961.84	1062.69
Total Cash Expense	4209.39	4155.54	4791.76	6217.76
Other Expenses				
Depreciation	587.77	607.93	5051.68	595.03
Interest on Average Investment	929.70	979.67	926.56	918.56
Total Other Expense	1517.47	1587.60	1432.24	1513.59
Total Expense	5727.11	5743.14	6224.00	6731.35
Family Earnings	4135.56	3271.27	1994.63	3327.14
Average Investment	18089.03	19098.80	18148.70	17878.65

of milk per cow per year or a decrease of 16,225 pound hogs (grain and hogs) would equate the family earnings between the two systems. Thirdly, the systems may be appraised by determining the changes in inventory valuations of land per acre necessary to equate the earnings. This would reflect erosion costs for which there are no basic data for determination.

Entry into "grade A" milk production is not entirely a decision for the individual farmer. Consideration must be given to the distance to market and means of transporting the milk. In many cases in the East Tennessee Valley, the dairy "grade A" alternative system is meaningless and without opportunity because of transportation difficulties to an available market. Excepting the dairy "grade A" system, this analysis presents three very different systems in regard to the slope of the income stream over a period of years. Except for the farmer's personal likes in regard to enterprises to produce, his choice in type of farming will be based on the immediacy of his credit needs and desires along with his knowledge (beliefs) of expected erosion costs.

In situations in which credit is largely extended on the basis of collateral rather than on the basis of prospects for profitable use, external capital rationing is likely to exist. Because farmers know that price and yield fluctuations in previous times often meant "ruin" to many farmers who attempted to use large quantities of credit, internal capital rationing also is likely to exist. In a situation of credit rationing farmers are prone to simply discount income losses in the future which result from erosion by more than the market rate of interest. This is very apt to be true when farmers relatively poor in wealth are considered. Among these farmers the conflict between the use of collateral for consumption or

production credit will be more intense than among the more wealthy farmers. It seems probable that most farmers in the area studied would (even if they had adequate information to predict erosion costs from alternative farming systems) discount the future by more than the market rate of interest. They would probably choose a farming system that gave a large immediate income rather than one that would maximize long-run earnings when discounting the future at market rate.

The public is also concerned with soil erosion costs in that they influence the health and education of farm people as well as conservation and damage to the country's resources. Should it be deemed desirable to take public action to increase water control and reduce soil erosion, certain changes in public policy might be made. Some possible changes are as follows: (1) change in lending practices so that loans would be made on the basis of prospects for profit rather than on the basis of collateral, (2) subsidize farming systems that would increase water control and thereby reduce soil erosion, (3) induce poor farm families to move into industrial employment, and aid remaining farmers in recombining the agricultural resources into "grassland" systems of farming.

Relation of Water Control to Selected Farming Systems

Improvement of water control in this analysis refers to a reduction in the undesirable effects of surface runoff. This includes a reduction in both rate and quantity of surface runoff and its resulting affect on soil erosion. The only available measure of changes in surface runoff is through infiltration rates. It follows that the only available empirical measure of soil erosion is through infiltration rates (higher the infiltration

rate the less soil erosion). The validity of this relationship was substantiated by observations of the Chestnee watershed in 1944. Sub-areas with high infiltration rates showed less suspended silt load in the streams than the sub-areas with lower infiltration rates.¹¹

Estimated infiltration rates for each of the selected farming systems on the basis of present soil type and appropriate land use, with specified use of soil conserving practices, are shown in Table VIII. It is noted that the greatest water infiltration was with the dairy system, and the least infiltration with the grain and hog system. The general diversified system was somewhat in between. This information concurs with the belief that there are considerable differences in amount of soil erosion with the different farming systems. Yet, this information (the best available) does not provide a means for measuring the economic differences in the soil erosion with the different systems. Such information is necessary to adequately determine the compatibility of increasing earnings with water control from both the individual farmer's point of view and the public point of view.

¹¹Tennessee Valley Authority, Report No. O-3736 (Knoxville, Tennessee: Tennessee Valley Authority, 1945), pp. 28 and 147.

