RESEARCH IN SOIL AND WATER CONSERVATION

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Agricultural Engineering Department

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Blacksburg, Virginia

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This is the second annual report that has been written about the soil and water conservation research project. The eighteen month life of the investigation has been devoted to planning, designing, and constructing; as well as to the actual collecting of experimental data. Definite progress can be reported in all phases of the study. Experience gained from continued study of the problems involved has furnished a basis upon which definite methods of procedure have been developed.

Increase in personnel during the past year has been largely responsible for the well-rounded program of study which is already under way. It is now possible to make, as a supplement to the field measurements, complete laboratory analyses (both physical and chemical) of the soils under investigation, and also special studies of the eroded materials.

The addition of a cooperative field project with the T. V. A. during the year has somewhat broadened the scope of investigation and added much to the work accomplished. Considerable progress can also be noted towards the initiation of cooperative studies with the Soil Conservation Service.

The great need for soil and water conservation research continues to become more apparent each year. Farmers and conservation workers freely admit that they are without pertinent experimental data upon which to base their recommendations. In 1934 Dr. H. H. Bennett, Chief, Soil Conservation Service, said, "It must indeed be somewhat confusing when specialists who have devoted years of study to the problem of erosion admit that we still stand only at the threshold of knowledge relating to the subject, but such is the situation, nevertheless. The investigations thus far carried out have led us at least far enough to recognize that we are faced by a variety of erosional behaviors that we do not at all understand."

PERSONNEL

James H. Lillard, Assistant Agricultural Engineer, devoted his full time to the project during the past year. In August, 1936 Howard T. Rogers was appointed Assistant Soil Technologist and assigned to the project on a full time basis. Mr. Reuben B. Hicks, graduate assistant in Agricultural Engineering, devoted about one-half time to the project. In addition to these staff members, the field work required the full time services of one helper.

PLAN OF PROCEDURE

During the past year the research work in soil and water conservation has been undertaken through three definite and supplementary steps:

This picture gives a general idea of the field setup for the soil and water conservation research project. All of the field laboratory work is done in this field house which was constructed especially for that purpose. To the left of the field house is the series of three plots on 20% slope. The automatic rainfall recorder and the recording thermometer cage can be observed in the upper left corner of the picture.

1. Controlled run-off plot measurements.

2. Physical and chemical studies of the soils under investigation.

3. General field experiments on plots and small watersheds.

A large amount of time has been consumed in securing equipment and working out suitable methods for both the laboratory and field house work. It has been necessary to construct many pieces of equipment in the Agricultural Engineering laboratory because such were not commercially available. All of the apparatus for making physical analyses of the soils had to be obtained and a large part of that necessary for the chemical studies.

This plan of work as outlined for the past year will be continued for next year without any major changes. It is hoped, however, that several new field investigations can be started, especially the proposed cooperative studies with the federal Soil Conservation Service. Following below is a more detailed summary of the progress and plans which have been made in each of the main steps followed in the soil and water conservation investigations.

