Chapter 5

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Potentials for Increasing Production in the Corn Belt

UNDER 1960 prices the demand for corn was about 3.8 billion bushels, but production in 1959 was some 4.3 billion bushels (11). Some 28 million acres of cropland are withdrawn from production in the acreage control programs, and it has been suggested that 45 to 70 million acres be withdrawn from cropland use. The differences between various estimates indicates a critical need for more valid estimates of production potentials. If production of the needed quantity of corn is to take place with maximum efficiency, what lands will remain in production and what lands and what acreage should be withdrawn?

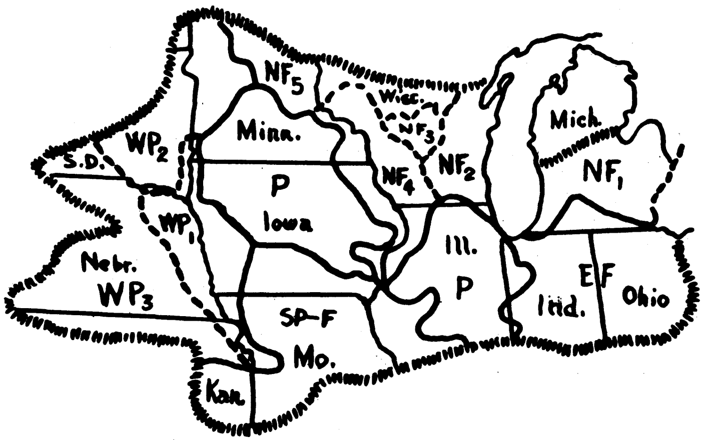
In this chapter we shall endeavor to illustrate how soil survey information can be used to appraise the crop production potential of a region. The probable effect of changing technology on corn production on different soil conditions will be examined in some detail, and a tentative evaluation of the corn production potential of the Midland Feed Region or Corn Belt will be made.

THE CORN BELT

The Midland Feed Region or Corn Belt has 11.5 percent of the total land area of the continental United States and about 34 percent of the cropland. It produces more than two-thirds of the corn, oats and soybeans. Corn is grown on more than 44 million acres (6).

This region is not uniform, however, in the amount of corn grown in all of its parts. Different suitability and productivity for corn is caused by soil, topography or climatic differences, singly or in combination. In Figure 5.1 the Midland Feed Region or Corn Belt[1] has been subdivided into 5 sub-regions. The land

[1] It includes north central Ohio, Indiana, Illinois and Missouri; Iowa; northeastern Kansas; eastern Nebraska; southeastern South Dakota; southern Minnesota, Wisconsin and Michigan.



PRAIRIE

P. CENTRAL PRAIRIE SUBREGION
WP. WESTERN PRAIRIE SUBREGION
WP_1 MISSOURI VALLEY HILLY AREA
WP_2 DAKOTA-MINNESOTA AREA
WP_3 NEBRASKA AREA

PRAIRIE-FOREST

SP-F SOUTHERN PRAIRIE FOREST

FOREST

EF. EASTERN FOREST SUBREGION
NF. NORTHERN FOREST SUBREGION
NF_1 SOUTHERN MICHIGAN AREA
NF_2 EASTERN WISCONSIN AREA
NF_3 CENTRAL WISCONSIN SANDY AREA
NF_4 MISSISSIPPI VALLEY HILLY AREA
NF_5 NORTHERN FRINGE AREA

Fig. 5.1. Sub-regions of the Midland Feed Region adapted from Soil, the 1957 Yearbook of Agriculture, page 536.

use, based on the 1955 census, is given in Table 5.1. The Central Prairie, Western Prairie and Eastern Forest sub-regions are highest in present use for corn, with the former ranking first. This is illustrated in Figure 5.2. These sub-regions have been described elsewhere as to soil, topography and land use and corn-yielding capacity, based mainly on 1946 to 1955 census data (6).