TABLE VIII

ESTIMATED INFILTRATION RATES FOR SELECTED FARMING
SYSTEMS AND SPECIFIED MANAGEMENT LEVELS FOR 121 ACRE MONROE
COUNTY FARM

Item	Infiltration Rates	
	Inches Per Hour	
"Good" Management Level	Winter	Summer
Grain and Hogs	.125	.289
General Diversified	.126	.292
Dairy "ungraded"	.137	.307
Dairy "grade A"	.137	.307
"Poor" Management Level		
Grain and Hogs	.090	.155
General Diversified	.091	.160
Dairy "ungraded"	.102	.178
Dairy "grade A"	.102	.178

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APPENDIX



TABLE II

ESTIMATED LABOR AND POWER REQUIREMENTS PER ACRE OR UNIT OF
SELECTED FARM ENTERPRISES, 121 RE MONROE COUNTY FARM

Item	Hour of Man labor												Horse	Tractor
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Man	
Crops (per acre)														
Corn for grain (40-50 bu.)	--	--	--	--	--	4.1	1.5	--	--	--	--	--	28.6	--
Tractor and workstock	--	--	--	7.0	4.0	4.1	1.5	--	12.0	--	--	--	37.8	2.6
Tractor (hand picked)	--	--	--	5.6	1.5	2.9	--	--	12.0	--	--	--	22.0	11.9
Oats for grain (40-50 bu. following corn)														
Tractor and workstock (binder)	--	--	1.1	--	--	4.0	4.0	--	3.3	--	--	--	12.4	4.3
Tractor (custom combining)	--	--	1.1	--	--	1.0	--	--	3.3	--	--	--	5.4	3.8
Burley tobacco (1600-1800 lbs.)	--	22.0	5.0	5.0	26.0	40.6	36.4	100.0	40.0	--	100.0	90.0	465.0	37.6
Alfalfa hay (3 tons)														
Workstock (loose)	--	--	1.2	--	--	6.0	6.0	6.0	--	--	--	--	19.2	--
Tractor (loose)	--	--	.7	--	--	4.2	4.2	4.2	--	--	--	--	13.3	8.8
Establish Alfalfa														
Tractor & workstock	--	--	--	--	--	--	6.0	3.8	--	--	--	--	9.8	3.8
Tractor	--	--	--	--	--	--	3.0	3.8	--	--	--	--	6.8	5.8
Lespedeza hay (1-2 tons) (following oats)				.5										
Workstock (loose)	--	--	--	.5	--	--	--	8.0	--	--	--	--	8.5	--
Tractor (loose)	--	--	--		--	--	--	5.7	--	--	--	--	6.2	3.5
Winter cover crops														
Tractor (following row crop)	--	--	--	--	--	--	--	3.0	--	--	--	--	3.0	2.5
Establish rotational pasture														
Tractor and workstock	--	--	--	--	--	--	--	6.0	3.8	--	--	--	9.8	3.8
Tractor	--	--	--	--	--	--	--	3.0	3.8	--	--	--	6.8	5.8
Maintain Pasture														
Tractor and workstock	--	--	.7	--	--	1.4	1.4	--	--	--	--	--	3.5	.7
Tractor	--	--		--	--	.8	.8	--	--	--	--	--	2.3	1.6

ESTIMATED LABOR AND MAINTENANCE REQUIREMENTS PER ACRE OR UNIT OF
SELECTED FARM ENTERPRISES, 1941-1942 MONROE COUNTY FARM (continued)

Item	Hours of Man Labor												Tractor		
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec		Man	Horse
Garden and truck	--	5.0	15.0	15.0	12.0	10.0	3.0	4.0	8.0	7.0	3.0	--	82.0	--	15.0
Livestock (per head)															
Milk cows (ungraded milk)															
Family cow	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	18.0	--	--
Hand (10 cow herd, 6000 lbs.)	13.0	12.0	12.0	12.0	12.0	12.0	11.0	11.0	12.0	12.0	12.0	13.0	120.0	--	--
Machine (10 cow herd, 6000 lbs.)	8.5	8.5	8.5	8.5	8.5	8.5	8.0	8.0	8.0	8.0	8.5	8.5	100.0	--	--
Milk cows (Grade A)															
Machine (15 cow herd, 6000 lbs.)	9.0	9.0	9.0	9.0	9.0	9.0	8.0	8.0	3.0	9.0	9.0	9.0	105.0	--	--
Machine (20 cow herd, 6000 lbs.)	8.5	8.5	8.5	8.5	8.5	8.5	8.0	8.0	8.0	8.0	8.5	8.5	100.0	--	--
Dairy heifers to 2 yrs.	3.0	3.0	3.0	2.0	1.0	0.5	0.5	0.5	0.5	0.5	2.5	3.0	20.0	--	--
Beef cow and calf (16 cow herd)	2.5	2.5	2.5	1.0	0.8	0.8	0.4	0.4	0.8	0.8	1.5	2.0	16.0	--	--
Beef heifers to 2 yrs.	2.5	2.5	2.5	1.5	0.5	--	--	--	--	0.5	2.5	2.5	15.0	--	--
Brood sow (2 litters)	3.0	3.0	12.0	8.0	8.0	2.0	2.0	2.0	12.0	8.0	8.0	2.0	70.0	--	--
Slaughter hog (225 lbs.)	0.5	0.5	0.4	--	0.2	0.4	0.5	0.5	0.4	--	0.2	0.4	4.0	--	--
Boar	3.0	3.0	2.0	2.0	3.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	30.0	--	--
Bull	5.0	5.0	5.0	4.0	4.0	4.0	3.0	3.0	3.0	4.0	5.0	5.0	50.0	--	--
Chicks & hens, home use	9.0	16.0	27.0	18.0	10.0	8.0	5.0	4.0	4.0	7.0	8.0	9.0	125.0	--	--
Hauling manure (per animal unit)															
Workstock	.6	.4	.5	--	--	--	--	--	--	--	--	.5	2.0	4.0	--
Tractor	.5	.5	.5	--	--	--	--	--	--	--	--	--	1.5	--	1.5
Grinding and mixing feed (1000 lbs.)	--	--	--	--	--	--	--	--	--	--	--	--	2.0	--	2.0