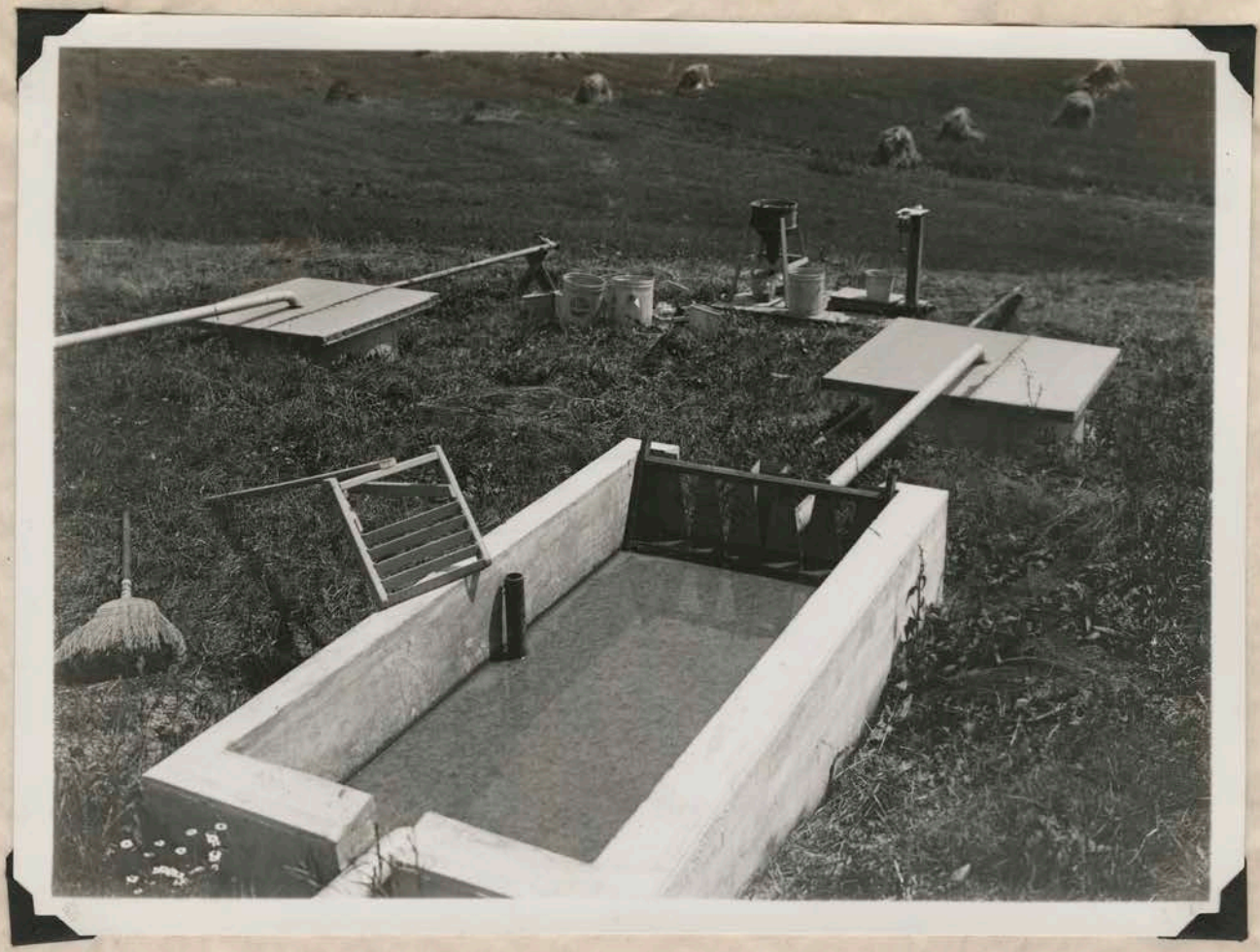
CONTROLLED RUN-OFF PLOT MEASUREMENTS

Controlled run-off plots seem to afford the best opportunities for fundamental study of the causal factors in the erosion process of any scheme yet devised. It is believed that a majority of the soil and water conservation investigators share this opinion. Careful study of the important controlled run-off plot investigation reports from all sections of the country indicates that there is much to be learned from such studies.

The system being studied here consists of series of three plots each on five different slopes, giving a total of fifteen plots. Slopes under investigation range from five to 25 per cent. Each plot has an area of 1/50 of an acre. The common three-year rotation of corn, wheat, and clover is being followed on all of the series. While the object of this study is not necessarily to study the influence of different crops on soil and water losses, such information is interesting and important because it is the first to be obtained for these soils. In fact such data is necessary as a basis for our mechanical and hydraulic investigations.

A hurried check-up of the data obtained thus far indicates some real progress in the work. Unfortunately, due to the tremendous amount of calculations involved, the field data have not been summarized sufficiently to include in this report. The heavy rains of the past six weeks have supplied a tremendous amount of run-off information which has not been analyzed as yet.

Some of the more important records which are being made in connection with the operation of the run-off plots are shown in the following outline:



This picture shows the concrete catchment tank. Observe the run-off materials in the tank. On the left wall is the agitator used to get the eroded soil in suspension before draining and sampling. Notice the divisibility weir on the far end of the tank. This serves as a safety device in case of excessive run-off by conducting 1/5 of the overflow into the galvanized tank shown in the background. The scales used for weighing the run-off and the fractionating hopper used for reducing the total run-off to a small laboratory sample are also shown in the background.

1. Total Erosion Losses

1. Soil loss from each plot after each rain.

2. Water loss from each plot after each rain.

Note: These data when collected over a reasonably long length of time can be expected to give a good insight into the relative effects of slope and vegetative cover on erosion losses. They should also yield definite information regarding the "critical" (slope above which ordinary storms cause too much loss for cultivation to be practical) slope for the soils under investigation. Such quantitative measurements of soil and water losses also afford excellent opportunities for careful study of the mechanics of soil erosion when correlated and studied along with various chemical and physical data which are being worked out in the laboratory. Much emphasis is being placed on this angle of the investigation in a concerted effort to determine every possible inherent characteristic which may either tend to make a soil erosive or cause it to resist erosion. If it is possible to establish any such fundamental relationships between physical soil properties and erosion it will give the results of this experiment a very broad application and go a long way in simplifying the soil and water conservation problem.

II. Meteorological Data

1. Complete rain and snowfall records.

2. Continuous temperature records.

Note: Complete rain and snowfall records are made by an automatic rainfall recorder and several standard government rain and snow gauges. The importance of studying rainfall intensity in connection with the run-off plots is very well appreciated. The recording rain gauge is equipped with a special extended scale thereby permitting very accurate intensity readings. Continuous temperature records are made by an automatic temperature recorder. Every effort is being made to collect complete meteorological data and to make use of all existing climatic records.

III. Plot History and Field Notes

1. Complete records of past cropping practices and soil treatments on experimental areas.

2. Complete records of present cropping practices including time of cultivation, methods used, soil condition, soil treatment, quality of crop produced, etc.

3. Records of soil and crop conditions immediately preceding each storm.

Note: These notes are complete to date. Such information will be indispensable in explaining the erosional behavior of the different plots during the different storm periods.

This picture shows some detail of the catchment troughs which are placed across the lower side of each plot. The runoff is conducted from these troughs through a 3" galvanized rain pipe into the concrete catchment tank shown in the picture on the following page. There is a "lip" on the up-hill side of these troughs which is forced vertically into the soil one foot.

Suggested Directions for Future Field Investigations

It is necessary to continue the collection of all field data as briefly summarized above. In addition, it would be beneficial to have the following information:

1. Periodic moisture determinations of all plots.

2. Humidity records.

3. Some measure of the velocity of run-off.

4. Determination of the period of run-off relative to the storm period.

5. Wind direction and velocity records.

Note: Special consideration is being given to these factors and as much of such information as possible will be obtained.