CORN PRODUCTION TECHNOLOGY

As described elsewhere (2, 6), the early systems of soil management in the Corn Belt revolved largely around lime, legumes and livestock. Generally this meant for cropland acres a cropping system which included about equal acreages of corn, a small grain (mainly oats) and a legume-grass meadow. Legumes,

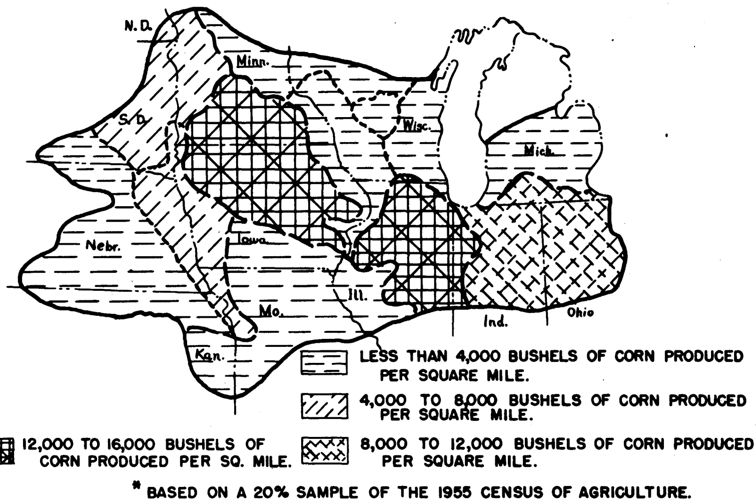


Fig. 5.2. Intensity of corn production in the Midland Feed Region.

Table 5.1. Present Land Use of Farm Land in the Midland Feed Region[a]

Sub-regions	Size Millions of Acres	Corn	Oats	Soy-beans	Wheat	Hay	Pasture	Forest
				(Percent)				
Central Prairie	40	33	17	13	1	10	20	5
Western Prairie	60							
Missouri Hilly Valley		28	14	3	2	8	35	9
Dakota-Minnesota		24	25	4	2	12	31	1
Nebraska		22	6	-	17	12	41	2
Prairie-Forest	36	13	5	6	5	9	45	16
Forest								
Eastern Forest	30	26	8	10	10	12	23	11
Northern Forest	52	11	12	1	2	16	36	22

[a] Based on a 20 percent sample from 1955 federal census.

manure and the soil were the main source of nitrogen for the grain crops. Deviations occurred, but on the whole about 30 to 50 percent of the cropland acres were used for corn. Generally, this was the land use pattern for the Corn Belt from the turn of the century to the 1955 to 1960 period. During this period there was comparative inflexibility in the use of the land for corn. But in the 1950's there were signs of rather drastic shifts in land use — these will be referred to later.

The story of mechanization and hybrid corn are familiar. Hybrid corn had its great impact in the thirties and early forties. The increased use of fertilizers is a well known phenomenon of the 1940 to 1960 period, as well as the increased use of insecticides and herbicides. Increased planting rates of corn, improved tillage, erosion control and drainage practices can be added to the list of technological advances.

Application of such technological advances was undoubtedly the basis for the 1952 estimation that an average yield of corn for Iowa of 85 bushels per acre was attainable (1). In the 1952 report it was estimated that 10.7 millions of acres of land could safely be used for corn by 1955. A number of lines of evidence now point to a potential acreage of at least half again as much.

This predicted average yield has not yet been reached, but the significance of the technological advances may well be not so much in the direction of increased yield per acre, as in the changes in land use. Legumes and oats may well be shifting on many soils from a complementary position in the cropping system to a non-essential one or to a competitive position as far as acreage of corn is involved. The agronomic feasibility of such a shift in production practices is indicated by the data presented in Table 5.2. The studies reported in this table indicate that, on land where rotations are not needed to control erosion, as high yields of corn can be obtained with adequate nitrogen under continuous corn culture as when a rotation containing a legume is used. The percentage of the time that corn occupies the land commonly changes from 33 or 50 percent to 100 percent as a shift is made from rotation to continuous cropping. Thus, on a given tract of land the quantity of corn produced may be doubled or tripled by such a shift in land use. The data in Table 5.3 illustrate the impact of this on potential corn output. A number of technological advances undoubtedly have made this possible, but the substitution of fertilizer nitrogen for the legume-supplied nitrogen undoubtedly will be the key technology.