^a Source: Data were adapted from: W. H. Pierce and M. S. Williams, Cost of Producing Farm Products, A. E. Information Series No. 29, (Raleigh, N. C. Department of Agricultural Economics, N. C. State College, 1952); B. D. Raskopf, Improving Incomes of Small Farms in Arcab, West Tennessee, Rural Research Series, Monograph No. 237, (Knoxville, Tennessee, Agricultural Experiment Station, University of Tennessee, 1948).

TABLE X

AVERAGE PRICES PAID BY FARMER FOR SEED, FEED
AND FERTILIZER TENNESSEE, 1947-51^a

Item	Unit	Average Price
Feeds		
Cottonmeal	cwt.	\$4.33
Soybean meal	cwt.	4.52
Tankage	cwt.	6.25
Bran	cwt.	3.49
Laying mash	cwt.	5.08
Chicken starter mash	cwt.	5.54
Mixed dairy feed 20%	cwt.	4.27
Stock salt	cwt.	--
Seeds		
Alfalfa	lb.	0.60
Sweet clover	lb.	0.243
Ladino clover	lb.	2.15
Rye grass	lb.	0.14
Orchard grass	lb.	0.345
Lespedeza korean	lb.	0.10
Lespedeza sericea	lb.	0.26
Fescue	lb.	0.75
Crimson clover	lb.	0.243
Corn hybrid	bu.	9.60
Corn open pollinated	bu.	4.57
Oats, winter	bu.	1.60
Fertilizer		
Agricultural limestone	ton	3.20
NH ₄ NO ₃	ton	75.60
20% P ₂ O ₅	ton	28.00
45% P ₂ O ₅	ton	54.00
Murate of Potash U.S.A.	ton	56.00
2-12-6	ton	36.80
3-9-6	ton	36.30
5-10-5	ton	43.10

^a Computed from data obtained from: United States Department of Agriculture, Agricultural Prices (Washington D. C., Bureau of Agricultural Economics, All issues 1947-1951).

TABLE XI

AVERAGE PRICES RECEIVED BY FARMERS IN TENNESSEE AND
IN SELECTED MARKETS, 1947-51^a

Item	Grade	Unit	Average Price	Market
Corn, grain	All grades	bu.	\$1.68	Tennessee
Oats, grain	All grades	bu.	1.04	Tennessee
Tobacco, (Type 31)	All grades	lb.	0.484	All Type 31
Alfalfa hay (baled)	All grades	ton	31.85	Tennessee
Lespedeza hay (baled)	All grades	ton	25.36	Tennessee
All hay (baled)	All grades	ton	24.38	Tennessee
Whole Milk	Grade A 4.5% B.F.	cwt.	5.67	Knoxville
Whole Milk	Ungraded 4.5% B.F.	cwt.	4.10	Knoxville
Whole Milk	All wholesale	cwt.	4.62	Tennessee
Veal Calves	All grades & wts.	cwt.	25.42	Tennessee
Veal Calves	Choice and Prime	cwt.	29.98	Chicago
Market Cows	Utility	cwt.	17.97	Chicago
Market Cows	Canner and Cutter	cwt.	16.04	Chicago
Feeder & stocker cattle	All grades & wts.	cwt.	24.36	Tennessee
Feeder stocker & feeder steers	All grades & wts.	cwt.	25.64	Kansas City
Hogs	All grades & wts.	cwt.	21.06	Tennessee
Hogs	Choice (200-240 lb.)	cwt.	22.50	Chicago
Sows	All grades	cwt.	19.46	Chicago