PHYSICAL AND CHEMICAL STUDIES OF THE SOILS UNDER INVESTIGATION

As late as 1930, Middleton of the Bureau of Chemistry and Soils, wrote "The literature reveals no laboratory studies which show any relation between erosivity and the physical and chemical characteristics of the soil types." Since about 1930, however, several investigators have reported work of this nature and while these reports have only indicated the possibilities of this type of study they show very definitely that in order to develop sound soil conservation and erosion control devices we must first recognize soil differences and then study both the physical and chemical characteristics of the major soil types with which we are working. The very fact that soils vary so widely in their behavior under similar external forces necessitates an understanding of their physical and chemical composition.

Before starting any of these studies considerable time was spent reviewing the literature on soil erosion. Some 25 or 30 of these more pertinent reports were abstracted and compiled.

A laboratory investigation of this nature would logically divide itself into two phases, a study of the properties of the soil in its entirety, and a study of the extracted colloids of the different horizons.

In order to supply this information for the soils of the control run-off plots where the fundamentals of erosive processes are being studied in an attempt to devise methods and devices for erosion control the following laboratory studies have been completed or started:

I. Total and detailed mechanical analysis of the complete soil profile for each plot (45 samples) showing:

1. % gravel
2. % coarse sand
3. % medium sand
4. % fine sand
5. % very fine sand
6. % total sand
7. % silt
8. % colloids
9. % conventional clay
10. % fine clay

Note: This study has been completed and from this data the soil class determined. This information will be indispensable in explaining the behavior of the different plots during the duration of the study.

II. Amount of coarse gravel, > 2.00 mm, in the surface soils.

Some plot differences as shown by these data:

5% Plots -	12.8%	20% Plots -	24.9%
	12.1%		19.9%
	6.5%		22.8%
10% Plots -	5.9%	25% Plots -	11.8%
	6.5%		16.7%
	1.5%		14.6%
15% Plots -	20.2%		
	16.9%		
	10.4%		

III. Organic matter content of the surface soils on 15 plots.

An approximate average of the organic matter content for the different slope series show:

5%	plots	-	approximately	3% O. M.
10%	"	-	"	2.7% O. M.
15%	"	-	"	2.9% O. M.
20%	"	-	"	2.2% O. M.
25%	"	-	"	2.5% O. M.

Note: The rate of organic matter in its effects on soil behavior will be studied.

IV. Moisture properties.

1. Hygroscopic water capacity:

Note: This data is complete for the entire profile of each plot (45 samples), and will serve as an indication of textural and related properties. Here again plot differences show up. This ability of soils to retain water against air-drying forces has been related to certain chemical properties, notably the total base exchange capacity of soils. These relationships will be studied during the progress of these investigations.

2. Maximum water-holding capacity:

Note: Equipment for this determination has been secured.

V. Chemical properties.

1. pH of the profile samples for all plots has been determined.

Note: A close check on soil reaction will be continuous.

2. Chemical composition of the colloidal fraction of the surface soils for each slope series giving:

% SiO_2
% Fe_2O_3
% Al_2O_3
% CaO
% MgO
% K_2O
% P_2O_5

Note: These determinations are about half completed. It appears that the chief value of chemical composition data in this study will be in explaining certain physical properties, and they may serve as an estimate of the amounts of plant foods such as calcium, phosphorus, and potash, which are lost through surface runoff under the different cropping systems. Since the colloidal fraction of soils is the active portion and carry most of the important plant food elements, this fraction was separated out by sedimentation methods and analyzed for the important constituents shown above. It was thought that for several reasons the chemical composition of the colloids would prove more valuable in this type of study than an analysis of the soil in its entirety.

It is planned, that as run-off data becomes available showing the amount of soil lost by surface run-off, to compute the actual amounts of plant food lost under different crops on the various slopes and soils investigated. This inventory of the composition of the colloidal material existing in the soils will serve as a guide in making these computations, especially with those crops which permit only the loss of the finer materials which are largely colloidal.

General Conclusion from These Studies:

The data on the physical and chemical properties of these soils which are being investigated constitute a rather complete "inventory" of the control plot soils.

Regardless of the direction or duration of these studies this information should prove valuable in explaining the behavior of the soils studied. It will be some basic information needed for each soil type for which methods and devices of erosion control are studied.

Suggested Direction for Future Laboratory Investigations:

With the completion of the above inventory for this series of plots and soil type it seems that future laboratory studies would largely be concerned with:

1. Securing similar information for any additional areas studied, varying the detail and plan of study to fit the objective of the investigation.

2. An analysis of the runoff materials.
   A. For this purpose the following plan is underway:
      1. A composite sample of the eroded materials is being collected for analysis.

      2. Equipment for determining the salt concentration of run-off waters, particularly from fertilizer studies, by means of an electrical conductivity unit is being secured.

3. Aggregation or soil structure studies.

   A. Equipment is being set-up for a wet-sieving method of aggregate analysis to study soil structure.

   B. The control plot soils should be analyzed to determine the effect of various treatments on the degree of aggregation.

   C. The soils of any area studied should be subjected to both total mechanical and aggregate analysis, from which the important property of "degree of aggregation" can be determined.

4. A major portion of the laboratory work should be concerned with the physical properties of the soils investigated in order to best serve the phase of soil and water conservation which this project is designed to study.

Progress on Infiltration Studies:

1. A comparative study of the infiltration capacity and rate of percolation for several major soil types has been started.

2. Equipment for a battery of steel tubing — burette units is being secured to measure the rate at which the different soils will take up water.

