Building Workable Programs of Land Use and Improvement for Missouri

Sixty-five Years of Research, Teaching and Farm Demonstration Work by the Missouri College of Agriculture

J. H. Longwell and Staff

Fig. 1. Sanborn Field at the Missouri Experiment Station is the third oldest experimental field in the United States. It has been used continuously for the study of soil fertility problems since its establishment in 1888.

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE

AGRICULTURAL EXPERIMENT STATION

J. H. Longwell, *Director*

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HIGHLIGHTS OF THIS BULLETIN

As early as 1886 Henry J. Waters, then a teacher and later the dean of the College of Agriculture, lectured at Missouri Farmers' Institutes on "Grass in Soil Conservation." —Page 3.

Earliest publication on soil improvement published by the College was Experiment Station Bulletin 19 on "Soils and Fertilizers" in 1892. —Page 4.

Soil protection by means of terraces was demonstrated on a 40-acre field in Carroll County in 1915 by Farm Advisor W. M. Cook. —Page 4.

The world's first scientific experiment to measure water run-off and soil losses under various cropping systems was established at the Missouri Experiment Station in 1917. —Page 5.

Water management and erosion control became a part of the regular classroom instruction at Missouri in 1918. Within the next two years courses were given in "Soil Fertility," "Soil Management" and "Drainage and Erosion Control." —Page 5.

Forestry courses contributing to well-rounded systems of land use and water conservation were developed in 1928 and the years immediately following. —Page 6.

Research in land use and improvement has been continuous at the Missouri Station since the establishment of Sanborn Field at Columbia in 1888. The extent of these investigations may be judged by the reports published by the College from 1892 to 1950. —Pages 7 to 9.

The ten earliest farm advisers in Missouri in their first full year of county extension work persuaded their farmers to spread a total of 4478 tons of agricultural limestone. For the annual totals of lime used since then — from 9029 tons in 1919 to 2,940,000 in 1950, see pages 10 and 11.

These and similar improvements in land use have enabled Missouri farmers in the last ten years to reduce their corn acreage 32 per cent and still grow 90 per cent as much corn. —Page 12.

Balanced Farming was developed in the late 1930s by the Extension Service to coordinate all the better practices of land use in a family-planned system to bring out the best capabilities of the individual farm and family. —Page 14.

Missouri ranks third among the North Central States in acceptance and performance of the soil and water conservation practices emphasized by the Federal Conservation Acts of 1936 and 1938. —Page 21.

Building Workable Programs of Better Land Use for Missouri

Sixty-five Years of Research, Teaching and Demonstration Work by the Missouri College of Agriculture

J. H. LONGWELL AND STAFF

INTRODUCTION

As the Missouri College of Agriculture has expanded and developed since its establishment on February 24, 1870, so has the concept of its responsibility to Missourians been broadened and clarified in the thinking of those who serve as its staff.

While there was some groping in the early days because of lack of precedent and basic data to support its teaching, there was clear recognition of many problems of importance to farm people. At that time attention was directed toward specific items. Only in more recent years has there been general recognition of the interrelationship of the various factors involved in successful farming and the necessity of considering the by-products likely to result from the adoption of various recommended practices.

The programs of the College of Agriculture for many years have been developed on the principle that staff members shall think and work with farm people and not attempt to tell them what to do. Understanding why practices and procedures are useful is just as important to farm people as knowing what to do and how to do it.

The basic nature of the soil was promptly recognized by the early staff of the College and its conservation and improvement were advocated. As early as 1886 Henry J. Waters, later Dean of the College, lectured at Farmers Institutes on "The Relation of Grass to Soil Conservation."[1]

"Soil Conservation" Not Completely Descriptive

The phrase "soil conservation" has an almost magic appeal and has attracted wide attention and stimulated general support of any program claiming soil conservation as its objective. Research programs, classroom work and extension programs in agricultural economics, agricultural engineering, field crops, forestry, soils, and wildlife — without using the term "conservation"— may include a great number of activities implied by that term. This has been and still is true of the better land use programs of the Missouri College of Agriculture.

[1]The University of Missouri — A Centennial History, 1839-1939, (Viles) 1939, E. W. Stephens Co., p. 306.

The staff of the College of Agriculture does not consider that any program concerned only with conservation is complete or satisfactory. They believe that we should include more than a conservation program — that we should include economic improvement of our soil resources. They believe that "land use," "soil saving," and more particularly "soil improvement" and "soil building" carry a meaning not indicated by "soil conservation" but which must be considered in developing any practicable program dealing with land use.

The measure of success of a farming system, whether on the individual farm, within a given region or on a national basis, is found in the production of the maximum amounts and quality of crops and livestock, while at the same time maintaining and improving the soil and water resources.

As will be brought out later, economics must also be considered in any sound program for land use.

Protection of the soil was advocated by the infant Agricultural Extension Service as early as 1915. (The Agricultural Extension Service was authorized by the Board of Curators in 1912.) The Director's report for 1915, referring to Carroll County activities, says of the agent, W. M. Cook, "He established in the county, in cooperation with the U. S. Department of Agriculture, the Mangum terrace system for preventing soil washing, which if it proves to be successful on our soils, will revolutionize this problem on the rolling lands of Missouri. It is probably one of the most important pieces of work done by any agent, certainly this is true from an economic standpoint . . . It was put on a 40-acre field and under conditions that will give it a fair test."