^a Average Tennessee prices computed from data obtained from: United States Department of Agriculture, Agricultural Prices, (Washington, D. C. Bureau of Agricultural Economics, All issues 1947-51); Chicago and Kansas City prices computed from data from: United States Department of Agriculture, The Livestock and Meat Situation, (Washington, D. C., Bureau of Agricultural Economics, Jan.-Feb., 1952) pp. 34-36.

TABLE XII

ESTIMATED CASH EXPENSES PER ACRE OF
SELECTED FARM CROPS, 1947-51 PRICE LEVEL

Enterprise	Item	Quantity	Rate	Expense
Burley Tobacco	Seed	.5 oz.	\$2.00 oz.	\$ 1.00
	Fertilizer			
	3-9-6	1000 lbs.	1.82 cwt.	18.20
	Plant Bed Cloth	25 sq. yds.	.125 sq. yd.	3.12
	Insecticide			5.00
	Marketing	1600 lbs.	3.5%	27.10
Total Per Acre				54.42
Corn	Seed	9 lbs.	17.14 cwt.	1.54
	Fertilizer:			
	5-10-5	300 lbs.	2.15 cwt.	6.45
	33-0-0	150 lbs.	3.78 cwt.	5.67
Total Per Acre				13.66
Oats	Seed	2 bu.	1.60 bu.	3.20
	Fertilizer:			
	0-20-0	150 lbs.	1.40 cwt.	2.10
	33-0-0	150 lbs.	3.78 cwt.	5.67
	Combining	1 acre	5.00 acre	5.00
	Baling Straw	1 acre	5.00 acre	5.00
Total Per Acre				20.97
Hay	Seed:			
Establish	Alfalfa	20 lbs.	.60 lb.	12.00
Alfalfa and	Orchard Grass	5 lbs.	.345 lb.	1.72
Orchard Grass	Fertilizer:			
	Lime	2 ton	3.20 ton	6.40
	0-20-0	600 lbs.	1.40 cwt.	8.40
	33-0-0	50 lbs.	3.78 cwt.	1.89
	0-0-48	100 lbs.	2.80 cwt.	2.80
	Borax	20 lbs.	5.00 cwt.	1.00
Total Per Acre				34.21

TABLE XII

ESTIMATED CASH EXPENSES PER ACRE OF
SELECTED FARM CROPS, 1947-51 PRICE LEVEL (CONTINUED)

Enterprise	Item	Quantity	Rate	Expense
Hay				
Maintain	Fertilizer:			
Alfalfa	0-20-0	200 lbs.	\$1.40 cwt.	\$ 2.80
	0-0-48	100 lbs.	2.80 cwt.	2.80
	Borax	20 lbs.	5.00 cwt.	1.00
Total Per Acre				6.60
Lespedeza	Seed	25 lbs.	.10 lb.	2.50
	Fertilizer:			
	0-20-0	200 lbs.	1.40 cwt.	2.80
Total Per Acre				5.30
Pasture				
Establish	Seed:			
Ladino Clover	Orchard Grass	10 lbs.	.345 lb.	3.45
and Orchard	Ladino Clover	2 lbs.	2.15 lb.	4.30
Grass	Fertilizer:			
	Lime	2 ton	3.20 ton	6.40
	0-20-0	600 lbs.	1.40 cwt.	8.40
	33-0-0	100 lbs.	3.78 cwt.	3.78
	0-0-48	100 lbs.	2.80 cwt.	2.80
Total Per Acre				29.13
Establish	Seed:			
Alfalfa	Orchard Grass	10 lbs.	.345 lb.	3.45
Ladino	Ladino Clover	1.5 lbs.	2.15 lb.	3.22
Clover				
and	Alfalfa	5 lbs.	.60 lb.	3.00
Orchard	Fertilizer:			
Grass	Lime	2 ton	3.20 ton	6.40
	0-20-0	600 lbs.	1.40 cwt.	8.40
	33-0-0	100 lbs.	3.78 cwt.	3.78
	0-0-48	100 lbs.	2.80 cwt.	2.80
Total Per Acre				29.69