3. This information, correlated with aggregate analysis data, should be valuable in designing and evaluating such erosion control devices as terraces, contour furrows, strip crops, etc., for the different soil types.

GENERAL FIELD EXPERIMENTS ON PLOTS AND SMALL WATERSHEDS

Throughout these investigations every possible step has been taken to insure that the information obtained be of such a practical nature that it can be readily applied to field conservation problems. It is believed that it is necessary for the results obtained from the controlled run-off plots and laboratory studies to be supplemented by broad and practical field experiments in order to make possible such a practical application of the research data.

Considerable progress can be reported in this connection. However, the project is just now reaching the stage where more emphasis will be placed on these correlative field studies. Following below is a more detailed story of what has been accomplished and is being accomplished in this phase of the investigations:

I. The development of practical and cheap methods of measuring soil and water losses from field areas.

1. Special field plot construction has been worked out and used which can be easily moved to permit normal field culture of the experimental areas.

Note: Four of such plots have been installed on the experimental farm. This work was done by Mr. Reuben B. Hicks as a part of his graduate thesis requirements, with the cooperation of the staff of the soil and water conservation project. Such plots offer an opportunity to study soil and water losses under exact field cultural conditions and will prove very helpful in the interpretation of the controlled run-off plot data.

II. The development of small watershed experimental areas.

1. For study of the effect of length of slope on soil and water losses.

2. For the study of such mechanical control as terraces, contour furrows, and deep tillage.

3. For the measurement of soil and water losses resulting from different types of cropping practices.

Note: Some progress has been made on these studies. Several small watersheds have been selected for study. About half of the necessary surveys and maps have been made. The necessary measuring and recording equipment has already been obtained and will be installed this summer. It is planned to give considerable effort toward getting these small watershed studies underway in the near future. They will be very important as a supplement to the more detailed research which is already being conducted.

III. Field run-off studies in cooperation with the T. V. A.

1. To determine the value of T. V. A. phosphate in conserving soil and water on permanent pasture lands through increased soil cover.

Note: These investigations are being made in Washington (Glade Springs Experiment Station) and Wythe counties. Twelve field run-off plots are now in operation. Six of these are located in that part of Wythe county lying in the Tennessee Valley and the other six are at the Glade Springs Experiment Station. These studies were put in by Mr. C. D. Kite, Assistant County Agent, T. V. A. and the Soil and Water Conservation Project staff. Mr. Kite is responsible for the operation of the plots and the collection of the field records. All of the analyses work is being done with the personnel and facilities of the soil and water conservation project. It is planned that these studies be expanded to include small farm and watershed investigations. It is felt that this work constitutes real progress in the soil and water conservation research project because it tends to broaden the scope of usefulness of any data which may be obtained.

IV. Proposed cooperative studies with the Soil Conservation Service.

1. To study the vital questions involved in designing a satisfactory conservation program on bright tobacco soils.

2. To study present methods of mechanical erosion control such as terraces, contour furrows, terrace outlet channels, and gully control with the idea of reducing costs and increasing efficiency.

Note: A number of field trips have been made by this staff and considerable time given to the formulation of plans for the work but no definite progress can be reported. However, the chance for cooperative action on the part of the SCS seems more promising now than at any other time.

SUGGESTIONS FOR FUTURE SUPPLEMENTARY FIELD EXPERIMENTS

In addition to completing the field experiments which are already under way, it would be very beneficial to the project to add the following:

1. Expand T. V. A. cooperative studies to include small watershed investigations.

2. Set up studies in the Piedmont region for the study of the bright tobacco erosion problems and also problems in connection with the many different mechanical control methods. (This should be done in cooperation with the SCS, if possible.)

PUBLICATIONS

The soil and water conservation research project has not been in progress long enough to make a written report of its findings. However, the following articles and talks were given by members of the staff during the year.

2 Radio talks
4 Newspaper articles
1 Paper presented on the program of the State Soil and Water Conservation Engineers' Conference.

All of these pertained to the work that is being done on the soil and water conservation research project.

LABORATORY AND EQUIPMENT

The laboratory and field house have both been equipped entirely during the year. While considerable equipment is still needed, it is felt that the facilities now available are fairly satisfactory for the work. The soils laboratory has been available only during the last four or five months.

SUMMARY

The possibilities for important research in soil and water conservation seem almost unlimited. The program and problems being worked on are becoming more complex and important as the work progresses. The results of such work will undoubtedly throw some light on at least a few of the dark, perplexing problems of the erosion process.

Respectfully submitted,

James H. Lillard
Assistant Agricultural Engineer

SOIL AND WATER CONSERVATION RUN-OFF STUDIES IN THE TENNESSEE VALLEY AREA OF VIRGINIA

INTRODUCTION

In January, 1935 the Tennessee Valley Authority, with the cooperation of the State Extension Division, started a program of general farm improvement in the nine counties of Virginia that drain into the Tennessee River. The purpose of this program is to demonstrate through cooperating farmers improved farming practices affecting the entire farm. It also includes demonstrations in erosion control and water conservation.

At the beginning of this farm program two major problems presented themselves, namely; arranging improved crop rotations and the adjustment of the land to its most profitable use. In many cases this involved an entirely new crop rotation for the low and more level land and the retirement of the more hilly land to permanent pasture. Through the use of proper kinds and amounts of fertilizer, lime and seed, the results of the adjusted rotation can be measured in actual crop production.