By 1922, this practice was being recommended generally. In St. Francois County, "Eight different communities have had terracing demonstrations and 13 farmers have used this means to save soil."[2]

The Agricultural Experiment Station research has guided Missouri's conservation and soil improvement effort. The first Experiment Station bulletin directly concerned with the problem of soil improvement was published in 1892. Developments in this field are indicated in the titles of the station publications issued throughout the years. (See Appendix, Table 3.)

First Measurement of Water and Soil Losses

In 1917 Prof. M. F. Miller, Chairman, Department of Soils, University of Missouri College of Agriculture, established the world's first scientific experiment for the measurement of water run-off and soil losses

[2]Ten Years of Extension Work in Missouri, Project Announcement 19, Jan. 1923, p. 102.

under different cropping systems and cultural practices.[3] The Missouri Agricultural Experiment Station study provided the basis in the United States for most studies and recommendations on soil conservation.

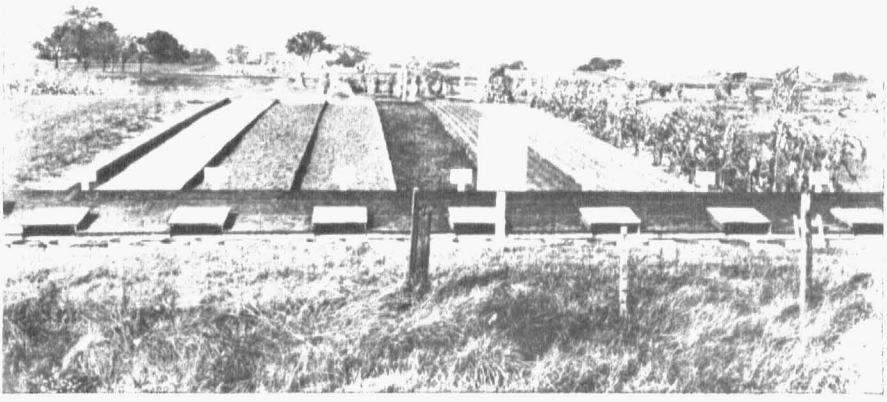

Fig. 2. These plots and catch-basins were established at the Missouri Station in 1917 to measure erosion losses of soil and moisture under different crops and cultural methods. It was the first experiment of its kind and has contributed much of the basic data on which present-day soil conservation systems have been built.

CONSERVATION IN THE COLLEGE CLASSROOM

Agricultural Engineering

Classroom teaching and the training of future leaders was undertaken about the same time. The Department of Agricultural Engineering organized new courses as follows:

In 1918, a course was organized under the title, *Irrigation and Drainage;*

In 1919, this course was changed to *Farm Surveying and Drainage,* with some attention to terracing;

In 1920, this work was reorganized into two courses, (1) *Drainage and Erosion Control,* and (2) *Drainage and Irrigation.*

These subjects are still being taught to students in the Missouri College of Agriculture.

[3]Fifty Years in the Service of Agriculture, 1888-1938, Missouri Station Bulletin 397, June 1938, p. 94; Erosion and Surface Runoff Under Different Soil Conditions, Research Bulletin 63, Dec. 1923.

While the previous discussion relates largely to Agricultural Engineering practices, it must be pointed out that the staff never considered this to be the only contribution which could be made to soil maintenance and improvement. Crop rotations, soil treatments with fertilizer and limestone, contouring, the use of green manure crops and pastures are important and their use was recommended.

Soil Management and Conservation

The Soils Department of the College also offered courses dealing with soil management and improvement. By 1919, a course in Soil Management was being offered. It was described as "a course having to do with practical management of soils and tillage, liming, manuring and fertilization." Such a course is still being taught, modified by newer knowledge. It is designed to teach "the principles of soil management as applied to the physical improvement and fertility maintenance of soils."

Another course established in 1919 was *Soil Fertility;* this course is still being taught under the title *Soil Fertility and Plant Nutrition.*

By 1939, increasing emphasis and additional basic information gave rise to a course in *Soil Conservation.* It is described as "a course emphasizing the conservation of soils and their fertility, with special attention of soil types of Missouri. Consideration is given to the factors influencing erosion and the processes of soil deterioration and to the agronomic principles of their control."

Although the term "soil conservation" or even "conservation" is not used in the title of the courses, soil, water, forest and wildlife conservation, maintenance, improvement, use and building are emphasized in many College of Agriculture courses. Attention is called in these courses to the inter-relationship of fertility, cropping systems, water management and livestock production to the maintenance, improvement and use of soil. Courses in *Field Crops, Farm Management* and *Balanced Farming* in particular stress these inter-relationships.

So much for the beginnings — and the above facts can be considered only as beginnings. Those early actions have been improved, expanded and refined constantly. Acceptance by farm operators has been general, but it must be recognized that many factors, particularly the economic, have influenced the rate of adoption by farmers.