TABLE XII

ESTIMATED CASH EXPENSES PER ACRE OF
SELECTED FARM CROPS, 1947-51 PRICE LEVEL (CONTINUED)

Enterprise	Item	Quantity	Rate	Expense
Pasture				
Maintain	Fertilizer:			
Pasture	0-20-0	200 lbs.	1.40 cwt.	2.80
	0-0-48	50 lbs.	2.80 cwt.	1.40
Total Per Acre				4.20
Crimson Clover				
	Seed:	20 lb.	.243 lb.	4.86
	Innoculant	1/3 box	.50 box	.17
	Fertilizer:			
	0-20-0	200 lbs.	.40 lb.	2.80
Total Per Acre				7.83

TABLE XIII

ESTIMATED CASH EXPENSES PER ANIMAL OF
SELECTED FARM ENTERPRISES, 1947-51 PRICE LEVEL

Enterprise	Item	Quantity	Rate	Expense
Swine				
Brood Sow (2 litters to weaning)	Tankage	75 lbs.	\$6.25 cwt.	\$ 4.69
	Soybean Oil Meal	75 lbs.	4.52 cwt.	3.39
	Breeding Fee		1.00	2.00
	Misc. (minerals, worm medicine)			1.00
	Marketing	1 sow	3%	2.04
	Grain Requirements			
	Corn	15 bu.	1.68	25.20
	Oats	15 bu.	1.04	15.60
Market Hog	Tankage	40 lbs.	6.25 cwt.	2.50
	Soybean Oil Meal	40 lbs.	4.52 cwt.	1.81
	Misc. (minerals, worm medicine)			.50
	Marketing	1 hog	3%	1.52
	Grain Requirements			
	Corn	9.5 bu.	1.68	15.96
	Oats	9.5 bu.	1.04	9.88
Boar	Tankage	50 lbs.	6.25 cwt.	3.12
	Soybean Oil Meal	50 lbs.		2.26
	Misc. (minerals, worm medicine)			1.00
	Purchase cost	1 (pig)		30.00
Beef Cattle				
Beef Cow and Calf	Vet. and Medicine	1 (cow)	1.00	1.00
	Death Loss		3.70	3.70
	Breeding Fee	1	3.00	3.00
	Salt	30 lbs.	1.28 cwt.	.38
	Marketing	1 cow	3%	4.31
	Marketing	1 calf	3%	3.08
Beef Heifers to 2 yrs.	Cotton Seed Meal	250 lbs.	4.45 cwt.	11.12
	Salt	30 lbs.	1.28 cwt.	.38
	Death Loss		4.86	4.86
	Vet. and Medicine	1	1.75	1.75

TABLE XIII

ESTIMATED CASH EXPENSES PER ANIMAL OF
SELECTED FARM ENTERPRISES, 1947-51 PRICE LEVEL (CONTINUED)

Enterprise	Item	Quantity	Rate	Expense
Dairy Cattle				
Dairy Cow	Cotton Seed Meal	400 lbs.	\$4.45 cwt.	\$17.80
	Haul Bill (Milk)	60 cwt.	.50 cwt.	30.00
	Death Loss		3.60	3.60
	Vet. and Medicine	1 cow	2.00	2.00
	Marketing	1 cow	3%	3.85
	Marketing	1 calf	head	1.00
	Grain Requirement			
	Corn	12.5 bu.	1.68	21.00
	Oats	12.5 bu.	1.04	13.00
Dairy Heifer to 2 yrs.	Calf Starter	200 cwt.	5.50 cwt.	10.50
	Cotton Seed Meal	350 cwt.	4.45 cwt.	15.58
	Salt	30 lbs.	1.28 cwt.	.38
	Death Loss		4.86	4.86
	Vet. and Medicine	1	1.75	1.75
	Grain Requirements			
	Corn	6 bu.	1.68	10.08
	Oats	6 bu.	1.04	6.24
Bull	Salt	30 lbs.	1.28 cwt.	.38
	Vet. and Medicine	1		1.00
	Death Loss	1 (bull)		3.70
	Purchase Cost			150.00
Poultry				
Hens	Laying Mash	55 lbs.	5.08 cwt.	2.79
	Grain Requirements			
	Corn	0.5 bu.	1.68	.84
	Oats	0.5 bu.	1.04	.52
Chicks	Starter and Grower	12 lbs.	5.54 cwt.	.66
	Chicks	1	.145	.145