TECHNOLOGICAL POTENTIALS

Previously the authors have made some preliminary analyses of the implications of the complex of new corn production technologies for several selected counties in Iowa (7, 10). In Appanoose County it was estimated that the corn production could be

Table 5.2. Relative Yields of Rotation and Continuous Corn Based on 1955 to 1959 Average Yields

Experimental field and soil type	Rotation corn[a]	Continuous corn: No nitrogen fertilizer	Continuous corn: Nitrogen fertilizer used[b]
		(Percent)	
Carrington-Clyde (Kenyon silt loam)	100	--	108
Clarion-Webster (Webster silty clay loam)	100	48	98
Pasture Improvement (Belinda silt loam)	100	79	82
Soil Conservation (Marshall silt loam)	100	90	104
Southern Iowa (Edina silt loam)	100	49	123
Howard County (Cresco silt loam)	100	79	90

[a] Yields of first year corn (corn following a legume-grass meadow) were taken as 100 percent for each location.
[b] All nutrients except nitrogen were supplied as needed to all areas. The maximum nitrogen treatments were 160 pounds per acre at all locations except in Howard County where 90 pounds per acre were used and in southern Iowa where it was 240 pounds per acre.

increased from 1.4 million bushels to 3.2 million bushels, or an increase of about 1.8 million bushels. This county has only a small amount of nearly level land suited to frequent or continuous corn production. Most of the cropland would require use of erosion control practices which would involve legume-grasses in the rotation.

But in Hamilton County we estimated that corn production could be increased about 6 million bushels by applying the technology available in 1957. We now consider this figure too low, and estimate that a 12 million bushels per year increase in corn production in Hamilton County is physically possible (over the pre-1957 production). This large potential increase in corn production in Hamilton County, where there are dominantly level to nearly level soils of high-yielding potential, can result primarily because increased acres can be used for corn largely in an almost continuous corn system of farming.

This example of applying new technology illustrates that not only do differences in corn production exist but also that a very high corn production potential is physically possible in some counties. But it is necessary to consider other factors too. Many

Table 5.3. Estimated Annual Physical Corn Production Potential of Corn Suitability Class A, B and C Soils for Selected Counties of the Central Prairie, Southern Prairie-Forest and Missouri Valley Hilly Sub-Regions

Sub-region	County	Present corn production	Estimated corn production potential[c]				
			Class A+B soils[d]		Class C soils[e]		Class A+B+C soils
			(Acres)	(Bushels)	(Acres)	(Bushels)	(Bushels)
Central Prairie	Hamilton, Ia.	8,530,000[a]	302,000	19,970,000	19,000	895,000	20,865,000
	Calhoun, Ia.	6,070,000[a]	320,800	22,980,000	10,300	384,000	23,364,000
	Christian, Ill.	3,280,000[b]	296,500	17,069,000	39,400	135,000	17,204,000
	Faribault, Minn.	8,315,281[b]	344,506	20,551,700	36,503	1,414,500	21,966,200
	Steele, Minn.	3,613,730[b]	185,760	9,712,500	85,037	2,474,300	12,186,800
Southern Prairie-Forest	Ringgold, Ia.	2,457,000[a]	55,706	3,684,000	62,618	1,504,000	5,188,000
Missouri Valley Hilly (of Western Prairie)	Shelby, Ia.	6,650,000[a]	59,300	4,059,000	206,700	9,644,000	13,703,000

[a] Iowa Farm Census, 1953-57 average.
[b] Federal Census, 1954 only.
[c] On present cropland only.
[d] Includes the soils best adapted to corn production and suited to continuous corn culture.
[e] Fair corn soils, but not suited to continuous corn production.

of the soils in other parts of the humid region might conceivably be used for crop production, but on many of them yields would be very low and production costs high. On many soils the full complex of the new technologies could not be applied efficiently because of limitations of size and uniformity of soil patterns. Therefore, any realistic appraisal of corn production potential must take into account not only the various technological and economic aspects of corn production, but it must consider whether or not the technologies can be efficiently applied to various soils. Among the facets involved are yielding capacity of soil types, slope or lay of the land, size and shape of uniform soil areas. For example, a farm with some highly productive soils, but which occur in small fields suitable for efficient use by 2-row equipment, would be poorly suited for 4-row and 6-row equipment. Thus it is evident that aggregate acreages of various kinds of land cannot be used as the only criteria in evaluating corn production potential. There must be supplemental studies or perhaps complete replacement with field-by-field or farm-by-farm analysis. The need for these kinds of studies is urgent, and too few have been made.