Forest Management and Conservation

Forest management and conservation courses have been given by the College of Agriculture since 1928. One of these courses, *Farm Forestry,* emphasizes the place of well managed farm woodlands in agriculture. This course makes clear the fact that application of

scientific forest management is especially important under Missouri conditions. A second course, *Forest Conservation,* deals with the forest resources of the United States and economical conservation of forest resources.

Forest land constitutes more than one-third (15,000,000 acres) of the land area of Missouri, and about half of this timberland is on farms. (See Table 7 of Appendix for publications dealing with better use of Missouri Forest Lands.)

Each student who spends one or more years of undergraduate study in the College of Agriculture studies, in his courses in technical agriculture, the importance of the maintenance, improvement and economic use of human, soil, water and forest resources. Graduates of the College obtain a sound and basic comprehension of a dynamic agriculture that is carried on by informed farm people who produce the amounts and qualities of farm products required to meet the needs of the nation's people and who at the same time understand how to maintain and improve the soil and water resources that make this production possible. Graduates of the Missouri College of Agriculture and of the agricultural colleges of the other states are the leaders of the research and educational programs that are changing land use from destructive to constructive processes at the same time that farm production is being increased.

SOILS RESEARCH

Adequate research is basic to classroom teaching and extension. The results of experimentation have been published in Experiment Station technical and popular bulletins.

Soils experiments were reported in various station bulletins (Table 4 in the Appendix.)

These studies concerned methods of soil management which would maintain, or better still improve soils and increase yields. The problem of soil washing or erosion was recognized and given special attention as early as 1915 (Agricultural Experiment Station Bulletin 128, pages 398-400.) Results of these water run-off studies also were published (Appendix, Table 5).

During the 1920s and 1930s increasing appreciation of the problem and knowledge about its solutions were apparent, judging from the content of publications issued during those years. The situation in Missouri with respect to basic soil types and their compositions, and the extent to which they had deteriorated, are described in the station bulletins listed in Table 6 of the Appendix.

Station Bulletin 349 provides a good picture of the gains and losses on Missouri soils prior to 1935.

Fig. 3. One of Missouri's 85 county soil testing laboratories, showing the county agent and laboratory technician making and interpreting the tests of soil samples submitted by local farmers. This service enables each farm operator to balance his fertilizer applications to fit the needs of each crop and each field.

While the physical destruction of soil by water or wind erosion is dramatic and easily seen, the most serious and wide-spread loss is the depletion of fertility by long continued removal of crops without restoring the plant food that has been removed. Depletion of plant food, with the resulting reduction of plant cover and lowered soil organic matter, contributes strongly to soil losses by erosion.

The research program in soils at the University of Missouri has been planned to discover the basic factors involved in soil chemistry and physics and in plant nutrition and to work out the applications of this basic information so that it may be put into practice by farmers. The development of the county soil testing laboratories has been an important part of this program. These laboratories make soil testing facilities available to all farmers at nominal cost. Based on these tests, farmers know the specific amounts of plant foods that must be added to their soils to provide for the production of the amounts of crops they plan to grow. This educational program has changed the concept of soil-crop production relationship from the old one of crop type and amount of production being limited by soil type and class to the present concept of supplying the necessary plant food on a variety of soil classes to

provide the plant food requirements for the crop the farmer desires to grow.

The accomplishments obtained under the county soil testing program are well illustrated in Table 1. Attention is called not only to the parallel increases in number of laboratories, number of tests and tonnage of fertilizer used, but also to the sharp increase in percent of plant food in the fertilizers used. This is in direct response, during the last five years, to the recommendation of the College that high analysis fertilizers be used.

Table 1 -- The Increase in Number of Soil Testing Laboratories, Number of Farmers Testing Their Soils, Tons of Limestone Used, and Percentage Plant Food in Fertilizer Sold in Missouri, 1946-1952 Inclusive.

Year	Number Labs.	Number Farmers Having Tests	Number Samples Tested	Farmers per Lab.	Tests per Lab.	Tons of Fertilizer Sold	Percent Plant Food in Fertilizer
1946	3	-----	-----	---	----	221,753	21.0
1947	18	9847	7800	547	433	293,705	20.8
1948	46	12577	24331	273	529	355,283	21.4
1949	60	19614	45369	326	756	364,677	23.1
1950	69	29080	67648	421	980	482,123	25.9
1951	72	32406	69939	450	971	647,393	27.4
1952	85	45161	96221	531	1132	847,284	29.5

AGRICULTURAL EXTENSION SERVICE PROGRAM

As reasearch by the Agricultural Experiment Station accumulated the results were made available to farmers through the Agricultural Extension Service staff. One method used was through the publication of Extension Circulars. The chronology and development of the science of soil and water management are illustrated in Extension circulars listed in Appendix, Table 8.

All other methods commonly used by the Extension Service were employed —

1. To attract attention of farm people
2. To arouse interest
3. To create desire and
4. To stimulate action on the problem of sound soil and water management.