In order for the hilly land to produce sufficient plant growth to justify it remaining in pasture, it is necessary to add plant food. As a means of promoting this phase of the program the T.V.A. furnished a triple superphosphate fertilizer to be applied on these pastures in amounts not to exceed 200 pounds per acre.

One method of measuring the economical results of the increased plant growth as a result of the fertilizer application is to get data on the increased pounds of beef or pounds of milk produced. Still there remains the problem of measuring this effect on the conservation of soil and water. Many studies pertaining to these subjects have been made in other states on soil types different from those in the Tennessee Valley. However, when considering the many conditions peculiar to this area, it is evident that data obtained from soil conservation studies in other states could not be depended on as a yardstick by which to measure the effects of the T.V.A. fertilizer on the soil losses and water run-off in this area.

As early as 1935 the Agricultural Engineering Department of V.P.I. suggested definite proposals to the T.V.A. for cooperative studies in soil and water conservation. As the T.V.A. program expanded the need for definite quantitative data on the effect of pasture fertilization on moisture conservation and erosion control became a very important problem.

PROCEDURE

In November, 1936 the Tennessee Valley Authority authorized the expenditure of $1500 for the development of simple field experiments for the quantitative measurement of the effect of pasture fertilization on soil and water losses. This program is being administered by the V.P.I. Extension Division through its Agricultural Engineering Department.

It was immediately decided that the best way to begin the study was to establish a number of simple field run-off plots in Wythe County and at the Glade Spring Experiment Station. It was further agreed that all of these initial studies should be on the Dunmore soil series since it is one of the more important soils in the Tennessee Valley area of Virginia.

Necessary agreements were secured from Mr. W. V. Stimson and Mr. Charles Kinder, T.V.A. Cooperators, to establish run-off studies on their farms in Wythe County. Mr. W. R. Perkins, Superintendent of Glade Spring Experiment Station, arranged for another area suitable for the studies on a farm adjoining the Experiment Station.

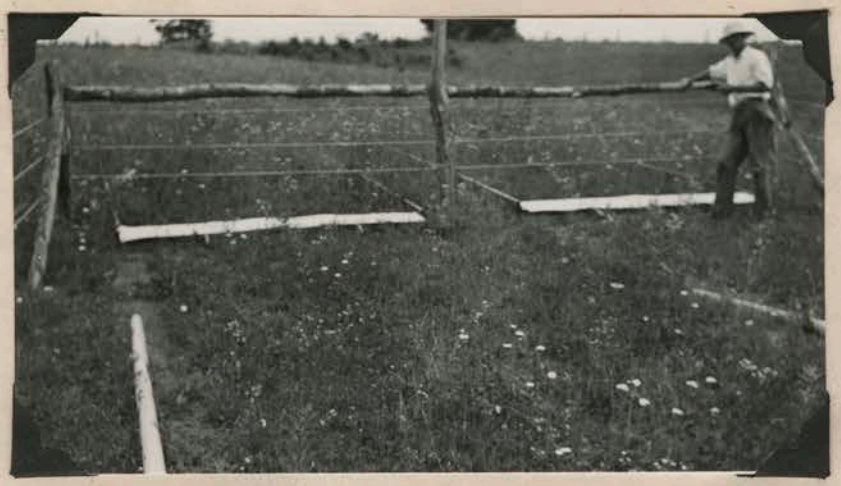
Six plots were installed in Wythe County and six at Glade Spring. In all cases two plots were constructed on the same slope in order that one plot might be treated and the second one to serve as a check. In Wythe County slopes of 18%, 24%, and 37% are being studied and at Glade Spring 15%, 23%, and 30% slopes are being used in hopes that they may serve as a fair check on the Wythe County studies.

Each plot has an area of 1/100 of an acre. They are 8 feet wide and long enough to enclose this desired area, measured on the horizontal plane. An area at least 2 feet wide is left between each set of plots in order to eliminate any possible border effect. The plots were constructed by carefully sinking 6 inch boards about 3 or 4 inches into the soil around the area to be studied. Care was taken not to disturb any soil lying within the boards.

At the bottom of each plot a catchment trough was put in flush with the ground line. All water and soil that comes off the plot is caught in this trough and conducted into a tank below. The tanks retain the entire amount of water and soil that might be lost during any one rain period. The area on each slope was selected so that the two plots might have uniform soil and comparable ground cover at the beginning of the experiment.

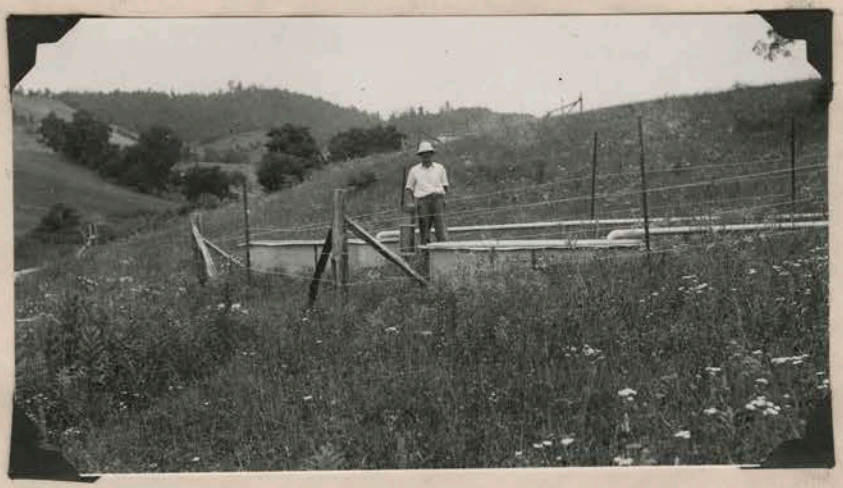
The different slopes in Wythe County had varying degrees of ground cover. The 18% slope has a short, fairly dense ground cover, with some blue grass and clover and a large percentage of wild grasses. This slope is located on a northwest exposure. The 24% slope had the poorest ground cover of the plots in Wythe County. It is located on a western exposure. The cover consisted of broom sedge and wild grasses with scarcely any clovers or blue grass. The plots on the 37% had a heavy, dense growth of wild grasses and broom sedge. This area has an eastern exposure.