PRODUCTION POTENTIALS IN SELECTED COUNTIES

We recognize that some of these and other considerations must be brought into the picture if serious estimates are to be made of corn production potentials in the Corn Belt. Clearly, such details are beyond the scope of this chapter. However, we did introduce some of these elements in making corn production estimates for selected counties within three sub-regions in the Corn Belt. The estimates are given in Table 5.3. A brief elaboration of the method and a discussion of each county follows. In Table 5.3 the soils are ranked according to their "relative suitability" for corn production. Briefly, Class A soil areas are the "ideal" condition, which consists of medium textured, easily tilled, level to nearly level soils. Muscatine silt loam is a representative soil. Class A soils occur in large, uniform areas and are capable of producing average corn yields in excess of 70 bushels per acre per year with moderate fertilization. They occur dominantly in association with Class B soils. Class B soils are only slightly less desirable in one or more characteristics but are still very highly desirable soils for corn production. Class C soils are mostly too sloping for use for continuous corn or may have other undesirable characteristics. They are capable of high sustained production with suitable management and conservation practices as needed. Class D land is marginal for corn production, and under present conditions Class E land probably is not suited for corn.

Corn production is considered to be the cheapest per bushel of product on suitability Class A soils, and most expensive on Class E soils. Only cropland in the counties considered was classified. The amount of Class A soils, the "ideal" corn soil, is limited, but large areas in the Central Prairie Region are classified as Class B soils.

In a county such as Shelby County, Iowa, there is a potential for a large increase in corn production, but mostly on the Class C land. In other words, the sloping soils of Shelby County are not as well adapted to utilizing existing corn production technology (i.e., frequent use with high yields) as are the level, uniform soils of Calhoun and Hamilton counties, Iowa, or Christian County, Illinois.

Present techniques and economy favor corn production on the class A and B soils. The data presented in Table 5.3 for Hamilton, Calhoun, Faribault and Christian counties indicate that there are large areas of class A and B soils in the Central Prairie sub-region. Other large areas of favorable soils occur in the Eastern Forest sub-region of northern Indiana and Ohio.

These few case studies are sufficient to indicate why there may be no apparent relationship between acreage of land removed from production and the amount of a given crop produced. Average annual corn production (yield per acre times the percent of the time that the land is in corn) on the class A and B lands is about 70 bushels per acre. On Class C land average annual production is estimated at about 35 bushels per acre, and on Class D land it is only about 14 bushels per acre.

Any bushel reduction that might result from removing 100 acres of Class D land from production could be compensated for by shifting about 40 acres of Class B land from a corn-corn-oats-meadow rotation to continuous corn.

IMPORTANCE OF SOIL CLASSIFICATION

The classification of all cropland into 5 general classes enables us to make some general statements about the relative suitability of different areas for corn production. It is obvious that corn can be produced more cheaply on areas where large-scale equipment can be used and where, with an expenditure of perhaps $12 to $15 per acre per year for fertilizer, average yields of 70 to 90 bushels of corn can be obtained, as compared to areas where yields are low and costs are high. However, it is important also to know where and how many acres of different classes of land there are. This is needed in the aggregate, but it is also needed on a field-by-field and farm-by-farm basis. It is needed for broad regions, and for small areas. We cannot stress too strongly that such information on classes of soils can be gained only from modern, detailed surveys; and these are too few in number and the current rate of progress is too slow.

MODEL OF CORN PRODUCTION POTENTIAL

If such soil class information were available for all potential cropland, it would make possible detailed predictions as to the amount of corn that could be profitably produced over a range of prices and an estimation of the amount and kind of land that would be required. Such information would make possible development of a realistic corn production model.

Such a model for the corn production industry as a whole can be visualized from Figure 5.3. The existence of the knowledge that would be necessary to construct such a model would not insure that corn would necessarily be produced on the land where it could be produced most efficiently, but it would furnish a framework of information within which rational plans would be possible either at the farm or national level.

As shown in Figure 5.3, to produce P amount of corn requires only A acres; this production is shown as all taking place on land of S suitability. As production is increased, land of lesser and lesser desirability must be used. To produce P_2 amount of corn, A_2 amount of land must be used, a portion of which is of S_2 suitability. Eventually a point is reached, P_n, at which all land would have to be used regardless of quality.

It is our purpose to determine in a general way our present location on the supply line A-Z. Are we approaching the point Z, or are we still to the left of point A?

CORN BELT POTENTIALS

An estimate of the corn production potential for the Central Prairie sub-region is given in Table 5.4, and an estimate for the entire Corn Belt Region is given in Table 5.5. Under the assumptions made, it is estimated that a corn production potential of about 4.6 billion bushels of corn exists in the Corn Belt. This contrasts with a present production of 2.1 billion bushels (1955 production).