It should not be surprising that progress was quite slow. Every sound educational program is slow. The new field of extension education, beginning in 1915, had to develop new procedures and techniques for this informal educational work.

Among the principles recognized through extended experience in the Extension Service are these: (1) people must see a real benefit to

themselves before they will make a change; (2) before people will spend money on a long time soil and water management program, there must be enough family income to provide for necessary family living expenses, the fixed cost of farm operations, and those other expenses which the family puts highest among their wants; and (3) it must be relatively easy for the farm operator to adopt the recommended practice. All of these were factors in the slow trend toward improved soil management.

Use of Agricultural Lime

The use of agricultural lime over the years is rather typical of the changes for all practices concerned with good soil and water management. It also illustrates the importance of the three principles previously mentioned. (See Appendix, Table 10, for data on annual use of agricultural limestone.)

Fig. 4. Lime spreading is a primary and essential step in growing legumes to convert air nitrogen into nitrogenous plant foods within the soil. This practice was first promoted by the College of Agriculture in 1913 with a total use of 4478 tons in 10 counties. Total application of lime on Missouri farms now exceeds 3 million tons a year.

While an amazing increase in the use of agricultural limestone has occurred during the last thirty years, the increase has not been constant. Utilization in 1921 was more than four times as much as in 1919, but the collapse of farm prices in 1921 appears responsible in part, at least, for a decline of one-third from 1921 to 1922.

By 1929, the tonnage used was 26 times as great as in 1919. In 1933, consumption shrank to one-fourth that of 1929. Farm purchasing power had shrunk proportionately during the great depression.

From the depression low of 1933, consumption climbed rather steadily to 7.35 times as much in 1939, when World War II started. These were the early years of Agricultural Adjustment Administration programs during which soil conservation payments were made available to farm cooperators. Approximately one-half the cost of liming cropland was covered by those payments.

During the 1930s it became easier to obtain crushed lime and to spread it. In the early 1920s most limestone was crushed as an individual or neighborhood undertaking. This was costly and the work was arduous. So was the spreading, done largely by hand power and with make-shift equipment.

The AAA program expanded demand enough to encourage commercial crushing and spreading and resulted in enough volume to lower costs below those of earlier years. The ability to purchase lime on the basis of "spread on the land" simplified the job and increased the demand.

During the 1940s, there was no significant new development in crushing, spreading, or public financial assistance. Nevertheless, the 1950 tonnage of limestone used was 47 times that in 1933. Throughout all these years the educational program on the value of lime had been carried on aggressively, and more and more evidence of its value was available and more and more people were inspired to use limestone. But, probably the most important factor in this expansion was the relative prosperity of agriculture as compared to that of 1921-1939.

Soil Terracing

Progress in terracing was quite similar. A full-time soil erosion specialist (in the agricultural engineering project since 1936) was employed by the Agricultural Extension Service. Civilian Conservation Camps (CCC) were established in 1933. The Agricultural Conservation program was authorized in 1936. The Missouri Terracing Conservation Contractors Association was organized October 27, 1938.

Figures in Table 11 of the Appendix show the progress in terrace construction.

Unfortunately complete data for each year are not available but the figures are sufficient to provide nearly all the story. Progress was

extremely slow as the value of terracing was first emphasized in the late 1920s. The depression and drouth of the early 1930s left few funds for this needed practice. CCC assistance brought about an increase, but the Soil Conservation and Domestic Allotment Act of 1936 (ACP), providing cash payments gave additional incentive.

ACP emphasis on terracing was not constant from year to year and this is reflected in the fluctuation in the amount of terracing done.

Contract terracing started just before World War II, but its influence was not fully felt until after the end of the war. Then veterans trained in the use of earth-moving machinery returned to civilian life and needed work; power machinery became generally available; and farm income was sufficient to create a demand for such services on a practical scale.

RECORDS OF ACCOMPLISHMENT

Development of water management and soil improvement practices on Missouri farms compares very favorably with their application in adjoining states. Appendix Table 12, summarized from the report of the Production and Marketing Administration for 1949 illustrates this fact.

Payments to Missouri farmers by PMA for performance of recommended practices for all counties in 1950 are shown in Table 13 of the Appendix. The total amount paid to Missouri farmers by PMA is second among the 48 states.

Changes in Land Use

Along with the adoption of these practices by farm people was a growing recognition of the need for changes in cropping systems and a better coordinataion of land capabilities and land use. For instance, Missouri's corn acreage has been reduced materially without a corresponding decrease in production. During the last decade corn acreage has averaged only 68 per cent of that of twenty years earlier, while production was 90 per cent of the average for 1921-30.

Table 2 -- Missouri's Corn Acreage and Production; 1921-30 and 1941-1949.

Period	Average Annual Corn Acreage	Percent of 1921-30 Acreage	Average Annual Corn Production Bu.	Percent of 1921-30 Production
1921-30	6,239,000	100.0	159,585,000	100.0
1941-49	4,256,000	68.2	144,349,000	90.5

There are a number of reasons for the higher yields during recent years. The acres removed from corn production were less productive and less suited to such crops. Better tillage practices, the increased use

Fig. 5. Missouri ranks third among the Cornbelt states in total acreage of green manure crops plowed under for increasing the soil reserves of nitrogen and organic matter. Here a heavy stand of second-year sweet clover is being turned under just ahead of corn planting.

of fertilizer and adapted hybrids are among the important factors. (The drouths of 1934 and 1936 prevented any valid comparison between that decade and the others.)