The areas selected at Glade Spring are all on approximately a north-west exposure. All three slopes were selected on an area which had very nearly the same ground cover as regards density and type of grasses. The cover consisted of wild grasses and weeds, very little blue grass or clover and practically no broom sedge.



View of lower end of run-off plots showing location of catchment troughs and fence enclosing the collecting tanks.

View of the tanks used for retaining run-off. Note the standard rain gauge located in the center of the enclosure.



View showing general field lay-out of the run-off plots at Glade Spring.

The treatment of one plot on each of the slopes studied was identical. The equivalent of 96 pounds of phosphate per acre of T.V.A. fertilizer was carefully distributed over the plots selected for treatment. The remaining plots were not treated with fertilizer of any kind. A mixture of 10 pounds of lespedeza, 5 pounds white clover and 2 pounds red top per acre was sown on both treated and untreated plots. The actual area in the plots above the catchment troughs is unfenced and livestock graze all plots. Thus, actual field conditions are approximated as much as possible. The catchment troughs and tanks are protected by wire fencing.

The amount of precipitation on the plots is measured by a standard rain gauge. Only one gauge is used at Glade Spring since all plots are on the same general exposure and fairly close together. The gauge is set up in the inclosure below the 23% plot for protection. In Wythe County one rain gauge is used on the 18% slope and one gauge for the 24% and 37% slopes since the latter are separated from the 18% plot by about 1/2 mile. The 24% and 37% plots are about 150 feet apart.

The rainfall for each period of precipitation is measured, and the approximate duration of the rain is noted. After each rain that produces run-off the water in the tank is carefully agitated until all soil materials are in suspension. Two 1/2 gallon samples are then collected from each tank. While the soil particles are still in suspension a 9 gallon bucket is filled to a mark on the side and weighed on a spring balance. This weight is recorded and the remainder of the water is measured out by volume, carefully filling each bucket to the same mark. Fractions of a bucket are weighed. In this manner the pounds of run-off from each plot are determined. A portion of the gallon sample taken is dried down to determine the soil-water ratio and the actual soil and water losses from each plot are determined. A composite sample of 1/1000 of the run-off from each rainfall is also retained in order that determination for the various plant foods lost may be made periodically for each plot.

Soil samples have been collected from each plot and various laboratory analyses will be made on them in the near future. It is believed that such information will prove important in the analysis of the field run-off data.

PRESENTATION AND DISCUSSION OF DATA

All plots were constructed during April and May of this year under the supervision of Mr. C. D. Kite, former T.V.A. Assistant County Agent in Wythe County. Mr. Kite left the service of the T.V.A. in June, three months before Mr. W. H. Dickerson was appointed to take over his duties. During this three month period no one was in close supervision of the plots, consequently, the data is not entirely complete for this period.

Table 1 shows the entire amount of run-off occurring from the six plots at Glade Spring through September 7, 1937. Up to this date no samples were collected for laboratory analysis and soil-water ratio determi-

Table 1. Run-off Losses from Glade Spring Plots
(Dunmore Soil)

Date 1937	Rain-fall in Inches	Run-off Losses in Gallons Per Acre						Duration
		15% Slope Fert.	15% Slope Unfert.	23% Slope Fert.	23% Slope Unfert.	30% Slope Fert.	30% Slope Unfert.	
June 30	3.35	240	778	204	177	480	204	Accumulated rain for entire month.
July 12	1.23	360	468	240	264	300	144	Accumulated rain for July 1 - 12.
July 31	2.28	0	0	1319	2195	1859	480	Accumulated rain for July 13 - 31.
Aug. 13	1.10	108	84	96	72	72	84	Intermittent showers.
Aug. 25	2.32	300	840	888	864	720	840	Two days rain.
Sept. 7	2.77	5733	11671	10028	21878	10028	7005	General rain.
Tot.	13.05	6741	13841	12775	25450	13459	8757	

nation. Note that on the 15% and 23% plots the run-off from the unfertilized plots is approximately twice that from the treated areas, while for the 30% slope the fertilized plot has been giving the greatest losses. This tendency, however, is tending to reverse itself in the more recent rains. A number of laboratory tests will be made at a later date which may help to explain such tendencies.

Table 2. Water Losses from Glade Spring Plots

Date 1937	Rain-fall in Inches	Water Losses in Gallons Per Acre						Duration
		15% Slope Fert.	15% Slope Unfert.	23% Slope Fert.	23% Slope Unfert.	30% Slope Fert.	30% Slope Unfert.	
Oct. 5	1.75	2039	3417	899	2745	1890	2470	Two days rain
Oct. 18	1.97	2489	4897	1911	7770	2009	1359	" " "
Oct. 28	1.79	4200	5650	1992	14944	2037	1511	" " "
Tot.	5.51	8728	13964	4802	25457	6036	5340	

Tables 2 and 3 give the water and soil losses from the Glade Spring plots for the rains since September 7. Careful soil-water ration determinations were made in the laboratory from representative samples of run-off collected in the field. The soil losses are naturally extremely small but it is interesting to note that on each slope the losses from the treated plots are very much less. It is realized that such small losses are negligible but such a trend may be important.

