MISCELLANEOUS PUBLICATIONS 65 JANUARY 1951

RESEARCH SETS PATTERNS FOR THE CENTRAL BLACKLANDS

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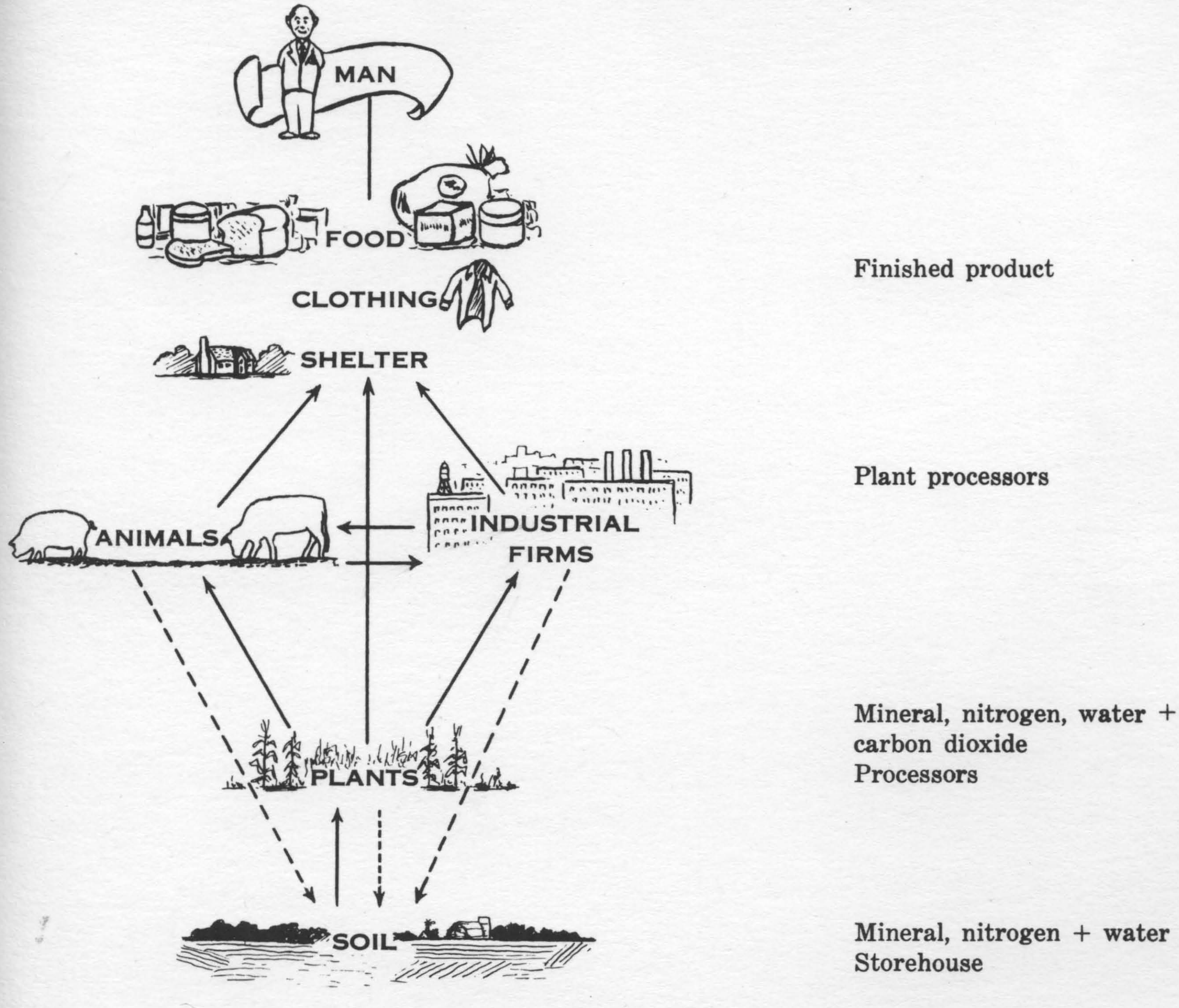

Man's dependence on the soil-plant-animal cycle.

THE TEXAS AGRICULTURAL AND MECHANICAL COLLEGE SYSTEM

GIBB GILCHRIST, Chancellor

RESEARCH SETS PATTERNS FOR THE CENTRAL BLACKLANDS

J. R. Johnston*

This report seeks to give its readers some ideas on a comprehensive research approach to the major agricultural problems of the Central Blackland area of Texas. The basic approach being used at the Blackland Agricultural Experiment Station at Temple can also be applied in each of the major problem areas in Texas.

The agricultural progress of an area is measured by the strength of its research and educational programs, and by the extent these fields are coordinated into its overall action program. Research is of little value unless the results are given to the public as the basis for sound and progressive programs of education and action. Educational efforts are fruitful only when they are based on sound research information.

There are many ideas today as to what actually constitutes research. Some think a compilation of literature citations is research when actually it is only a portion thereof. Some think field demonstrations are research; others think they are purely educational methods. Actually, all of us are researchers to some degree. Is there anyone who has not compared one factor or approach with another to see which would give the best result? Modern research in agriculture, however, has long since advanced beyond the casual and haphazard observational status and has become highly specialized with specifically trained personnel working on difficult and varied problems.

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Agricultural endeavor in the United States could be classified in the following breakdown.

1. Fundamental research
2. Applied research
3. Pilot farm research
4. Extension education program
5. Farm planning service (action agencies)

Pilot farm research, in this outline, occupies a position between strictly research and educational and action phases of agriculture. The pilot farm unit could well be the connecting link between research and farmer acceptance; thus bringing about closer coordination between these phases and a considerable shortening of time between development of research information and its use on our farms and ranches. It appears to me that work of this type should be emphasized in our agricultural programs.

Sir Albert Howard's "Criticism of Present-Day Agricultural Research" lists four phases in his breakdown on agricultural research:

1. Background or fundamental research
2. Basic or applied research
3. "Ad hoc" research, work on special problems as they arise
4. Pilot or development research

Some of Howard's criticism applies to our agricultural research in Texas. In one instance, he praised at length the fine work in improvement of small grain varieties and then concluded: "Nevertheless the gain per acre obtained by changing the variety is as a rule small. As will be seen subsequently, the great problem of agriculture at the moment is the intensive cultivation of the new types; how best to arrange a marriage between the new variety and a fertile soil. Unless this is done, the value of a new variety can only be transient; the increased yield will be obtained at the expense of the soil capital; the labors of the plant breeders will have provided another boomerang." This is rather tough talking indeed; however, I wonder if it could apply to some of our research in crop improvement.