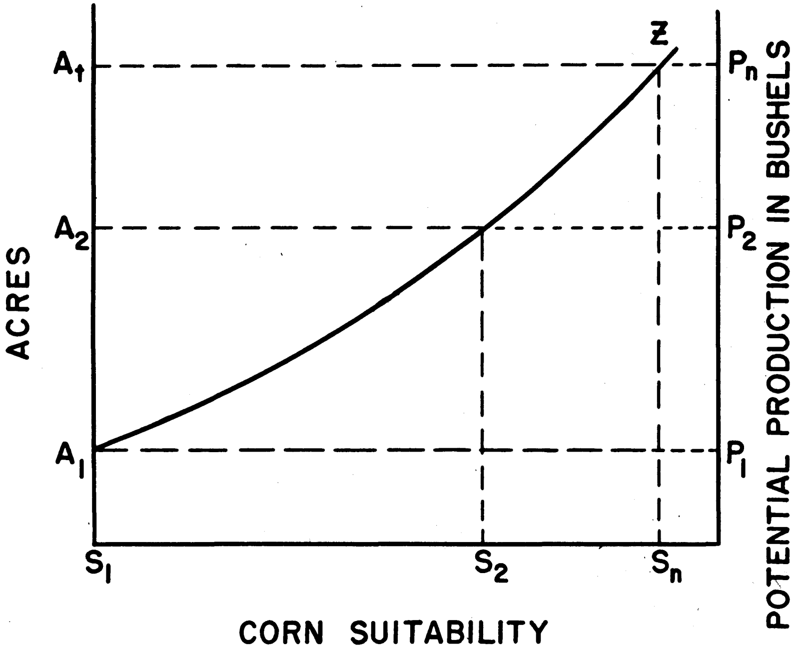


Fig. 5.3. Relationship of relative suitability of land for corn production to acres needed for a given amount of production.

The methods and assumptions need brief elaboration here. About a 20 percent randomly selected county sample was chosen for each of the sub-regions. Available county-wide soil survey and statistical soil survey or land capability information was studied. Then the complex of new corn production technology was evaluated for its suitability for the different soil or land capability situations within each county. Attainable corn yields were next estimated for the different soil and land capability situations. A corn production potential for each county was then computed. The corn production for each sub-region was then obtained by expanding the 20 percent county sample. The estimates obtained by this procedure have their limitations and could be improved appreciably by better data. However, with the admitted limitations, the estimates given are considered to be of the right order of magnitude and direction.

Table 5.4. Corn Production Potential on Highly Suitable Soils in the Central Prairie Sub-Region

State	Approximate area in Central Prairie sub-region acres	Percent of area with soils highly suitable for corn (Corn suitability classes A and B)[a]	Estimated average production in bushels per acre per year	Potential corn production in bushels per year
Indiana	1,300,000	30	80[b]	32,000,000
Illinois	15,000,000	71	80[b]	848,000,000
Iowa	14,400,000	59	75[c]	637,000,000
Minnesota	8,500,000	52	52[d]	229,000,000
		61	73	1,746,000,000

[a] Present cropland only considered.
[b] Yield estimate based on estimates given by McKenzie (3, 4).
[c] Yield estimate based on estimates by Shrader *et al.* (9) as applied to a 90 percent sample of Land Use Capability Classes I and II in the sample counties.
[d] Yield estimates based on information furnished by Dr. R. H. Rust, Department of Soils, University of Minnesota. Estimated average yields per acre are comparable with these for Iowa but recommended intensity of cropping is somewhat less.

SUB-REGION IMPLICATIONS

It is to be noted that highly favorable soils of the Central Prairie sub-region have an estimated corn production potential of 1.7 billion bushels, or about one-half of the total U. S. corn needs.

The estimated production potential for the Central Prairie sub-region is listed by states in Table 5.4. This table indicates the yield estimates used and the source of these estimates. This study indicates that the concentration of good corn land is highest in northern Illinois and next highest in northern Iowa. It appears that there is an enormous potential for expanded corn production in the Central Prairie sub-region.

The estimates given in Table 5.5 are for the entire Corn Belt. The estimates of acreage of good corn land are based primarily on the county summaries of land use capability classes which were available for most of the area. These acreage estimates are believed to be reasonably accurate. The estimates of yields for the various sub-regions are, in some cases, based on very limited information and should be considered only as general guides to the probable magnitude of potential production.