TABLE XIV

ESTIMATED INVESTMENT, REPAIRS, DEPRECIATION,
AND INTEREST FOR FARM BUILDINGS, FENCES, HORSE-DRAWN AND
MISCELLANEOUS EQUIPMENT, 1947-51 PRICE LEVEL

Item	Estimated New Value 1947-51	Estimated Useful Life Years	Depreci- ation Dollars	Repairs and Upkeep Percent of Orig- inal Cost	Interest 5% Ave. Invest- ment	Total
Buildings						
Dwelling	\$2500.	35	\$71.43	2	\$62.50	\$183.93
Barn	2000.	35	57.14	2	50.00	147.14
Poultry House	100.	25	4.00	2	2.50	8.50
Garage	125.	25	5.00	2	3.12	10.62
Smoke House	75.	25	3.00	2	1.88	6.38
Machine Shed	125.	25	5.00	2	3.12	10.62
Machine Shed and Crib	125.	25	5.00	2	3.12	10.62
Hog House	25.	15	1.67	5	.62	3.04
Milk Parlor	1000.	40	25.00	2	25.00	70.00
Dairy Barn	1000.	40	25.00	2	25.00	70.00
Well	500.	50	10.00	2	12.50	32.50
Fences						
Woven Wire Fence (760 rods)	988.	20	49.40	1	24.70	83.98
Barbed Wire Fence (680 rods)	408.	20	20.40	1	10.20	34.68
Horse Drawn Equipment						
Plow, 2-horse	21.	18	1.08	37	.54	9.58
Sectional Harrow	43.	17	2.28	10	1.12	7.70

TABLE XIV

ESTIMATED INVESTMENT, REPAIRS, DEPRECIATION,
AND INTEREST FOR FARM BUILDINGS, FENCES, HORSE-DRAWN AND
MISCELLANEOUS EQUIPMENT, 1947-51 PRICE LEVEL
(CONTINUED)

Item	Estimated New Value 1947-51	Estimated Useful Life Years	Depreci- ation Dollars	Repairs and Upkeep Percent of Orig- inal Cost	Cost	Interest 5% Ave. Invest- ment	Total
Horse Drawn Equipment							
Cultivator, 2-horse	91.	17	4.82	12	10.92	2.28	18.02
Cultivator, 1-horse	12.	21	.51	10	1.20	.30	2.01
Planter, 2-row	190.	15	11.40	2	3.80	4.75	19.95
Planter, 1-row	48.	16	2.70	2	.98	1.20	4.88
Mower, 2-horse	179.	17	9.48	8	14.32	4.48	28.28
Dump Rake	91.	19	4.31	4	3.64	2.28	10.23
Wagon	152.	20	6.84	10	15.20	4.56	26.60
Miscellaneous Equipment							
Chicken Brooder	24.	15	1.44	4	.96	.60	3.00
Milking Machine	304.	20	15.20	5	15.20	7.60	38.00
Milk Can	9.	10	.90	10	.90	.225	2.025
Water Heater (30 gal.)	115.	20	5.75	5	5.75	2.88	14.38
Milk Cooler (6 can)	300.	20	15.00	5	15.00	7.50	37.50
Other Dairy Equipment	50.	10	5.00	20	10.00	.63	15.63
Misc. Equipment	50.	20	2.50	5	2.50	1.25	6.25
Hog Feeder	65.	10	6.50	3	1.95	1.62	10.07
Water Pump and Pipe	500.	15	30.00	7	35.00	15.00	80.00

TABLE XV

ESTIMATED INVESTMENT, REPAIRS, DEPRECIATION,
AND INTEREST FOR TRACTOR EQUIPMENT,
1947-51, PRICE LEVEL

Item	Estimated New Value	Estimated Useful Life Years	Depreci- ation ^a Dollars	Repairs And Upkeep Percent of Orig. Cost	Cost	Interest ^b 5% Ave. Invest.	Total
	1947-51						Dollars
Tractor, 2-row	\$1778.	13	\$123.09	6	\$106.68	53.34	\$283.11
Plow, 2-bottom	219.	15	13.14	11	24.09	6.57	43.80
Tandem Disk	214.	14	13.76	8	17.12	6.42	37.30
Bush and Bog Disk	285.	15	17.10	5	14.25	8.55	39.90
Sub-soiler	146.	20	6.57	5	7.30	4.02	17.89
Culti-packer, 2-roller	161.	15	9.66	5	8.05	4.83	22.54
Cultivator, 2-row	209.	20	9.40	9	18.81	6.27	34.48
Planter, 2-row	205.	20	9.22	5	10.25	6.15	25.62
Section Harrow	69.	15	4.14	13	8.97	2.07	15.18
Grain Drill, 12-hole	374.	16	21.04	7	26.18	11.22	58.44
Mower, 7-feet	256.	12	19.20	12	30.72	7.68	57.60
Side Delivery Rake	261.	15	15.66	7	18.27	7.83	41.76
Hay Loader	265.	20	11.92	5	13.25	7.95	33.12
Wagon (4 wheel trailer)	250.	20	11.25	8	20.00	7.50	38.75
Manure Spreader	347.	15	20.82	7	24.29	10.41	55.52
Hammer Mill	184.	15	11.04	2	3.68	5.06	19.78
Fertilizer Spreader	200.	15	2.00	7	14.00	6.00	22.00