We have come to accept statistical analysis as essential in our research. Howard brings us to attention sharply by the following conclusions after discussing this subject: "Only those results which are fortunate enough to secure what has been described as the fastidious approval of the higher mathematics are now accepted. There is an obvious weakness in the technique of these field experiments which must be mentioned. Small plots and farms are very different things. It is impossible to manage a small plot as a self-contained unit in the same way as a good farm is conducted." The following question has come to my mind: Can misleading information be obtained from a fundamentally unsound experiment by use of higher mathematics?

In discussing the Research Institute, Howard made the following remark: "It is true that most, if not all, of these establishments possess a farm, but this is mostly taken up with sets of permanent experiments. I know of no research institute in Great Britian besides Aberystwyth where a scientific worker has under his control an area of land with his own staff where he can follow the gleam wheresoever it may lead him. Even Aberystwyth stops short before the animal is reached."

Figure 1 shows how man depends on soil, plants and animals for his existence. Our interest in agriculture--soils, crops and livestock--is purely selfish and everything we do to maintain soil productivity at a high level, and to improve crops and livestock, is in the interest of self preservation. The mere improvement and conservation of soil for the land's sake is not in accord with our human interests. We want to conserve and improve our soil so we may extract more and more from it as crops over an indefinite period of time.

If there is any one segment of the soil-plant-animal cycle which has been neglected in Texas insofar as research is concerned it is that of the soil. The productivity of the land over a long period of time plays a highly important role in the permanent security of any nation. Who can question the value of high soil productivity of American land during the past 50 years, in helping the United States maintain a prominent place in world leadership?

In Texas, our past interest in the land has been largely exploitative. Much of our research has been "how to get more out of the land yearly in the form of crop and livestock products." Too little research has been devoted to "how productivity can be maintained and added to the land so that production of crop and livestock products may be raised and kept at a high level." Fortunately, during recent years, sound research has been started on how to maintain and improve soil productivity in Texas. When the results of a well-rounded research program in soils, crops and livestock become available and are applied on our farms and ranches, we can expect Texas to move up insofar as agricultural production per unit of land is concerned.

Land in the Blackland Prairie has been in cultivation for approximately 100 years. During this time, the soils have been exploited mercilessly, resulting in severe deterioration. Figure 2 shows two soil profiles which occur opposite each other on a narrow country road. One is in a field which has never been plowed, the other is in a field which has been in cultivation approximately 75 years. The marked contrast in color, plant root material

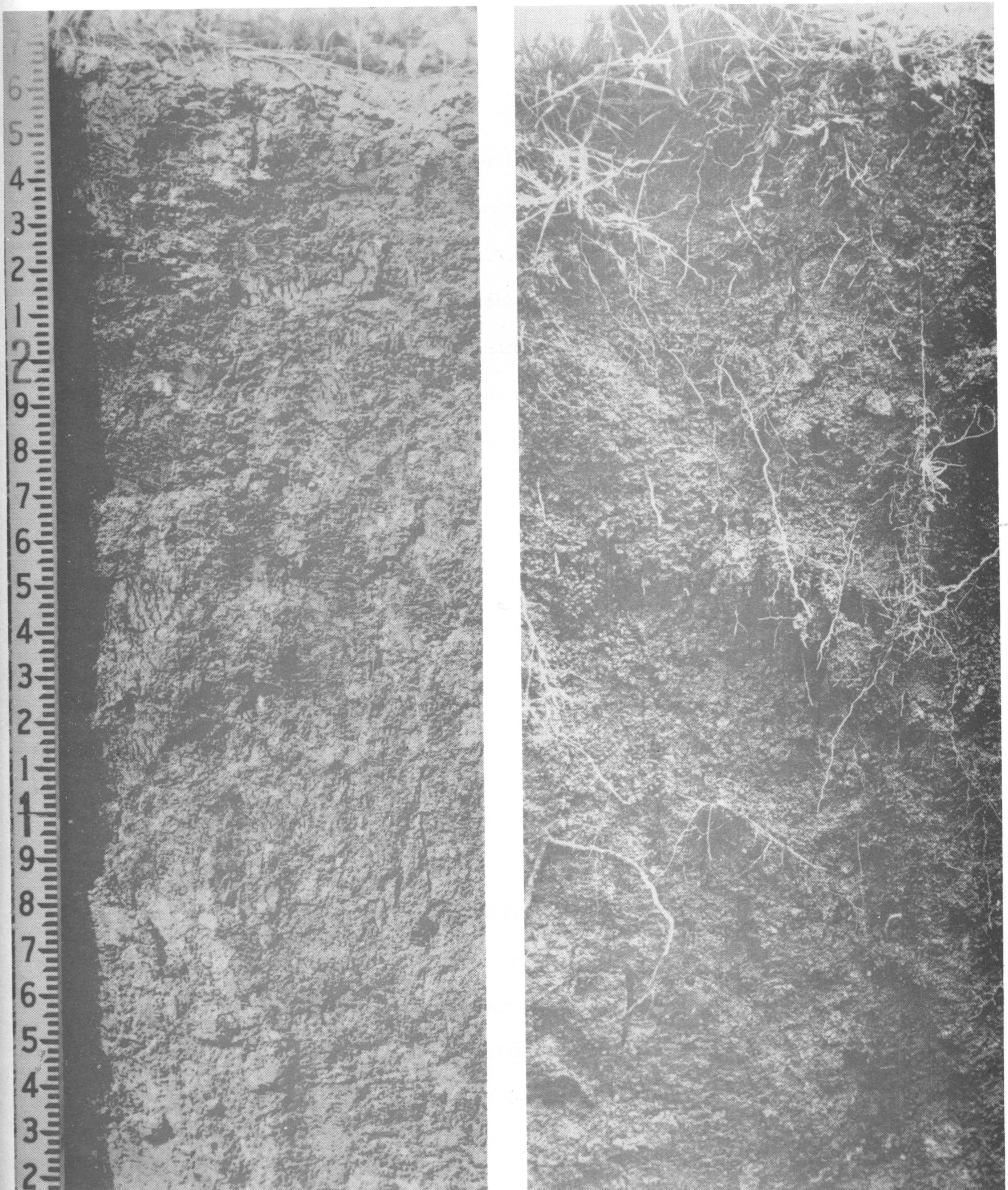

Figure 2. Austin clay profiles. The one on left has been in cultivation for approximately 75 years; the one on right has never been plowed.

and soil structure is highly interesting. When saturated, the 1-4 inch layer of the non-cultivated soil transmits water at the rate of 5.5 inches per hour; the same depth of the cultivated soil, when saturated, transmits water at the rate of only 0.004 inch per hour. Therefore, is it any wonder that water erosion and low crop yields are so common in the Blacklands today as compared with what they were years ago before erosion and continuous row cropping removed the organic matter and destroyed the soil structure?