Table 3. Soil Losses from Glade Spring Plots
(Dunmore Soil)

Date 1937	Rainfall in Inches	Soil Losses in Pounds Per Acre						Duration
		15% Slope Fert.	15% Slope Unfert.	23% Slope Fert.	23% Slope Unfert.	30% Slope Fert.	30% Slope Unfert.	
Oct. 5	1.75	6.8	13.9	3.2	11.2	7.0	9.8	Two days rain
Oct. 18	1.97	7.5	16.7	4.7	27.2	4.5	4.7	Three " "
Oct. 28	1.79	11.6	35.1	4.1	11.0	11.0	17.3	Two " "
Total	5.51	25.9	65.7	12.0	49.4	22.5	31.8	

Table 4. Water Losses from Wythe County Plots-Stimson Farm
(Dunmore Soil)

Date	Rainfall in Inches	Water Losses in Gallons Per Acre		
		18% Slope Fertilized	18% Slope Unfertilized	Duration
Aug.11	2.2	3,246	2,476	Showers
Aug.25	2.43	Catchment Tank	Disturbed	Two days general rain
Aug.30	2.71	17,453	9,443	General rain
Sept.7	1,20	737	144	General rain
Oct.5	4.05	11,465	5,156	Three days general rain
Oct.18	2.54	8,970	2,842	Two days general rain
Oct.28	1.99	7,538	1,416	Two days rain
Total	17.14	49,409	21,477	

The data shown in Tables 4 and 5 is not believed to be reliable because immediately preceding the rain of August 25, a bull broke through the fence enclosing the tanks and catchment troughs and severely damaged this equipment. In order to make the necessary repairs the entire catchment trough

Table 5. Soil Losses from Wythe County Plots - Stimson Farm
(Dunmore Soil)

Date 1937	Rainfall in Inches	Soil Losses in Pounds Per Acre		
		18% Slope Fertilized	18% Slope Unfertilized	Duration
Aug.11	2.20	38.0	52.0	Showers
Aug.25	2.45	Catchment Tank	Disturbed	Two days general rain
Aug.30	2.71	92.0	77.0	General rain
Sept.7	1.20	7.0	0.6	" "
Oct. 5	4.05	20.0	13.0	Three days gen. rain
Oct.18	2.54	11.4	9.1	Two days rain
Oct.28	1.99	12.5	5.5	Two days rain
Total	17.14	180.9	156.2	

had to be removed. This, of course, caused certain soil within the plot area to be disturbed. It is impossible to evaluate the effect of such disturbance on run-off. Therefore, it is believed that the data obtained from these plots will not be dependable until the plots have had sufficient time to resume normal soil and plant conditions.

Table 6. Water Losses from Wythe County Plots - Kinder Farm
(Dunmore Soil)

Date 1937	Rainfall in Inches	Water Losses in Gallons Per Acre				Duration
		24% Slope Fert.	24% Slope Unfert.	37% Slope Fert.	37% Slope Unfert.	
Aug.11	2.41	587	848			Showers
Aug.25	2.40	10,580	15,243	5,335	6,750	Two days gen.rain
Aug.30	2.80	17,409	23,237	9,686	11,244	General rain
Sept.7	1.20	528	1,870	192	360	General rain
Oct. 5	4.31	17,483	29,514	6,164	16,787	Three days gen.rain
Oct.18	2.65	7,363	16,317	3,633	6,990	Two days rain
Oct.28	2.13	6,469	15,062	1,272	3,720	Two days rain
Total	17.90	60,419	102,091	26,282	45,851	

The data in Tables 6 and 7 shows the same tendencies as explained for Tables 2 and 3. Again, the soil losses are small but the water losses are indeed significant. For instance, on the 24% slope, untreated, the water loss for the period from August 11 to October 28 was 102,091 gallons per acre or approximately 20 percent of the entire rainfall. For the same period the 24% treated slope lost slightly over 12 percent of the total rainfall through

Table 7. Soil Losses from Wythe County Plots - Kinder Farm
(Dunmore Soil)

Date 1937	Rainfall in Inches	Soil Losses in Pounds Per Acre				Duration
		24% Slope Fert.	24% Slope Unfert.	37% Slope Fert.	37% Slope Unfert.	
Aug.11	2.41	4.7	31.0	Samples	Not Taken	Showers
Aug.25	2.40	89.0	416.0	22.0	23.0	2 days gen.rain
Aug.30	2.80	58.0	277.0	48.0	59.0	General rain
Sept.7	1.20	1.4	9.4	1.0	1.5	General rain
Oct. 5	4.31	41.0	141.0	9.2	48.0	3 days gen.rain
Oct.18	2.65	16.3	67.2	11.5	21.4	2 days rain
Oct.28	2.13	12.4	32.0	4.2	10.4	2 days rain
Total	17.90	222.8	973.6	95.9	163.3	

run-off. The losses from the 37% slope showed the same relationship but considerably smaller losses. This may be due to a better land cover at the beginning of the experiment.

The data shown in Table 8 is significant because it shows that the concentration of the run-off from the plots is higher where no fertilizer treatment has been applied. This is true even for the unfertilized plots which have shown less run-off than the corresponding treated areas.