Releasing two million acres of Missouri cropland from corn production during the last twenty years has permitted a corresponding expansion of acreage in pasture crops and small grains used for pasture. As a result, total feed production has increased permitting an even greater increase in livestock production as livestock efficiency increased.

Increasing the acreage used for pasture simplified the job of preventing erosion. Coordination of erosion control with better farming methods which increased net farm income created an effective appeal for more and more farm people.

Evolution of Extension Program

Meanwhile the concept of Missouri Extension workers was changing. Originally Extension was conducted on a project basis, each project being associated with a corresponding subject matter department in the College of Agriculture. Project specialists concerned themselves only with the subject matter peculiar to their fields.

For example, the soils and crops specialists worked with farm people on problems of lime and other fertilizers, tillage practices and

plant varieties. The agricultural engineering helped on terraces. The livestock specialist concerned himself with livestock feeding, management and breeding. The farmer himself had to correlate these individual practices and adapt them into an overall farm management plan for his own farm.

This system was followed as late as 1940 but by that time extension work in individual farm planning had demonstrated the possibilities of improving the service to farm people. In this program all the activities engaged in on the farm and in the farm home are integrated into a farm plan.

Balanced Farming

Individual farm and home planning was then adopted by the Missouri Extension Service, under the name Balanced Farming, as a method of doing Extension Work. It is still used and has proved to be the most effective way of assisting farm people that the Extension Service has found.

The welfare of people, now and through the years ahead is the ultimate concern of the Balanced Farming program. To insure this welfare the Balanced Farm plan for any particular family must consider optimum net farm income, consistent with permanent use of farm land, and efficient use of that income and other family resources to insure gracious living along with the opportunity to contribute to the community.

Such an approach clearly recognizes the problem of soil conservation and appreciates its importance. At the same time it distinctly recognizes the essential inter-relationships between the economics of farming and soil conservation. Soil conservation carried to its logical conclusion would require that all sloping land be kept in good stands of grass, since all experimental data show that to be the most effective means of preventing soil deterioration.

But grass as the only crop on a farm usually does not permit optimum farm income. It is essential, therefore, that every farmer balance the need for maximum income against the need for soil improvement and arrive at a plan which provides for as much as possible of each. Neither can be considered independently from the other.

The Balanced Farming approach recognizes another fundamental principle of Extension teaching — that no plan is of any real value until it has been put into practice on the farm and in the home.

The statistics on terracing and the use of lime illustrate both of these points. Whenever farm income permits, farmers adopt better methods of soil and water management (soil conservation). Whenever the adoption of a practice is made easy, its use is accelerated. The AAA program which provided lime trucks to haul *and spread* the lime greatly ex-

panded its use. In a similar manner the development of a competent reliable group of terracing contractors speeded up the expansion of terracing.

Balanced Farming an Individual Farm Program

Another fundamental principle of Extension is that its contribution must be *assistance*. The farm family concerned must make the decisions, develop its own plan, put it in operation and revise it whenever desirable.

Every Balanced Farm plan must be the product of the farm family concerned. It does not require approval of others. It is our firm conviction that farm people will have much more interest in their own plans, imperfect as they may be, and make much more effort to put them in operation than they will any other plan, regardless of its advantages or the skill of the planner.

Fig. 6. Rough pasture lands, formerly close-cropped and weedy, are now producing thick growths of grass and legume mixtures as the result of a statewide campaign for pasture renovation. Reconditioned, terraced if necessary, fertilized, and clothed with dense turf, these slopes now produce abundant forage for grazing, grass silage and hay.

This last principle cannot be over-emphasized. Land-grant college people direct their whole approach to the job of education on the basic feature of individual self-determination and self-government. If we are to continue to be a democratic nation whose citizens can really develop a sound program for agriculture or any other aspect of national life, our citizens must learn to think and plan for themselves. This is in sharp contrast to the view of those who believe that since experts can make better decisions or plans than laymen, plans for the laymen should be developed by the experts. This latter does not contribute to the development of the individual.

Education may be defined as a program which results in changed attitudes or practices. Specifically then, Extension's job is not completed *until the recipient* has made a change. It is not enough to present new ideas. All of the facilities needed to convert the idea into fact (a change in practice) must be made available. Both subject matter and technical services are essential parts of any such successful educational program.

Balanced Farming does provide both. Balanced Farming by the farm family furnishes ample opportunity for any interested professional worker or commercial concern to assist such families but only as they contribute to the whole plan. Extension workers learned years ago that the offer of separate pieces of an overall plan was not effective.

Conservation Through Forestry

The Missouri Agricultural Extension Service has maintained a full-time extension forester since 1936. Its educational program covers the entire state and is closely coordinated with the work of the Missouri Conservation Commission and the United States Forest Service. Nearly 14 million tree seedlings have been distributed to 11,000 cooperating farmers.