To restore these deteriorated soils to their original status would take centuries and is out of consideration. However, it is possible to return some organic matter and nitrogen by using grasses and deep-rooted legumes in our farming systems. Consistent and systematic replacement of active organic matter in these soils with grasses and legumes in our cropping systems will restore temporarily good soil structure and water relationships. Our research and farming experience in the Blacklands show that additions of organic matter and nitrogen by the use of sweetclover in the cropping systems is the best procedure now known for the restoration of high productivity to these soils. Figure 3 shows the effect of the biennial Madrid sweetclover in the cropping system on the yield of corn from Houston black clay soil. Figure 4 shows the effect of the annual Hubam sweetclover in the cropping system on root rot incidence in cotton. Recent data show that the biennial sweetclovers will possibly have to be used as annuals in systems with cotton where the root-rot disease is a serious factor.

Results obtained in 1949 and 1950 show the value of the deep-rooted biennial sweetclover for moisture conservation on Houston black clay

Figure 3.
Effect of a deep-rooted legume (Madrid sweetclover) in rotation on yield and quality of corn.

Figure 4.
Effect of Hubam sweetclover in a 2-year rotation on root rot incidence in cotton. Rotation cotton on left, continuous cotton on right.

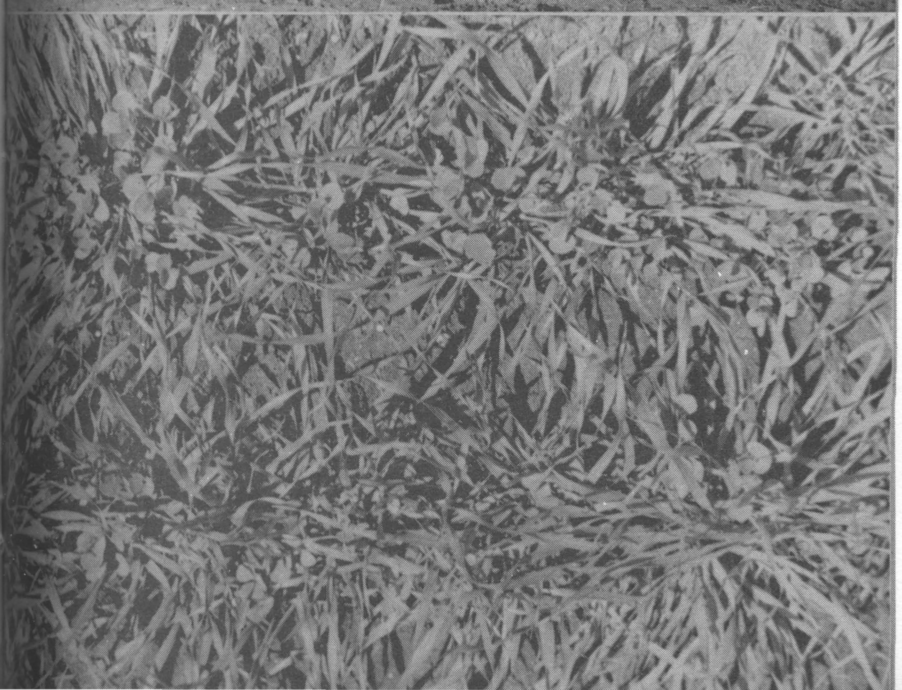

Figure 5.
Fall seeded New Nortex oats and Madrid sweetclover growing together above a phosphate fertilizer band.

soil. Of the 23.76 inches of rainfall from December 1, 1949 to October 1, 1950, cotton land following oats-Madrid sweetclover stubble plowed under in November 1949, lost only 0.160 inch of water as runoff. Land in adjacent fields with oats-Madrid sweetclover cover lost but 0.126 inch of water.

Hubam, Madrid and Evergreen sweetclovers have proved to be good forage crops for grazing purposes. Studies are underway at the Blackland station in which these crops are being used in livestock-forage systems of farming. Figure 11 shows cattle grazing Hubam sweetclover in 1946; this crop produced 309 pounds of steer gain per acre.

Several years ago, our research staff recognized sweetclover as the key crop in soil improvement work for the Blackland Prairie. Consequently, we set out to learn all we could on cultural and management practices for this crop in our area. Aside from fitting sweetclover into cropping systems for water conservation, soil improvement and forage production, I believe the development of fertilization procedures and seeding methods, and obtaining certain physiological information, have been worthwhile.

Table 1 shows the value of phosphorus fertilizer on the growth of Hubam sweetclover. Where phosphate was placed two inches below the seed in a band, the growth was much better than where the phosphate was in contact with the seed.

Table 1. Effect of phosphate and phosphate placement on the growth of Hubam sweetclover in Austin clay under greenhouse conditions

Fertilizer treatment	Dry matter production - grams per pot: Roots	Tops	Roots and tops
None	2.6	3.3	5.9
25 pounds phosphoric acid per acre as bands in contact with the seed	4.0	6.1	10.1
25 pounds phosphoric acid per acre as bands two inches below the seed	5.0	9.8	14.8

Figures 6 and 7 show the effect of phosphate on the growth of Hubam. Table 2 shows the effect of phosphate on root and top growth of Hubam and Madrid sweetclovers under field conditions. This information proves that phosphorus fertilization of sweetclover is an essential procedure in the restoration of high soil productivity to Texas Blacklands.

Table 2. Effect of phosphate on root-top growth of an annual and a biennial sweetclover in Austin clay under field conditions

Variety	Pounds phosphoric acid per acre	Dry matter production, pounds per acre: Roots	Tops	Roots and tops
Hubam	0	71	459	530
"	40	306	2501	2807
Madrid	0	187	711	898
"	40	947	5526	6473

The use of radioactive phosphate in 1950 with Evergreen sweetclover shows that banding of the phosphate is much more effective in promoting sweetclover growth than broadcasting, Table 3. This study showed that phosphate fertilizer applied near the surface of Houston black clay soil is effectively translocated downward into the soil by sweetclover, as much as 18 inches in