Very few supplementary laboratory tests have been completed to date. Composite samples of all run-off materials are being kept in order that periodic analysis can be made in the future. Some equipment has already been purchased for this work. It is planned to determine as completely as possible the total amount of plant foods which may be lost through run-off.

Table 8. Ratio of Soil Losses to Total Run-off for Rains of October 5, 1937 through October 28, 1937

PLOT	Ratio of Soil Loss to Total Run-off					
	Rain Oct 5, 1937		Rain Oct. 18, 1937		Rain Oct. 28,1937	
	Fert.	Unfert.	Fert.	Unfert.	Fert.	Unfert.
15% Slope	.000402	.000487	.000351	.000394	.000333	.000746
18% Slope	.00021	.000313	.000153	.000384	.000200	.000467
23% Slope	.000428	.000491	.000286	.000403	.000249	.000088
24% Slope	.000281	.000571	.000266	.000494	.000230	.000255
30% Slope	.000419	.000476	.00018	.000345	.000650	.001374
37% Slope	.000260	.000396	.000379	.000453	.000393	.000338

Table 9. Some Preliminary Data on the Structures of Dunmore and Westmoreland Soils

(H. T. Rogers)

Aggregate Analyses by the Screen - Hydrometer Method

Size of Particle	SURFACE SOILS							SUB-SOILS						
	Dunmore (Wythe & Glade Spring)						Westmoreland (Tazewell)	Dunmore (Wythe & Glade Spring)						Westmoreland (Tazewell)
	18%	24%	37%	15%	23%	Ave.		18%	24%	37%	15%	23%	Ave.	
2.0-5.0 mm	31.6	29.8	39.0	40.2	33.2	34.8	46.9	15.9	12.2	37.7	12.3	10.4	17.7	13.2
1.0-2.0 "	19.3	17.3	18.8	22.0	22.5	20.0	24.7	18.3	9.4	22.4	23.2	18.4	18.3	18.8
.5-1.0 "	16.3	11.1	14.6	12.3	14.9	13.8	13.5	24.2	15.9	15.2	23.6	19.7	19.7	26.9
.25- .5 "	11.5	10.2	8.2	6.8	7.8	8.9	5.7	15.1	15.5	6.5	12.7	16.1	13.2	16.3
.1-.25 "	4.6	3.7	6.4	4.9	5.3	5.0	3.8	4.7	17.4	6.1	10.5	14.7	10.7	10.7
.05- .1 "	.7	7.9	1.6	-	2.3	2.0	-	12.8	19.6	2.7	8.7	10.5	10.9	-
.01-.05 "	9.2	12.0	5.2	10.2	8.0	8.9	6.0	5.0	9.0	7.2	7.0	6.2	6.9	9.0
.005-.01"	2.0	4.2	4.2	4.0	6.0	4.1	3.2	2.2	1.0	2.2	2.0	3.0	2.0	2.0
.1- "	83.3	72.1	87.0	86.2	83.7	82.5	94.6	78.2	70.4	87.9	82.3	79.3	79.6	85.9
.1 "	16.7	27.9	13.0	13.8	16.3	17.5	5.4	21.8	29.6	12.1	17.7	20.7	20.4	14.1
.05 "	16.0	20.0	11.4	16.2	14.0	15.5	11.6	9.0	10.0	9.4	9.0	10.2	9.5	14.6
.01 "	6.8	8.0	6.2	6.0	6.0	6.6	5.6	4.0	1.0	2.2	2.0	4.0	2.6	5.6
.005 " (Clay)	4.8	3.8	2.0	2.0	0.0	2.5	2.4	1.8	0.0	0.0	0.0	1.0	0.6	3.6

Various physical tests which may have a direct bearing on the erosion process will be made. It is believed that such tests will be of great value in explaining and interpreting the field data. Some preliminary studies in aggregate analysis of the Dunmore and Westmoreland soils have already been completed and are presented briefly in Figure 9. The Westmoreland soil is included because it is a very important pasture soil in the Tennessee Valley area of Virginia and should receive early consideration in these studies.

OUTLOOK

The preliminary results of these studies definitely indicate that the pastures located on Dunmore soils are losing much of their annual rainfall along with small amounts of top soil. It seems very important to make further investigations to determine definitely how much, if any, of these losses can be eliminated through fertilization both with and without the aid of different mechanical structures.

In order for such investigations to be accurate and complete several of the more important pasture land soils must be studied thoroughly. Certainly, the Westmoreland soil should be studied along with the Dunmore series. As personnel and funds will permit, the experiments should be expanded to include the following soils in the order listed - Clarksville, Frederick, Hagerstown, and Muskingum.

Thus, it is recommended that the following plan of work be followed and developed during the present fiscal year:

1. Continue the operation of the 12 run-off plots on the Dunmore soil.
2. Develop at least two small watersheds having an area of not more than 25 acres each on Dunmore soil, which lend themselves to the establishment of run-off measuring equipment and to the study of the effect of fertilization with T.V.A. phosphates.
3. Construct approximately 12 run-off plots on Westmoreland soil for further study of the beneficial effects of fertilization on soil and water conservation.
4. Develop at least two small watersheds on Westmoreland soil similar to the ones described under (2) for Dunmore soils.
5. By means of several small watersheds or otherwise, install definite studies to measure the effect of fertilization plus such mechanical structures as contour furrowing and terracing on soil and water conservation.
6. Set up as many generalized field experiments as possible where periodic observations and field tests can be made. These are to include the study of diversion ditches, gully and gall reclamation and other engineering services.