The Balanced Farming program provides a natural approach to better woodland management. About one-tenth of the farmers who adopt the Balanced Farming system include woodland management in their farm plans. (See Table 9 of Appendix for Extension Service Circulars on Conservation of Forest Resources.)

APPENDIX

Table 3 -- Missouri Agricultural Experiment Station Publications Concerned With Soil Improvement

Bulletin No.	Title	Date Published
19	Soils and Fertilizers, Part I	October 1892
20	Soils and Fertilizers, Part II	January 1893
34	Manures and Fertilizers	April 1896
63	Commercial Fertilizers	February 1904
146	Agricultural Lime	March 1917
183	Crop Rotations for Missouri Soils	May 1921
211	Controlling Surface Erosion of Farm Lands	April 1924
234	Meadow and Pasture Management in the Ozark Region of Missouri	May 1925
271	The Control of Gullies	May 1929
518	Cropping Systems for Soil Conservation	September 1948
522	Evaluating Annual Changes in Soil Productivity	June 1949
Circular No.		
38	The Principles of Maintaining Soil Fertility	April 1910
69	The Fertility of the Soil	April 1914
102	Keeping Soils Productive	January 1921
104	The Missouri Soil Survey	March 1921
247	Cropping Systems and Soil Fertility	December 1942
303	Missouri Program of Land Improvement	July 1945
310	Soil Treatment to Improve Permanent Pastures	October 1946
330	Let's Look at the Soil	July 1948
335	An All-Year Pastures System for Missouri	February 1949
336	Keeping up Soil Organic Matter	March 1949
357	Soil Improvement and Soil Conservation in Missouri	June 1951

Table 4 -- Soil Experiments Reported by the Missouri Agricultural Experiment Station

Bulletin No.	Title	Date Published
83	Soil Experiments on the Upland Loam of Southeast Missouri	January 1910
84	Soil Experiments on the Prairie Silt Loam of Southwest Missouri	January 1910
86	Soil Experiments on the Rolling Limestone Upland of Southwest Missouri	March 1910
88	Soil Management in the Ozark Region	July 1910
118	Drainage Investigations on the Northeast Missouri Prairie	May 1914
119	Soil Investigations--Jasper County Experiment Field	October 1914
126	Soil Experiments on the Level Prairies of Northeast Missouri	March 1915
127	Soil Experiments on the Dark Prairies of Central and Northeast Missouri	March 1915
128	Soil Experiments on the Rolling Glacial Land of North Missouri	April 1915
129	Soil Experiments on the Red Limestone Upland of Southwest Missouri	April 1915
130	Soil Experiments on the Gray Prairie of Southwest Missouri	April 1915
182	Thirty Years of Field Experiments With Crop Rotation, Manure, and Fertilizers	April 1921

(Continued on page 18)

Table 4 (continued)

202	Soil Experiments on the Gravelly Ozark Upland (Soil Type--Clarksville Gravelly Loam)	March 1923
203	Soil Experiments on the Brown Silt Loam of the Ozark Border Region (Soil Type--Union Silt Loam)	April 1923
235	The Brown Loess Soils of Missouri and Their Utilization	June 1925
238	The Soils Experiment Fields of Missouri	March 1926
395	Soil Fertility Investigations; Brown Limestone Land of Southwestern Missouri (Newtonia Experiment Field)	June 1938
458	Sanborn Field: Fifty Years of Field Experiments with Crop Rotations, Manure, and Fertilizers	December 1942

Table 5 -- Station Publications Relating to Surface Water Runoff and Soil Erosion

Research Bulletin No.	Title	Date Published
63	Erosion and Surface Runoff Under Different Soil Conditions	December 1923
177	The Influence of Systems of Cropping and Methods of Culture on Surface Runoff and Soil Erosion	November 1932
212	The Physico-Chemical Properties of Soils Affecting Soil Erosion	July 1934
280	The Effect of the Degree of Slope and Rainfall Characteristics on Runoff and Soil Erosion	April 1938
363	The Effect of Slope on Soil Erosion	April 1943
Station Circular No.		
78	The Control of Soil Washing	October 1915
98	The Mangum Terrace	September 1920
Bulletin No.		
362	Soil Conservation in an Improved Agriculture	March 1936
400	Terracing, an Important Step in Erosion Control	July 1938
405	Evaluating Annual Charges in Soil Productivity	June 1939
421	The Classification of Land: Proceedings of the First National Conference on Land Classification	December 1940
434	The Missouri Soil Saving Dam: Low-Cost Structure for Use in Farm Plans of Water Management	October 1941
499	The Missouri Soil Saving Dam: Low-Cost Structure for Use in Farm Plans for Water Management	August 1946
507	Terracing for Erosion Control	July 1947

Table 6 -- Station Publications With Respect to Basic Soil Types and Their Compositions

Bulletin No.	Title	Date Published
264	The Soils of Missouri	January 1929
324	Soil Fertility Losses Under Missouri Conditions	May 1933
349	Soil Erosion in Missouri	April 1935

Table 7 -- Station Publications Dealing With Better Use of Missouri Forest Lands

Bulletin No.		
392	Forest Restoration in Missouri	November 1937
Research Bulletin No.		
452	Forest Resources and Industries of Missouri	December 1949
475	Strip Mined Lands of the Western Interior Coal Province.	May 1951

Table 8 -- Extension Service Publications Dealing With the Chronology and Development of the Science of Soil and Water Management.