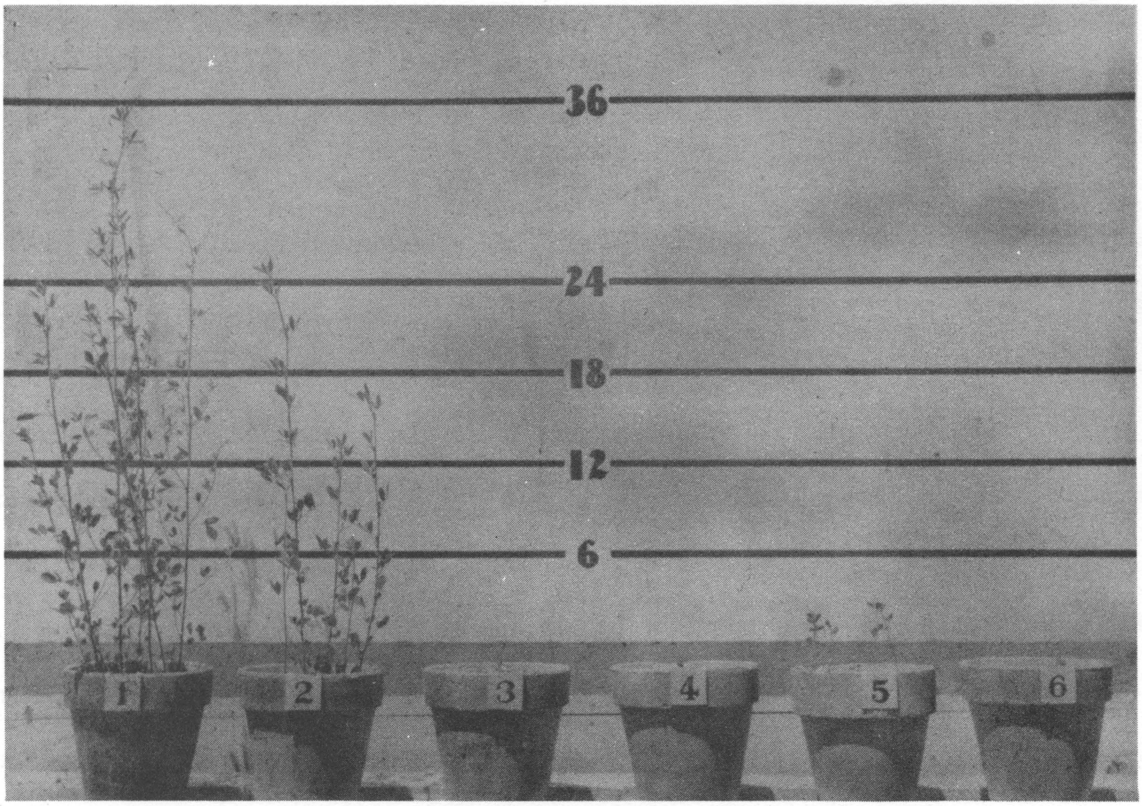

Figure 6. Growth of Hubam sweetclover on successive 6-inch layers of soil from an Austin clay profile.

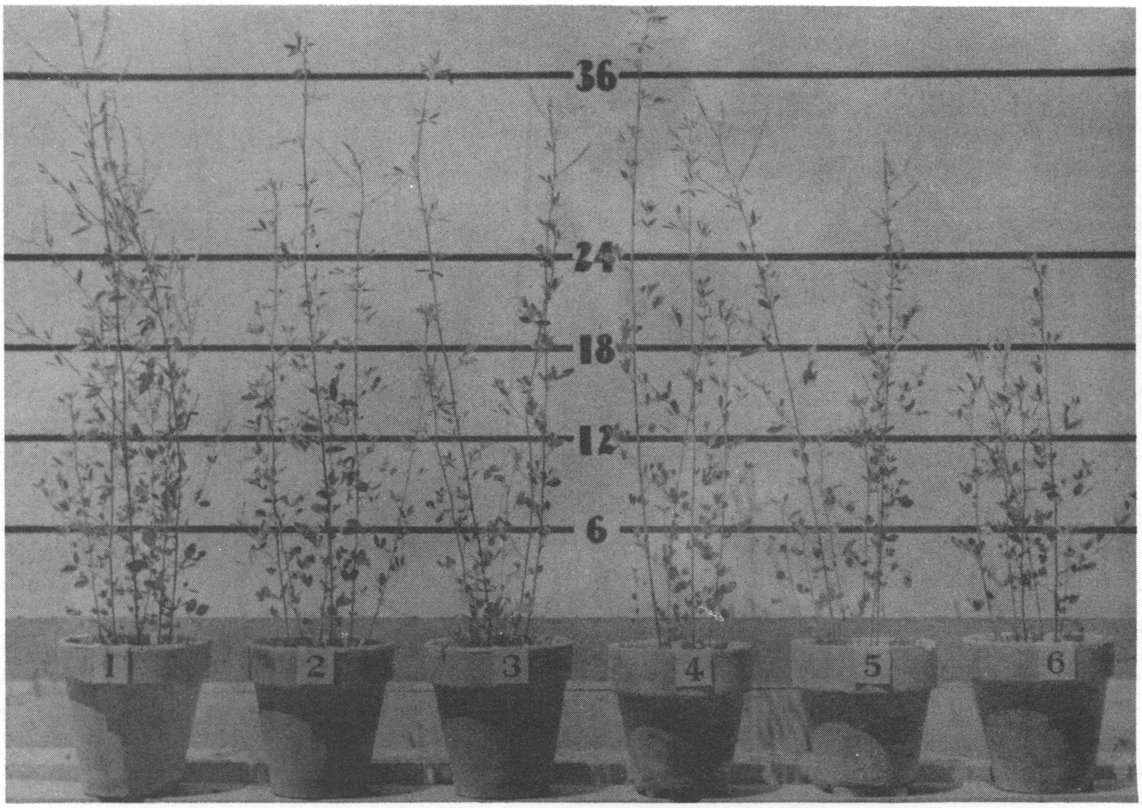

Figure 7. Effect of 25 pounds phosphoric acid per acre as bands below seed on growth of Hubam sweetclover growing on successive 6-inch layers of soil from an Austin clay profile.

4 months of growth. This means a uniform distribution of organic phosphate in the root zone for the use of succeeding crops of cotton and corn. Table 3 shows that banding 300 pounds of 0-20-0 fertilizer per acre permitted the development of 7,269 pounds of dry matter per acre in tops and roots which contained 172.6 pounds of nitrogen and 13.57 pounds of phosphorus; broadcasting the phosphate resulted in 5,714 pounds of dry matter per acre containing 133.4 pounds of nitrogen and 8.94 pounds of phosphorus. The non-phosphated plants produced 3,611 pounds of dry matter per acre containing only 82.2 pounds of nitrogen and 3.94 pounds of phosphorus. The addition of 2,518 pounds of dry matter, 55.2 pounds of nitrogen and 5.12 pounds of phosphorus per acre to the top 18 inches of soil by 4 months' growth of Evergreen sweetclover roots after band phosphating has many implications insofar as high soil productivity is concerned.