Table 5.5. Estimates of Corn-Producing Potentials of the Midland Feed Region Based on the Acreage of Land Use Capability Classes I and II

Sub-regions	Present corn production[a]		Land use capability		Potential corn production on land use capability		Estimated percent of U.S. needs (1960)
			Class I	Class II	Class I	Class II	
	Millions of bushels (1955)	Percent of U.S. production (1955)	Millions of acres	Percent of area	Yield per acre	Millions of bushels	
Prairie							
P. Central Prairie	900	25	24	61[b]	73	1750	46
W.P. Western Prairie	500	14	26	43[b]	40	1000	26
Prairie-Forest							
S.P.-F. Southern Prairie-Forest	100	3	6	13[c]	60	360	9
Forest							
E.F. Eastern Forest	400	11	17	57[b]	65	1100	29
N.F. Northern Forest	200	6	11	21[b]	40	400	11
Subtotals	2100	59				4610	121

[a] 1954 Federal Census.
[b] 20 percent sample of entire area (1/5 of counties, randomly selected).
[c] 20 percent sample of Kansas and Iowa, and 5 percent in Missouri (1/5 and 1/20 of all counties, randomly selected).

The Southern Prairie-Forest sub-region has an estimated corn production potential of 0.36 billion bushels. The Prairie-Forest sub-region includes an area of more than 55 counties in southern Iowa, northern Missouri and adjoining parts of Illinois. Though this study did not evaluate in adequate detail the effect of field size and shape, or efficiency of adapting the complex of new technology of corn production in the Southern Prairie sub-region, it seems that much of this sub-region would continue to be at a considerable disadvantage as regards efficiency of corn production. The lower estimated corn yields (60 bushels per acre) would also seem to indicate that corn production in the Southern Prairie-Forest sub-region would be at some efficiency disadvantage compared to the Central Prairie or Eastern Forest sub-regions.

The Western Prairie and Northern Forest sub-regions have a large potential increase, percentage-wise, in corn production. Low yields and also a smaller field size in the Northern sub-region would seem to indicate the complex of new technology would be less efficient in these sub-regions.

Yields in the Western Prairie sub-region can be markedly increased through irrigation. However, there is evidence (5, 8) that yields on the plains under irrigation average about the same as non-irrigated yields in Illinois, Indiana or Ohio. Therefore, it appears that on a purely competitive basis the Western Prairie sub-region is not as suitable a place to produce corn as in the eastern part of the region.

Soil and climatic conditions and the status of technology all favor the intensive production of corn in the 40 million acre Central Prairie sub-region of northern Iowa and northern Illinois, and the 26 million acre Eastern Forest sub-region of northern Indiana and Ohio. Existing information indicates that under conditions approaching maximum efficiency a total of approximately 3 billion bushels of corn could be produced annually in these two sub-regions.

It is highly unlikely that all of the best corn land in these regions will ever be used for corn or that corn production will be eliminated in the other areas, but it is possible that long-time trends in adjustments will tend in this direction.

LIMITATIONS

This study is very obviously made with incomplete data. Samples are missing from large portions of the area studied. Numerous assumptions are made which the authors consider to be valid but for which no rigid proof exists. It is, for example, assumed that land use capability classes 1 and 2 define in a general way the same areas as corn suitability classes A and B. Studies made on individual counties indicate that there is good agreement between these two estimates of land quality in the Central Prairie sub-region but poorer agreement in some of the other sub-regions.

In this paper no notice is taken of the corn production potential of the rest of the nation outside of the Corn Belt. Although several promising areas such as the Mississippi Delta and sections of the southeastern United States are known to exist, they were considered as being outside the range of this study.

IMPLICATIONS AND CONCLUSIONS

This study indicates (1) that if we are to arrive at a valid estimation of production potential for a crop, it must be made on the basis of soil survey information; (2) that the sampling technique used in this study offers promise for furnishing information on a regional basis of considerable accuracy and at a reasonable cost; (3) that the position of a soil on the landscape must be considered in evaluating its production potential; (4) that more complete and valid estimates of yields than are now available are needed and (5) that before such a study can be used as a basis for action it will be necessary to determine the present level of adoption of various technologies by farmers.

Incomplete though this study is, it does indicate that a very large potential for increased corn production exists within the Corn Belt and that the opportunities for increasing production without loss of efficiency are greatest in the Central Prairie and Eastern Forest sub-regions. It appears that at least 70 percent of the nation's needs for corn could be produced on the highly favored soil in these two sub-regions.

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