Circular No.	Title	Date Published
14	The Soil Saving Dam	February 1917
34	Tile Drainage	August 1917
113	Liming Materials	June 1922
121	Sweet Clover in Missouri	January 1923
131	Liming Missouri Soils	June 1923
132	Soil Improvement by the Missouri Plan	June 1923
208	How to Use Agricultural Limestone	August 1928
248	Terracing Farm Lands	April 1930
317	Terracing To Prevent Erosion	February 1935
332	The Good Use of Farm Land in Missouri	December 1935
351	Farm Ponds in Missouri	August 1936
355	Terrace Outlets for Missouri	December 1936
358	The Restoration of Bluegrass Pastures in Missouri	March 1937
361	Improvement of Farm Ponds and Watersheds for Erosion Control and Wildlife Production	April 1937
362	Conserving Soil With Natural Grass Waterways	April 1937
365	Conserving Soil by Contour Farming	May 1937
368	Conserving Soil by Strip Cropping	June 1937
375	Re-planning Missouri Farms	January 1938
392	Improvement of Farm Ponds and Watersheds for Erosion Control and Wildlife Production (Revision of Circular 361)	November 1938
399	Conserving Soil by Contour Farming (Revision of Circular 365)	February 1939
427	Building Soil, Security, and Self-Reliance: Annual Report, 1940	March 1941
433	Water Management for the Farm: Conserving Soil and Water for Efficient Production of Crops and Livestock	August 1941
434	Diversion Dikes and Channels for Saving Soil	September 1941
459	Home Equipment to Lay Out Guide Lines for Contour Farming	March 1942
482	Farm Ponds in Missouri (Revision of Circular 351)	January 1943
493	Soils and Soil Fertility for Alfalfa	June 1943
504	Fertilizer Recommendations for Spring and Summer Crops	January 1944
510	Fertilizers for Fall Sown Crops	August 1944
537	Balanced Farming in Missouri	November 1946
557	Water Management for the Farm: Conserving Soil and Water for Efficient Production of Crops and Livestock	April 1948

Table 9 -- Extension Service Circulars on Conservation of Forest Resources

Circular No.	Title	Date Published
342	How to Plant Small Trees	April 1936
343	Tree Windbreaks for Missouri Farms	April 1936
345	Tree Planting for Erosion Control	May 1936
348	Improving Food and Cover for Wildlife on Missouri Farms	July 1936
563	Planting and Care of Trees	August 1948
576	Farm Woodland Management	November 1949

Table 10 -- Tons of Agricultural Limestone Used Annually in Missouri (Selected Years, 1919 to 1950, Figures From Agricultural Extension Service, Crops Project)

Year	Tons	Year	Tons	Year	Tons
1919	9,020	1932	108,431	1942	1,710,000
1920	18,000	1933	59,991	1943	1,485,000
1921	41,253	1934	83,297	1944	1,605,000
1922	28,953	1935	122,499	1945	1,275,000
1923	32,588	1936	403,821	1946	2,730,000
1925	102,000	1937	375,037	1947	2,880,000
1928	141,000	1938	440,561	1948	2,280,000
1929	236,000	1939	441,217	1949	2,551,798
1930	228,000	1940	1,385,000	1950	2,940,985
1931	128,623	1941	1,560,000	1951	2,727,807
				1952	2,803,152

Table 11 -- Progress in Terrace Construction by Missouri Farmers

	Missouri Agricultural Extension Service Reports				PMA Reports	
Year	Number Farms	Miles Terrace	Acres	Miles by Contractors	Farms	Acres
1928	72		1,076			
1929	45		1,371			
1930	304		8,862			
1931	288		9,218			
1932	486		10,047			
1933			12,038			
1934	1,423		8,414			
1935			2,352			
1936	1,284		24,340			12,378
1937	1,703		32,529			90
1938		590.3				6,200
1939		333.7		(1/4 of total)		3,000
1940	1,936	1,338.5	30,980		1,044	11,574
1941	1,648	1,022.8	42,590.7	177	855	11,254
1942	1,894	1,104.0	32,813	197	1,201	14,560
1943	2,115	1,353.9	46,275	888.8 (est)	1,587	15,714
1944	2,749	3,033.6	69,049	1,630.0	2,876	35,656
1945	1,912	1,387.2	83,033	2,707	1,767	15,498 (est)
1946	2,773	3,392.7	63,040	1,883.1	3,161	37,334
1947	3,487	2,944.8	48,192	1,957.9	2,799	52,352
1948	3,544	3,355.2	58,621	3,311.8	2,126	27,079
1949	2,582	3,199.7	68,472	2,451.3	3,002	42,945
1950	4,580	3,324.4	69,330	2,591.8	3,655	46,796
1951	4,143	3,021	64,490	1,950	2,148	24,729
1952	3,836	2,505	46,873.5	2,098.2	*	*

*Information not available when table was completed.