Table 3. Effects of phosphate and phosphate placement on growth and the nitrogen and phosphorus contents of sweetclover roots and tops

Phosphate treatment	Plant part	Dry matter production*	Nitrogen content		Phosphorus content	
		Pounds per acre	%	Pounds per acre	%	Pounds per acre
None	Tops	1926	2.44	47.0	0.123	2.37
Broadcast**	"	3681	2.47	90.8	0.155	5.71
Banded**	"	4751	2.47	117.4	0.178	8.45
None	Roots***	1685	2.09	35.2	0.093	1.57
Broadcast**	"	2033	2.10	42.6	0.155	3.23
Banded**	"	2518	2.17	55.2	0.203	5.12

* Harvested 116 days after planting.
** Sixty pounds phosphoric acid per acre.
*** Roots obtained from 0-18-inch depth.

It occurred to us in 1945 that we might be able to use the biennial sweetclovers as annuals by planting them in the fall, thus being able to take advantage of the greater root system of the biennials and still use them in spite of the root-rot disease. Fall seeding of Madrid sweetclover worked satisfactorily during the favorable falls of 1945 and 1946. The dry falls following, however, showed that late fall establishment made the biennials act as true biennials, producing seed the second summer instead of the first. Winter survival of the late seedlings then became a problem. A chance observation during the 1947-48 winter in a field of oats and Evergreen sweetclover, showed that sweetclover seedlings growing in the drill with oats survived the cold whereas the seedlings between the drills were killed. We attributed the survival of the plants in the drill to the close association with the fibrous-rooted crop and to the close proximity with the phosphate band, which was 2 inches deep, in contact with the drilled oat seed. We now drill sweetclover above the small grain and phosphate band by making a simple adjustment on a combination fertilizer drill equipped with a small seed attachment, all three operations being performed simultaneously. Figure 5 shows Madrid sweetclover and oats growing together in the drill.

Table 4 shows some interesting relationships in the root development of three varieties of sweetclover when fall and spring-seeded. These data obtained from this physiological study during the past 2 years show that, insofar as root development is concerned, fall-seeded biennial sweetclovers approach their maximum root development by the following July, regardless of whether they produce seed. Madrid sweetclover seeded October 15, 1948, produced 2,046 pounds of dry root material per acre by July 5, 1949. By April 6,

Table 4. Root and top growth of three varieties of sweetclover planted at different dates on Austin clay

Variety	Seeding date	July 5, 1949			April 6, 1950			July 19, 1950			2-yr. totals for Hubam		
		Roots	Tops	Total	Roots	Tops	Total	Roots	Tops	Total	Roots	Tops	Total
		Pounds per acre			Pounds per acre			Pounds per acre			Pounds per acre		
Hubam	10-15-48	339	3501	3840				139	2305	2444	478	5806	6284
Madrid	"	2046	3558	5604	2098	1778	3876	1985	4162	6147			
Evergreen	"	1613	2895	4508	1868	1796	3664	1391	3806	5197			
Hubam	3-15-49	401	1478	1879				270	1917	2187	671	3395	4066
Madrid	"	1066	2037	3103	2496	1458	3954	1736	3476	5211			
Evergreen	"	885	2262	3147	1736	1220	2956	1928	5158	7086			
Hubam	10-15-49							228	3191	3418			
Madrid	"							2270	3436	5706			
Evergreen	"							1348	3030	4379			

1950, this same sweetclover had about the same amount of root material per acre, 2,098 pounds. Root development by Evergreen sweetclover, treated the same as Madrid, was 1,613 and 1,868 pounds per acre, respectively, for the July 5, 1949 and April 6, 1950 dates.

The Hubam sweetclover root system, seeded October 15, 1948 and sampled July 5, 1949, consisted of only 339 pounds of dry matter per acre. This is contrastingly smaller than the 2,046 and 1,613 pounds per acre of dry matter for the Madrid and Evergreen varieties. This same trend was obtained from the October 15, 1949 seeding of these three varieties. On July 19, 1950, the root development was 228 pounds, 2,270 pounds and 1,348 pounds of dry matter per acre, respectively, for Hubam, Madrid and Evergreen. Figure 9 shows certain morphological characteristics of the root systems of these three varieties of sweetclover.

The use of Hubam in a 2-year rotation with cotton is now accepted as one of the best control measures for root rot, Figure 4. Oats in a 2-year rotation also gives good control of the disease in cotton. Hubam has the added advantage of increasing the nitrogen supply in the soil. The management of these two crops in rotation with cotton has one feature in common--both are out of the way before August which permits the land to be plowed and kept free of root-rot susceptible plants during August and September. Therefore, it appears to be feasible to plow under fall-planted biennial sweetclovers in July, thereby gaining the advantage of the large root systems of these plants while maintaining clean, fallow land during August and September.

The response of warm season crops in the Blackland Prairie to commercial fertilizers has been negative in most instances, or at least

Figure 8.
A field of cotton defoliated with an experimental spray compound. Photograph made August 25, 1950.

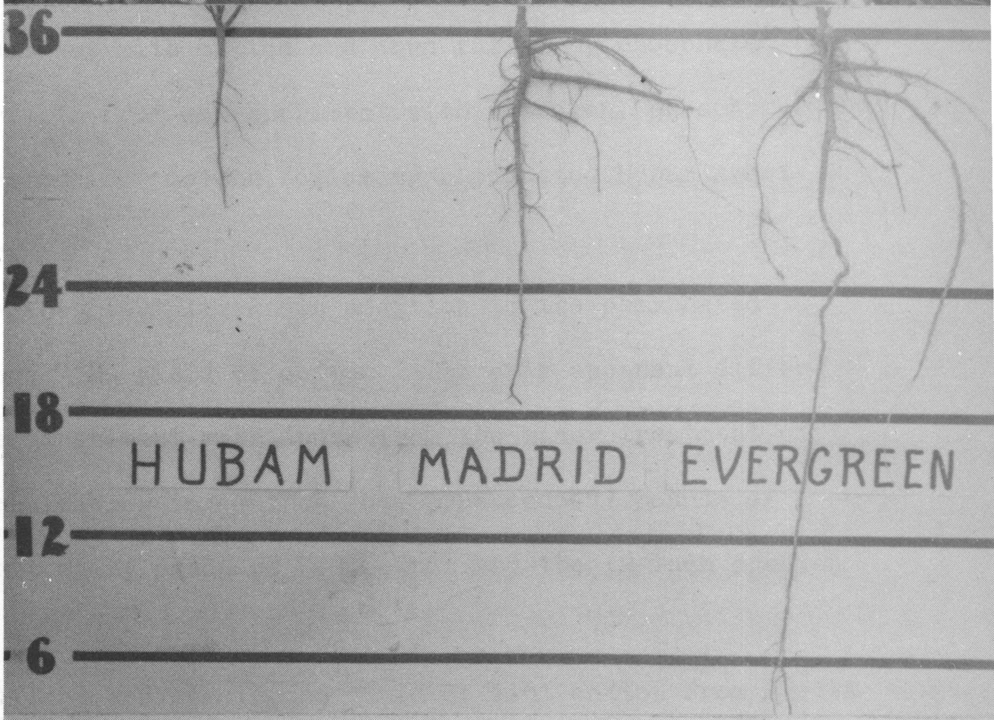

Figure 9.
Comparative root systems of Hubam, Madrid and Evergreen sweetclover. Scale in inches.