a - Estimated new value less 10 percent (for trade-in value) divided by the estimated total years of useful life.

b - One-half of the purchase price plus 10 percent (for trade-in value) multiplied by 5 percent.

TABLE XVI

ESTIMATED RATES OF PRODUCTION FOR SELECTED FARMING
SYSTEMS, 121 ACRE MONROE COUNTY FARM

		Farming Systems			
	Unit	Grain & Hogs	General Diversified	Dairy "Ungraded"	Dairy "Grade A"
Crops					
Corn for grain	Bu.	50	55	--	--
Oats for grain	Bu.	50	55	--	--
Burley tobacco	Lb.	1600	1600	1600	--
Hay					
Lespedeza	Ton	1.5	--	--	--
Alfalfa	Ton	--	3	3	3
Livestock					
Pigs per litter	No.	13	14	--	--
Beef per cow	Lb.	400	400	400	--
Milk per cow	Lb.	--	6000	6000	6000
Pasture per A.U.	Acre	1.5	1.6	2.3	3.0

TABLE XVII

ESTIMATED AVERAGE INVESTMENT FOR LIVESTOCK AND FEED
SUPPLY, SELECTED FARMING SYSTEMS, 121 ACRE
MONROE COUNTY FARM

Item	Average Unit value		Selected Farming Systems			
	Rate	Unit	Grain & Hogs	General Diversi.	Dairy Ungraded	Dairy Grade "A"
Livestock						
Sows	\$75.00	hd.	\$ 750.00	\$ 225.00		
Boar	50.00	hd.	50.00			
Beef Cows	150.00	hd.	2250.00	2250.00	\$2250.00	
Beef heifers	100.00	hd.	300.00	300.00		
Dairy cows	150.00	hd.	150.00	1800.00	2700.00	\$3750.00
Dairy heifers	100.00	hd.		300.00	400.00	500.00
Bull	150.00	hd.	150.00	150.00	150.00	150.00
Hens	1.00	hd.	15.00	15.00	15.00	15.00
Total Livestock			<u>3665.00</u>	<u>5040.00</u>	<u>5815.00</u>	<u>4415.00</u>
Feed						
Corn	.84	bu.	1176.00	646.80		
Oats	.52	bu.	728.00	400.40		
Alfalfa Hay	15.92	ton		668.85	859.95	764.40
Lespedeza Hay	12.68	ton	266.28			
Total Feed						
Supplies			<u>2170.28</u>	<u>1716.05</u>	<u>859.95</u>	<u>764.40</u>

TABLE XVIII

SYSTEM OF LAND USE CLASSIFICATIONS^a

LAND USE CLASSES

A. Cultivated Land

- C_1 - Coverage - Generally close-growing vegetation on uplands, may be row crops on bottomlands and colluvial areas. Growth vigorous.
 Slope - Generally less than 20 percent.
 Soils - Favorable (well-drained alluvial soils, terrace soils, colluvial soils)
 Erosion - Apparently there has been only slight to moderate erosion loss, but none active at present.
 Management - Consider breaking (contour or other), tillage (contour or not), terracing, rotation system, etc. Growth of crops is an indication of fertility and also of infiltration.
- C_2 - Intermediate between C_1 and C_3 . (Slope largely between 20 percent and 40 percent.)
- C_3 - Coverage - Generally row crops, poor.
 Slope - Usually above 10 percent.
 Soils - Largely the poorer soil series.
 Erosion - Moderately severe to severe, and active.
 Management - Area shows every indication of poor handling such as rows down slope.

TABLE XVIII

SYSTEM OF LAND USE CLASSIFICATIONS^a
(CONTINUED)

LAND USE CLASSES

B. Pasture

P₁ - Coverage - Complete, no bare spots, grass 1-1/2 inches minimum height.