Table 12 -- Soil Conservation Accomplishments in Nine North Central States, 1948

Practice	Missouri	Illinois	Indiana	Iowa	Kansas	Kentucky	Minnesota	Tennessee	Wisconsin
1. Tons agricultural lime-stone spread	2,564,807	4,850,000	2,103,081	2,950,000	900,759	902,899	294,000	450,000	1,926,022
2. Tons fertilizer used									
(a) raw rock phasphate	29,306(1)	608,000	62,331	27,690	1,211	31,299	4,048	229.5	8,369
(b) other than rew rock	325,977(1)	385,000	744,758	272,440	318,710	429,556	220,128	471,898.3	395,752
3. Total miles terraces built in 1948	3,355	460	262	1,900	12,223	1,727	50.35	600	381
4. Cumulative miles of terraces built	35,227	2,475	1,048	6,960	76,042	13,428	441.8	7,000	4,573*
5. Acres of crops contoured									
(a) with terraces	301,154	64,000		84,000	572,853	14,030		350,000	20,000
(b) without terraces or strip cropping	759,412	180,000	30,917	1,300,000	340,536	99,330	15,206	500,000	80,528
6. Estimated acres in legumes (excluding soybeans & cowpeas)	10,924,810	2,020,000	3,509,000	2,816,836	1,888,623	2,529,685	3,751,000**	2,000,000	3,699,000
7. Acres of green manure crops plowed under	852,722	100,000	85,000	1,800,000	1,000,476	660,934	17,892	500,000	118,000
8. No. of standard farm ponds									
(a) built in 1948	3,540	665	253	470	2,594	9,570	24	651	43
(b) cumulative to date	59,633	3,100	1,303	1,700	34,512	46,756	76	3,000	75

(1) These figures were taken from Mo. College of Agr. Exp. Station Bulletin 531. Previous figures (raw rock, 60,000; other than raw rock, 422,000) were from estimate by the Nat'l. Fertilizer Association

**Includes "all hay"

*1,073 miles reported by SCS

Table 13 -- Agricultural Conservation Program Payments Made to Missouri Farmers, by counties in 1951*

County	Total Payments	County	Total Payments
Adair	$ 109,937	Linn	$ 108,436
Andrew	83,720	Livingston	105,392
Atchison	191,498	McDonald	71,328
Audrain	199,105	Macon	119,658
Barry	113,468	Madison	23,516
Barton	79,697	Maries	52,752
Bates	155,207	Marion	121,166
Benton	76,235	Mercer	70,092
Bollinger	51,605	Miller	51,377
Boone	140,673	Mississippi	122,654
Buchanan	74,669	Moniteau	100,528
Butler	75,504	Monroe	157,611
Caldwell	67,980	Montgomery	130,803
Callaway	133,320	Morgan	66,322
Camden	29,191	New Madrid	245,087
Cape Girardeau	140,442	Newton	92,540
Carroll	127,530	Nodaway	210,665
Carter	9,967	Oregon	90,244
Cass	119,807	Osage	65,933
Cedar	70,244	Ozark	49,447
Chariton	131,414	Pemiscot	121,984
Christian	91,912	Perry	113,244
Clark	127,864	Pettis	165,655
Clay	49,635	Phelps	59,183
Clinton	79,784	Pike	148,701
Cole	76,188	Platte	83,338
Cooper	101,173	Polk	100,707
Crawford	44,255	Pulaski	33,299
Dade	83,196	Putnam	80,249
Dallas	67,493	Ralls	104,588
Daviess	120,719	Randolph	79,672
DeKalb	84,446	Ray	85,477
Dent	48,232	Reynolds	24,483
Douglas	75,119	Ripley	41,665
Dunklin	204,511	St. Charles	129,884
Franklin	136,983	St. Clair	73,959
Gasconade	63,382	St. Francois	53,586
Gentry	73,777	St. Louis	66,804
Greene	132,109	Ste. Genevieve	67,857
Grundy	60,437	Saline	176,845
Harrison	120,703	Schuyler	63,105
Henry	147,302	Scotland	113,446
Hickory	48,306	Scott	183,635
Holt	113,189	Shannon	28,531
Howard	100,707	Shelby	125,700
Howell	116,981	Stoddard	164,324
Iron	39,453	Stone	55,560
Jackson	89,982	Sullivan	113,409
Jasper	111,221	Taney	40,166
Jefferson	48,873	Texas	91,536
Johnson	120,224	Vernon	101,636
Knox	121,655	Warren	70,221
Laclede	77,495	Washington	37,763
Lafayette	161,277	Wayne	17,693
Lawrence	159,789	Webster	132,532
Lewis	136,101	Worth	62,628
Lincoln	111,653	Wright	83,578
		TOTAL MISSOURI	$11,079,533

*Taken from Missouri Statistical Report, Production and Marketing Administration, 1951.