Figure 10.
Effect of 20 pounds of phosphoric acid per acre in bands on resistance to winter killing of New Nortex oats during 14° F. freeze on March 11, 1948. Phosphated oats produced 35 bushels per acre; nonphosphated oats produced 12 bushels per acre.

negative from the standpoint of profitable increases in crop production. A large number of fertilizer experiments have been conducted on the soils of the area with cotton and corn during the past 20 years. We think this lack of response may be caused by poor air-water relationship in the soil resulting from a depleted supply of active soil organic matter. As pointed out, we have learned in some measure, at least, how to add some active organic matter to the soil by the use of phosphated deep-rooted legumes. We have fertilizer experiments underway with cotton and corn following phosphated sweetclover. The 1950 results from an experiment with nitrogen, phosphorus and potash fertilizers applied for cotton following phosphated Hubam sweetclover are given in Table 5.

These data show that fertilizers in addition to the phosphated sweetclover did not increase the yield of cotton. The only apparent differences in yields from this experiment were those from the minor treatment of plant spacing: the 3-inch spacing in 40-inch rows produced 477 pounds of lint per acre, the 6-inch spacing produced 440 pounds and the 12-inch spacing produced 413 pounds.

Table 5. Effect of fertilizer and spacing on yield of lint cotton from Empire variety following phosphated Hubam sweetclover in a 2-year rotation

Fertilizer*	Spacing in 40-inch rows			Average yield
	3-inch	6-inch	12-inch	
None	510	462	405	459
Nitrogen alone	495	470	436	467
Phosphate alone	503	398	367	423
Potash alone	442	446	422	437
Nitrogen & phosphate	414	470	430	438
Nitrogen & potash	508	435	392	445
Phosphate & potash	462	386	413	420
Nitrogen, phosphate & potash	490	452	439	460
Spacing average	477	440	413	443

* Nitrogen, 30 pounds per acre. Phosphorus, 60 pounds phosphoric acid per acre. Potassium, 60 pounds potash per acre. Individual data are averages from 3 replications.

We have been successful to some extent in learning how to use nitrogen and phosphorus fertilizers for winter grain. The use of phosphate is important in increasing resistance to cold injury as well as in giving better forage and grain yields, Figure 10. Table 6 shows the effect of nitrogen and phosphorus fertilizer on grain yield from oats in 1949. Table 7 shows the effect of nitrogen and phosphorus on yields of winter forage from New Nortex oats.

Table 6. Effect of nitrogen and phosphorus fertilizers on yield of grain from Mustang oats on Austin clay soil in 1949

Fertilizer treatment	Yield of grain, bushels per acre
None	54.9
30 pounds nitrogen per acre	58.5
60 pounds phosphoric acid per acre	67.2
30 pounds nitrogen and 60 pounds phosphoric acid per acre	74.8

Table 7. Effect of nitrogen and phosphorus on yield of winter forage from New Nortex oats on Austin clay soil in 1949-50

Fertilizer treatment	Yield of forage, pounds dry matter per acre
None	567
30 pounds nitrogen per acre	1023
30 pounds phosphate per acre	1088
30 pounds nitrogen and 30 pounds phosphoric acid per acre	1410

The use of fertilized deep-rooted legumes and grasses in proper balance with soil-depleting crops is necessary in the Blackland area if soil structure and soil productivity are to be improved and maintained at a high level of production. A balance between constructive and destructive soil processes must be reached before permanently high productivity can be attained. The destructive processes, such as organic matter depletion, soil structure decline, erosion losses, nutrient depletion and lowering of available water storage capacity resulting from continuous row cropping, have been and still are common in the Blackland area. These destructive soil processes will have to be counterbalanced by the use of mineral fertilizers, legumes and grasses for the restoration and maintenance of organic matter, of good soil structure, control of erosion losses, a plentiful supply of available nutrients and a high water storage capacity before high productivity can be assured.

Crop rotation experiments have been conducted in Texas for several years. These studies, for the most part, have not been highly fruitful. We now believe the failure of the early experiments was caused by a lace of knowledge on how to manage properly our better legumes and grasses for the all-important purpose of soil improvement and moisture conservation. Fortunately, the research on cropping systems in Texas is now on a logically sound basis and should give some highly valuable information in a few years. A number of experiments are being started on some of the major soil types in the State. The 1950 results of a 3-year experiment on Houston black clay with corn shows the value of good legume management for corn production, Table 8.

Table 8. Effects of cropping system on yield of corn from Houston black clay in 1950

Cropping practices	Yield of corn, bushels per acre
Corn	41
Corn (winter peas-green manure)	39
Corn, oats	44
Corn, oats-Hubam sweetclover	60
Corn, oats-Madrid sweetclover	63
Corn, Hubam sweetclover	65
Corn, Madrid sweetclover	68

Water management is a major problem in Texas. A good, strong supply of water is important in both agriculture and in cosmopolitan and industrial areas. Conservation and proper use of natural rainfall would make the overall problem simpler. In agriculture, water management has many facets; we are concerned with erosion, drainage, irrigation and the soil's available water storage capacity, to say nothing of domestic water supply for mankind and for livestock in rural areas. Much effort has been used in developing terracing techniques for either impounding and holding of water on the land, or for draining excess water from the surface slowly to prevent gully and sheet erosion. We are now devoting more time to the soil and how to alter certain of its physical, chemical and biological properties so water management, insofar as conservation and soil productivity is concerned, will be simplified. If good progress can be made in improving soil structure and soil water relationships, I believe we will be in position to revalue the terracing techniques in our conservation farming. It might be possible to use level terraces for better water conservation in certain areas in place of drainage terraces.