Grazing - Apparently not over-grazed.

Trampling - Apparently not trampled sufficiently to cut sod.

Soil - Usually deep - 2 feet minimum, and of the better series.

Slope - Related to soil association but in general not over 50 percent.

Erosion - No active erosion.

(A P₁ pasture should show evidence of good management. It may be terraced, contoured furrowed, and used in rotation with other pastures for controlled grazing. Weeds are clipped. A very heavy broomsedge sod is P₁.)

P₂ - Coverage - Complete, no bare spots, grass 1 inch minimum height.

Grazing - Not over-grazed.

Trampling - No excessive trampling.

Soil - Generally 2 feet minimum depth, and on better series.

Slope - Related to soil association.

Erosion - No active erosion.

TABLE XVIII

SYSTEMS OF LAND USE CLASSIFICATIONS^a
(CONTINUED)

LAND USE CLASSES

P_3 - Intermediate between P_2 and P_4 . Some of the steeper P_2 areas should come in this group.

P_4 - Coverage - Generally less than 60 percent. Usually has bare spots.

Grazing - Apparently over-grazed.

Trampling - Usually severely trampled.

Soil - General soil factors are dependent upon other conditions.

("Good" soils may be severely eroded because of poor management, etc.)

Slope - Rather important, and a contributing factor to erosion.

Erosion - Usually quite active. Often severe gully damage.

(Grazed woodlands classed as pasture are P_4 . A P_4 pasture shows little evidence of management.)

C. Forest

F_1 - Canopy (including understory), 80 percent or more.

Litter - 3 inches minimum depth. Should cover at least 90 percent of ground surface.

A_1 Horizon of soil - 4 inches minimum depth of organic layer, and partly decomposed litter.

Soil - 2 feet minimum depth.

Slope - No limitation.

TABLE XVIII

SYSTEMS OF LAND USE CLASSIFICATIONS^a
(CONTINUED)

LAND USE CLASSES

Exposure - Generally north, east, or northwest.

Fire damage - None in recent years.

Grazing - None.

F₂ - Canopy (including understory), 60 to 80 percent.

Litter - 2 to 3 inches minimum depth. Should cover not less than
90 percent of ground surface.

A₁ - Horizon of soil - 2 inches minimum depth of organic layer and
partly decomposed litter.

Soil - 1-1/2 to 2 feet minimum depth.

Slope - No limitation.

Exposure - Generally north, east, or northwest.

Fire damage - None in recent years.

Grazing - None.

F₃ - Canopy (including understudy), 25 to 60 percent.

Litter - 1 to 2 inches in depth and covering at least 80 percent
of ground surface.

A₁ Horizon of soil - Organic matter 1 to 2 inches in depth.

Soil - 1-1/2 feet in depth.

Slope - No limitation.

Exposure - No limitation.

Fire damage - None in recent years.

TABLE XVIII

SYSTEMS OF LAND USE CLASSIFICATIONS^a
(CONTINUED)

LAND USE CLASSES

Grazing - None.

F₄ - Canopy (including understory), 25 percent or less.

Litter - Generally very thin. Coverage less than 75 percent of ground surface.

A₁ Horizon of soil - less than 1 inch depth of organic layer.

Soil - Not more than 12 inches in depth.

Slope - No limitation.

Exposure - No limitation.

Fire damage - Often, or recently burned.

Grazing - Generally grazed.

D. Rock

This includes areas whose surface is almost entirely rock outcrops.

E. Idle Land

This includes cropland "resting" or not in crop this or past season, but not yet in trees. Land to be placed in C₁, C₂, or C₃ group according to slope, soil association, and erosion conditions.

F. Waste Land

This includes land abandoned because too steep, too eroded, or for

TABLE XVIII
 SYSTEMS OF LAND USE CLASSIFICATIONS^a
 (CONTINUED)

LAND USE CLASSES

other reasons. If pastured, place with P_4 ; if not pastured, place with F_4 .

G. Hay Crop Areas

These should be placed with C classes, according to cover, permanence, slope, etc. Most hay meadows are C_1 . Annual lespedeza is C_2 . Some hay areas on steep slopes are C_2 on poorer soil association.

^aSource: Tennessee Valley Authority, Report No. O - 3736, Report on Initial Phases Chestuee Watershed Project (Knoxville, Tennessee: Tennessee Valley Authority, 1945), pp. 137-140.