A growing vegetative cover on the land is widely recognized as being effective in absorbing the impact of falling rain drops and reducing the erosive power of flowing surface water, thus reducing erosion and promoting better water storage. This factor must be given full consideration in the development of cropping systems on different kinds of land. A vegetative mulch cover has proved to be a satisfactory soil and moisture conservation practice in certain areas of the United States. We are now learning how to use subsurface tillage plows in the heavy soils of the Blackland Prairie.

These plows enable us to do a good job of tillage while leaving plant residues on the soil surface for protection against the beating action of raindrops and for greater infiltration and storage of water. We have a farming system underway in which we are using phosphated small-grain sweetclover in 2-year contour-strip rotation with cotton in combination with mulch tillage methods. We are hopeful that this combination of practices will be helpful in solving the water management and soil productivity problems of Blackland soils.

Our work at the Blackland station on the crops phase of the soil-crops-livestock cycle is not anyway near a complete program insofar as crop production is concerned. We have a limited amount of work underway which deals with genetical improvement of crops. We have no research on insect control with the various crops and livestock we work with. Research on these problems is done by specialist at the Main Station and at USDA field stations. In the field of crop improvement and crop production, we are conducting work on control measures for the root-rot disease in cotton, cotton mechanization with particular emphasis on defoliation for Central Texas conditions, Johnson grass control and utilization, hybrid corn development, crop variety and strain testing of the commercially important crops--cotton, corn, oats, wheat, barley, grain, sorghum, flax, grasses and legumes. Figure 4 gives some results from root rot investigations. Figure 11 gives results in cotton defoliation.

Preliminary to a short discussion of our work with beef cattle, which represent the livestock phase of our soil-crops-livestock approach to sound agriculture in the Blacklands, I want to mention a principle of grassland agriculture which I believe is going to become very important on every farm and ranch in the area. A very large percentage of all farms have surface water drainageways of some type. In many instances, these are unsightly weed patches or damaging gullies. All such drainageways should be covered with a vigorous grass or grass-legume mixtures so disposal of excess water will be orderly. These permanent grass areas should be divided between cool-season and warm-season grasses. A fairly good combination in our area is tall fescue (Kentucky 31 preferred) and Turkestan bluestem (K. R. preferred). We are still hopeful of being able to use a warm-season perennial legume with the cool season grass. European Broadleaf Birdsfoot trefoil and Texas Common alfalfa hold some promise in this connection. At this time, it appears that a reseeding winter annual legume such as Hairy vetch, Cogwheel clover or Button clover offers some possibilities for growing with the vigorous K. R. bluestem grass. In addition to common Bermuda, Coastal Bermuda and certain strains of Buffalo grass show promise as other warm-season perennial grasses. There are other cool-season grasses which are performing well in some tests. Of these, Lincoln brome grass and Harding grass look exceptionally good.

Grassed waterways should be wide enough to be worth fencing and extensive enough to provide some year-round grazing for livestock. The remaining acreage can then be devoted to cropping systems for the production of crops required by the individual type of enterprise the farmer chooses. At the Blackland station, we are working with a number of farming systems which can be used on the cropland in our area.

I believe some livestock production data from various individual forage crops and combinations of forage crops will be of value later when discussing farming systems in more detail. In 1950, yearling Hereford steers

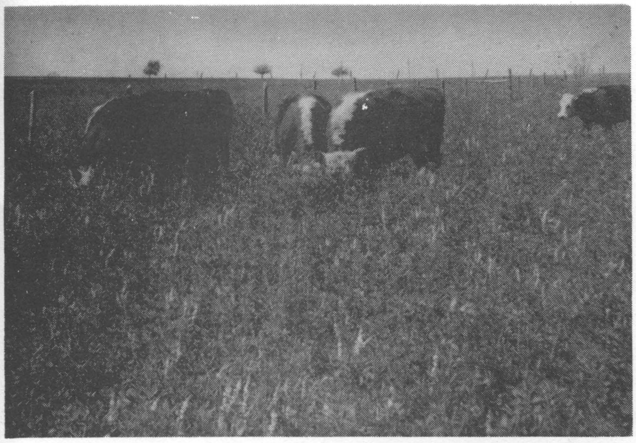

Figure 11. Hereford steers grazing Hubam sweetclover. This combination produced 309 pounds of steer gain per acre in 1946.

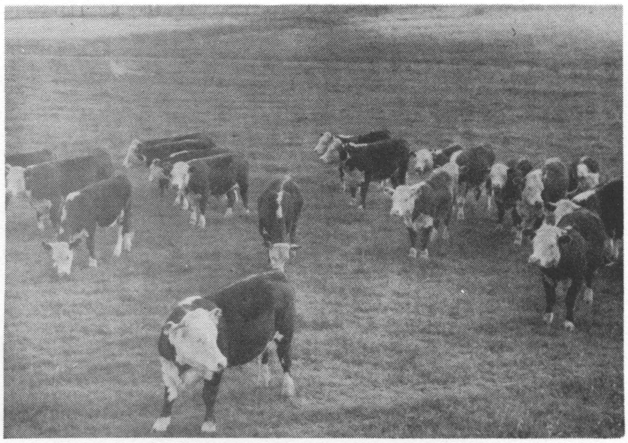

Figure 12. Cattle on a Bermuda grass waterway. This waterway produced 184 pounds of steer gain per acre during 1950 up to October 1.

Figure 13. Cattle grazing Kentucky 31 fescue and Texas Common alfalfa in a waterway. This is a new seeding and was grazed only during May 1950. During this month it produced 60 pounds of steer gain per acre.

Figure 14. Steers grazing winter oats and Madrid sweetclover in March. This mixture has produced as much as 342 pounds of steer gain per acre in one year.

Figure 15. Long yearling steers grazing Sweet Sudangrass in August. In 1948, this crop following 2 years Hubam sweetclover produced 404 pounds of steer gain per acre.

produced 184 pounds of gain per acre from an improved Bermuda grass pasture, Figure 12. In November 1949, a Kentucky 31 fescue-alfalfa mixture was seeded and fertilized with 30 pounds of nitrogen and 120 pounds of phosphoric acid per acre. This seeding started late and had a rough time during the winter. Nevertheless, 10 steers on 5 acres produced 300 pounds of gain during May 1950, Figure 13. We are hoping to get as high as 500 pounds of gain per acre per year from this pasture under favorable conditions. This pasture will be top-dressed each fall with 200 pounds of ammonium nitrate per acre; phosphate will be applied at 3 to 5-year intervals.

Small grain, sweetclover, Sudan grass and Johnson grass are the crops for tillable land under forage-grain-livestock farming systems for the Texas Blacklands. A fertilized oats-Madrid sweetclover combination has produced 342 pounds of steer gain per acre during one season of grazing, Figure 14. Hubam sweetclover has produced 309 pounds of steer gain in one season, Figure 11. In 1948, with only 20.40 inches of rainfall, Sweet Sudan grass following 2-years of Hubam, produced 404 pounds of gain per acre, Figure 15. Johnson grass alone has not been a high producer of beef gain; 100 pounds of gain per acre from this grass is considered good.

The forage crops just discussed are grasses and legumes. They have a very definite place in farming systems for the addition of sorely needed organic matter and nitrogen to the soil for soil structure improvement, better soil-air-water relations and better plant nutrient availability in the soil. The use of livestock for the consumption and processing of the forage and grain on the farm increases the value of these crops for soil and water conservation and soil improvement. When forage-grain crops and livestock are rotated with cash crops, production from the latter is increased. Complete and proper management of the soil-plant-animal cycle on our farms and ranches will lead to a permanently productive agriculture.

We are attempting to combine our segmented research data into farming systems. A major portion of the research has to be done on a segmented basis. We often have the results dangling in many loose ends, expecting someone else to join them together in a complete package for the farmer and ranchman. I believe research people have neglected this phase of our agricultural endeavor. Not that I believe every research worker should be concerned with the complete package, though I do believe every research organization should have the personnel and facilities to put things together, thus eliminating all possibility of misinterpreted and misleading information reaching farmers and ranchmen. Plainly speaking, let the doctors take some of their own medicine before prescribing it. This phase of agricultural work is not altogether the responsibility of research; educational and action agencies also have a definite responsibility in it.

I would like to describe a few farming systems we are working on at the Blackland station wherein we are attempting to bring together the research information available on production problems pertaining to certain types of farming adapted to our area. Also, we are attempting to use these farming systems as a base on which to do further research so that we may increase production still further.

A cotton-beef cattle system of farming is receiving attention since it appears that straight cotton farming is not conducive to a permanently productive agriculture in the area. A 2-year cropping system of cotton, small grain-sweetclover, with approximately equal acreage of each crop each year, is being used in this farming system. The small grain-sweetclover mixture receives 40-50 pounds of phosphoric acid per acre as fertilizer when planted. The cotton and close-growing grass-legume mixture are grown in uniform width strips approximately on the contour. Subsurface tillage is being used on the small-grain-sweetclover stubble in preparation of a seedbed for cotton, thus leaving a protective mulch on the surface while the land is being prepared for cotton and while in cotton.

All other known positive practices for cotton are being used in this system for high production, including a good variety (Empire), early season control of insects, seed treatment for seedling disease control, early planting, weed control, defoliation and mechanical harvesting. A detailed fertilizer and plant spacing experiment is being conducted within the frame work of this system for information which may lead to still higher and more economic production per acre.

The beef cattle phase of this farming system is dependent on forage from permanent grassland occupying the waterways as well as the small grain-sweetclover in the 2-year cropping system on the crop land. Adequate acreage of cool season and warm season grass in the waterways, bolstered with forage from the small grain-sweetclover, will provide green grazing for a major portion of, if not the entire year. Surplus production from the small grain-sweetclover crop can be used for hay or grain production. We are using beef steers in our work with this system. Later, we hope to change to a cow herd for a complete beef-production unit within this cotton-beef system of farming.

A grain-forage-livestock system of farming, with either beef cattle or swine as the livestock, is being developed for the Blackland area. A 2-year cropping system of corn, small grain-sweetclover with an equal acreage of each crop grown each year, is being used. We have this cropping system on each of 2 land conditions, Houston black clay - Class II land and Austin clay - Class III land. On the Class II land, the fields are run across the slope as field strips, on Class III land, the fields are contour strips.

The cultural practices for the small grain-sweetclover consists of two seedings of small grain (oats in this instance), two applications of fertilizer and one seeding of biennial sweetclover. The first seeding of oats, 1 1/2 bushels per acre, is made in dry soil in late August or early September as soon as a seedbed can be prepared following corn harvest, and is fertilized simultaneously with 16 pounds of nitrogen and 20 pounds of phosphoric acid per acre. The drill rows of this first seeding all run in the same direction. The second seeding of oats, another 1 1/2 bushels per acre, is made after a good fall rain at right angles to the first seeding. Ten pounds of sweetclover are seeded per acre with the second seeding of oats, the mixture being fertilized with 11 pounds of nitrogen and 48 pounds of phosphoric acid per acre, all operations being performed simultaneously with a combination fertilizer grain drill with a small seed attachment. This small grain-sweetclover combination is used altogether for beef cattle grazing.

All positive practices for high corn production are being used in the system. Texas 28 is now being grown as possibly the most desirable hybrid; spacing of 18-20 inches in 36-inch rows is used. Good seed, treated for seedling diseases, are planted. Weed control with shallow cultivation is practiced to avoid damage to the lateral roots. And the last cultivation is done with disk hillers for the double purpose of moisture conservation and lessening the damage to the feeder roots near the surface. Corn harvest is done with a 2-row mechanical picker. The corn produced in this system is used for finishing the beef cattle for slaughter.

This farming system, the same as the cotton-beef system, is dependent on permanent grass from waterways for an approach to year-round grazing. It has much promise for swine production in our area. The only change desirable in crops would be that of changing from oats to barley, thus providing extra grain for feeding pigs if the small grain provides an excess of forage during the spring.

Beef-forage-grain and dairy-forage farming systems being started this year hold much promise for the area from the standpoint of high forage production for either beef cattle or dairying. The cropping system for the beef cattle is Sweet Sudan grass-Johnson grass, oats-sweetclover, sweetclover-oats. There is no row crop in either of these systems, therefore, it is possible to treat the ever-present Johnson grass as a good forage crop rather than as a serious weed pest. The cultural and fertilizer practices for the first-year small grain-sweetclover are the same as described for the oats-sweetclover in the grain-forage-livestock system. Where barley is used in place of oats, 3/4 bushel is drilled at each seeding date. The early fall seeding of small grain will be made in standing Sudan grass after the ground has been loosened up with chisel attachments on a subsurface type plow. Seeding of small grain (two bushels of oats or one bushel of barley) in the second-year sweetclover stubble after the soil has been loosened with chisels, will give additional fall, winter and spring forage.

As you can see from this discussion, we are doing research on several problems pertaining to good management of the soil-plant-animal cycle as related to sustained and high agricultural production for the Texas Blacklands. Furthermore, we are putting the various phases of research into actual farming systems insofar as our facilities permit.

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